

A303 Amesbury to Berwick Down

TR010025

Deadline 8

**8.52.3 – Written summary of oral submissions put at
Flood risk, groundwater protection, geology
and land contamination hearing
on 29 August 2019**

APFP Regulation 5(2)(q)

Planning Act 2008

The Infrastructure Planning (Examination Procedure) Rules 2010

September 2019



Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Examination Procedure)**Rules 2010****A303 Amesbury to Berwick Down****Development Consent Order 20[**]**

**Written summary of oral submissions put at Flood risk,
groundwater protection, geology and land contamination hearing
on 29 August 2019**

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1 Introduction

- 1.1.1 This note summarises the submissions made by Highways England ("the Applicant") at the Flood Risk, Groundwater Protection and Land Contamination hearing held on 29 August 2019 ("the Hearing") in relation to the Applicant's application for development consent for the A303 Amesbury to Berwick Down project ("the Scheme").
- 1.1.2 Where the Examining Authority ("the ExA") requested further information from the Applicant on particular matters, or the Applicant undertook to provide further information during the hearing, the Applicant's response is set out in this document. This document does not purport to summarise the oral submissions of parties other than the Applicant, and summaries of submissions made by other parties are only included where necessary in order to give context to the Applicant's submissions in response, or where the Applicant agreed with the submissions of another party and so made no further submissions itself (this document notes where that is the case).
- 1.1.3 The structure of this document follows the order of items published by the ExA on 22 August 2019 ("the Agenda"). Numbered agenda items referred to are references to the numbered items in the Agenda. The Applicant's substantive oral submissions commenced at item 3 of the agenda, therefore this note does not cover items 1 and 2 on the agenda which were procedural and administrative in nature.

Written summary of the Applicant's oral submissions

3 FLOOD RISK AND DRAINAGE	
3.1 Drainage design and climate change allowances	
Agenda Item	Highways England response
<i>i. 40% climate change allowance for peak rainfall intensity – update and discussion.</i>	Mr Paul Brown QC , on behalf of Wiltshire Council and Ms Katherine Birt , on behalf of the Environment Agency, confirmed that both parties are content that the climate change allowances within the OEMP are adequately expressed and that no further discussion is required on the point.
<i>ii. Is additional wording required in either MW-WAT14 of the OEMP or Requirement 10 of the dDCO to specify the capacity of the drainage design?</i>	<p>Mr Brown QC, on behalf of Wiltshire Council, set out that the Council still believe that additional wording (noted below) is required to be added to MW0WAT14 to enable overarching design principles for detailed design to be set out on the face of the document – this will help the contractor and interested parties understand the parameters that will be expected to be attained. Mr Garry Thomset, on behalf of the Environment Agency, set out that the Environment Agency agrees with Wiltshire Council's position on this matter.</p> <p><u>Wiltshire Council Proposed Wording (as expressed in their Deadline 5 and 7 submissions</u></p> <p><i>“...surface water drainage (including road drainage) system reflects....with Requirement 10 of the DCO and shall be designed to:</i></p> <p><i>a) Maintain pre-development runoff rates (peak flow and volume) for the 1, 30 and 100 year rainfall events;</i></p> <p><i>b) Convey the 1 in 30 year rainfall event without causing flooding to any part of the site;</i></p> <p><i>c) Manage the 1 in 100 year rainfall event within the site without causing flooding to any building (including a basement) or in any utility plant susceptible to water (e.g. pumping station or electricity substation);</i></p> <p><i>d) Manage flows from rainfall in excess of the 1 in 100 year rainfall event in routes that minimises the risks to people and property;</i></p>

e) Provide a 40% uplift in peak rainfall intensity to allow for climate change in accordance with Environment Agency guidance;

f) Enable automated control of the tunnel drainage.”

Mr Richard Turney, on behalf of the Applicant, explained that this provision is not required. Requirement 10 of the DCO establishes a process for the detailed design of the drainage to be approved by the Secretary of State in consultation with the Environment Agency and Wiltshire Council, and for this to be based on the mitigation measures in the ES, which includes the Road Drainage Strategy [REP2-009]; a document which in any event reflects what is requested by Wiltshire Council.

