Hopton (CA2) Tunnel Alternatives Summary Report

24th April 2018

Contents

1 Summary Report

1.1 Overview

1.1.1 This summary report reviews the HS2 West Midlands to Crewe ('Phase 2a') route alignment as it passes Hopton Village, between Ingestre and Marston, which falls within Colwich to Yarlet Community Area 2 (CA2).

1.1.2 The summary report considers three alternative tunnel options (a short bored tunnel, a long bored tunnel and a short cut and cover tunnel) which have been assessed against the Proposed Scheme in terms of engineering, construction, environment and cost.

1.2 The Proposed Scheme

1.2.1 The Proposed Scheme (Option H1) in the section under consideration that passes by Hopton village approaches Ingestre on the Trent North embankment. The alignment then rises to follow an increase in ground elevation and cuts through Ingestre Park Golf course at a depth of up to 17m below existing ground surface, before passing to the south of the Staffordshire County Showground in a cutting. Due to the undulating topography, the alignment passes to the south of the main part of Hopton Village using a mixture of deep cuttings (at depths up to 17m) and embankments. Beyond Hopton village to the north-west, the Proposed Scheme is in a deep cutting. The scheme crosses under the diverted A5066 Sandon Road at grade, before entering another deep cutting and then follows the existing ground level past Marston Village. See Appendix A for the plan and long section of the Proposed Scheme.

1.2.2 The Proposed Scheme includes realignment of the A518 Weston Road, the raising of the B5066 Sandon Road and crossings of several unnamed watercourses. Railway systems requirements include equipment associated with power distribution, overhead line electrification, train control and telecommunications systems.

1.2.3 The Proposed Scheme requires demolition of 10 residential properties and one farm. There are visual, noise and amenity impacts in Hopton and Marston which have been assessed in the Environmental Statement. The Proposed Scheme involves some loss of land within Ingestre Park Golf Club and Staffordshire County Showground and some loss of agricultural land and holdings and of ecological habitat, including the southern part of Lionlodge Covert Local Wildlife Site. There is an effect on the historic landscape character in the area, on the setting of Ingestre Conservation Area (including Ingestre parkland) and a small number of listed buildings all of which have been assessed in the Environmental Statement.

1.2.4 The Proposed Scheme crosses a landfill in the location of Staffordshire County Showground which presents a risk from contamination. There will also be potential impacts on a number of watercourses and tributaries. Diversion or realignment of

local roads and public rights of way will result in some increased journey times. The Proposed Scheme will affect a strategic residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough in 2014.

1.2.5 Mitigation measures incorporated into the Proposed Scheme include partial compensation for the loss of ancient woodland, landscape planting and habitat creation. The design also ties the engineering earthworks for embankments and cuttings into their wider landscape context and mitigates views of structures and overhead line equipment from sensitive receptors where reasonably practicable. The provision of noise barriers and bunds are incorporated in the Proposed Scheme to avoid or reduce noise effects on residential and non-residential properties (including in Ingestre, Park Farm (Stafford), Hopton, Mount Edge and Marston).

1.2.6 Significant residual effects will remain during both the construction and operational phases of the railway. Save for the required property demolitions, the majority of these effects arise during the construction stage only and are therefore largely temporary in nature, lasting only for the duration of the construction works.

1.2.7 At the construction stage the residual effects include:

- Temporary loss of 135ha of 'best and most versatile' agricultural land (of which 100Ha will be required permanently).
- Demolition of 10 residential properties and one farm.
- Impacts on 7 agricultural holdings.
- Loss of historic buildings.
- Loss of 0.3 Ha of ancient woodland.
- In combination (noise and visual effects) at 33 residential properties.
- Traffic impacts.

1.2.8 At the operational stage the residual effects include:

- Loss of 100ha of best and most versatile agricultural land.
- In combination (noise and visual) effects at 78 residential properties.
- Impacts on the setting of Ingestre Conservation Area and landscape character.
- Loss of 800 parking spaces at the Staffordshire County Showground.
- Longer travel times for Bridleway and footpath diversions.

1.3 Short Bored Tunnel (Option H2)

1.3.1 The short tunnel option (Option H2) would run between a southern porous portal 150 m in length located 350m northwest of the A518 Weston Road (chainage 210+500) and it would emerge at a porous portal of 150m located 550m northwest of the B5066 Sandon Road (chainage 212+700). Between those two points, the railway would be in a 2.2 km long twin bored tunnel. The tunnel would pass under Hopton watercourse and B5066 Sandon Road: see Appendix B for plan and long section of Option H2.

1.3.2 The vertical track alignment of Option H2 would be 20m lower than the Proposed Scheme (H1). Ground improvement/ground treatment would be required to facilitate the tunnel boring at Hopton.

1.3.3 The increased track centre-to-centre spacing of 22metres in the tunnel would require greater land take and larger earthworks at the approaches to the tunnel portals. A main compound for tunnelling would be required close to the northern tunnel portal. Portal buildings and rescue areas would be located at each end of the tunnel structure with an appropriate access road.

1.3.4 Engineering benefits of Option H2 over the Proposed Scheme include:

- No requirement for the Hopton retaining wall and removal of the cuttings up to 17m in depth.
- Reduced surface works and surface level construction between the A518 Weston Road and B5066 Sandon Road together with a reduction in land take requirements for construction and operation.
- No diversion of B5066 Sandon Road.

1.3.5 By contrast, the engineering disbenefits of Option H2 compared with the Proposed Scheme include:

- A reduction in design speed of the railway in this location from 400kph to 360kph.
- Potential added complexities to construction (difficult tunnelling conditions at Hopton Fault) which would increase the construction risks and lengthen the construction programme.
- A requirement for pumping stations for tunnel low point drainage.
- Minor worsening for railway operations with respect to headways and owing to increased track gradients, minor increase in maintenance for the associated plant, moderate increase in auxiliary power demands and in the traction power loading owing to change in track gradient and air resistance encountered by the train operating through the tunnel section.

1.3.6 Option H2 would add very significant additional construction cost to the Proposed Scheme cost, namely an additional £231.91 million. This is due to costs associated with tunnel construction, as well as the additional requirements for track systems equipment. Further details of the additional construction costs are set out in the table below.

