

Summary Report on extending Chilterns Tunnel to Liberty Lane

By REPA Engineering Team
for Potter Row Neighbourhood Watch Scheme (PRNWS)



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Summary Report for Potter Row Neighbourhood Watch Scheme (PRNWS).

Introduction

1. This report is by the REPA Engineering Team for the PRNWS.
2. REPA is the Residents' Environmental Protection Association with over 800 members centred on the communities of South Heath and Hyde Heath. It was formed in 2013 and has actively promoted a tunnel extension since its inception. In 2015 a 2.6km tunnel extension to South Heath was adopted, but this still left the north side of South Heath and all of Potter Row negatively impacted.
3. HS2 Ltd agree the engineering feasibility of a further short extension to the bored tunnel, and accept that it would have environmental benefits. But HS2 Ltd contend that the net costs of a further extension (of 1.5km to Leather Lane), that they put at £40m and we estimate at no extra cost, were disproportionate to the environmental benefits¹. This position was endorsed by the House of Commons Select Committee in their final report².
4. Using new information this report examines a slightly shorter 1km extension to Liberty Lane and assesses that HS2 Ltd have overestimated the costs and understated the benefits.

Overview

5. The proposal is to extend the Chilterns bored tunnel by one kilometre from South Heath to Liberty Lane. This gives it a better portal position –in engineering, environmental and community terms. The extension can be achieved at no extra cost and in the time currently allowed for the overall construction of the Chiltern Tunnel and assuming a tunnel boring rate of 80m/week (ie as assumed by HS2 Ltd).

Background and Summary

6. In 2014, REPA proposed extending the Chiltern tunnel from Mantles Wood to Liberty Lane. In its petition to the House of Commons (HoC), REPA proposed a further 0.5km extension to Leather Lane, when we became aware that this was practicable without affecting the viaduct at Wendover Dene. REPA has now reduced the length of its proposed extension back to Liberty Lane, as it is cheaper on HS2 Ltd's estimates (although we argue a net engineering saving) but still protects all the South Heath community, protects most of Potter Row, still protects Jenkins Wood, and avoids an additional adverse impact on Grims Ditch. It has clear advantages over a portal at South Heath, as currently proposed by HS2 Ltd.
7. In 2015, there was an extensive debate about the cost of boring and the rate of boring progress (the latter impacting more on a long tunnel extension than a short one) in the HoC. REPA gave evidence that the additional tunnel boring cost was about half what HS2 Ltd estimate (ie about £26k/metre compared to the HS2 Ltd figure of £48.5k/m), using the British Tunnelling Society (BTS) benchmarking study and identifying comparator tunnels. REPA also gave evidence using expert

¹ High Speed Rail London-West Midlands, SES3 and AP4 Environmental Statement, Volume 2, CFA9, October 2015, para 5.1.65

² "We heard that the Leather Lane extension would cost of the order of £40m on top of the South Heath option. We were not convinced that there would be significant environmental benefit. Our view was that it was not justified" (para 129) HoC Select Committee. Second Special Report of Session 2015-16. 22 February 2016

witnesses that both the rate of tunnel progress at 80m week and the fit out rates were overly conservative.

8. HS2 Ltd estimated that the extension to Leather Lane (1.5km further on) cost £40m extra, while REPA contended that there was a net saving. The HS2 Ltd £40m net cost becomes about £25m for the shorter extension to Liberty Lane (assuming adjustments to the Leather Lane figures). Both the £40m and £25m figures exclude a further £11m that HS2 Ltd now say must be added for additional spoil movements.
9. In the 2016, REPA asked OTB Engineering to review our proposals and our bored tunnel costings. OTB conducted their own independent cost assessment and their 'best estimate' (£22.3k/m) was lower than our figure (£26k/m). OTB's Report also showed an adjusted 'best estimate' (£25.7k/m) assuming the HS2 Ltd rate of progress of 80m/week. **So using either the REPA benchmarking figure (£26.4k/m) or the OTB figures, the change in tunnelling costs alone is sufficient to virtually eliminate the net cost figure claimed by HS2 Ltd.**
10. In 2016 REPA also did new work on the spoil strategy. First, demonstrating that National Policy Statement for National Networks on waste generation and disposal has not been followed (as the tunnel extension reduces cutting spoil production and would be environmentally preferable to an open cutting, and that adverse effects on landfill capacity have not been avoided). Secondly, showing that HS2 Ltd's cost estimate for reducing spoil generation are incorrect (as they neither correctly account for the reduced movement of spoil, nor the reduction in landfill charges).
11. Far from the extra tunnelling resulting in a higher net transportation cost (the further £11m claimed by HS2 Ltd), transport costs and landfill charges both enjoy substantial savings (£21m). This is unsurprising as HS2 Ltd's plans involve large quantities of spoil going to landfill, some of which is planned to travel long distances by road. **Taking advantage of the reduction in spoil generated, we estimate that the revised costs of disposal by themselves eliminate the net cost claimed by HS2.**
12. REPA representatives, with their MP, Cheryl Gillan, met with HS2 Ltd in September 2016 to discuss aspects of this latest proposal. This report is being sent to HS2 Ltd, including the accompanying Annex that provides a review by OTB, as discussed at our meeting.

Proposal

13. Technically the proposal is to extend the tunnel from 47.200 to 48.200 (excluding the porous portals), so that the northern section of the Chiltern tunnel emerges near the highest surface point, at Liberty Lane, rather than part way up the hill at South Heath. The northern part of the tunnel will have a lower gradient, the tracks will converge on the current vertical alignment quickly (as HS2 Ltd's gradient is downhill northwards from 48.350) and they will converge horizontally before the Grims ditch (ancient monument) is reached.
14. HS2 Ltd assessed the tunnel end point at 48.300 rather than 48.200 (although the topography would seem to favour 48,200, as Chart 2 indicates)
15. Key aspects of this proposal are displayed in the two charts below, and discussed under three heads:
 - the community benefits;
 - the environmental benefits;
 - the engineering benefits

Chart 1: Current and proposed location for extended tunnel with haul road and access options