This is explained further by the Applicant below:

a) The Road Drainage Strategy [REP2-009] provides commitments on the runoff rates from the proposed scheme which are more onerous than those listed by Wiltshire Council. To the west of the tunnel, the runoff will be attenuated and then infiltrated to ground. This means there will be no runoff from these catchments up to and including the 100 year + climate change event. The tunnel is a self-contained system which does not receive direct rainfall and therefore is not impacted by the criteria. Finally, to the east of the tunnel the Road Drainage Strategy makes a commitment to ensure that the rate of runoff from the scheme which ultimately discharges to the Avon is reduced by 20% (as originally requested by the Council during consultation) when compared to existing rates thus providing betterment. This is set out in paragraphs 3.2.4 and 5.2.3 of the Road Drainage Strategy.

b) The criteria listed here are normally associated with drainage systems adopted by a drainage board or water authority, not a highway authority. The Road Drainage Strategy design for conveyance will be in accordance with the criteria in DMRB HD33/16 (as set out in paragraph 2.2 of the Road Drainage Strategy), which are more appropriate than the Council's suggestion. For example, the Design manual for Roads and Bridges include specific standards for road drainage which take in to consideration road features not present in non-highway developments. These include hard strips/hard shoulders and verges which allow the highway to contain flood waters away from the running carriageway ensuring a safe environment for the motorist.

c) The Road Drainage Strategy paragraph 3.2.4 outlines the criteria the new road drainage systems will be designed to. The DMRB requires the design to ensure no flooding from the site in a 100 year event with an appropriate allowance for climate change. The use of a 30% climate change allowance for the road drainage systems has also been agreed with the Council. As the requirement to achieve this is already embedded within the Road Drainage Strategy, it would be inappropriate and unnecessary to duplicate this requirement in the OEMP.

d) Information regarding the exceedance routes from the drainage features provided for in the Road Drainage Strategy has been provided to the Council demonstrating no risk to people or property from that design. The information provided to the Council also demonstrated that storm events up to and including the 1000 year return period event can be contained within the

	<p>basins without overtopping. Therefore the criteria requested by the Council are already included within the application in the Road Drainage Strategy (and the DMRB that will inform the detailed design that is referenced within it).</p> <p>e) The climate change allowances provided within the design have now been agreed with Wiltshire Council. A value of 30% climate change allowance will be utilised for the Road Drainage systems (as is secured through the Road Drainage Strategy) and a 40% allowance will be utilised in the detailed design of the land drainage systems (secured through reference to the 'appropriate allowance' (as it may change over time) as set out in item MW-WAT13 of the OEMP).</p> <p>f) Please see item 3.2ii below.</p>
3.2 Road Drainage Strategy	
Agenda Item	Highways England response
<p><i>i. Are the pollution prevention measures sufficient?</i></p> <p><i>a. Are standards in excess of DMRB HD45 required? If so, how should this be secured?</i></p> <p><i>b. Are the measures to manage pollution risk in the Drainage Treatments Areas adequate?</i></p>	<p>Mr Thomset, on behalf of the Environment Agency, set out that although the Agency are generally content with the road drainage proposals, it wished to see the DCO, OEMP, or Road Drainage Strategy make specific provision for the fact that the design may need to go further than HD45 and that the Drainage Treatment Areas need to be of a sufficient size to provide pollution control. Mr Brown QC, on behalf of Wiltshire Council, agreed with the Environment Agency.</p> <p>Both parties considered that providing these statements on the face of the application will save time and expense when the contractor comes on board and avoids a paper chase of needing to consider documents such as the SoCG between the parties.</p> <p>Mr Turney, on behalf of the Applicant, explained the Applicant's view that these are all matters of detailed design that will be able to be resolved through the Requirement 10 process. The important point is that the Secretary of State will be determining if the <u>design</u> is appropriate for this Scheme, taking account of the local environmental considerations - if this requires more than HD45 provides, then so be it. No statement is therefore required on the face of the DCO, OEMP, or Road Drainage Strategy.</p> <p>It should also be noted that, as reported in the Chapter 11 of the Environmental Statement [APP-049], on the basis of the mitigation set out in the Road Drainage Strategy, the assessment concluded that there would be no likely significant effects on the water quality of the River Till and the groundwater, and a likely significant beneficial effect on the water quality of the River Avon.</p>
<p><i>ii. Should the nature of the tunnel drainage (manual or</i></p>	<p>Ms Carly Van De Kirk, on behalf of Wiltshire Council, set out that the Council considers that the Applicant should be required to commit to automated drainage control measures, noting that it is, in the Council's view, the most robust form of control allowing for the quickest response time; and will allow for concerns as to whether there would be sufficient pollution storage to</p>

automated) be secured at the pre-consent phase? If so, how (for example in the OEMP or dDCO Requirement 10?

be allayed. Furthermore Ms Van De Kirk considered that a decision needs to be made as there is no DMRB standard to fall back upon – it needs to be a specific parameter.

Mr Thomset, on behalf of the Environment Agency, agreed with the Council and explained that the Agency wanted to reduce the potential for human error and minimise risks. He stated that the Agency cannot envisage a scenario where it would say yes to a manual control as part of the Requirement 10 process, so any flexibility now would be meaningless and waste time in the future.

