

Independent Review of HS2 Ltd Cost Estimates contained in the Hillingdon Working Group Report

Introduction

1. As requested by the Secretary of State, I have undertaken a review of the HS2 Ltd cost estimates contained in the Hillingdon Working Group (HWG) Report, with the objective of assessing whether the cost estimates for the viaduct and tunnel have been produced on a consistent basis and so are a valid basis for comparison. A copy of the commissioning review scope document is attached at **Annex A**. In conducting the review, I met with representatives of both HS2 Ltd and Hillingdon Council (HC). The findings of my review are reported below.

Scope of review

2. It is noted that the views of HC and HS2 Ltd, as detailed in the HWG Report, continue to substantially reflect the positions presented by HC and HS2 Ltd to the House of Commons Select Committee. Although HS2 Ltd has provided greater detail regarding their cost estimates, these continue to be disputed by HC. Specifically, HS2 Ltd estimate that the tunnel would cost £273m more than the viaduct, whereas HC are of the view that the tunnel would cost £59m to £81m more than the Bill scheme.

3. In approaching this cost estimate review, I have had regard to the significant amount of work undertaken and presented in the HWG Report. I have therefore sought to focus my attention on the areas where it is possible to add the most value, by reviewing what I see as the fundamental elements that are vital to ensuring a fair comparison of the tunnel and viaduct cost estimates.

4. The first element, which I see as the most important factor, is to examine whether a consistent approach has been applied in assessing the costs of the viaduct and tunnel options. Having regard to the current level of design and the assessments already undertaken in the HWG, I have not focussed on the costings of each specific design element. I have instead focussed on assessing whether a consistent approach has been applied to the development and costing of the tunnel and viaduct options.

5. The second element, is to examine in more detail the specific areas of disagreement regarding the cost estimates. I have therefore examined in more detail the specific differences as detailed in HC's Position Statement included at Annex Z to the HWG Report, which is reproduced here at **Annex B**.

6. In relation to the costings of each specific design element, I have limited my review to (i) assessing whether the cost estimates are set at a reasonable

level; and (ii) reviewing whether the commercially sensitive construction rates used are consistent with industry standards.

7. It is important to recognise that some of the underlying differences in the cost estimates stem from judgements by both HS2 Ltd and HC on the engineering solutions which have been proposed and which therefore underpin the cost estimates. I have not sought to assess in any detail from a technical stance the validity of these different approaches but have set them out for comparison purposes and provided some commentary thereon.

Whether HS2 Ltd has applied a consistent approach to the make-up of the tunnel and viaduct options

8. The starting point for the cost estimates contained in the HWG Report are the plans provided at Annexes H to K of the HWG Report, which show the layout and composition of the respective viaduct and tunnel options. These plans show the alignment and key features of each scheme during the construction and operational phases and form the basis for HS2 Ltd's estimated costs.

9. In developing the viaduct scheme and the tunnel proposal, the approach taken by HS2 Ltd has been to assume a "reasonable worst case" that provides certainty that the proposed railway could definitely be delivered within the powers sought as part of the HS2 Phase One Bill. This is the same approach that has been used by HS2 Ltd in relation to the rest of the HS2 Phase One scheme. HS2 Ltd have told me that the nature of this approach means that they have taken a reasonable, but cautious approach in specifying the amount of land and infrastructure required for the construction and operation of the railway.

10. I am satisfied that this is an appropriate approach to follow, as to do otherwise would pose a significant risk to the timely delivery of HS2 Phase One. For example, if the scope of Bill powers sought was set too narrow, it would increase the risk that additional powers would be needed to actually build the railway. Any requirement to obtain further powers would involve further consent applications, which are lengthy in nature, which in turn may result in significant delays to the implementation of the HS2 Phase One or, as a worst case, if the additional powers are not approved it may prove impossible to construct the railway.

11. In reviewing the composition of the viaduct scheme and tunnel options, I have paid greater regard to examining the detail of the tunnel scheme, as the viaduct option is the same as that set out in the HS2 Phase One Bill. In doing so, I have taken the opportunity to probe and challenge HS2 Ltd on the make-up of the tunnel option and the need for specific elements. Following this review, I am satisfied that the tunnel scheme developed by HS2 Ltd and included in the HWG Report is based very largely on reasonable judgements at this stage and was unable to identify any obvious omissions or unnecessary, duplicated features. There are, however, alternative judgements

and proposals put forward by advisers to HC, which are considered in more detail below.

12. Accordingly, at this stage, I am satisfied that the details and content of the Bill viaduct scheme and tunnel option, as set out in the HWG Report, provide a materially appropriate basis for a consistent comparison of the viaduct and tunnel options.

Whether HS2 Ltd have applied a reasonable and consistent approach in calculating the cost estimates for the tunnel and viaduct options

13. The cost estimates for the viaduct and tunnel options, as detailed in Annex O of the HWG Report, have been prepared by HS2 Ltd. These were initially prepared by consultants Atkins based on Outline Design Detail and subsequently assured internally by the HS2 Ltd appointed cost estimators. HS2 Ltd have told me that the cost estimates are point costs based on the reasonable worst cost basis, which do not include contingency.

14. In relation to the tunnel option, the construction rates used are consistent with those used for estimating the cost of the northern extension to the Chiltern Tunnel (as detailed in Additional Provision 4 to the HS2 Phase One Bill), which were assured by the Department for Transport's (DfT) Project Representative, and the overall tunnel option cost estimate is consistent with the assured data contained within the Hybrid Bill Estimate of Expenditure and the parameters contained within HS2 Ltd's published Tunnel Guide¹.

15. As referred to above, the HS2 Ltd cost estimates are based on the Bill viaduct scheme and tunnel option plans as provided at Annexes H to K to the HWG Report. In reviewing the cost estimates, I have mapped the individual cost elements against these plans and am content that there are no obvious omissions or duplicated cost items in relation to the Bill viaduct scheme and tunnel options.