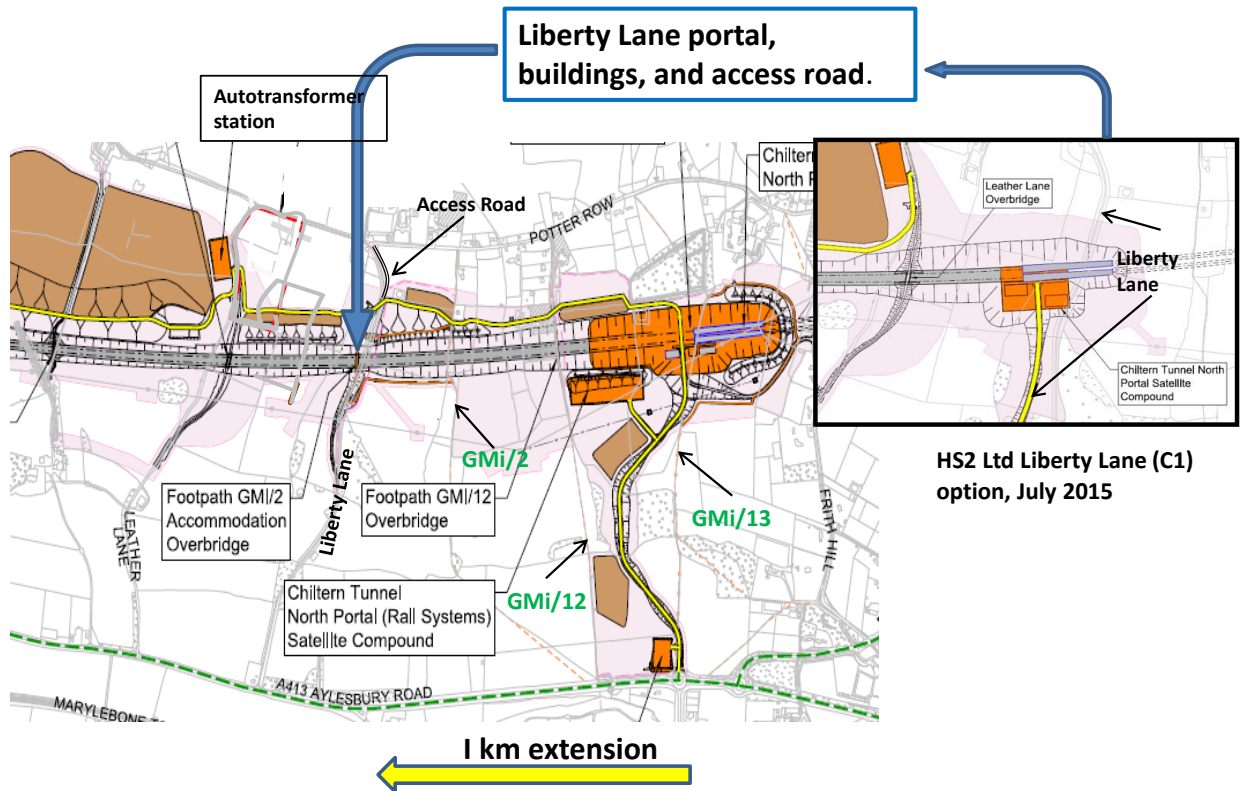
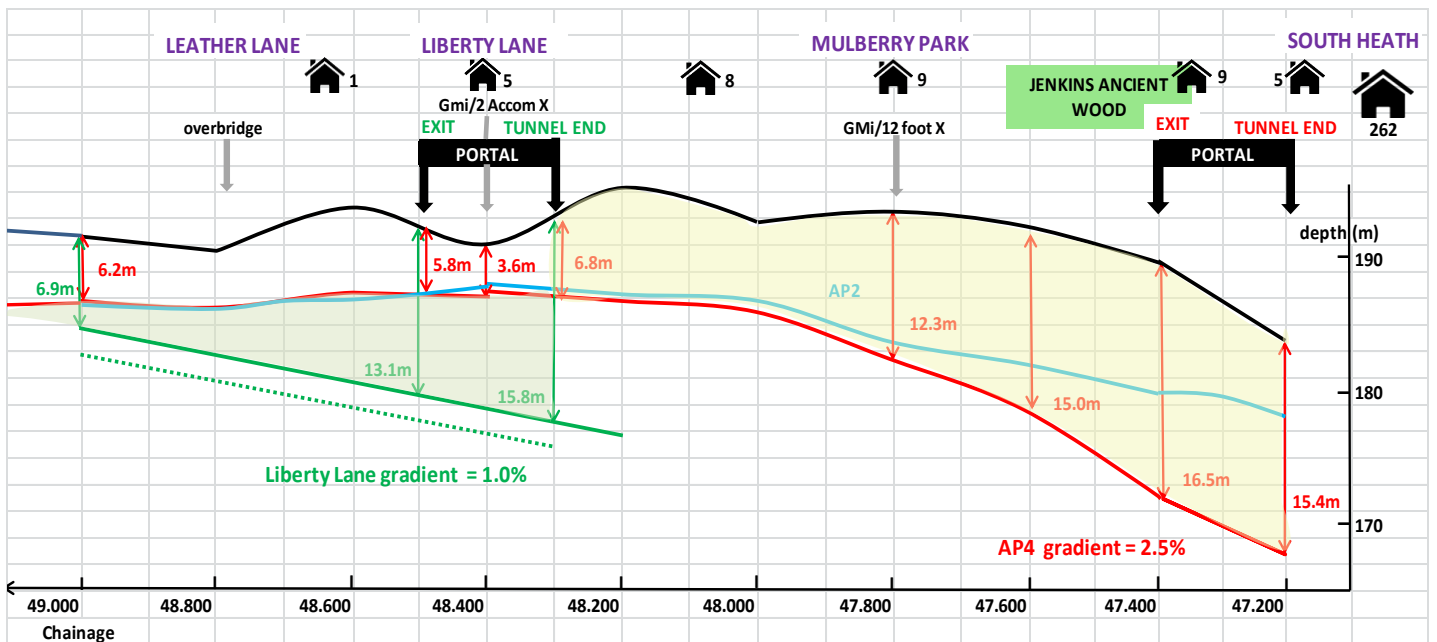


Chart 2: Current and proposed location showing property, depths, gradient and spoil extraction



Community benefits

- Currently 334 properties are subject to property blight (being within 1km of the South Heath portal). This would reduce to just 36, so protecting the majority of the community. Chart 2 shows the distribution of the Potter Row properties (and the South Heath totals). One Potter Row home (at Mulberry Park) with its 5 adjacent outbuildings would not need to be demolished.
- The tunnel would extend 1km further from South Heath, with the result that the noise impacts of the operational railway would be eliminated for South Heath, and the construction noise impacts would be reduced. The majority of Potter Row would also gain. Over 140 properties would benefit especially at night-time, when despite mitigation, they currently are modelled to exceed the noise threshold above which there is an adverse effect. Under 20 of the 140 would remain above the night-time L_{max} LOAEL.

Environmental benefits

- An additional 1km of the AONB would be protected (including the ancient woodland Jenkins Wood, that is currently about 25m from a deep cutting). Much of the Potter Row historic landscape and archaeology would also be undisturbed.
- The need for pylon changes would be removed
- Footpaths would be little affected, even if the haul road is not moved (see Chart 1).
- Less spoil would need to be stored at Hunts Green, as less cutting spoil would be excavated (see the green shaded area on Chart 2, which implies a much smaller volume than the AP4 yellow shaded area that would not need to be excavated by a cutting, were the tunnel to be extended).