Ms Kate Hunt, on behalf of the Applicant set out that flexibility is needed for detailed design, noting that even manual operation is done remotely. Ms Hunt explained that if the valve was to operate automatically it would work on a variety of different inputs – some of which are complex. The valve would interpret signals from a number of different triggers, including some complex, interpreted data so there is potential that automatic activation from these interpreted signals could be less robust than manual controls, leading to increased activation of the valve, increasing the maintenance burden on the impounding sump. The detailed designer will need the flexibility to optimise the inputs to be sure that they would neither overload the valve nor be less robust than necessary, and as such there should not be a specific direction within the application documentation. Please see further discussion on this point in the Applicant's response to SWQ Fg 2.14 [REP6-028].

Mr Turney, on behalf of the Applicant, noted in response to the Council that item 3.28.14 of the SoCG with Wiltshire Council does not commit to automatic valves, just 'where relevant'. It was agreed at the Hearing that this issue should be moved to the 'Not Agreed' section of the SoCG.

Mr Andrew Rhind Tutt expressed concern that if the drainage system does not work quickly (i.e. pursuant to an automatic control as expressed by the Environment Agency) this could lead to water affecting the power supply for the system, leading to failure and consequential possible effects to Blick Mead.

Mr Turney, on behalf of the Applicant, explained that the drainage system will have a power failsafe and that more detail would be provided in this summary note. This is therefore explained below:

- 1) The quantity of water during a strong downpour would not present a significant challenge to the tunnel drainage system

The tunnel drainage system is fully independent of the surface highway drainage system: any rainwater falling on the open carriageway is conveyed by the surface drainage system and is not permitted to enter the confines of the tunnel. This is confirmed in Section 4 of the Drainage Strategy [REP2-009]. Thus the only water arriving at the low point sump inside the tunnel is from the minimal tunnel infiltration water passing through the tunnel lining, from liquid falling onto the tunnel carriageway (during normal operations this would be from wet vehicles entering the tunnel but not rainfall on the adjacent open air carriageway), and any liquid from incidents (i.e. fire fighting water or spillage incidents) or from planned maintenance activities (tunnel wall washing).

	<p>The tunnel drainage is required to be sized to contain and convey any and all of these flows, by Highways England’s design standard BD78/99 (part of the DMRB). The flow rates involved during spillage events, fire fighting or planned maintenance events are substantially greater than the “normal operations” inflow rates and, therefore, heavy downpours do not present a significant challenge to the capacities or pumping rates of the tunnel drainage system.</p> <p>2) Failure of an incoming power supply would not be detrimental to the operation of the tunnel drainage system</p> <p>Highways England’s DMRB specifically requires the tunnel to be powered by two fully independent power supplies, backup power in the form of an uninterruptible power supply (UPS) and, if necessary, a diesel generator. Either of the two incoming power supplies alone will have sufficient capacity to power the entire tunnel indefinitely. The tunnel drainage system design will be fully compliant with this requirement for it to be approved. In addition, as explained in our written response to question Fg2.14, on loss of power the diverter valve would move to its “fail safe” position (diverting water to the impounding sump) and so under total loss of power the surface drainage system would be protected from tunnel discharges.</p> <p>It should be noted that because of the significant disparity between the inflow rates during normal operations and during maintenance, spillage or fire fighting activities, the tunnel drainage pumps will not be operating 24 hours a day during normal operations – in fact, the drainage system pumps will operate only infrequently and for short durations under normal operations. For the majority of the time, the minor inflow of water will simply be contained within the tunnel low point sump until the levels rise high enough for the pumps to switch on and pump out the low point sump.</p> <p>Therefore, the failure of a single incoming power supply has no material impact on the operation of the tunnel lighting nor the tunnel drainage system and there is no credible risk of the tunnel flooding under these conditions.</p>
3.3 Field Drainage	
Agenda Item	Highways England response
<i>i. Are the controls in the OEMP (for example MW-COM7) adequate?</i>	<p>There were no comments from Interested Parties on this agenda item at the Hearing.</p>
<i>ii. Are the reporting criteria acceptable? For example, does the wording “if</i>	<p>Mr Turney, on behalf of the Applicant, confirmed that 'if required' refers to if a drainage <u>design</u> needs to take place after the survey, which will not necessarily be needed in every occurrence. The wording in reporting criteria column has therefore been updated at Deadline 8 to refer to “any design” rather than “design (if required)” to clarify this point.</p>