16. More detail is provided below in the section on the commercially sensitive construction rates, but I am satisfied that the build-up of cost estimates detailed in the HWG Report are reasonable and appropriate for the maturity of the design of the proposed Bill viaduct scheme and tunnel proposals. More fundamentally, I am also satisfied that the construction rates have been applied consistently in relation to the Bill scheme and tunnel options.

'Reasonable Worst Case' Approach

17. In undertaking the review, I have explored the "reasonable worst case" approach to understand whether an alternative cost assessment approach would deliver a different result in the cost difference between the viaduct and tunnel options. It is apparent that the largely unknown ground conditions in the

¹https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/434516/HS2_Guide_to_Tunnelling_Costs.pdf

Colne Valley play the most significant factor in applying different approaches. In terms of geology, it is generally recognised that the Colne Valley is in a transitional area between London Clays and the Lambeth and Reading Beds, and is understood to be made up largely of cracked chalk.

18. Given the lack of specific local geological survey data, the risks associated with the underground tunnel option costs increasing are higher than for the viaduct option. In particular, it does not seem unreasonable to judge that the unknown nature of the ground conditions in the Colne Valley area has the potential to have a much greater impact in relation to construction of underground structures. For example, if the ground conditions were found to be worse than assumed, this would have a significant impact on the construction of the underground chambers required and the tunnelling rates of the Tunnel Boring Machines (TBMs). This in turn, could increase costs and affect the timing of the HS2 Phase One construction programme. The impact of poor ground conditions on the construction of the viaduct option may be expected to be less significant by comparison, as they would only impact the construction of the viaduct piers.

19. Similarly, if the ground conditions are better than anticipated, although savings may be realised in relation to the provision of smaller viaduct foundations, the same is less true for the tunnel option. In particular, although better ground conditions would make tunnelling faster and less challenging, all the tunnel infrastructure, including the temporary structures required to enable the launch of the TBMs, would still be required. These are significant cost items in the tunnel option.

20. I do not, therefore, believe that changing the basis of the cost estimates (i.e. from the “reasonable worst case” approach) would materially narrow the gap between the costs of the viaduct and tunnel options.

Whether HS2 Ltd has applied a consistent approach to taking account of cost opportunities and risks

21. As described above, the approach taken by HS2 Ltd has been to assume a reasonable worst case for defining the composition, and estimating the cost, of the viaduct scheme and tunnel option. In relation to the resulting cost estimates, HS2 Ltd have then applied a standard percentage reduction (of around 10%) to reflect the efficiencies and value engineering that are anticipated to be realised in relation to all construction works. It should be noted that HS2 Ltd has not applied this percentage reduction to Land and Property costs. For the purposes of the cost estimates contained in the HWG Report, HS2 Ltd has applied this standard percentage consistently to both the viaduct scheme and tunnel options.

22. The key difference between the HS2 Ltd (£273m) and HC (£59-81m) cost differentials is that HC have proposed the removal of the standard efficiencies percentage reduction and instead assumed the realisation of a number of specific cost saving opportunities in relation to the tunnel option and a

significant cost risk in relation to the viaduct scheme. In addition, HC have flagged an apparent £22m discrepancy in the Chiltern Tunnel costs. I have examined each of these points below.

£22m Chiltern tunnel difference

23. HC's Position Statement (Annex B) highlights that there appears to be a hidden cost of £22m within the Chiltern Tunnel elements, which their tunnel consultants, Peter Brett Associates (PBA) have not been able to identify. HC explained that from the cost estimate information provided by HS2 Ltd, they had been unable to identify what this £22m difference covered.

24. I raised this issue with HS2 Ltd, who explained that extending the tunnel through the Colne Valley would require some minor changes to the eastern end of the Chiltern Tunnel as currently detailed in the HS2 Phase One Bill. At my request, HS2 Ltd provided the following breakdown of the cost elements that make up this £22m difference in the cost of the Chiltern Tunnel:

- approx. £3m relates to the extension of the Chilterns tunnel to the intervention gap;
- approx. £12m related to additional handling of excavated material. Under the tunnel option it is assumed that all tunnel spoil material is removed from site rather than used as local environmental mitigation and an allowance (£6/m³) has been made for additional handling, treatment and storage prior to removal by road to ensure the material is in a suitable stable state for off-site removal compared to onsite placement only;
- approx. £4m in additional preliminaries and temporary works; and
- approx. £2m (percentage based) allowance for main contractor design, overhead and profit on these additional costs.

25. I am satisfied that it is reasonable for these costs to be accounted for in the HS2 Ltd cost estimates to ensure a full and consistent comparison of the viaduct and tunnel options.

£20m opportunity for sustainable placement of tunnel arisings

26. HC's Position Statement (Annex B) highlights a £20m tunnel option cost saving opportunity through the sustainable placement of tunnel arisings in the vicinity of the Harefield intervention gap. Sustainable placement is the on-site placement for disposal of surplus excavated material to avoid causing environmental effects that would otherwise be associated with the offsite disposal of that material. HC are of the view that as sustainable placement had been used elsewhere on HS2 Phase One, it could be used in the vicinity of the proposed Harefield intervention gap to avoid offsite transport costs.

27. HS2 Ltd have confirmed that their cost estimate for the tunnel option assumes the off-site disposal of the majority of the arisings from the boring of the Chiltern Tunnel and the Harefield intervention gap excavation. Only a nominal amount of excavated material would be retained on site for landscaping around the intervention gap.