1.3.7 The environmental benefits of Option H2 over the Proposed Scheme would include:

- Reducing the need for surface works and surface level construction between the A518 Weston Road and B5066 Sandon Road, so reducing the number of residential demolitions from ten to six.
- A reduction in the amount of land required for construction and operation, resulting in reduced impacts on agricultural land and holdings and ecological habitat.
- A reduction in noise and visual impacts on properties at Hopton.
- A reduction in impacts on local landscape character, historic character and listed buildings in the area.
- A reduction in the need to divert/align local roads and public rights of way.
- A reduction in effects on the residential development site, between Hopton and Marston, identified within the adopted Plan for Stafford Borough 2014.

1.3.8 The environmental disbenefits of Option H2 over the Proposed Scheme include:

- Increases in localised noise, landscape and visual impacts around the tunnel portals during construction of those portals.
- Significantly greater number of HGV traffic movements during construction, which would increase the impact on the strategic and local road network.

1.3.9 Overall it is considered that Option H2 would result in a minor net improvement in residual environmental effects compared to the Proposed Scheme. This minor improvement would come at the additional construction cost of £231.91 million identified above.

1.4 Long Bored Tunnel (Option H3)

1.4.1 The long tunnel Option (Option H3) runs from 150m porous portal located west of the Great Haywood viaduct at Lionlodge Covert (chainage 207+250) and would emerge at a 150m porous portal located 750m northwest of the B5066 Sandon Road (chainage 212+900). Option H3 therefore extends 3.2 km further to the southeast than Option H2. It would comprise a 5.6km long twin bored tunnel, with 150m porous portals, a

ventilation shaft and associated infrastructure: see Appendix B for plans and long section of Option H3.

1.4.2 The alignment of Option H3 meets the requirement to provide clearance below the Trent Walk and Hanyards watercourses and is designed to address significantly rising ground beyond the Staffordshire County Showground.

1.4.3 The vertical track alignment would be up to 35m lower than the Proposed Scheme (H1). Ground improvement/ground treatment would be required to facilitate tunnel boring at Ingestre and Hopton. A single ventilation shaft would be required north of the A518 Weston Road.

1.4.4 The petition received from Jeremy Lefroy MP proposes a bored tunnel between Upper Hanyards Farm (chainage 208+800) and B5066 Sandon Road (chainage 212+200). This would theoretically involve a shorter length of tunnel than Option H3. However, Mr Lefroy's tunnel alignment is not practicable to construct. The southern portal location suggested would create an unacceptable vertical alignment for the railway, as the tunnel would need to pass under the Berryhill (south) watercourse and then emerge to the south to tie in with the remainder of the route, but without creating an unacceptable vertical alignment. In order to achieve the length of tunnelling suggested by Mr Lefroy, the southern portal would need to be located in the same location as that proposed under Option H3.

1.4.5 The northern portal location proposed by Mr Lefroy at the B5066 Sandon Road would still require the diversion of that highway. Given that one of Mr Lefroy's objectives is to avoid such a diversion, it would be necessary to move the northern portal further to the north of Sandon Road. This would result in the northern portal being positioned in a similar location to that proposed for the northern portal for Option H3.

1.4.6 The effect of these changes, which seek to optimise Mr Lefroy's proposal, is a tunnel option that corresponds to Option H3.

1.4.7 As for Option H2, Option H3 would require additional land take either side of the alignment, additional earthworks at tunnel portals and construction compounds for the tunnelling activity.

1.4.8 More physical equipment is needed in the longer tunnel under Option H3 than in Option H2. The configuration/nature of the equipment also differs slightly, because of the need for a tunnel ventilation shaft, and additional cross-passages, power supply, overhead line electrification, train communication equipment.

1.4.9 The engineering benefits and disbenefits of Option H3 over the Proposed Scheme are similar to those that would result from Option H2, save that there would be an engineering requirement for an increased area of construction around Lionlodge Covert LWS. There would be a moderate worsening for railway operations in terms of

headways and auxiliary power demands, a major worsening in traction power loading owing to tunnel air resistance and a minor increase in maintenance.

1.4.10 Option H3 would add a very significant additional construction cost to the Proposed Scheme cost, namely an additional £481.88 million. This is due to costs associated with tunnel construction, as well as additional requirements for track systems equipment. Further details of the additional construction costs are set out in the table below.

1.4.11 The environmental benefits and disbenefits of Option H3 over the Proposed Scheme include those resulting from H2. In addition, Option H3 would require no property demolitions and a reduced land take at Ingestre Park Golf Club and Staffordshire County Showground. Option H3 would significantly reduce the noise and visual impacts upon properties at and between Ingestre and Hopton.

1.4.12 Overall it is considered that Option H3 would result in a moderate net improvement in residual environmental effects compared to the Proposed Scheme. This moderate improvement would come at the additional construction cost of £481.88 million identified above.

1.5 Short Cut and Cover Tunnel (Option H4)

1.5.1 A short cut and cover tunnel option (Option H4) has been considered beginning at a 150m porous portal located 850m northwest of the A518 Weston Road (chainage 211+000) and emerging at a 150 porous portal located 50m northwest of the B5066 Sandon Road (chainage 212+200). The cut and cover tunnel would be 1.2km long: see Appendix B for plans and long section of Option H4.

1.5.2 Option H4 has been considered in light of the very high construction costs of Options H2 and H3. Option H4 has been designed with the objective of seeking to achieve operational noise benefits for both Hopton and Mount Edge.

1.5.3 The vertical track alignment of Option H4 would be 16m lower than the Proposed Scheme (H1). Permanent re-profiling of the ground, above the tunnel, would be required. A temporary realignment is required in crossing the Kingston Brook watercourse during construction at Hopton. However, the watercourse would be reinstated, above the tunnel, on its existing alignment.

1.5.4 Portal buildings and rescue areas would be located at each end of the tunnel structure with an appropriate access road. Option H4 does not require a combined ventilation and intervention shaft.

1.5.5 The engineering benefits of Option H4 over the Proposed Scheme include:

- No requirement for the retaining wall at Hopton.
- A small reduction in land required for construction and operation.

1.5.6 The engineering disbenefits of Option H4 over the Proposed Scheme include:

- Technical and construction complexities associated with the supported excavation depth of approximately 30m required over the deepest section of tunnel.
- An increase in mass haul and construction activity.
- Generation of a significantly greater number of HGV traffic movements during construction.
- A minor worsening in terms of railway operations because of effects on headways, a minor worsening in auxiliary power demand and maintenance requirements, and a moderate worsening in traction power loading owing to change in track gradient and tunnel air resistance.