<i>required” introduce uncertainty?</i>	
3.4 Flood Risk Assessment	
Agenda Item	Highways England response
<p>i. Update on the outstanding matters raised by Wiltshire Council including related Protective Provisions.</p>	<p>Wiltshire Council and the Environment Agency confirmed that the FRA and protective provisions are now fully agreed with the Applicant.</p> <p>There was discussion at the Hearing as to how the conclusions and commitments given in the peer review process of the FRA should be reflected in the Scheme documentation, noting that the Applicant had committed in its SoCG with Wiltshire Council to take these points into account as part of the Requirement10 process.</p> <p>In response to this, Mr Turney, on behalf of the Applicant, set out that:</p> <ul style="list-style-type: none"> • Both bodies would be able to check this through the Requirement 10 process. • It is not appropriate for the peer review process to be appended to the FRA and an update to that document to be submitted. That document is not secured through a DCO requirement and so updating the FRA would not bolster its status in any way. • Requirement 10 refers to 'mitigation measures in the ES'. Whilst the FRA is included as part of the ES, the FRA does not set out mitigation measures, it just refers to them in making its assessment. Thus, updating the FRA does not achieve the 'securing' of the peer review process. • Requirement 10 deals with the detailed design process - in putting that detailed design forward the detailed designer will need to re-assess that the design achieves the same results as the ES (which the peer review process clarified) and so Wiltshire Council will be able to consider this as part of considering the detailed design. <p>In any event, the Applicant is willing to discuss with Wiltshire Council if any changes can be made to the OEMP to reflect the peer review process.</p>
<p>ii. Flood risk policy in the National Policy Statement for National Networks</p>	<p>Wiltshire Council and the Environment Agency confirmed at the Hearing that, further to the peer review process, they are content that the Scheme is compliant with the flood risk policy in the NPSNN.</p>

3.5 Need for additional drainage engineer post for Wiltshire Council	
Agenda Item	Highways England response
n/a	<p>Mr Turney, on behalf of the Applicant, confirmed that the Applicant accepts the principle that it should pay the costs of Wiltshire Council in respect of their approvals pursuant to the DCO, but it must be limited to that, rather than the costs of the Council's wider statutory duties.</p> <p>This principle is reflected in paragraph 24 of the Protective Provisions and will also be reflected in the Side Agreement between the parties. Discussions continue on the detail on the point (including whether a specific post is required), but it is considered that there is nothing in this discussion that need affect the ExA's reporting on drainage issues.</p>
4 CONTAMINATION (INCLUDING GROUNDWATER CONTAMINATION)	
Agenda Item	Highways England response
<p>i. Whether the controls in dDCO Requirement 7 and the OEMP (for example PW-GEO1, PW-GEO2, MW-GEO6, MW-GEO7, MW-GEO8, MW-WAT6, MW-WAT7) are adequate.</p> <p>ii. Is any other pre-commencement survey work necessary or are the proposed controls adequate?</p>	<p>Ms Van de Kirk explained that Wiltshire Council are still concerned about pre-commencement survey information and support the Environment Agency's desire for more controls over pre-commencement work.</p> <p>Mr Thomset, on behalf of the Environment Agency, explained that the Agency are concerned that Requirement 7 of the DCO only applies to unexpected contamination. The Agency is concerned about discovery of contamination even where reported in the ES. The Agency's ask for a new requirement for pre-commencement surveys and investigation aligns with standard measures under the TCPA regime. It is considered by the Agency that the Applicant has been reactive rather than proactive in its consideration of contamination issues.</p> <p>Mr Turney, on behalf of the Applicant, pointed out that the Applicant had been proactive, given the on-going Phase 7 surveys being undertaken and explained below; but agreed with the ExA that the results of these surveys would not be able to be considered as part of the Examination.</p> <p>Mr Turney then went on to explain that item MW-GEO8 of the OEMP had been updated on 20 August to provide for proposed work areas located within 50m of potential or known areas of land contamination, as identified in the Environmental Statement, to be investigated (and if necessary, mitigated) in line with CLR11, a process which involves engagement with stakeholders such as the Agency and Wiltshire Council. It is considered that this update (further to the raft of other measures within the MW-GEO series of items) reflects the standard practice for dealing with such issues and ensures that contamination issues will be dealt with appropriately. This matter was discussed further at the Issue Specific Hearing on the DCO on 30 August, where the EA requested further wording to be added to item MW-GEO8 in respect of the EA's role within that framework. Please see the summary of oral submissions of that hearing.</p>