28. HS2 Ltd also explained that HS2's Excavated Material and Waste Management Policy considers disposal, including on-site disposal through sustainable placement, to be the options of last resort. Sustainable placement would be proposed where this was considered to be more sustainable, or have less environmental impact, than transporting to an off-site landfill site. In the case of the proposed intervention gap at Harefield, this would be located adjacent to the M25 motorway and a link road would provide access between the Harefield construction site and the M25. In these circumstances, HS2 Ltd are of the view that it would be inconsistent with the agreed HS2 Ltd Excavated Materials and Waste Management Policy to justify the need for sustainable placement at this location.

29. The £20m opportunity identified by HC reflects a situation where permission would be sought from Hertfordshire CC and Buckinghamshire CC for 'sustainable placement' to be retained on the site around the Harefield intervention gap, thereby reducing offsite transport costs. HS2 Ltd have assumed that the retention of about half (2million m³) of the total excavated material could potentially be accommodated in this scenario.

30. The 2million m³ of excavated material concerned is roughly equivalent to the retention of material on site under the viaduct scheme at this location, but under that scheme the material is required for visual and noise mitigation purposes and is not, therefore, sustainable placement. Under the tunnel scheme, this mitigation would not be required, hence retention of surplus material on-site would be sustainable placement and run contrary to the HS2 waste disposal hierarchy and would need landfill planning approval. It should be noted that the sustainable placement proposed would be outside Hillingdon Council's administrative boundary in South Buckinghamshire.

31. A secondary issue is that the HS2 Ltd cost estimates for the off-site disposal of this material, assumes the material could be disposed of within approximately 20km of the intervention gap. If this were not possible in practice, it would be necessary to transport the excavated material a further distance, which would result in increased costs beyond those within the HS2 Ltd tunnel design costings.

32. It is reasonable to assert that this proposal presents an opportunity for a saving of up to £20m for the tunnel option. However, it is not sufficiently clear at this stage whether this saving could be realised. There are unknown factors on whether permission could be successfully secured for the proposed sustainable placement and, if sustainable placement was possible, whether and what level of landfill tax may be applicable (i.e. which would need to be offset against any savings). In relation to securing permission, even if powers were sought via the hybrid Bill process, it is possible that the land owner would petition the Bill and it is possible that Select Committee could direct that sustainable placement be rejected at this location in favour of offsite disposal given the fact that it is not compatible with HS2 Ltd's own policies. In addition, as noted above, if this opportunity was not realised, a cost risk also

exists regarding the distance that the excavated material may need to be transported.

33. As a result I do not believe that this opportunity can be banked for the purposes of the HWG Report cost estimates. However, this appears to be the type of opportunity that could contribute to the overall standard percentage (around 10%) reduction that HS2 Ltd has applied to reflect the efficiencies and value engineering that are anticipated to be realised in relation to all construction works.

£14m opportunity by redesigning the portals in the intervention gap

34. HC's Position Statement (Annex B) highlights a £14m tunnel option cost saving opportunity by redesigning the tunnel portals located in the proposed Harefield intervention gap. HC proposes reducing the porous portal hood lengths from the 200m assumed by HS2 Ltd, to 100m long. HC also consider that some double counting may be present in the calculation of HS2 Ltd's cost estimates for the porous portal tunnel hoods, which they believed could be integrated into the intervention gap box structure. HC believe the combination of these changes could deliver a cost saving of £7m for each portal.

35. In discussing this opportunity with HS2 Ltd, they advised that the design of the 200m long intervention gap portals, as costed in the HWG Report at £18.5m each, is based on the current level of design which has regard to the HS2 Ltd's preliminary work on aerodynamic effects to avoid tunnel 'boom' from the operation of high speed rail services. At my request, HS2 Ltd also reviewed their cost estimates for the porous portal and the intervention gap structures, and has confirmed that no double counting is present.

36. I believe that a cautious approach is warranted at this time in relation to these cost saving opportunities, as I understand that potential also exists for the porous portal hood lengths to extend during detailed design, which would increase costs. In essence there are complex judgements to be made for a high-speed railway which requires very high levels of airflow management considerations.

£27m opportunity by using circular shafts and optimising design/spacing

37. HC's Position Statement (Annex B), highlights a £27m tunnel option cost saving opportunity by: removing one of the proposed vent shafts (which I will call 'Vent Shaft G') either via reviewing operational spacing requirements or optimising shaft spacing; implementing circular vents shafts (i.e. rather than rectangular); and lowering the TBMs into the turnout chamber, rather than down a large vent shaft.

38. Advice from HS2 Ltd is that, as detailed in the HWG Report, if the tunnel option was progressed then the tunnel aerodynamic design and further assessment of firefighting requirements could potentially allow the omission of Vent Shaft G. However, I have been told by HS2 Ltd that the removal of this shaft would increase shaft spacing such that the current assessment of fire

safety requirements based on High Speed 1 (HS1) would no longer apply and new fire safety assessments and aerodynamic assessments would be required. At this stage of design, on a reasonable worst case basis, it would not appear to be appropriate to assume that Vent Shaft G could be removed and fire safety, an absolute requirement, be achieved. As a result the cost of the additional vent shaft is properly shown in the current HS2 estimate.

39. In terms of optimising vent shaft spacing in order to enable the removal of Vent Shaft G, HS2 Ltd explained that a key consideration in relation to the proposed vent shaft locations is that an inclined tunnelled rail connection is required between the Harvil Road railhead (which is at surface level and connects to the classic rail network) and the HS2 tunnels in a turnout chamber at the bottom of Vent Shaft F. This direct rail link is considered by HS2 Ltd to be essential to enable works trains from the classic rail network to support the efficient fit-out of the HS2 tunnels with track and the other railway systems required. As a result, HS2 Ltd consider that any proposal to move Vent Shaft F to the east to optimise vent shaft spacing (i.e. to allow the removal of Vent Shaft G) would increase the distance to the railhead by around 400m. This would seem to indicate that any saving made by optimising vent shaft spacing to allow the removal of Vent Shaft G, would need to be off-set by the need to provide a longer inclined tunnelled rail connection between the railhead and Vent Shaft F. HS2 Ltd has calculated the net saving would be in the region of £1.5m. HS2 Ltd also advise that moving Vent Shaft F eastwards would mean that part of the rail link tunnel would then be constructed under the Chiltern Railway line embankment and would introduce a new risk of settlement.