Engineering requirements and benefits

- The tunnel would have a gradient of 1% (or slightly less) for the approach to the Liberty Lane north portal (compared to 2.5% at the South Heath portal), emerging at the top of the hill:
 - This is better for safety, as confirmed by HS2 Ltd
 - The 1% gradient is within HS2 Ltd's specification for the '*maximum desirable gradient at 1.5% with a maximum limiting gradient of 2.5%*'³
- The ground level at 48.200 (Liberty Lane) is relatively high and over 12m higher than at the South Heath portal, so
 - Less extensive and expensive excavation is required (because the REPA tunnel end point would be only 11.5m below the HS2 Ltd alignment, and the topography means that HS2 Ltd's proposal is turning towards the REPA alignment, as shown by Chart 2
 - Lesser water drainage issues
 - Any threat of drying out Jenkins Wood that is very close to the deep cutting is removed
- The REPA track separation (with the portal at Liberty Lane) would return to the standard separation before reaching Grim's Ditch (at 49.350), so it has no greater impact than HS2 Ltd's current proposals.
- Access to the portal for construction could be achieved, as Chart 1 shows, either
 - Via the currently proposed haul road off the A413 Great Missenden Link Road roundabout and then along the trace of the tunnel from South Heath; or

³ FOI16-1583 to Mr Griffiths, 17 October 2016

- Via a new haul road between Liberty Lane and Leather Lane to the A413 (as originally suggested by HS2 Ltd in July 2015) and as is being petitioned in the HoL by BCC and GMPC). This would avoid disturbance to the footpaths from Great Missenden to the Chiltern Ridges, and help reduce traffic and safety concerns at the GM roundabout.

The principal advantage of keeping the existing haul road is that it avoids the HS2 Ltd objection that it is now too late to move it using a Transport & Works Act Order (TWAO), but gives sufficient time to progress a TWAO for the changed works (eg tunnel, portal buildings etc).

- Permanent portal access during operations could be achieved onto Potter Row (the Liberty Lane section that joins onto Potter Row is already safeguarded). Other options exist (see Chart 1).
- The fit out compound would be sited further north, potentially on land already safeguarded between Liberty Lane and Leather Lane. If the Haul Road were moved it would be next to it.

Discussion

Costs

16. REPA estimate that extending the tunnel by 1km will make a net saving over HS2 Ltd’s current proposals. Table 3 (at the end of this section) shows various basis on which we have assessed the costs (in columns (f),(g) and (h)).

Tunnelling

17. The net costs break down into 4 main elements: extra boring costs, civils savings; extra system costs (for fit out); and land and property savings. The most contentious of these is the boring costs, about which REPA believe that HS2 Ltd’s estimates were about twice what they should be. REPA’s tunnel boring figures were based on comparator tunnels from the BTS benchmark study (done for the Treasury). To gain an independent authoritative assessment, REPA asked OTB Engineering to conduct an independent costing. David Hindle, an OTB Director, was directly involved in the original study. See Appendix 1 for their assessment.
18. The results are compared to the latest HS2 Ltd estimates (derived from those provided to the HoC Select Committee). The OTB independent estimates for boring costs are slightly lower than REPA’s own estimates, even when their estimate is adjusted to assume a rate of progress of only 80m/week (which is the HS2 Ltd assumption).

Table 1: Tunnel boring cost estimates

Extra construction cost	HS2 Ltd latest estimate (17 Sept 2015)	REPA estimate (using BTS benchmarking study)	OTB independent ‘best estimate’	OTB ‘best estimate’ (but with 80m/week rate of progress)
Rate per metre (for boring)	£48.5k/m (2011 Q2)	£26.4k/m (2010)	£22.3k/m (current cost)	£25.7k/m (current cost)

19. If the marginally higher REPA estimate (£26.4k/m) is used and all other costs remain derived from HS2 Ltd’s estimates, then the net cost is virtually eliminated (column f in Table 3), ie giving a £7.6m cost for a 1km extension. Were the lower OTB estimate of £22.3k/m used, the total net cost would be just £3.6m.

Civil engineering

20. Civils savings are strongly influenced by the cuttings figure (for excavating, storing, moving to environmental works) the landscaping figure, and the cost of transportation of any surplus offsite. The tunnel will replace one kilometre of cuttings, but the cutting north of the Liberty Lane tunnel end will be wider and deeper than HS2 Ltd's cutting.
21. Appendix 2 explains the position on waste in more detail. There are policy concerns about the waste disposal plans as well as about the costs that have been proposed.

HS2's position on spoil movements and REPAs alternative

22. HS2 Ltd have said that extending the tunnel by the additional 1km would result in 650km³ of material currently excavated from the portal and South Heath cutting not being available for export to near Aylesbury, and as a result spoil excavated in London would need to be expensively diverted to near Aylesbury to make up the shortfall: this diversion would cost an additional £11M (in addition to the figures provided to REPA and the HoC Select Committee last year).
23. There is a material reduction in the total spoil produced, with the additional tunnel arisings at the M25 portal being far less than excavated deep cuttings spoil from the South Heath area). As a result less material needs to be taken to landfill.
24. REPA believe that exploiting the savings inherent in producing less spoil and sending less to landfill not only does not cost £11m extra but results in a saving of just over £21m.
25. The situation on spoil balances is that HS2 overall produces a surplus of the type of material that would be produced from the South Heath cutting. The HS2 AP4 ES Waste and Material resources section Table 1d tells us there is an overall surplus of 18.7Mt, of which 9.9Mt is of the type of material from South Heath. Of this overall surplus 12.5Mt goes to landfill, of which 4 Mt (2M m³) of the South Heath type of material or substitutable material is known, from the ES, to go to landfill.
26. Focusing on London, there is a surplus of about 4Mt of material suitable for the Aylesbury use which is intended to be moved by road, of which 2 Mt (1M m³) is produced from Euston. The ES says that this last material is intended to be taken to landfill via the M25 and north up the M1, probably to be taken to non-hazardous landfill at Bletchley or Calvert. Alternative landfill capacity in Surrey would involve a longer road journey.
27. The 0.38 Mm³ of extra material arising from the Chiltern Tunnel for AP4 (at the M25 end) is assumed by HS2 Ltd to be removed by road. This would become 0.53 Mm³ if the tunnel is extended by 1km, as we propose. Once treated this is also substitutable material, however HS2 Ltd plan for it to be transported off site by road to landfill, probably via the M25.
28. The alternative approach that REPA recommend is that the tunnel is extended, overall waste is reduced, and the shortfall of waste in the Aylesbury area is provided by diverting waste from London to Aylesbury that is currently planned to be taken by road from London to more distant landfill. This would save money in transportation costs and landfill charges.
29. The arisings from the Chilterns Tunnel surplus to the requirements for local mitigation could be placed on the M25 site in sustainable placement. Currently, as Table 3 shows, it is assumed to cost just under £2m to take it away.