	<p>Dr Kate Fielden, on behalf of the Stonehenge Alliance, asked if there would be monitoring at the SAC in respect of contamination issues. The Applicant can confirm that monitoring of the vegetation at the SAC is secured through MW-BIO3 of the OEMP, and that monitoring of the water environment will be considered as part of the Water Management Plan required by item MW-WAT2.</p>
<p>Update on the Phase 7 surveys</p>	<p>The Applicant explained that:</p> <ul style="list-style-type: none"> • The Phase 7 ground investigation is a 2-year ground investigation programme in two phases (7A and 7B). The first phase in 2019 is to provide identified supplemental information to inform the main works tender design. • Phase 7A was also split into two parts to accommodate landowner harvesting requirements. 7A(i) comprised exploratory holes needed for the design of green bridges but included where the proposed scheme crossed RAF Stonehenge and RAF Oatlands Hill and so some contamination testing was undertaken. This was completed 3-4 weeks ago on site. The Contractor returned on the 19th August 2019 to commence 7A(ii) which is currently programmed to finish on 20th September 2019, which also includes additional investigation in the former RAF Oatlands Hill. • The Phase 7Ai Factual Report is currently being compiled by the ground investigation contractor and a draft is expected for review by Highways England on the 13th September, a finalised version is to be issued by the ground investigation contractor to Highways England by the start of October. <p>Tenders will be invited in late 2019. Going forward it is Highways England's intention to work with tenderers to finalise the ground investigation scope for 7B and its interpretation to support their design whilst also taking onboard the views of stakeholders. Phase 7B is currently programmed for Q2 2020.</p>
<p>5 PRIVATE WATER SUPPLIES</p>	
<p>Agenda Item</p>	<p>Highways England response</p>
<p>i. Whether the controls in the OEMP (for example MW-WAT2, MW-WAT4, MW-WAT10, MW-WAT11, MW-WAT15, MW-COM6) are adequate?</p>	<p>Mrs Hosier, Fowler Fortescue on behalf of the Turner Family and Mr Howard Smith on behalf of Mr Whiting set out that they considered that the provisions of the OEMP are not adequate, despite the recent changes to it further to the NFU's requests. The parties set out that the provisions of MW-COM6 need to be more specific, provide for replacement supply as soon as possible, enable water supply from neighbouring land if required, provide for a mains supply to each farm that can be used as an auxiliary supply if need be and include an undertaking that all costs will be borne by Highways England or its contractors. The parties concluded by stating that it is not 'unlikely' that farmers' water supplies will be affected.</p> <p>Mr. Turney, on behalf of the Applicant, explained that the Applicant's assessments indicate that such effects are unlikely. MW-COM6 is deliberately not specific but instead provides a framework for the appropriate measures to be put in place that</p>

	<p>are suitable for the farm in question – including a framework for providing temporary replacement supply, that can be seen alongside the provisions of MW-COM7 which encompass the provision of permanent replacement supply.</p> <p>As the Water Supply Statements required by MW-COM6 need to be agreed pre-commencement of works, they will be able to reflect discussions with landowners and occupiers.</p> <p>Mr Turney went on to say that providing a mains supply everywhere across the Scheme would be disproportionate given the provisions of the OEMP and in any event may not be suitable for all locations.</p>
<p>ii. Should PW-WAT1 be expanded to specifically address monitoring and protection of private water supplies and should Wiltshire Council be consulted?</p>	<p>Mr Turney, on behalf of the Applicant explained that the Applicant considers that given the scale and nature of the preliminary works, the provisions for protection of the water environment contained within items PW-WAT1 to PW-WAT3 are sufficient to mitigate the risks to private water supplies.</p> <p>In a response to Mrs Hosier, Mr Turney also confirmed that private water supplies will be monitored as part of the Groundwater Management Plan and pursuant to item MW-COM6(b) of the OEMP.</p>
<p>iii. In the relevant sections of the OEMP, should Wiltshire Council's role be expanded to include its public health/ protection functions? [MW-WAT2]</p>	<p>Mr Turney, on behalf of the Applicant, confirmed that this has been provided for in item MW-WAT2 of the OEMP at Deadline 8.</p>
<p>6 TUNNELLING</p>	
<p>Agenda Item</p>	<p>Highways England response</p>
<p>Whether the OEMP (for example D-CH32, MW-WAT8, MW-WAT10) provides adequate controls (including reporting criteria,</p>	<p>Mr Turney, on behalf of the Applicant explained that item MW-WAT8 of the OEMP provides the basic measure (i.e. minimisation) and protection (i.e. the need to obtain dewatering licences) if required. This can be seen alongside item D-CH32 which requires a closed face tunnelling methodology for the main bores.</p>