40. In relation to the shape and size of the vent shafts, HS2 Ltd's current design assumptions generally assume rectangular shafts as these offer better space for the subsequent ventilation and electrical requirements. There are however, examples of circular shafts on the project, which have an internal diameter of approximately 23m. However, advice from HS2 Ltd is that as these shafts do not span the full width of the two tunnel bores, they require the construction of underground adits to provide the necessary ventilation and smoke extraction to both HS2 tunnel bores. Based on comparative costs of the HS2 assessed Alexandra Place shaft (near to South Hampstead station, Primrose Hill), which is a 23m internal diameter vent shaft, HS2 Ltd believe the costs for a circular shaft in lieu of a rectangular shaft would be broadly comparable. However, advice from HS2 Ltd is that in the case of Vent Shaft F, which needs to support tunnelling in two directions during construction, a smaller circular shaft would restrict working space. In case of Vent Shaft F, a larger rectangular shaft would be more appropriate.

41. Although scope exists for the realisation of these opportunities, I do not believe there is sufficient certainty to incorporate these specific cost savings into the cost estimates at this time. However, these appear to be the type of opportunities that could be captured by the standard percentage reduction that HS2 Ltd has applied to reflect the efficiencies and value engineering that are anticipated to be realised in relation to all construction works.

42. Separately, when I met with HC, they also highlighted a related issue whereby they understood that Vent Shaft F and the adjacent turnout chamber (i.e. where the rail link from the railhead connects to the HS2 tunnels) were to be constructed as separate structures. HC were concerned that such an approach would not be a cost efficient method of construction. Having discussed this issue with HS2 Ltd, they have clarified and confirmed that this is not the case and that the tunnel option assumes that Vent Shaft F and the turnout chamber would be constructed as a single combined structure. This should be confirmed with HC advisers.

£25m opportunity in refining alignment and design of intervention gap

43. HC's Position Statement (Annex B) highlights a £25m tunnel option cost saving opportunity by refining the alignment and design of the proposed Harefield intervention gap. HC propose that savings could be made by: reducing the length of the intervention gap; reducing the track/tunnel separation to allow a narrower intervention gap; and reducing the depth of the tunnels to allow a shallower intervention gap.

44. Advice from HS2 Ltd is that the design of the intervention gap developed by HS2 Ltd for the tunnel option adopts the requirements of the Technical Standard for Interoperability (TSI). The TSI defines the technical standards required to satisfy the essential requirements to achieve interoperability of high-speed railway systems and is a legal requirement across Europe. These requirements include safety, reliability and availability, health, environmental protection and technical compatibility.

45. HS2 Ltd has assumed a 900m long intervention gap incorporating two 200m portals and a 500m opening. This is based on TSI requirements, which require the provision of a clear 500m opening. Furthermore, HS2 Ltd are of the view that under the tunnel option proposed, which currently entails some 37.7 km of continuous tunnel with no crossovers, HS2 Ltd would look to provide crossovers within the intervention gap. In the opinion of HS2 Ltd, this would mean that the box length may increase rather than reduce when detailed design was undertaken.

46. In response to the HC proposal that the width of the intervention gap could be reduced to around 35m, HS2 Ltd have advised that the 40m width they have assumed is based on: providing appropriate spacing between the tunnel bores (i.e. 1 x tunnel diameter); the provision of walkways to allow the evacuation of passengers in an emergency; the provision of appropriate track spacing to enable the provision of track crossovers (which HS2 Ltd considers would be required for a 37.7km tunnel); and the provision of appropriate emergency vehicle access roads and facilities to enable passenger evacuated from trains in an emergency to reach surface level. HS2 Ltd's assumed track spacing also has regard to the tunnel design requirements (at this stage of design) and the currently limited knowledge regarding local ground conditions. HS2 Ltd are of the view that any proposals to reduce the space between tunnel bores would introduce significant new construction risks and is inconsistent with a reasonable worst case basis of estimation.

47. I was told by HC that they are of the view that the depth of the intervention gap box could be reduced if the vertical alignment of the track was raised by 10m to 15m at this location. HS2 Ltd advise that whilst there could be some scope to modify the vertical alignment during a more detailed design stage, perhaps by 5-10m, regard must also be given to the applicable track geometry parameters for high speed rail services (i.e. how sharply the HS2 track can be curved up, down, left or right) and incorporation of cross-overs. This would seem to indicate that the scope to raise the level of the HS2 tunnels would be limited by retaining sufficient cover to the tunnels where they pass under the Colne Valley Lakes (where a cover of 2x tunnel diameter has been provided and reducing this would introduce new construction risks) and maintaining an appropriate gradient to achieve a suitable tie-in to the existing railway profile north of the M25 without introducing a pronounced hump in the HS2 tracks at this location. In this regard, some limited savings in the intervention gap cost may be realised at a detailed design stage but it may not be prudent to assume that these could be fully realised at this stage.

48. As a result, I do not believe these cost savings should be incorporated into the reasonable worst case cost estimates. In relation to the potential opportunity to reduce the depth of the intervention gap, this appears to be the type of opportunity that would be covered by the standard percentage reduction that HS2 Ltd has applied to reflect the efficiencies and value engineering that are anticipated to be realised in relation to all construction works.