Non-compliance with NPSNN policy

30. National Policy Statement for National Networks (NPSNN) sets out policy on waste disposal. Because consent for HS2 is via the hybrid bill, HS2 does not have to comply with NPSNN, although it is unlikely that Parliament would expect lesser environmental standards to be applied.
31. NPNN Section 5.42 requires the Promoter to **minimise** the volume of waste produced and the volume sent to landfill (which in this case would be achieved by more tunnelling) unless the alternative (in this case the current scheme in deep cuttings) is the best overall environmental outcome. The policy statement also requires the Secretary of State to satisfy himself that adequate steps have been taken to minimise the volume of waste arising and sent to landfill and to satisfy himself that such waste arisings do not have an adverse effect on the capacity of existing waste management facilities.
32. The total quantum of waste intended for landfill are significant (14Mt) and greatly exceed the ES levels (4.5Mt) that HS2 Ltd had had assessed as broadly reasonable in 2013. They are also large in the context of available landfill capacity and so would have an adverse effect on the capacity available.
33. In the context of NPSNN, it seems reasonable that spoil should not be taken to landfill from the M25 portal, but that any spoil additional to the requirements of environmental mitigation should be sustainably placed there, avoiding both lorry movements and landfill capacity consumption.

Effect on cost

34. HS2 Ltd estimated the cost of excavation savings to be £14.25M (September 2015) for extending the tunnel to Leather Lane from South Heath. This implies a saving of £9.9M for extending to Liberty Lane. However this estimated saving would be reduced by £11m for the additional transport cost for sourcing the Aylesbury spoil from London by HS2 Ltd. (See Table 3 columns (d) and(e).
35. Because spoil could be diverted from longer road journeys from London in reality there could be a substantial saving in road transport costs and landfill charges. We estimate these savings to total to a further £21M. See Table 2 below.

Table 2: Transportation and Landfill costs

	distance (miles)	volume (Mm ³)	unit cost (£/m ³)	HS2 Ltd (£M)	REPA (£M)	Notes
South Heath cutting to Aylesbury	8	0.65	10.00		-6.50	current quoted cost
London to Aylesbury	50	0.65	14.00		-9.10	current quoted cost
London to landfill	50	0.65	14.00		9.10	current quoted cost (assume displace longest)
Landfill charges		0.65	20.00		-13.00	
Landfill tax		0.65	2.65		-1.72	
total (£M)				11	-21.22	

36. We have used the HS2 Ltd figure of 0.65Mm³ as the volume of spoil that would not be excavated from the South Heath cutting if the bored tunnel is extended by 1 km, which is the volume HS2 Ltd say would no longer be available for transportation from South Heath for environmental mitigation near Aylesbury. The actual reduction in spoil excavated may be greater, so the excavation, transportation and landfill savings would be larger. Using 0.65Mm³ gives the smallest possible savings: in reality the savings might be substantially more.

37. On the basis of a 0.65Mm³ reduction in spoil needing to be taken to landfill, the costs of disposal (in Table 2) by themselves (ie taking all other costs on an HS2 Ltd basis – including tunnel boring), eliminate the net cost claimed by HS2 for a tunnel extension. (See Table 3 column (g).)
38. In addition to the savings in Table 2 above, there are further savings in excavation costs. In July 2015, HS2 Ltd estimated the excavation cost saving to Liberty Lane to be just £4.4M. Even if the reduction in excavated volume is only 0.65Mm³, this would save £14.3M at £22/m³ (the average stated to apply to the South Heath cuttings).
39. Table 3 below shows various ways of summing the costs. **It shows that either correcting the assessment of spoil disposal costs (col g) or of tunnel boring (col f) are sufficient individually to almost wholly off-set HS2 Ltd's estimated net cost of the tunnel extension.** In combination, and taking other matters into account (eg the underestimate of excavation costs), the net saving is considerable from extending the tunnel – some £30m (col h)

Table 3: Summary of HS2 Ltd costs and REPA costs

Extension to:	HS2 Ltd cost estimates (£M)				REPA cost estimates (£M)			Notes
	Leather Lane	Leather Lane	Leather Lane	Liberty Lane	Liberty Lane	Liberty Lane	Liberty Lane	
Basis:	C5 - C6	C5 - C6	C5 - C6	C1 - C6	C1 - C6	C1 - C6	C1 - C6	
C6 = South Heath: 47.205 C1 = Liberty Lane: 48.300 C5 = Leather Lane: 48.740	HS2 Ltd 21 July 2015	HS2 Ltd 1 Sept 2015	HS2 Ltd 17th Sept 2015	HS2 Ltd C1 assumptions (prorated from HS2 Ltd data)	Adjusted for tunnel cost (REPA benchmarking) ONLY	Adjusted for alternative spoil scheme (for moving 650km3) ONLY	Adjusted for OTB Report (& 80m/wk), cuttings cost (at £22m3), and spoil scheme	
Extra kms:	1.54	1.54	1.54	1.10	1.00	1.00	1.00	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Land & Property	-£13.1	£0.0	-£13.1	-£13.1	-£13.1	-£13.1	-£13.1	Still excludes any effect of blighted resale values
Tunnel cost	£66.8	£76.6	£76.6	£54.6	£27.8	£49.9	£27.1	
Bored Tunnel (BT)	£65.1	£74.4	£74.4	£53.1	£26.4	£48.5	£25.7	HS2 Ltd BT = £48.5k/m; REPA BT = £26.4k/m; OTB BT = £22.3k/m adjusted to £25.7k/m for 80m/wk progress
Green Tunnel (GT)	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	
Portals	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	
Shafts	-£0.6	-£0.1	-£0.1	-£0.1	-£0.1	-£0.1	-£0.1	
Extra Disposal	£2.3	£2.3	£2.3	£1.6	£1.5	£1.5	£1.5	
Civils	-£10.6	-£31.9	-£31.9	-£23.7	-£23.7	-£23.7	-£28.1	
Cuttings	-£8.1	-£14.3	-£14.3	-£9.9	-£9.9	-£9.9	-£14.3	assumes 650km3 at £22m3
Landscape	-£0.6	-£5.8	-£5.8	-£5.5	-£5.5	-£5.5	-£5.5	
Embankments	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	
Env mitigation	-£1.1	-£2.3	-£2.3	-£1.9	-£1.9	-£1.9	-£1.9	
Bridges	-£3.9	-£5.1	-£5.1	-£2.6	-£2.6	-£2.6	-£2.6	
Highways	£0.0	-£1.2	-£1.2	-£1.2	-£1.2	-£1.2	-£1.2	
Other	£0.33	-£3.1	-£3.1	-£2.7	-£2.7	-£2.7	-£2.7	
Extended Prelims	£2.6	£0.0	£0.0	£0.0	£0.0	£0.0	£0.0	
Railway systems	£3.3	£5.1	£5.0	£5.0	£5.0	£5.0	£5.0	
Sub total	£59.5	£49.8	£49.7	£35.9	£9.1	£31.2	£4.0	
indirect	£10.2	£9.0	£8.9	£6.4	£1.6	£5.5	£0.7	based on 17.8% of eng cost
less ecp/VE	-£5.1	-£5.6	-£5.5	-£4.0	-£1.0	-£3.5	-£0.4	based on 11.1% eng. cost
Interim Total	£51.5	£53.1	£39.9	£25.2	-£3.4	£20.1	-£8.9	
HS2 Ltd Jan 2016 Adj. for road & rail transport, spoil disposal excl. landfill fees & tax			£11.0	£11.0	£11.0			Assumes 650km3 spoil transported to Aylesbury from Ruislip via Calvert
REPA scheme Adj for road transport & spoil disposal incl. Landfill fees & tax.						-£21.2	-£21.2	Assumes different spoil scheme for moving 650km3 of spoil to Aylesbury
Total	£51.5	£53.1	£50.9	£36.2	£7.6	-£1.1	-£30.1	