<p><i>consultation and approval to minimise dewatering and abstraction?</i></p>	<p>Mr Thomset, on behalf of the Environment Agency, indicated that they agree with the Applicant's position but request that closed face tunnelling should also be required for cross passages.</p> <p>Mrs Marie Ayliffe, on behalf of the Applicant explained why this is not appropriate:</p> <ul style="list-style-type: none"> • The current limitations with TBM technology, and particularly mini TBMs, will make it very difficult to build the cross-passages using a closed-face technique without adversely impacting and increasing the diameter of the main tunnel bore. The increase in diameter is as a direct result of the geometry and the flat surface required for starting the mini TBM drive and waterproofing connection between the two tunnels. • Irrespective of the geometry issue, the technology associated with mini TBMs is in the relatively early stages of development and to the Applicant's knowledge has only been used on one subsea tunnelling project in Hong Kong (Tsuen Mun Chep Lap Kok) where the increase in main tunnel diameter could be accommodated. The size of cross-passage required for emergency evacuation is also beyond the limit of what can be constructed by micro-tunnelling pipejacking. • Therefore the Applicant does not consider that it is practical to limit cross-passage construction to closed-face techniques as this is not supported by available technology. In addition, there is no closed-face tunnelling technology available to form the larger M&E plant rooms from the tunnel. • Traditional cross-passage construction relies on grouting a plug of ground from the main tunnel, excavation in stages with suitable ground support installed if required and local face depressurisation to effectively drain residual groundwater from the plug. It does not require wholesale dewatering and reduction of groundwater levels; the effects of face depressurisation are much more localised and of a much smaller scale. There should therefore be no concern that large scale dewatering could occur if closed face tunnelling is not mandated. • By way of example, the most relevant and recent cross-passage construction in chalk geology in the UK using traditional open-face methods is from Crossrail C310 North Woolwich to Plumstead under the River Thames as shown in the image below. • The twin 7.12m diameter 2.6km Thames Tunnels were driven under the River Thames at 10-12m cover. The site geology consists of the Chalk Group (Haven Brow Beds and Cuckmere Beds) with intermediate flint layers. The groundwater hydrology was controlled by two aquifer systems made up of the Upper Chalk and overlying floodplain Terrace Gravels, which are in hydrostatic contact and connected directly with the River Thames. As such, groundwater levels changed daily in response to the tidal motion of the River Thames with a variation of over 8m causing face pressure changes of approximately 0.8bar. Therefore the support pressure had to be constantly reviewed and adapted. • Construction of the cross-passages was undertaken using staged excavation and sprayed concrete lining techniques to reduce the permeability of the chalk and reduce water inflow. Fissure grouting was carried out for the two cross-
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passages under the River Thames from the main tunnel bores. The success of grouting was proofed with probe drilling before the segments were removed. The slide shows the means of construction with support to the ground above the cross-passage tunnel using spiles, combined with local depressurisation of the excavated surface in conjunction with staged excavation and installation of a sprayed concrete lining to form the cross-passage. There was no need to dewater and indeed this would not have been possible considering the particular geology and hydrogeology at the location.

- The Applicant would therefore conclude that it is not appropriate to restrict cross-passage construction to closed-face technology which pushes at the boundaries of what is able to be achieved. Open-face techniques are available that satisfy the requirement to minimise dewatering and have been proven on other major infrastructure projects including Crossrail.
- In response to a comment from Wiltshire Council, it is also confirmed that providing for one form of technique within the OEMP would also not be appropriate - it would restrain flexibility for an issue that will need to be managed through the detailed design and construction process.

Crossrail C310

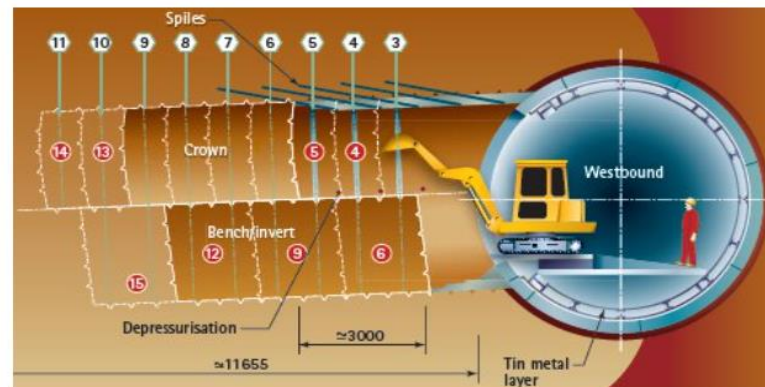


Figure 5, Construction procedure for cross passages

Slide extract from the British Tunnelling Society Evening Meeting, 10th October 2014, as published in Tunnels & Tunnelling International.

Presentation by Dr Reeves

The Applicant's response to the presentation of Dr Reeves at the Hearing and the cover letter with which it was submitted in Appendix A to this document.