£35m risk to viaduct through more extensive foundation requirements

49. HC's Position Statement (Annex B) highlights an additional £35m cost risk in relation to the viaduct foundations. HC envisage that the viaduct foundations would need to be deeper than currently envisaged by HS2 Ltd. HC explained that, based on their understanding of the ground conditions, they consider that 50m to 60m long piles would be required to pass below fractured chalk. The additional £35m cost proposed by HC assumes a 100% cost increase for the viaduct foundations, which allows for deeper foundations, the use of a larger scale plant, strengthened work platforms, materials and time costs.

50. Advice from HS2 Ltd is that the outline design of the piled viaduct foundations has been based on a geotechnical desk study compiled from previous published geotechnical data available from the British Geological Society (HS2 Ltd have been unable to secure the necessary permissions to undertake local geological surveys as yet). The HS2 Ltd design assumes the provision of foundation piles that are, on average, approximately 30m deep. The provision of 30m deep piles is assumed using the 'reasonable worst case' principle, based on HS2 Ltd's current knowledge regarding ground conditions (which assumes poor ground conditions made up of weathered chalk and superficial deposits). The assumptions used by HS2 Ltd for the viaduct

foundations are also informed by experience on other similar projects, such as the HS1 viaduct over the Medway River in Kent.

51. HS2 Ltd noted that these assumptions would need to be verified by a detailed geotechnical investigation, which may vary the current design. However, having assumed a 'reasonable worst case', they consider greater potential exists for the estimated viaduct foundation costs to reduce rather than increase.

52. I recognise that HC and HS2 Ltd have different views on the size of the viaduct foundations required. It would however seem that to increase the cost estimates for the viaduct foundations based on the current understanding of ground conditions without revisiting the costs of the tunnel option on the same basis would be introduce inconsistency in the basis of the existing comparisons.

£61m difference due to standard applied %age for Indirect Costs

53. HC's position statement (Annex B) highlights a £61m tunnel option cost saving opportunity by removing the cost difference due the application by HS2 Ltd of a standard percentage increase for 'Indirect Costs' in relation to the viaduct scheme and tunnel option. In particular, HC contend that if the tunnel scheme were adopted the design and project management costs would be less on a contract that already includes a significant tunnel.

54. HS2 Ltd's cost estimates, which reflect the stage of design and the need to fairly compare options, have consistently applied add-on percentages for Indirect Costs (i.e. including preliminaries, contractor design costs and temporary works). This approach to cost estimation is the same as that used by HS2 Ltd to assess the rest of the Phase One route.

55. However, although I accept that HS2 Ltd has applied a standard, percentage based approach to the viaduct and tunnel options (and I also recognise that the tunnel option would be more complicated and challenging to construct), I also accept HC's argument that the more appropriate cost to be included would be the actual estimate of the incremental indirect costs incurred for the tunnel option.

56. I therefore requested that HS2 Ltd review this cost element to refine the calculation of the cost difference between the Bill viaduct scheme and the tunnel option.

57. Advice from HS2 Ltd is that at this early stage of the Project, the organisational design remains formative and strategies affecting indirect costs (e.g. design, insurance, accommodation, IT and procurement) are likely to experience further development. It is for this reason that tailored indirect cost impact assessments are not attempted for each potential change.

58. HS2 Ltd also contends that the additional works costs imply an increase in construction effort (i.e. more labour, plant and materials). This additional work

will have to be designed (including design support throughout construction), procured and managed either in additional concurrent work packages or the same number of work packages of longer duration. It may also be the case that additional indirect time is incurred by project management teams as tunnel boring operations involve 24hr/7day working.

59. In terms of corporate costs it is true that not all categories will scale in a linear fashion with additional works cost. However, the additional works and associated additional duration (or concurrent scale) of design and project management effort, is likely to require some additional support from corporate teams such as Finance, HR, Stakeholder Management, Commercial and IT and some additional overheads such as accommodation, equipment and licences. The cost of insuring the works (included in corporate costs) is also likely to increase in proportion to the works cost.

60. Whilst there is merit to the 'economy of scale' argument, advanced by HC, when this change is treated in isolation, it is, in HS2 Ltd's opinion, optimistic to 'bank' this given the number of unknowns at this stage e.g. programme implications. There are also potential 'dis-economies of scale' that arise from market capacity issues e.g. how much tunnelling work could be designed, managed and delivered concurrently whilst maintaining competitive rates?

61. The approximate split of the 18% which has been applied is client design 3.5%, project management 7% and corporate 7.5% (of which 2% is insurance). If a proportion of these were not to be applied in a 'what if' sensitivity test (i.e. a fixed/non-impacted element assumed) then an addition of perhaps 15%-16% rather than 18% would result. This assumes that the critical path is unaffected and that approximately half the corporate 'team' costs have an elastic or unresponsive relationship to the works costs. The result of this 'what if' test, i.e. applying indirect costs at 15% instead of 18%, would be a reduction of circa £11m in this £61m cost difference. If the amount was 10% instead of 18%, the reduction would be of the order of £28m.

62. While I believe there are some merits in assuming a lower indirect cost for the tunnel, in the overall context of the difference of £273m and the degree of estimation inherent in the calculations, these amounts would not constitute a material difference.

Effects of Prolongation

63. In the currently estimated cost difference of circa £273m, prolongation effects have not been taken into account.

64. It has been assessed by HS2 Ltd that the extended tunnel option (including rail systems fit-out) could take up to six months longer to construct than the proposed scheme.

65. Tunnelling works are on, or close to, the critical path in the overall construction programme and additional tunnelling may well introduce, or

increase the risk of delays to related work packages and/or the overall construction programme.

66. If this 6 month prolongation translated into a six month delay to the overall construction programme this would result in a disproportionate increase in the value of Indirect Costs. Whilst I have noted this view on prolongation, I have not formed any judgement on its likelihood as it is beyond the scope of my review.