Other costs

40. Although in comparison with those to Leather lane the cost to Liberty lane seems high, REPA have used HS2 Ltd estimates.
41. The land and property figures make no allowance for the voluntary compensation schemes (on the basis the properties will be bought and then later resold). However no allowance has been made for any final reduction in value due to other properties proximity to HS2 Ltd. A heavily redacted report received under FOI suggests it might be 15% in this area. A number of high value houses (besides those bought by HS2 Ltd) are in the area where the discount can be expected to be greater.

Haul road

42. Ideally the haul road specified in AP4 would be revised to provide access from the A413 nearer to our proposed Liberty Lane portal and north of the Great Missenden Link Road. Following their assurances in October 2015, this matter has been discussed this for a year, and HS2 Ltd now say that there is no longer time to achieve a Transport and Works Act Order (TWAO) before the time that HS2 Ltd have scheduled for constructing the haul road. However, it would be practicable to still use the AP4 haul road to access the trace at South Heath and reach the portal and associated worksites (ie at Leather lane) via the trace route, were the tunnel extended to Liberty Lane. The haul road arrangements themselves therefore require no revision to give access to the compounds for the Liberty Lane portal.
43. The permanent access to a Liberty Lane portal is most naturally from Potter Row, but there is no urgency in obtaining planning consent for this, so it can be achieved with a TWAO.

Schedule

44. HS2 Ltd said that to achieve the tunnel extension in AP4 and finish construction at the same time that they needed to fit-out the extended tunnel from both ends, shortening the fit out period and so compensating for the longer period of tunnel boring. As a result, AP4 made provision for a tunnel fit-out compound at South Heath.
45. While HS2 Ltd have said that it is too late to move the AP4 haul road, there is no similar timing issue for moving the portal, as it would not need to be built for several years.
46. Were the tunnel extended 1km to Liberty Lane, the additional time boring the tunnel could readily be made up in the fitting out from both ends. However this would require a fit out compound to serve the Liberty Lane portal. The location of such a compound was not considered by HS2 Ltd when they assessed the options of tunnelling to Liberty Lane (as option C1) in July 2015, as Chart 1 shows. It is suggested the site can be accommodated further north, and that scheduling should not be an issue.
47. While we do not accept that there would be a need to fit-out from both ends, as HS2 Ltd's schedule assumes excessively low tunnel boring rates and fit-out rates, and the fit-out compound at the north portal of the Chilterns tunnel may hence prove unnecessary, fitting-out from both ends could achieve the planned completion date even on HS2 Ltd's advance rates (80m/wk).
48. Whether the fit out compound can be accommodated on ground already specified as required under the Bill is not clear, but HS2 Ltd do now own extensive land in the Potter Row area. The construction of a fit-out compound need not be an early activity in the construction schedule, and so can be achieved by a TWAO without affecting the schedule.

Appendix 1: OTB



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Ms Hilary Wharf
On behalf of
Residents' Environmental Protection Association

For the attention of Ms Hilary Wharf
By email to hilary.wharf@hs2actionalliance.org

Monday 7th November, 2016

Our ref: UK16037L_L03_R2

Dear Sirs,

REPA's Proposal to Extend the Chilterns Tunnel to Liberty Lane

REPA seek a design for HS2 for the Chilterns Tunnel in the vicinity of South Heath and Hyde Heath (from Mantles Wood to Leather Lane) where its environmental impact is lessened and improves upon the proposal made by HS2. The local organisations i.e. REPA and Potter Row Neighbourhood Watch Scheme in South Heath, have petitioned HS2 and the Government for these improvements. In the absence of a suitable proposal from HS2, REPA has sought to obtain independent advice on design and construction of the tunnel. Whilst OTB has not been commissioned to provide an alternative design, it has been asked to comment on the relative merits of options presented by REPA.

Following the Additional Provision 4, HS2 propose to now locate the northern portal of the Chilterns Tunnel at South Heath to the north of Frith Hill, previously it had ended at Mantles Wood. According to REPA, this location remains unacceptable and it has asked OTB to comment at on the tunnel boring costs of a short extension to Liberty Lane, approximately 1km further on. REPA argue that the benefits derived from even a small further extension of the Chilterns Tunnel will be significant.

REPA's Proposal

To extend the tunnel 1 km from the current chainage at South Heath (Ch.47.2km excluding the portal to Ch.47.4km including the portal) to a portal near Liberty Lane (Ch.48.2km excluding the portal to Ch.48.4km including the portal).

Construction Options

There are two means of constructing the extension either by bored tunnel or by mined tunnel. The bored tunnel would simply require the tunnel boring machines to go a further 1 km each, each of the TBMs having been launched and serviced from West Hyde close to the M25. The mined tunnel would be constructed from Liberty Lane towards West Hyde using conventional mining methods and being supported and lined by sprayed and in-situ concrete.

While the mined option has the advantage of not producing any more spoil at the M25 end, it is unlikely to be cheaper especially if two mined tunnels are required. We have therefore focussed on the bored tunnel option in this memo.

Construction Costs - Bored

There will be no technical or engineering difficulty in a 1 km extension of the tunnel. No additional shafts will be required.