1.5.7 Option H4 would add very significant additional construction cost to the Proposed Scheme cost, namely an additional £159.31 million. Further details of the additional construction costs are set out in the table below.

1.5.8 The environmental benefits of Option H4 over the Proposed Scheme are similar to those of the short bored tunnel, Option H2. The number of residential demolitions would reduce from 10 to 8 as compared with the Proposed Scheme.

1.5.9 The environmental disbenefits of Option H4 over the Proposed Scheme would include a requirement for additional land-take temporarily, and a temporary increase in noise and landscape and visual impacts resulting from additional surface works at Hopton. The tunnel depth would not be sufficient to reinstate the existing ground level, and would need to be re-landscaped, thereby creating an artificial mound.

1.5.10 Overall it is considered that Option H4 would not result in a significant net improvement in residual environmental effects compared to the Proposed Scheme. Construction of Option H4 would cost an additional £159.31 million in comparison with the Proposed Scheme.

1.6 Cost Comparison

1.6.1 A comparison of the estimated construction costs of the tunnel options (including the Proposed Scheme) discussed in this summary report is set out in the following detailed table below.

1.6.3 The table shows the cost differences of the Hopton Tunnel (Options H2, H3 and H4) compared to the Proposed Scheme. It should be noted that costs are likely to change following further design development.

Item	Proposed Scheme (£ million)	Option H2 (£ million)	Option H3 (£ million)	Option H4 (£ million)
Tunnels	0.00	135.18	313.62	70.49
Civil engineering (excluding earthworks)	95.89	100.94	77.58	92.06
Rail Systems	16.76	32.03	62.16	25.96
Indirect Costs	18.59	45.65	73.35	38.92
Sub-total: Construction & Indirect Costs:	131.24	313.80	526.71	227.43
Sub-total difference:		182.56	395.47	96.19
Earthworks (increase against Proposed Scheme)		8.51	-8.82	47.35
Land & Property (reduction against Proposed Scheme)		-12.30	-20.60	-1.30
Efficiency Adjustment		-12.72	-18.45	-28.45
Avoided design improvements required for Proposed Scheme		-0.40	-3.40	0.00
Total Difference:		165.65	344.20	113.79
Contingency (40%)		66.26	137.68	45.52
Total cost difference from Proposed Scheme:		231.91	481.88	159.31

Notes:

1. Tunnel costs include bored tunnels, cut & cover tunnels, shafts and portals,
2. Civil engineering costs include bridges, viaducts & other structures, roads and utility diversions,
3. Indirect Costs include HS2 corporate costs, project management, design development & insurances. They are calculated on a % basis,
4. Earthworks costs represent the cost increase in constructing each option: i.e. H2 (short bored tunnel), H3 (long bored tunnel) and H4 (cut & cover tunnel). The earthworks model considers re-use of excavated material, processing requirements, mass haul, disposal etc. These costs cannot be isolated for a specific section of route,
5. The cost shown for Land & Property represents the savings for avoided purchases and compensation costs associated with each option,
6. The Efficiency Adjustment represents expected opportunity cost savings associated with cut & cover tunnel, civil engineering, rail systems and indirect costs.
7. Contingency (40%) is consistent with the Proposed Scheme and is applied to the Total Difference,
8. All costs are stated at base date 1Q 2015.

1.7 Conclusion

1.7.1 The bored tunnel options (Options H2 and H3) would result in environmental and community benefits in comparison to the Proposed Scheme. Those benefits would be greater in the case of the longer tunnel (Option H3). However, bored tunnels are more complex and very significantly more costly to build. Tunnel working would also increase construction and maintenance risks.

1.7.2 Bored tunnels also result in operational disadvantages which increase in severity as the tunnel lengthens, with greater risk to reliable operation of the train service, in the case of the long tunnel option (H3).

1.7.3 The cut and cover tunnel option (Option H4) would result in greater adverse environmental effects during the construction in comparison with the Proposed Scheme. Option H4 would bring a reduction in adverse environmental and community effects in comparison with the Proposed Scheme during the operation of the railway.

1.7.4 All tunnel options would result during construction in an increase in excavated material and HGV movements on the highway.

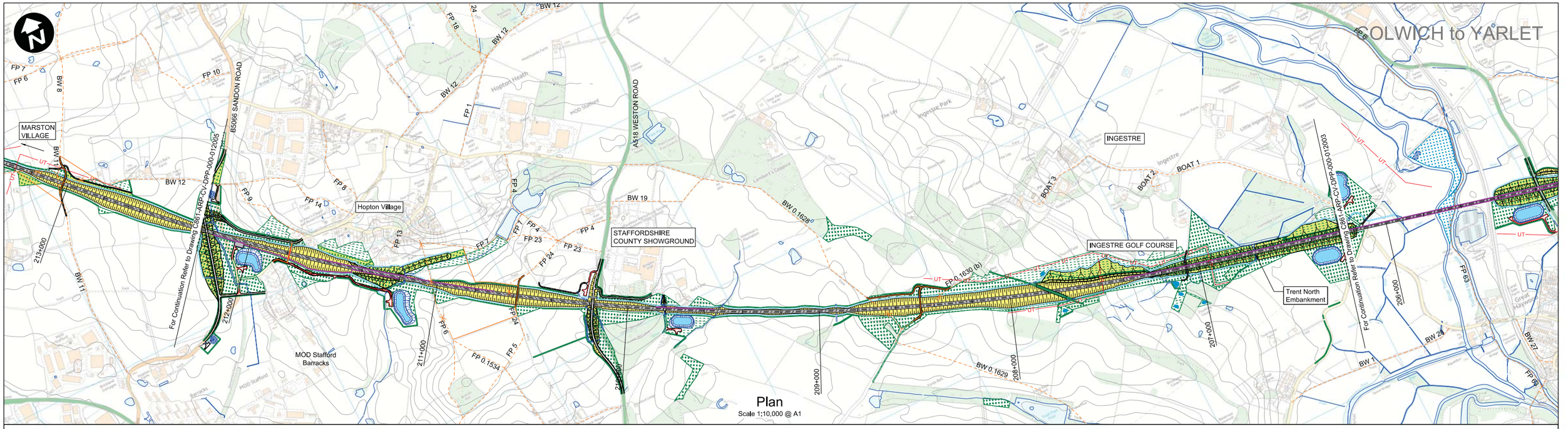
1.7.5 All three tunnel options considered would result in very significant additional construction costs in comparison to the Proposed Scheme.