7 REQUIREMENTS AND OEMP

Agenda Item	Highways England response										
<p><i>i. Any other proposed alterations to the Requirements in the dDCO, or the OEMP [limited to matters relating to flood risk, groundwater protection, geology and land contamination] not already discussed; to include the amendments to the OEMP suggested by Wiltshire Council in [REP7-043] and the Environment Agency [REP7-045] (for example dDCO Requirement 3, MW-G7, MW-WAT3, MW-WAT10, MW-WAT12, MW-WAT13 and Annex A.3 of the outline Soils</i></p>	<p>In the tables below, the Applicant sets out its response to the matters discussed at the Hearing under this item.</p>										
	<p><u>Wiltshire Council Requests</u></p>										
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Management Strategy).		made here due to its multi-faceted functions and statutory role.	
	MW-WAT3	<p>the Council requires that the text is amended to state: "Wiltshire Council and the Environment Agency" as Wiltshire Council is the statutory authority leading on surface water flood risk management, so the EA cannot speak on the Council's behalf.</p> <p>The Council notes that this text has been accepted by HE for the new PW-WAT3.</p>	This change has been made to the OEMP at Deadline 8.
	MW-WAT12	With regard to point b) of MW-WAT12, the Council requires that the text is amended to state: "...pursuant to the Environment Agency's and Wiltshire Council's protective provisions in the DCO,...".	This change has been made to the OEMP at Deadline 8.

	MW-WAT13	<p>Following the post construction groundwater monitoring, Highways England will provide data collected and allow the Environment Agency/Wiltshire Council to adopt the boreholes to inform their groundwater flood warning service.</p> <p>Once further modelling work is completed by Highways England at detailed design stage, meeting the standards for flood map updates, the Environment Agency and Wiltshire Council can utilise this modelling work to update the fluvial, pluvial and groundwater flood map.</p>	A change has been made at MW-WAT15 at Deadline 8 to facilitate the sharing of monitoring data.
	Soils Management Strategy	The Council welcomes the inclusion of an outline Soil Management Strategy at Annex A.3. With regard to section 2.1.3, the Council considers that an additional bullet point is required to state, “ h) the drainage characteristic (permeability, conveyance etc.) of each soil horizon ”.	This change will be made to the OEMP at Deadline 8.
	Soils Management Strategy	<p>In section 3.1.3 of Annex A.3., the Council recommends that the following additional wording is included so that it would read: “...This will be determined on a case-by-case basis, but for avoidance of doubt will include any activity associated with implementing the authorised development, and will be informed by:...”.</p> <p>Furthermore, the Council requires that an additional point d) is added to this paragraph which states, “d) the drainage</p>	The first suggested change by the Council is not agreed. This is because it may be that the activity on the land parcel will not affect the soil, and so an arbitrary provision that all activities must be subject to a Soils Handling Strategy is not appropriate. The ‘determined on a case by case basis’ refers to the details of the method statements, not whether one is required or not. As stated within 3.1.1, ‘the Contractor shall prepare a Soil Handling Strategy for each land parcel where there is the potential for the disturbance of soil resources’. This therefore incorporates any activity associated with the authorised development which has the potential to disturb soil and, as such, no amendment is required.

		characteristics of the soil both above and below ground.	<p>At the Hearing, Mr Turney acknowledged the Council's concern that paragraph 3.1.2 of the SMS should not be a closed list. A change has been made to the SMS at Deadline 8 to resolve this issue.</p> <p>Paragraph (d) will be added to the OEMP at Deadline 8.</p>
	Soils Management Strategy	In section 3.1.4 of Annex A.3., the Council requires that an additional point is added to this paragraph which states, " n) the methods to be used to maintain the existing drainage characteristics of each land parcel (infiltration, conveyance etc.) and manage the risk of compaction that may affect the drainage characteristics. "	This change will be made to the OEMP at Deadline 8.
	Soils Management Strategy	With regard to section 3.19 of Annex A.3., the Council considers that the following scheme wide principle should also be emphasized and included here. " Water flows from sites will be limited during construction to existing runoff rates, unless otherwise agreed with Wiltshire Council and the Environment Agency in accordance with relevant legislation" (PW-WAT3 and MW-WAT3 (provided alternative drafting is accepted)).	This change will be made to the OEMP at Deadline 8.

<u>Environment Agency Requests</u>		
OEMP Item	EA Request	Applicant Response
MW-WAT12	<p>Depending on the level of dewatering required if the applicant does have to change their construction methodology, the amount of water from dewatering may have a potentially significant impact due to the quantity being released and the risks this may cause downstream. Therefore this would need to be adequately managed. We therefore recommend some wording to be included in the OEMP similar to that provided below. MWWAT12 (Flood Risk Management Plan) would appear to be the best place to include this:</p> <p><i>“The construction method at present does not require any dewatering. It is essential that any changes to the detailed design are adequately risk assessed. The EA should be consulted on any updated design and risk assessment, and agreement reached with the EA regarding conclusions and any mitigation measures proposed. No works should commence until written agreement that these plans provide appropriate measures and mitigation to protect the site and surrounding area from flood risk during construction and operation of the scheme.”</i></p>	<p>Please see item 27.1.12 of Highways England's comments on Interested Parties' Deadline 6 submissions [REP7-021] which sets out the numerous controls within the OEMP which will limit and mitigate any dewatering that is required to be undertaken.</p> <p>Furthermore, item MW-WAT12 (d) sets out that the Flood Risk Management Plan must include <i>"any flood risk management or mitigation measures implemented, or to be implemented, in support of temporary and permanent works proposals"</i>.</p> <p>Such 'proposals' would include any dewatering that is deemed necessary. As such, the OEMP provisions already provide for the EA to consider such matters.</p> <p>Furthermore, the construction methodology (closed face tunnelling) is a non-dewatering methodology and is secured by item D-CH32 of the OEMP [REP6-012]. The contractor will be obliged to construct the tunnel using this methodology, therefore impacts of dewatering which have not already being considered are negligible. The Applicant does not propose to update the OEMP as suggested.</p>