Private review of reasonableness of the commercially sensitive construction rates used HS2 Ltd for the purposes of the cost estimates.

67. As explained in the review scope document, owing to an ongoing procurement exercise for the HS2 Main Works Civil Contracts, it has not been appropriate for HS2 Ltd to make available details of the commercially sensitive construction rates used to make up the cost estimates contained in the HWG Report. The uncontrolled circulation of this information would present potential risks that could compromise the current, ongoing procurement exercise.

68. That said, I believe that the level of detail included in the HS2 Ltd cost estimates contained in the HWG Report provides sufficient granularity to determine if the cost estimates of any of the individual design items were unreasonably high or low. This is reflected in the fact that Hillingdon's engineering experts have not sought to challenge specific cost estimates for particular elements, but rather focused on whether they consider the particular items should or should not be included or the underlying assumptions. Essentially these are engineering judgements rather than financial ones, which are considered in more detail in the section above.

69. However, as part of my review, I have been provided with an opportunity to review privately these commercially sensitive construction rates. In addition, as part of my review, I have also had the opportunity to explore and clarify the processes used by HS2 Ltd develop these construction rates, to inform my understanding of what benchmarks have been used and what challenge and assurance processes has been undertaken.

70. Advice from HS2 Ltd is that the estimates are prepared and quality assured by industry leading design engineering companies (Professional Services Contractors - PSCs) in accordance with procedures established by HS2. The procedures set out basic conventions for preparation of estimates such as base date; exclusions; coverage rules and breakdown structures; advice regarding presentation conventions: assurance requirements and key assumptions. The estimators are required to assess the most likely accepted tender value for the works within their scope. There is regular communication between HS2 Ltd and the PSCs during the preparation of design and estimating information.

71. Upon receipt of estimates from the PSCs HS2 Ltd carry out various further assurance activities such as checking that they: comply with procedures; are arithmetically correct; reflect the design, programme and construction methodology information; are internally and historically consistent; are at appropriate levels of detail and comprise robust rates and allowances.

72. Techniques used to generate and assure the estimates include: measurement and rate development from first principles: market testing of key rates, quotations and assessments from specialists; cost comparisons and benchmarking with similar works and risk, opportunity and efficiency challenges.

73. The HS2 Ltd estimates, upon which those referred to are based, have been subject to iterative development and improvement, multi-layered assurance processes and extensive independent review. The estimates (including rates etc.) were further reviewed and reported on by the Department for Transport's Project Representative. In addition, under the David Higgin's Review (2014) these estimates were re-assured by an independent team appointed by Sir David Higgins

74. I am satisfied that the construction rates have been developed and adopted via a robust and informed process and that they are consistent with current industry standards. More importantly, I am also satisfied that there is consistency in the application to the construction rates to estimate the cost of both the viaduct scheme and the tunnel option.

Conclusions

75. In approaching this cost estimate review, I have had regard to the significant amount of work already undertaken in preparing the HWG Report. To add the most value I have, therefore, sought to focus my attention on listening to both parties on areas identified as comprising the majority of the cost difference and as such what I see as the fundamental elements that are vital to ensuring a fair comparison of the tunnel and Bill scheme options.

77. In relation **to the make-up of the tunnel and viaduct options**, I am satisfied that the tunnel scheme developed by HS2 Ltd and included in the HWG Report is reasonable and was unable to identify any obvious omissions or unnecessary/duplicated features. I am also satisfied that the details and content of the viaduct scheme and tunnel option, as set out in the HWG Report, provide an appropriate basis for a consistent comparison of the two options

78. I am satisfied that the HS2 Ltd cost estimates **apply a reasonable and consistent approach in calculating the cost estimates for the tunnel and viaduct options**. The build-up of cost estimates detailed in the HWG Report are reasonable and appropriate for the maturity of the design of the proposal viaduct scheme and tunnel proposals. I have reviewed the 'reasonable worst case' principle applied by HS2 Ltd and am satisfied that this principle has

been applied consistently as a basis for the cost comparison exercise recognising of course that engineering solutions are both to a degree a matter of professional judgement and on the basis of the method of evaluation selected are cautious.

79. More fundamentally, I am also satisfied that the construction rates have been applied consistently in relation to the viaduct scheme and tunnel options.

80. I am satisfied that **HS2 Ltd has applied a consistent approach to taking account of cost opportunities and risks.** The key difference between the HS2 Ltd (£273m) and HC (£59-81m) cost differentials relates to how HS2 Ltd and HC have assessed cost saving opportunities and cost risks. HS2 Ltd have applied a standard percentage reduction (of around 10%) to reflect the efficiencies and value engineering that are anticipated to be realised in relation to all construction works, whereas HC have proposed the removal of the standard efficiencies percentage reduction and instead assumed the realisation of a number of specific cost saving opportunities in relation to the tunnel option and a significant cost risk in relation to the viaduct scheme.

81. I have considered each of the specific cost opportunities that HC has identified in relation to the tunnel option and the cost risk they have identified in relation to the viaduct foundations. In discussions with HC and HS2 Ltd, it is apparent that some of the differences resulted from differing professional judgements on the engineering solutions that should be applied. I have concluded that, although a number of small cost saving opportunities could be banked (i.e. in relation to the removal of Vent Shaft G and 'Indirect Costs'), these do not materially alter the cost differential that HS2 Ltd report between the tunnel and the viaduct option. I do not believe that sufficient certainty exists at this time to accept and incorporate the other cost savings identified by HC into the HS2 Ltd cost estimates.

82. In addition, I consider that the approach adopted by HS2 Ltd of applying a standard percentage reduction (of around 10%) to reflect the efficiencies and value engineering that are anticipated to be realised in relation to all construction works, to be reasonable, and consistent with all other aspects of HS2 Phase One. This better caters for the inherent uncertainty that exists at the current level of design. I also note because the tunnel option is estimated to cost more than the viaduct option, this percentage based approach assumes a larger scope of cost opportunities being realised in relation to the tunnel option.