Appendices

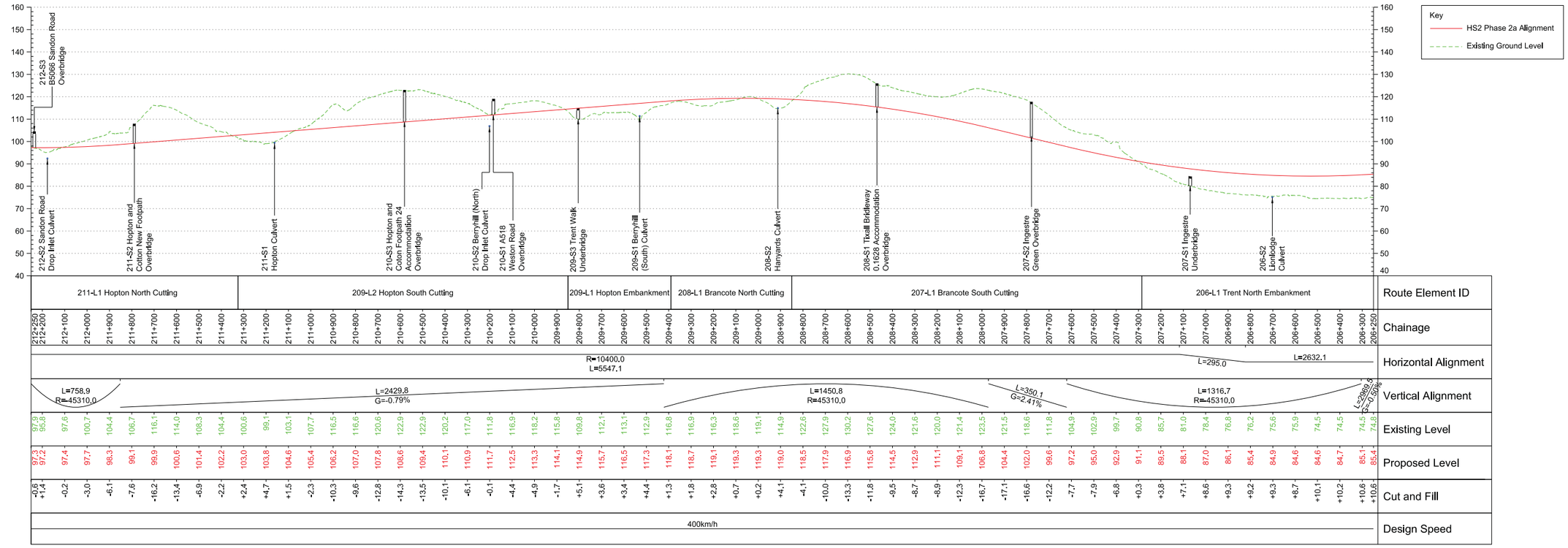
Appendix A – Proposed Scheme Plan

A.2 Plan and long section of Proposed Scheme (H1)

C861-ARP-CV-DPP-000-011004-P10



Plan
Scale 1:10,000 @ A1



Profile
Scale H:1:10,000 V:1:1000 @ A1

Fit for Acceptance

METRES @ 1:10000 — 0 100 200 500 1000

METRES @ 1:1000 — 0 10 20 50 100

Rev	Description	Drawn	Checked	Con App	HS2 App
P10	CP3 Interim Preliminary Design	JP 14/07/2017	SAO 13/07/2017	DE 13/07/2017	
P09	CP3 Interim Preliminary Design	JP 13/07/2017	SAO 12/07/2017	DE 12/07/2017	
P08	CP3 Interim Preliminary Design	RP 07/07/2017	SAO 07/07/2017	DE 07/07/2017	
P07	CP3 Interim Preliminary Design	RP 16/06/2017	CH 16/06/2017	DE 15/06/2017	
P06	CP2+ IDR Close Out Update Interim Preliminary Design	RP 23/03/2017	PM 22/03/2017	DE 22/03/2017	

Legends/Notes:

- Depot, station, headhouse or portal building
- Tunnel portal
- Electricity substation
- Land drainage area
- Ecological mitigation pond
- Balancing pond
- Replacement floodplain storage
- Woodland habitat creation
- Wetland habitat creation
- Grassland habitat creation
- Landscape mitigation planting (scrub / woodland)
- Grassed areas
- Sustainable placement
- Public realm/Replacement community facility
- Hedgerow habitat creation
- UT — Main utility works
- Engineering earthworks
- Landscape earthworks
- Rail alignment formation
- Returned to suitable development use
- County boundary
- Borough / District boundary
- Community Area boundary
- Watercourse diversion
- or — Existing watercourse
- Ditches - new
- Existing Woodland
- Existing Buildings
- Existing Inland Water
- 130.0m — Existing Contours
- HS2 Access road
- Noise fence barrier
- HS2 Mainline Rail alignment
- 10+000 — Chainage (e.g. 10+000)
- Existing public right of way (PRoW)
- New, diverted or realigned PRoW
- Stopped-up PRoW
- Tunnels external extent

Registered In England
Registration No. 06791686
Registered office:
2 Snow Hill,
Queensway,
Birmingham, B4 6GA

Creator/Originator
Ove Arup & Partners International Ltd

Zone	Route Wide
Design Stage	Hybrid Bill - Interim Preliminary Design
Drawing Title	Main Line Sheet 4 Chainage 206+250 to 212+250
Project/Contract	P2A Civils Design & Environmental Services
Discipline/Function	Civil
Drawn / Checked / Approved	NC / SAO / DE
Date / Scale / Size	05/01/2016 / AS SHOWN / A1
Drawing No. / Rev.	C861-ARP-CV-DPP-000-011004 / P10

Appendix B – Concept Plans for Alternative Tunnel Options

B.1 Combined plan for alternative tunnel options

C861-ARP-CV-DSK-000-00001

B.2 Plan and long section drawing for Short Bored Tunnel (H2)