The REPA Engineering Team (led by Rodney Craig) has evaluated the cost of providing bored tunnels in the Chilterns. REPA say that the HS2's costs are too high and are about twice those that would actually be realised based on REPA's benchmarking, essentially out-turn costs of selected case studies published by British Tunnelling Society. Mr David Hindle, an OTB Director, was directly involved in this original study.

OTB Engineering | 1

Using this study REPA say that the incremental costs of extending the 15.9km Chilterns Tunnel by 1 km can be based on an average cost per route metre (per both tunnels) of £26,400 (£26.4k). In contrast, REPA report that HS2 indicate that the costs would be between £44,000 (44k) per route metre or £49,000 (£49k) per route metre when additional programme costs have been included

So as to examine the costs proposed by HS2 and REPA, OTB has undertaken a high-level independent reassessment of costs. It must be highlighted that REPA only seek to demonstrate the incremental cost of the tunnel – that is the ‘extra-over’ cost to HS2 as a result of extending the Chilterns Tunnel by 1 km.

Bored Tunnels

The cost of increasing the length of the tunnel is the sum of material costs and programme-dependent costs. Material costs are the costs of the materials used in the tunnel and its construction, principally the cost of the tunnel lining. Programme-dependent costs are due to the operation of the site during construction and include costs of labour and equipment. They vary due to time i.e. how long it takes to do the job. The costs of site establishment (including the costs of the TBM) can be assumed to be amortised over the initial 15.9km of tunnel.

So as to capture variability in the assumptions a ‘three-point’ estimate was prepared and values were selected for upper and lower bounds and a best estimate. Key parameters are the costs associated with operating the site and the TBMs, and the costs associated with the tunnel lining and any internal civil structures. The spreadsheet allows for reasonable variations to be manipulated and tested.

The results of our estimate is as follows:

Route metre costs	OTB best estimate (includes rate of 120m/wk)	Lower bound (includes rate of 135m/wk)	Upper bound (includes rate of 80m/week)
Cost to construct	£22.3k	£16.4k	£34.9k
Project budget	£26.8k	£19.7k	£41.5

So as to set a project budget the cost-to-construct has been multiplied by 1.2 to provide for some contingency. We understand however that the HS2 Ltd cost estimates (44k/m to 49k/m) provided to REPA exclude any contingency.

Our cost estimate of £22.3k/m to construct (based on an average tunnelling rate of 120m/week) is very similar to the REPA assessment of £26.4k/m. Assuming a rate of progress that HS2 use of 80m/week, and all other factors the same as the best estimate, then the cost estimate becomes £25.75k/m (excluding contingency).

This estimate is the ‘cost to construct’ the ‘extra-over’ additional cost of extending the Chiltern Tunnel by around 1 km. The HS2 cost estimate (£44k to £49k/route metre) is closer to the upper bound estimate and appears disproportionately high. It is right that the HS2 estimate is greater so as to ensure that sufficient funds are allocated by Government. However, as we understand that no contingency has been allowed for in the HS2 Ltd estimates, it is difficult to see how the cost estimate can be justified.

Concluding Remarks

It is feasible to extend the Chilterns Tunnel and an additional length could be constructed for between c.£22.3k/m (our best estimate) and £25.7k/m (best estimate when adjusted to a rate of 80m/week). This is marginally less than the REPA estimate of by around £26.4k/m and substantially less than the HS2 Ltd amount of £44k/m to £49k/m.

Yours sincerely,

OTB Engineering Ltd.

Enc.

Cost estimate spreadsheet- ref

Copy of Cost Estimate Spreadsheet

Three point estimate for extra over costs for around 1km tunnel extension - Liberty Lane.						
UK16037L						
	Upper Bound	Best Estimate	Best Estimate using 80 m/week	Lower Bound		
Programme cost						
Cost per day	£ 150,000	£ 100,000	£ 100,000	£ 80,000	Based on cost to run construction site/day.	
Material cost						
Cost per m finished tunnel	£ 10,000	£ 8,000	£ 8,000	£ 6,000	Tunnel lining, drainage and first stage concrete	
Time factor						
Rate of progress	80	120	80	135	m/week	
Length of tunnel	1000	1000	1000	1000	m	
Fixed cost pre bored tunnel	£ 10,000,000	£ 8,000,000	£ 8,000,000	£ 6,000,000		
Programme cost						
Time to build	13	8	13	7	weeks	
Cost to build	£ 13,125,000	£ 5,833,333	£ 8,750,000	£ 4,148,148		
Time difference due to stagger	10	5	10	4	weeks	
Time related cost due to difference in time to complete	£ 1,500,000	£ 500,000	£ 1,000,000	£ 320,000		
Totals						
Material cost	£ 20,000,000	£ 16,000,000	£ 16,000,000	£ 12,000,000	for two tunnels	
Programme cost	£ 14,625,000	£ 6,333,333	£ 9,750,000	£ 4,468,148		
Total	£ 34,625,000	£ 22,333,333	£ 25,750,000	£ 16,468,148		
Expressed as cost/route m	£ 34,625	£ 22,333	£ 25,750	£ 16,468	Cost to build	
Include optimism bias	1.6	£ 55,400.0	£ 35,733.3	£ 41,200.0	£ 26,349.0	Budget cost for HS2 (incl. risk)
Include project risk	1.2	£ 41,550	£ 26,800	£ 30,900	£ 19,762	Project cost for HS2 (incl.contingency)
Revised 4/11/16						

Appendix 2:

Civil Engineering - Cuttings excavation, material transport and landfill

Overview

The current HS2 scheme from the Chilterns tunnel North portal 1km north to Liberty lane requires the excavation of at least 0.65 M m³ of chalk and stiff clay. This material is used partly as fill on the embankments close by but approximately 0.65 Mm³ is to be taken by road along the A413 to the HS2 route south east of Aylesbury.

Nationally, after allowing for use as engineering fill and environmental mitigation earthworks, the overall HS2 materials balance shows an excess of 4.9 Mm³ of this sort of material [1]. About 2 Mm³ of this and substitutable environmental mitigation fill comes from the London areas and is intended to be transported by road to landfill. About 1.2 Mm³ of this excess material comes from the Euston area and is (according to the Environmental Statement [2]) to be sent by road to permitted landfill via the A41 and the M1 – presumably to somewhere in Buckinghamshire. Based on the Environment Agency register of permitted landfill sites [3] the most likely destination for this material is in the Milton Keynes / Bletchley area, which is a journey of about 50 miles however: this area is currently permitted and available for non-hazardous waste. There is limited capacity for inert waste, but inert waste capacity could be used. A further 0.38 Mm³ (0.53 Mm³ if the tunnel is extended by 1km) of substitutable material is available at the South end of the Chilterns tunnel near the M25 [4], this is also to be transported off site by road probably to landfill via the M25.