83. In relation to the viaduct foundations, I recognise that HC and HS2 Ltd have different views on the size of the foundations required. However, I am satisfied that HS2 Ltd's assumed viaduct foundation design is consistent with the "reasonable worst case" principle and that seeking to increase the cost estimates for the viaduct foundations would be introducing inconsistency to the basis of existing comparisons.

84. I am satisfied with the **reasonableness of the commercially sensitive construction rates used by HS2 Ltd for the purposes of the cost estimates**. In particular, I am satisfied that the construction rates have been developed and adopted via a robust and informed process and that they are consistent with current industry standards. I am also satisfied that there is consistency in the application of the construction rates to estimate the cost of both the viaduct scheme and the tunnel option.

85. In concluding this review, I am grateful for the information provided both by HC and HS2 Ltd, the assembly of previous submissions to and outcomes from the HWG and the support of Departmental officials.

Ed Smith

Lead Non Executive Board Member, Department for Transport

7th October 2016

Independent Review of the HS2 Ltd Costs Estimates contained in the Hillingdon Working Group Report

Introduction

1. The Hillingdon Council (HC) has petitioned Parliament calling for the HS2 Phase One route to be tunnelled under the Colne Valley (the HS2 Bill scheme passes across the surface and a viaduct). HC's case for a tunnel was considered fully, but ultimately rejected by the House of Commons (HoC) Select Committee.

2. In the run up to the London Mayor election, in response to concerns raised by Zac Goldsmith MP, Boris Johnson, Nick Hurd MP and HC about the impacts of the HS2 route through the Colne Valley, the then Secretary of State (Patrick McLoughlin) established a joint working group, made up of representatives from HC, HS2 Ltd and the Department for Transport (DfT), to look again and provide greater clarity and transparency regarding the relative costs and impacts of the tunnel and viaduct options (the Working Group was chaired by DfT).

3. The outcomes of this working group, which are detailed in the Hillingdon Working Group Report, continue to substantially reflect the positions presented by HC and HS2 Ltd to the House of Commons Select Committee. However, although HS2 Ltd has provided greater detail regarding their cost estimates, these continue to be disputed by HC. In response to representations from Boris Johnson at a meeting in August, the Secretary of State for Transport agreed to commission an independent review of the HS2 Ltd cost estimates contained in the Hillingdon Working Group Report.

4. Following the meeting, the Secretary of State has issued the letter at **Annex A**, which explains that having fully reviewed the Hillingdon Working Group Report he is minded to agree with the decision made by the HS2 Commons Select Committee that the case for a tunnel has not been made. The letter also indicates that in light of local concerns regarding the HS2 Ltd cost estimates, he intends to appoint one of the Department's Non-Executive Directors to review the cost estimates presented in the Working Group Report to provide an extra level of assurance in making a decision.

Independent Review

5. It is requested that you undertake a review of the HS2 Ltd cost estimates contained in the Hillingdon Working Group Report, which compare the costs of the HC tunnel option and the viaduct scheme contained in the HS2 Phase One Bill.

6. In undertaking the review, it is requested that you consider:

- Whether HS2 Ltd have applied a reasonable and consistent approach in calculating the cost estimates for the tunnel and viaduct options;
- Whether HS2 Ltd has applied a consistent approach to the make-up of the tunnel and viaduct options; and
- Whether HS2 Ltd has applied a consistent approach to taking account of cost opportunities and risks.

7. In addition, it is noted that due to commercial sensitivities regarding the ongoing procurement of HS2 construction contracts, it has not been possible for HS2 Ltd to share details of the construction rates used to calculate the cost estimates. It is, therefore, requested that as part of the independent review, that you undertake a private review of reasonableness of the commercially sensitive construction rates used HS2 Ltd for the purposes of the cost estimates.

8. The review is not expected to consider the overall engineering design or terrain conditions, nor repeat the work of the House of Commons Select Committee and the Hillingdon Working Group in areas other than the HS2 Ltd cost estimates.

Timing

9. It is requested that following completion of your review, you report to the Secretary of State by Friday 7 October 2016.

September 2016

Hillingdon Council's position statement in response to HS2 Ltd's assessment of the relative costs and impacts of the Colne valley tunnel and viaduct scheme

INTRODUCTION

Following the Secretary of State's agreement in May 2016 to establish a joint working group to look again at the merits of both a tunnel and viaduct in Hillingdon, the Council has engaged constructively with HS2 Ltd and the DfT to contribute to this work.

The Council engaged the services of Peter Brett Associates (PBA) to explore the technical and construction cost elements of both options. It also engaged the services of Regeneris Consulting, because it was agreed that it is vital that the cost differentials between the surface scheme and the tunnel options are assessed not just in terms of the construction costs but also the environmental and socioeconomic costs.

This Statement summarises the work of PBA and Regeneris, which is contained within their separate reports. In particular it draws out the main conclusions for the cost differences between the tunnel and viaduct options.

COMPARISON OF CONSTRUCTION COSTS

Hillingdon Council commissioned PBA to contribute to the Tunnel Working Group and to reassess the comparative construction costs of the viaduct and tunnel options. PBA's report builds on its earlier work 'HS2 Tunnel Extension: Reducing the Environmental, Social and Economic Burden in Hillingdon' which was published in December 2014. In addition, it takes account of the reports by HS2 Ltd including the:

- 'HS2 Proposal for Northern Extension of Northolt Tunnel SIFT Report' dated 2nd March 2015 and
- 'HS2 Engineering Review of HS2 Tunnel Extension Proposal by London Borough of Hillingdon for a tunnel through the Colne Valley'.