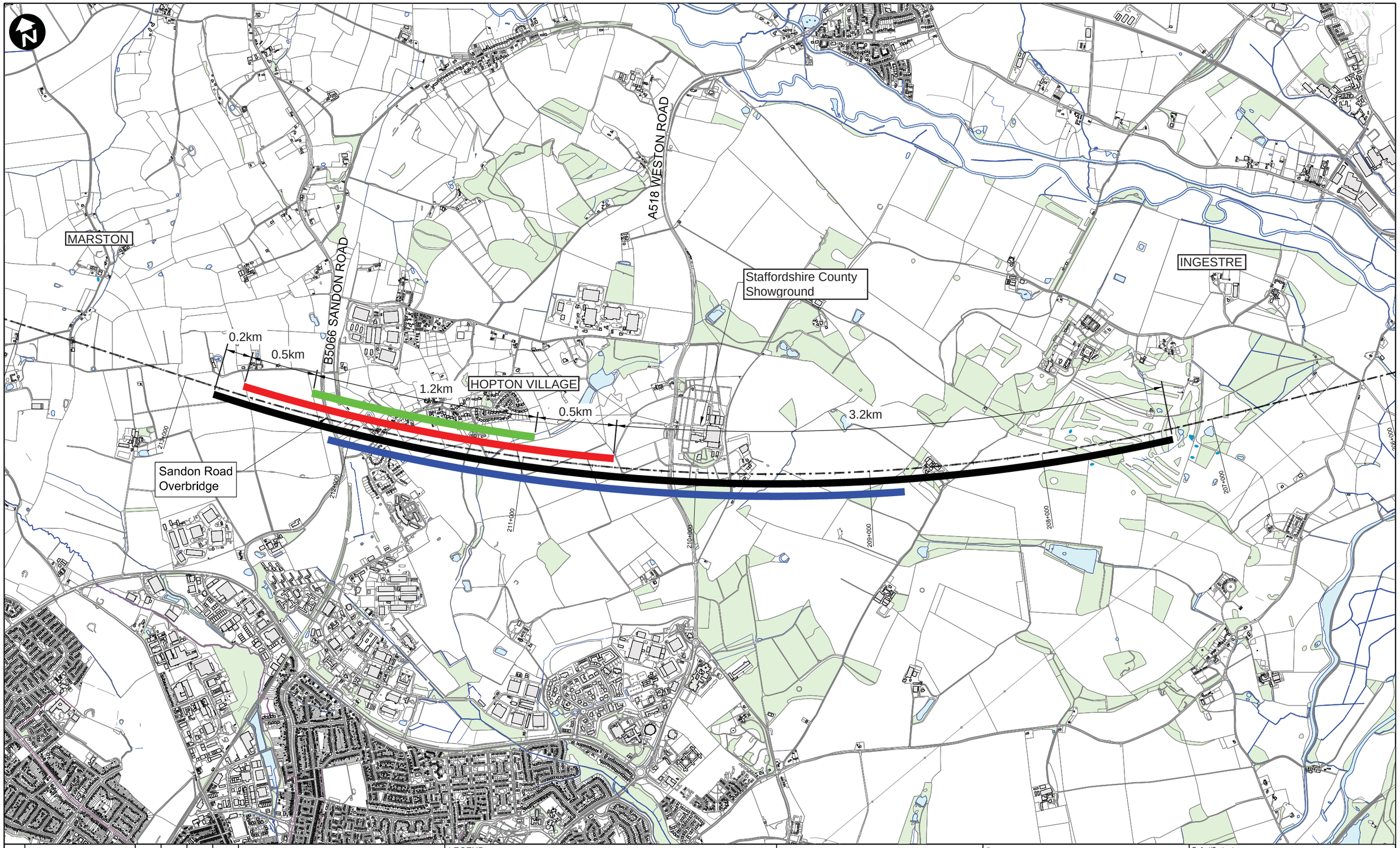
C861-ARP-CV-DSK-000-252102

B.3 Plan and long section drawing for Long Bored Tunnel (H3)

C861-ARP-CV-DSK-000-252103

B.4 Plan and long section drawing for Short Cut and Cover Tunnel (H4)

C861-ARP-CV-DSK-000-252104



Rev	Description	Drawn	Checked	Con App	HS2 App

Scale with caution as distortion can occur.

LEGEND

- Short Cut & Cover Tunnel (H4)
- Short Bored Tunnel (H2)
- Proposed Route (H1)
- Long Bored Tunnel (H3)
- Jeremy Lefroy (MP) Petition - Tunnel Option

Registered in England
Registration No. 06791686
Registered office:
2 Snow Hill,
Queensway,
Birmingham, B4 6GA