If this 1km section of the route were to be tunnelled, this cutting excavation would not take place and some of the material from near the Chiltern tunnel south portal and Euston could be diverted from landfill to the Aylesbury area, which is a journey of about 40 miles, but is comparable to the distance the material might otherwise need to travel by road to landfill.

National policy is to minimise waste sent to landfill

The National Policy Statement for National Networks (NPNN) Section 5.42 requires the Promoter to minimise the volume of waste produced and the volume sent to landfill (which in this case would be achieved by a tunnel) unless the alternative (in this case the current scheme in deep cuttings) is the best overall environmental outcome.

The policy statement also requires the Secretary of State to satisfy himself that adequate steps have been taken to minimise the volume of waste arising and sent to landfill and to satisfy himself that such waste arisings do not have an adverse effect on the capacity of existing waste management facilities. [5]

There is no evidence to show that the promoter has carried out an analysis of the alternative (tunnel extension) to the current scheme. There is no evidence to show that the Secretary of State has satisfied himself on this point or been informed on the issue by HS2 Ltd. On most projects the SoS would fulfil his responsibilities through checks made by the Planning Inspectorate (the government agency responsible for examining planning applications for nationally significant infrastructure projects). It appears that in the case of the HSR Hybrid Bill only Parliament and its Select Committees provide scrutiny on the issue

Using HS2 Ltd cost estimates and assumptions, but redistributing waste disposal, it appears that a 1km tunnel extension can be built at no additional cost increase to the project, and with a superior environmental result, in conformity with NPNN.

HS2 overall excavation waste arisings and disposals

Since the original Environmental Statement, total HS2 inert waste arising due to excavation to be sent to landfill has grown from 2.5 Mm³ (3.8 Mt) to 14Mt now [6].

In 2013 Arup (on behalf of HS2 Ltd) asked the Building Research Establishment (BRE) to assess whether the level of planned waste was reasonable. At that time BRE concluded that, while it was not good, it was broadly consistent with the average of rail infrastructure projects [7]. Having increased the amount 3.5 times, the level is significantly more than would be expected.

The current AP4 ES states that it is the intention that 8.1 Mm³ (12.1 Mt) of this waste will go to landfill in Bucks and Surrey and 0.3 Mm³ (0.4Mt) will go to Northamptonshire [8].

Impact on the capacity of existing waste management facilities.

In their analysis, HS2 Ltd calculate that the inert waste is equivalent to 11% of all predicted remaining inert waste capacity at 2025 in the regions that HS2 (phase1) passes through i.e. London, South East, East of England, East Midlands and West Midlands [9]. They then conclude there will be a moderate adverse impact It is however HS2 Ltd's intent to deposit 93% of the waste in Buckinghamshire and Surrey.

Buckinghamshire and Surrey have just 4.6% of the land area of the 5 regions. The area within 20 miles of Denham and 40 miles of Euston where 2 Mm³ of the road based waste arising occurs is just 1.5% of the 5 regions area.

The Office of Fair Trading carried out an assessment of the waste to landfill market in 2005 and have concluded that non-hazardous waste is a local market with users on average travelling 10 miles to their nearest landfill site [10], any impact that significantly alters users ability to gain access is an adverse effect on the capacity.

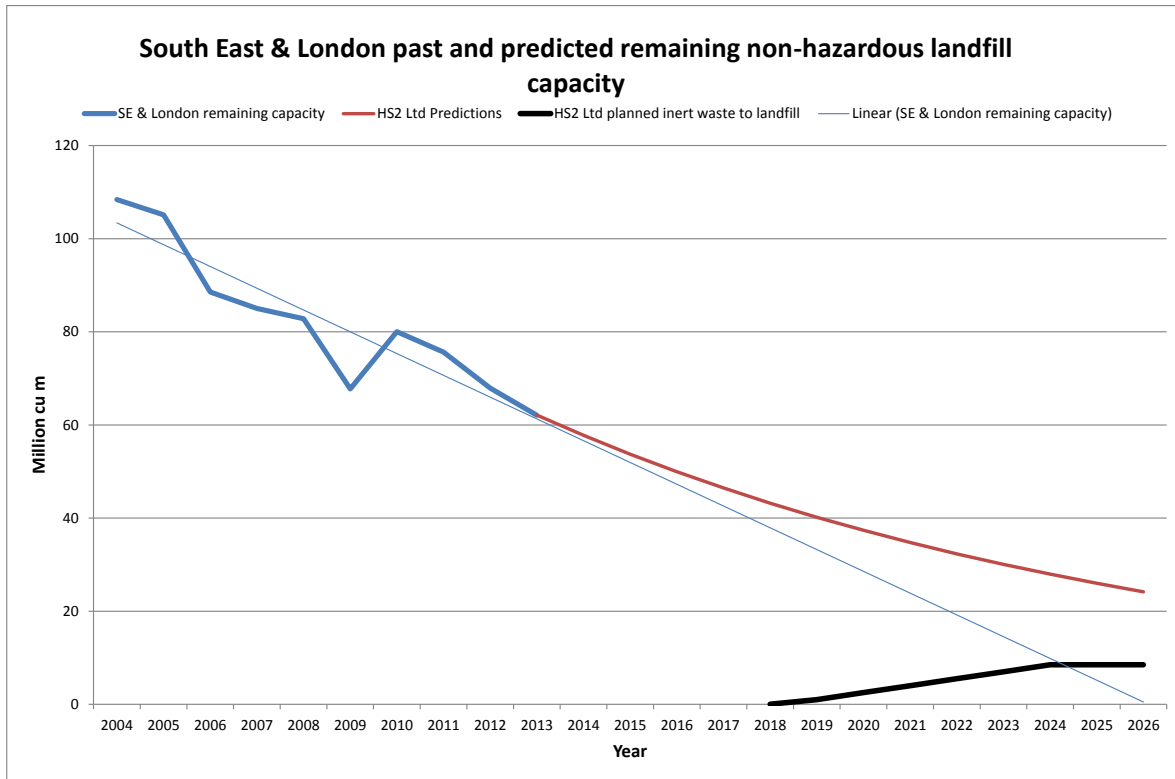
Analysing Buckinghamshire and Surrey inert landfill capacity in 2013 there was 8.2 Mm³ of inert capacity remaining in the two counties much of it in the Redhill area of Surrey 70 miles from Euston via the proposed access route. [11]. HS2 Ltd predict that under current depletion rates (without HS2) by 2026 London and the South East will have 7.9 Mm³ of inert landfill capacity remaining in total [12]. Based on the 2013 proportion 2.4 Mm³ (30%) of this would be in Buckinghamshire and Surrey. Unless landfill designated for non-hazardous waste (domestic waste via local authorities and commercial waste), is made available there will not be sufficient capacity for the 8.1 Mm³ to be deposited in Bucks and Surrey during the 5 year period planned.