During the course of the Tunnel Working Group, it was agreed that the Proposed Scheme (viaduct scheme) should be compared with the HS2 Tunnel Option C scheme, which was largely based on the Option C contained with 'HS2 Proposal for Northern Extension of Northolt Tunnel SIFT Report' dated 2nd March 2015.

There are a number of factors which constrained PBA's work including:

- information provided by HS2 Ltd (including comparative costs) was not made available early on in the project and some subsequent information was inconsistent.

- further information was made available at a later stage but unfortunately it contained gaps and inconsistencies. In the absence of information, PBA have had to make reasonable assumptions.
- some of the information required further clarification and there was insufficient time left to carry out a detailed assessment.

PBA's assessment makes it clear that there is potential for the difference in the construction cost between the Proposed Scheme and the HS2 Tunnel Option C to be between £59 million and £81 million, rather than the difference estimated by HS2 Ltd of £273 million. This difference is considered to be relatively marginal in a scheme of this magnitude and does not take account of the socio-economic impacts of the proposed scheme that are identified by Regeneris.

The difference between the figure of £273 million and £81 million arises largely due to a number of key opportunities for substantial reductions, which include the following:

- £20m opportunity for sustainable placement of tunnel arisings
- £14m opportunity by redesigning the portals in the intervention gap
- £27m opportunity by using circular shafts and optimising design/spacing
- £25m opportunity in refining alignment and design of intervention gap
- £35m risk to viaduct through more extensive foundation requirements
- £61m difference due to standard applied %age for Indirect Costs

These amount to a £182m effect on the differential costs

The difference between the range of £81 million and £59 million is due to the comparison against the “with” and “without” Chiltern Tunnel totals. There appears to be a hidden cost of £22 million within the Chiltern Tunnel elements, which PBA have not been able to identify.

COMPARISON OF THE WIDER SOCIO- ECONOMIC AND ENVIRONMENTAL COSTS

Hillingdon Council commissioned Regeneris Consulting to contribute to the Tunnel Working Group and to reassess the socio-economic and environmental impacts on the borough, building on its previous report 'London Borough of Hillingdon HS2 Impacts Study - A Final Report' which was published in December 2014.

As with PBA, a number of factors constrained the work of Regeneris including:

- the fundamental difference of opinion between HS2 Ltd and Regeneris on the assessment framework for assessing economic impacts.
- HS Ltd did not provide any costs relating to the wider socio-economic and environmental impacts on the borough because they use a

'national welfare economics based approach' which assesses the impacts of HS2 at a high strategic level on a route wide basis.

- Regeneris have focused their analysis on the local economic impacts of the two options using the DfT Webtag guidance for Regeneration Impacts, which has been used to assess the local economic impacts of transport infrastructure schemes since 2014.
- late and inconsistent information provided by HS2 Ltd, for example relating to the landtake for the two options. Where information was imperfect or unavailable, Regeneris have taken a pragmatic approach and made reasonable assumptions.
- some of the information required further clarification and there was insufficient time left to carry out a detailed assessment.

The work by Regeneris which is set out in 'LB Hillingdon HS2 Impacts Study – July 2016 update' shows that the quantifiable wider costs in Hillingdon associated with HS2 could amount to at least £14.75 million. It should be noted that this excludes any costs relating to property values and noise impacts because there was insufficient information to carry out any analysis. It also excludes any costs associated with financial impacts that may be covered by statutory compensation. These figures also exclude the unquantifiable impacts of HS2 such as loss of habitats; the impact on landscape character; the harm to visual amenity; the closure or unacceptable diversions to public rights of way; and the reduced business investment due to weakened confidence in the area.

The conclusions in Hillingdon's Report on 'HS2 Colne Valley Tunnel Extension Working group - Significant Effects Comparison' confirm that 'There is agreement with HS2 Ltd that the environmental effects of a tunnel scheme are significantly better than the surface scheme'. The Report goes on to state 'However, the Council considers that HS2 Ltd's findings are based on overly cautious assumptions of the tunnel scheme effects, understatement of surface scheme effects and /or lack of acknowledgement of a host of other surface scheme effects. As a consequence, the Council's opinion is that the environmental performance of the tunnel scheme is far better than given credit for by HS2 Ltd.'

CONCLUSIONS

The Tunnel Working Group has been useful in reviewing the merits of the two options i.e. the Colne Valley tunnel and viaduct in Hillingdon.

As a result of this work, PBA's assessment makes it clear that there is potential for the difference in the construction cost between the Proposed Scheme and the HS2 Tunnel Option C to be between £59 million and £81 million, rather than the difference estimated by HS2 Ltd of £273 million.

The work by Regeneris shows that the quantifiable wider socio-economic costs in Hillingdon associated with HS2 could amount to at least £14.75 million. If these wider costs were taken into consideration, the cost difference would reduce to between **£44.25 million and £66.26 million.**

The above assessment indicates that the cost difference between the tunnel and viaduct option is likely to be marginal, particularly in a scheme of this magnitude. This therefore casts doubt on the decision to dismiss the Colne Valley tunnel.

We believe that the tunnel construction costs have been significantly over-estimated and we do not believe that the wider costs of the viaduct scheme have been properly considered by HS2 Ltd. There was insufficient time for the Tunnel Working Group to carry out a full assessment of the viaduct and tunnel options and notwithstanding this, the Tunnel Working Group did not allow for proper independent scrutiny.

There still remains much uncertainty about the HS2 Bill scheme and to date HS2 Ltd has not been able to provide sufficient proposals to offset the severe and prolonged constructional and operational effects of HS2 in Hillingdon. Many of the mitigation costs for the viaduct scheme are as yet unclear. Based on our assessment, we still maintain that there is a strong justification for a tunnel across the whole of Hillingdon.