Creator/Originator
Ove Arup & Partners International Ltd

Zone: CA2

Design Stage: DESIGN FOR PETITION

Drawing Title: Ingestre to Marston

Alternative Tunnel Option

Project/Contract: P2A Civils Design & Environmental Services

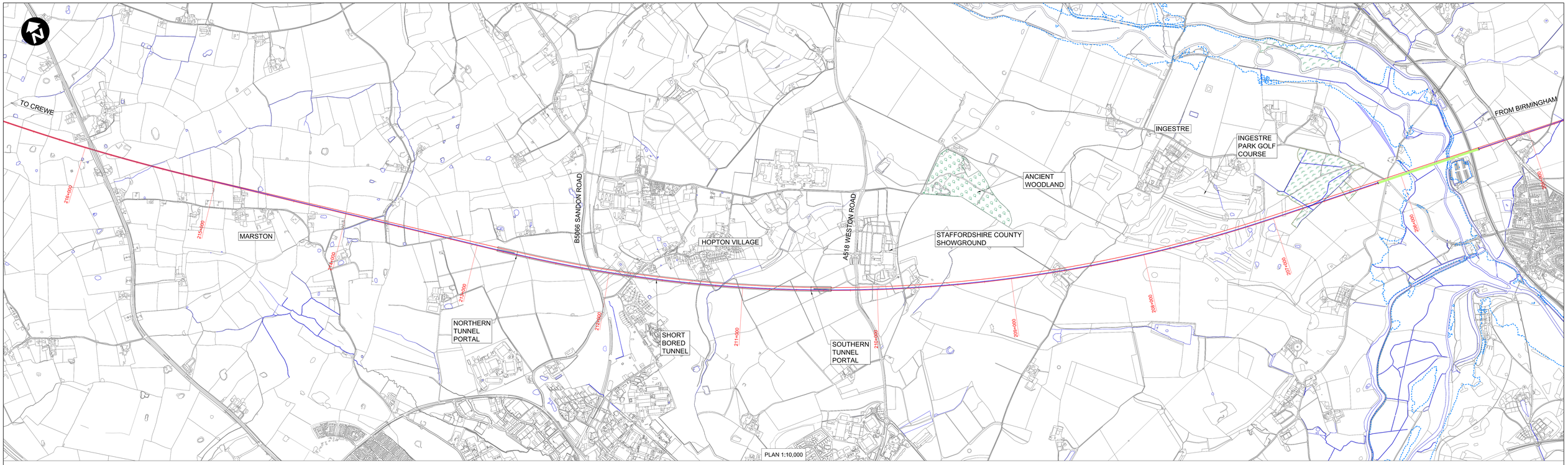
Discipline/Function: Highways

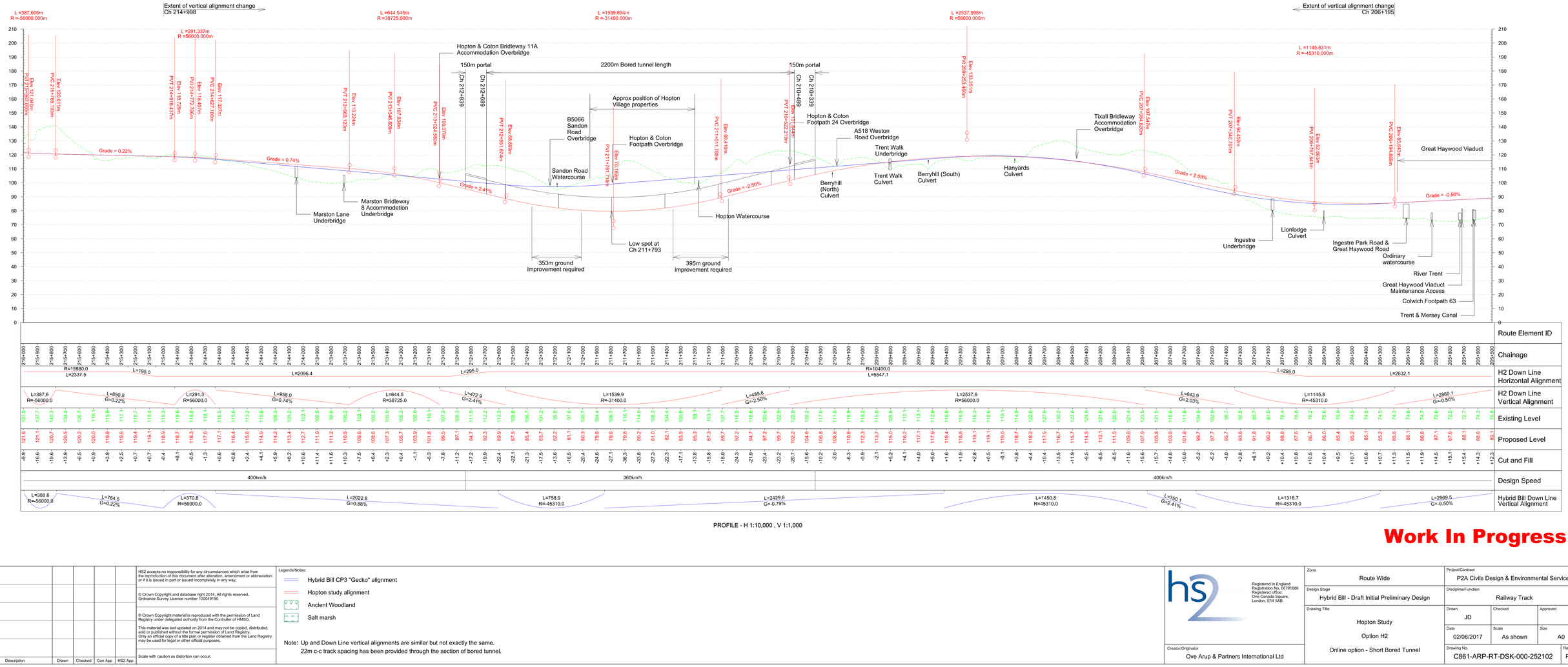
Drawn	Checked	Approved
DW	SG	DE

Date	Scale	Size
31/03/18	AS SHOWN	A3

Drawing No.: C861-ARP-CV-DSK-000-000001

Rev.: P00.1





PROFILE - H 1:10,000 , V 1:1,000

Work In Progress

Rev	Description	Drawn	Checked	Con App	HS2 App

Legends/Notes:

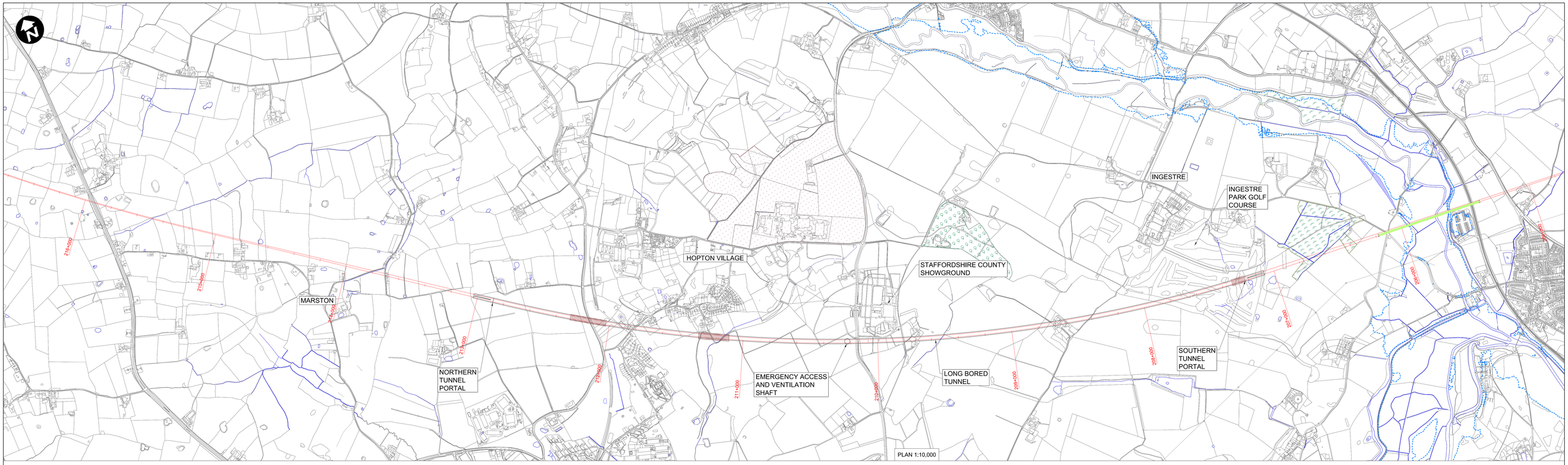
- Hybrid Bill CP3 "Gecko" alignment
- Hopton study alignment
- Ancient Woodland
- Salt marsh