HGV traffic access to sites is controlled to avoid a local nuisance. Inert landfill deposited in Buckinghamshire and Surrey is about 0.25 Mm³/year so during the 5 year planned period 6 times as many lorries will need to access the inert sites than routinely occurs. This would require changes to the planning applications and it is not reasonable to suggest that this would represent no adverse impact on landfill capacity.

In the event that HS2 Ltd do use non hazardous waste landfill capacity for the excess inert waste, they calculate that in 2026 the South East and London will have 13.5 Mm³ remaining [13] although linear regression analysis suggests it will be < 5 Mm³ (table 1). If HS2 Ltd is correct, using the current proportions 10.26 Mm³ maybe expected to be in Buckinghamshire and Surrey. If the 8.1 Mm³ were deposited in this period just 2 Mm³ of capacity would remain. Again it is unreasonable to think this will not have an adverse impact not just in Buckinghamshire and Surrey but also on the London, Berkshire, Oxfordshire and Hertfordshire Local Authorities and businesses that also use

this capacity. The Highways Agency also plans to deposit significant inert waste to landfill over the period [14].

Table 1



Market forces suggest that gate fees for landfill will increase over the period.

In any event, the bulk of the available capacity in Buckinghamshire and Surrey is not close to the origin of the HS2’s London arisings to be transported by road. If HS2 Ltd choose to take the 2 Mm³ of London arising intended for road transported to the nearest sites (e.g Denham Park Farm Quarry) they will quickly fill what little capacity remains for the local market. HS2 Ltd have the opportunity to reduce the spoil arising at South Heath and divert 0.65 M m³ of the London arisings from landfill which would be consistent with their and the Secretary of State’s obligations in the NPNN to minimise waste to landfill and to not adversely impact the capacity of waste facilities. It would also be desirable from the point of view of costs and avoiding landfill to put all the tunnel arisings at the Chiltern tunnel south portal to local sustainable placement.

Landfill costs were considered in a review of work [21] by Peter Brett Associates, which says:

3.8.2 The volume of excavation arisings from twin tunnels forming the CVT would be **approximately 975,000m³**. Hard chalk is 2.5 tonnes/m³. Assuming the chalk is quite porous and weathered (1.5 tonnes/m³), excavations arisings from the tunnel alone would be approximately 1,500,000 tonnes.

.....

3.16.15 The disposal of excavated material adding only a further £5m to PBA's Option B2 estimate, assuming it only being a transport cost, is not justifiable. At this stage it could only represent an aspiration or opportunity and should not form the basis of the estimate. **If that material needed to be disposed of commercially to off-site pits/landfill, the cost of its disposal is likely to be in the order of £20-25 million.**

This implies a landfill cost of about £15-20/m³, which corroborates the value of £20/m³ used here.

Costs – Civil Engineering - Cuttings excavation, material transport and landfill

In July 2015 at the time that the Commons Select Committee considered extending the Chilterns Tunnel, HS2 Ltd advised them that the saving in civil works attributable to reducing the extent of the cutting was -£5.26 m to go to Liberty lane (1km) and -£11.6m to go to Leather Lane (1.5km) [15]. HS2 Ltd subsequently revised their costs on the 1 Sept 2015 [16] and again on the 17th Sept 2016 [17] increasing the civil engineering saving attributable to tunnelling to Leather Lane to £31.8m that based on their previous work implied a saving of £9.9 m to go to Liberty Lane. REPA have consistently disputed these estimates and have highlighted multiple errors, they continue to consider that the base excavation saving is too low.

At the cost per cubic metre stated by Mr Tim Smart of £22/m³, the cost reduction from not excavating 0.65mm³ would be £14.m.

In January 2016 HS2 Ltd decided that they needed to reduce their estimated reduction by £11m to allow for replacing the 0.65 Mm³ required at Aylesbury [18]. They planned to do this by taking London waste by train to Calvert and then by road to the Aylesbury area, stating this would cost £31/m³ and cause an additional 153,000 (two way) lorry movements. The assert that this represents a net increase in cost of £11m. However while they acknowledged that the cost of transport to landfill sites would be reduced and that the cost of landfill gate fees (and Tax) would be reduced they did not quantify these aspects.

Table 2: Transportation and Landfill costs

	distance (miles)	volume (Mm ³)	unit cost (£/m ³)	HS2 Ltd (£M)	REPA (£M)	Notes
South Heath cutting to Aylesbury	8	0.65	10.00		-6.50	current quoted cost
London to Aylesbury	50	0.65	14.00		-9.10	current quoted cost
London to landfill	50	0.65	14.00		9.10	current quoted cost (assume displace longest)
Landfill charges		0.65	20.00		-13.00	
Landfill tax		0.65	2.65		-1.72	
total (£M)				11	-21.22	

In practice the material for the Aylesbury areas can be sourced directly from the London area with a net transport saving, rather than an increase, of about £21m, a reduction of 153,000 lorry movements, and a reduction of approximately £13m in landfill gate fees based on the average cost [19] and £2m in landfill tax [20], a further total reduction of £21m (rather than an increase of £11m).

References

1. HS2 Oct 2015 SES3 and AP4 ES Volume 5 | Technical appendices Waste and material resources WM-001-000 Annex 1 - Community forum area and regional waste and material resources reporting tables Annex A table 1d
2. HS2 Nov 2013 ES Vol 5 Waste and material resources assessment (WM-001-000) Table 1 & Volume 5 Appendix – Transport Assessment- TR-001-000 | London assessment (CFA1) Table 6-43: Construction traffic routes to/from construction compounds
3. Environment Agency Web Site <http://maps.environment-agency.gov.uk>
4. HS2 Ltd e mail 14th Jan 2016 Promoters exhibit
5. National Policy Statement for National Networks Presented to Parliament pursuant to Section 9(8) and Section 5(4) of the Planning Act 2008 December 2014
6. HS2 Oct 2015 SES3 and AP4 ES Volume 3 – Route-wide effects Table 9
7. HS2 Nov 2013 ES Vol 5 Waste and material resources assessment (WM-001-000) Annex 2 Volume 5 Annex 2 - Construction waste benchmarks for railway projects
8. SES3 and AP4 ES Volume 3 – Route-wide effects Table 18
9. SES3 and AP4 ES Volume 3 – Route-wide effects 19.6.52 This will be equivalent to an 11% reduction in inert waste landfill capacity across the aggregated five regions according to the amount of capacity projected to be available at the end of construction in 2025
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