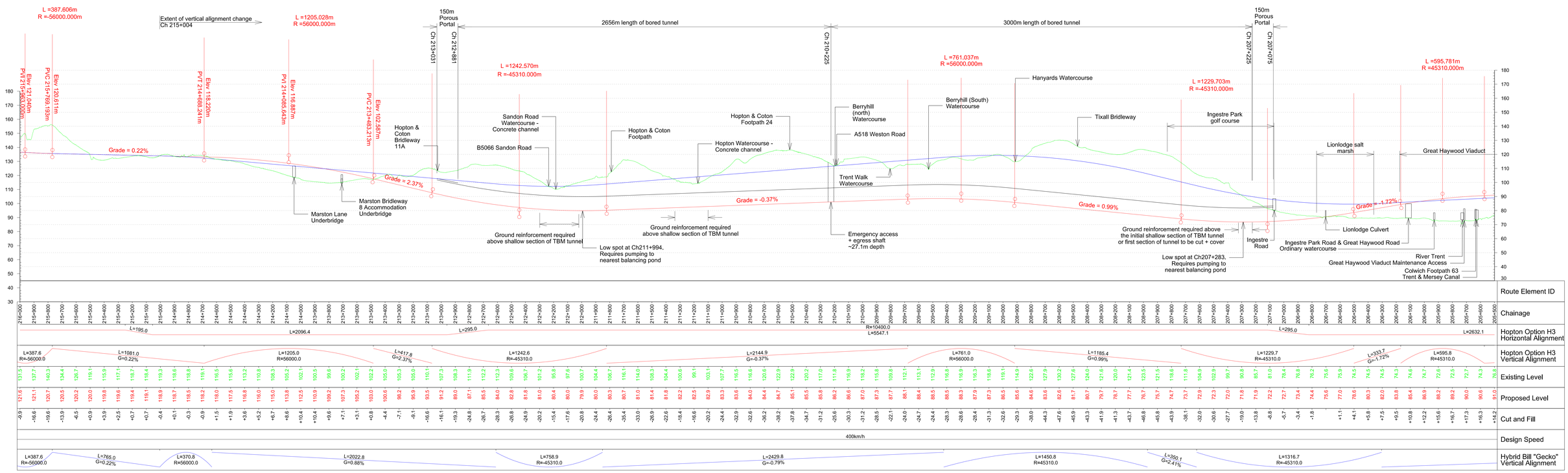
Note: Up and Down Line vertical alignments are similar but not exactly the same.
22m c-c track spacing has been provided through the section of bored tunnel.

Registered in England
Registration No. 06791686
Registered office:
One Canada Square,
London, E14 5AB

Creator/Originator
Ove Arup & Partners International Ltd

Zone	Route Wide
Design Stage	Hybrid Bill - Draft Initial Preliminary Design
Drawing Title	Hopton Study Option H2 Online option - Short Bored Tunnel
Project/Contract	P2A Civils Design & Environmental Services
Discipline/Function	Railway Track
Drawn	JD
Checked	
Approved	
Date	02/06/2017
Scale	As shown
Size	A0
Drawing No.	C861-ARP-RT-DSK-000-252102
Rev.	P00.1





PROFILE - H 1:10,000 , V 1:1,000

Work in Progress

Rev	Description	Drawn	Checked	Con App	HS2 App

Legends/Notes:

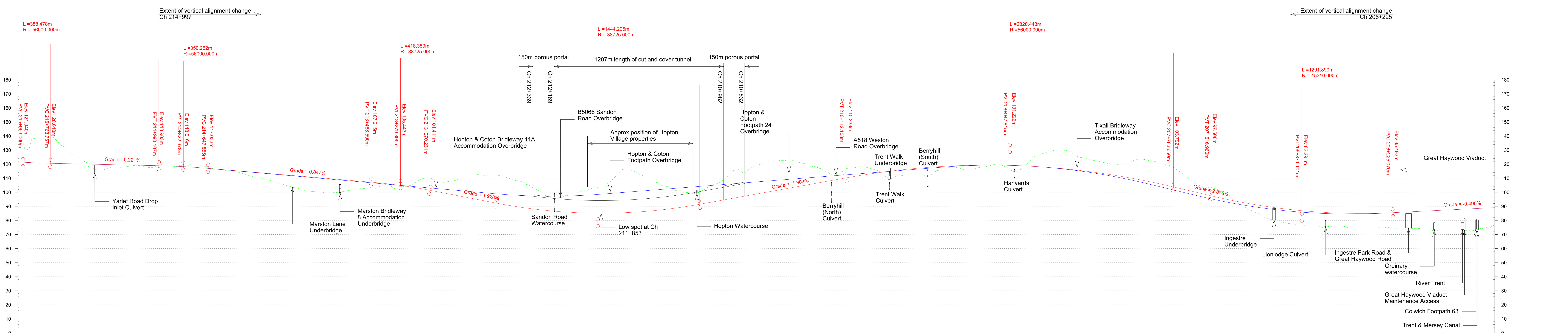
- Hybrid Bill CP3 "Gecko" allignment
- Hopton study allignment
- Ancient Woodland
- Salt Marsh
- Battlefield

Notes:
Up and Down Line vertical alignments are similar but not exactly the same.
22.0m c-c track spacing has been provided through the length of the tunnel.

Registered in England
Registration No. 06791686
Registered office:
2 Snow Hill,
Queensway,
Birmingham, B4 6GA

Creator/Originator: XXXXXXXXXXX

Zone	Route Wide
Design Stage	Hybrid Bill - Draft Initial Preliminary Design
Drawing Title	Hopton Study Option H3 Online option - Long Bored Tunnel
Project/Contract	P2A Civils Design & Environmental Services
Discipline/Function	Railway Track
Drawn	JD
Checked	
Approved	
Date	28/07/2017
Scale	As shown
Size	A0
Drawing No.	C861-ARP-RT-DSK-000-252103
Rev.	P00.1



Route Element ID

Chainage	Existing Level	Proposed Level	Cut and Fill
216+000	131.5	121.6	-9.9
215+900	137.7	121.1	-16.6
215+800	140.3	120.7	-19.6
215+700	134.4	120.5	-13.9
215+600	126.7	120.2	-6.5
215+500	119.1	120.0	+0.9
215+400	115.9	119.8	+3.9
215+300	117.1	119.6	+2.5
215+200	118.7	119.4	+0.7
215+100	118.4	119.1	+0.7
215+000	119.3	118.9	-0.4
214+900	118.6	118.6	
214+800	118.8	118.1	-0.7
214+700	119.1	117.4	-1.7
214+600	116.5	116.6	+0.1
214+500	115.6	115.8	+0.2
214+400	113.2	114.9	+1.7
214+300	110.8	114.1	+3.3
214+200	108.3	113.2	+4.9
214+100	105.2	112.4	+7.2
214+000	102.1	111.5	+9.4
213+900	100.5	110.7	+10.2
213+800	99.6	109.9	+10.3
213+700	100.2	109.0	+8.8
213+600	102.1	108.2	+6.1
213+500	102.2	107.3	+5.1
213+400	105.0	106.4	+1.4
213+300	105.3	105.2	-0.1
213+200	105.0	103.7	-1.3
213+100	110.1	102.0	-8.1
213+000	107.3	100.1	-7.2
212+900	108.3	98.1	-10.2
212+800	111.9	96.2	-15.7
212+700	112.2	94.3	-17.9
212+600	112.3	92.3	-20.0
212+500	109.6	90.5	-19.1
212+400	106.7	89.0	-17.7
212+300	101.2	87.7	-13.5
212+200	95.8	86.7	-9.1
212+100	97.6	85.9	-11.7
212+000	100.7	85.4	-15.3
211+900	104.4	85.2	-19.2
211+800	106.7	85.2	-21.5
211+700	116.1	85.4	-30.7
211+600	114.0	86.0	-28.0
211+500	108.3	86.8	-21.5
211+400	104.4	87.8	-16.6
211+300	100.6	89.1	-11.5
211+200	99.1	90.6	-8.5
211+100	103.1	92.4	-10.7
211+000	107.7	94.2	-13.5
210+900	116.5	96.0	-20.5
210+800	116.6	97.8	-18.8
210+700	120.6	99.6	-21.0
210+600	122.9	101.4	-21.5
210+500	122.9	103.2	-19.7
210+400	120.2	105.0	-15.2
210+300	117.0	106.8	-10.2
210+200	111.8	108.6	-3.2
210+100	116.9	110.5	-6.4
210+000	118.2	112.1	-6.1
209+900	115.8	113.7	-2.1
209+800	109.8	115.0	+5.2
209+700	112.1	116.1	+4.0
209+600	113.1	117.1	+4.0
209+500	112.9	117.9	+5.0
209+400	116.8	118.5	+1.7
209+300	116.9	119.0	+2.1
209+200	116.3	119.2	+2.9
209+100	118.6	119.3	+0.7
209+000	119.1	119.2	+0.1
208+900	114.9	119.0	+4.1
208+800	122.6	118.5	-4.1
208+700	127.9	117.9	-10.0
208+600	130.2	117.1	-13.1
208+500	127.6	116.1	-11.5
208+400	124.0	114.9	-9.1
208+300	121.6	113.6	-8.0
208+200	120.0	112.1	-7.9
208+100	121.4	110.4	-11.0
208+000	123.5	108.5	-15.0
207+900	121.5	106.4	-15.1
207+800	118.6	104.2	-14.4
207+700	111.8	101.8	-10.0
207+600	104.9	99.5	-5.4
207+500	102.9	97.1	-5.8
207+400	99.7	94.9	-4.8
207+300	90.8	92.9	+2.1
207+200	85.7	91.1	+5.4
207+100	81.0	89.6	+8.6
207+000	78.4	88.3	+9.9
206+900	76.8	87.2	+10.4
206+800	76.2	86.3	+10.1
206+700	75.6	85.6	+10.0
206+600	75.9	85.2	+9.3
206+500	74.5	85.0	+10.5
206+400	74.5	85.0	+10.5
206+300	74.5	85.2	+10.7
206+200	74.3	85.6	+11.3
206+100	74.6	86.1	+11.5
206+000	74.7	86.6	+11.9
205+900	72.6	87.1	+14.5
205+800	72.5	87.6	+15.1
205+700	72.7	88.1	+15.4
205+600	74.3	88.6	+14.3
205+500	76.8	89.1	+12.3

Hopton Option H4 Down Line Horizontal Alignment: R=15980.0 L=2337.5; L=195.0; L=2096.4; L=295.0; R=10400.0 L=5547.1; L=295.0; L=2632.1

Hopton Option H4 Down Line Vertical Alignment: L=388.5 R=-56000.0; L=770.7 G=0.221%; L=350.3 R=56000.0; L=1159.3 G=0.847%; L=418.4 R=38725.0; L=470.9 G=1.928%; L=1444.3 R=-38725.0; L=1042.9 G=-1.803%; L=2328.4 R=56000.0; L=266.7 G=2.356%; L=1291.9 R=-45310.0; L=2890.3 G=-0.496%

Design Speed: 400km/h; 360km/h; 400km/h

Hybrid Bill CP3 Down Line Vertical Alignment: L=388.6 R=-56000.0; L=764.5 G=0.221%; L=370.8 R=56000.0; L=2022.8 G=0.883%; L=758.9 R=-45310.0; L=2429.8 G=-0.792%; L=1450.8 R=45310.0; L=350.1 G=2.411%; L=1316.7 R=-45310.0; L=2969.5 G=-0.496%

PROFILE - H 1:10,000 , V 1:1,000

Work In Progress

Rev	Description	Drawn	Checked	Con App	HS2 App

Legends/Notes:

- Hybrid Bill CP3 "Gecko" alignment
- Hopton study alignment
- Ancient Woodland
- Salt Marsh

Note: Up and Down Line vertical alignments are similar but not exactly the same.
7.5m track separation provided through the section of cut + cover tunnel.

Registered in England Registration No. 06791686 Registered office: One Canada Square, London, E14 5AB

Zone: Route Wide
Design Stage: Hybrid Bill - Draft Initial Preliminary Design
Drawing Title: Hopton Study / Option H4 / Online option - Short Cut + Cover Tunnel
Creator/Originator: Ove Arup & Partners International Ltd
Project/Contract: P2A Civils Design & Environmental Services
Discipline/Function: Railway Track
Drawn: JD | Checked: | Approved:
Date: 07/06/2017 | Scale: As shown | Size: A0
Drawing No.: C861-ARP-RT-DSK-000-252104 | Rev.: P00.2