Blick Mead

Further to discussions at ISH8, the ExA asked the Applicant to confirm if it had determined appropriate wording for item MW-WAT10 of the OEMP in respect of Blick Mead. Notwithstanding the Applicant's view that this is not required given the results of the ES in respect of Blick Mead and the fact that it is a receptor within the Groundwater Risk Assessment which will be considered as part of the re-assessment required by MW-WAT10, proposed wording has been developed in line with the Applicant's previous submissions that effects on Blick Mead must be seen in the context of groundwater matters as a whole. The proposed wording was read out at the Hearing, is set out below and is incorporated in the OEMP submitted at Deadline 8:

Ref	Source Ref.	Action / commitment (including specific location and any monitoring required)	Reporting criteria	Responsible person(s)
MW-WAT10	ES Chapter 11, section 11.7	<p>Groundwater Management Plan (GMP):</p> <p>The main works contractor shall develop a Scheme-wide GMP, outlining how groundwater resources are to be protected in a consistent and integrated manner. The Plan shall address:</p> <ul style="list-style-type: none"> a) Potential effects on groundwater (resources and quality) that fall outside other regulations such as the Environmental Permitting Regulations. b) An update to the Groundwater Risk Assessment for the final design and construction plan and which demonstrates that the final design and construction plan does not give rise to any materially new or materially adverse environmental effects in comparison with those reported in the environmental statement. 	<p>Secretary of State approval of the GMP as appended to the CEMP, following approval by the Authority.</p> <p>Consultation with the Environment Agency, Wiltshire Council, and Natural England with regard to elements of the GMP which may impact the River Avon SAC).</p>	Main works contractor

			<ul style="list-style-type: none"> c) The groundwater level and water quality monitoring/telemetry and reporting programme. d) Development of baseline groundwater conditions and derivation of trigger levels and action levels/mitigation/action plans for exceedances and accidents/incidents. e) The management of groundwater flood risk. f) In respect of all of the above matters, the Plan must specifically indicate how Blick Mead is to be considered <p>During the development of GMP, the main works contractor shall consult with the Environment Agency and Wiltshire Council with regard to the groundwater flood risk component and any heritage implications to Blick Mead and Natural England with regard to elements of the GMP which may impact the River Avon SAC (which incorporates a section of the River Till).</p>		
<p>It was agreed at the Hearing that it was appropriate for discussions as to a potential DCO Requirement to take place at the DCO Hearing due to take place the day after the Hearing. Highways England's submissions in relation to this issue are therefore contained within the written summary for that Hearing.</p>					

Appendix A - Dr Reeves Presentation & Stonehenge Alliance Cover Letter.

Dr Reeves Presentation & Stonehenge Alliance Cover Letter.		
Cover Letter 23 rd August 2019. Kate Fielden on behalf of Stonehenge Alliance.		
	Comment	Applicant Response
	I attach the latest version of his slides (for the convenience of having them together with his notes) and the notes to which he would refer in his presentation. The notes are more full than 10 minutes would allow and would be abbreviated for the presentation. They are provided at greater length in what is hoped will be more helpful detail to the reader.	No comment
	As Dr Reeves tried to explain on Wednesday, it seems that the complete picture of the geology and hydrogeology affecting the tunnel has not so far been fully explored or explained. He does have a pretty thorough knowledge of the situation, since he first became involved in A303 tunnelling proposals at Stonehenge at the 2004 Public Inquiry where he argued the (Stonehenge Alliance's) case for inadequate information and potential tunnelling problems on far less information at the time. The 2004 scheme was abandoned owing to a considerable increase in cost, primarily for the reasons Dr Reeves had put forward: the nature of the Chalk Rock and groundwater/water table problems – which had been dismissed by the Highways Agency at the Inquiry.	The Scheme is very different to the 2004 Scheme. It is less shallow and does not rely on dewatering for tunnelling – a commitment has been made to minimise dewatering and to the use of a closed face tunnel boring machine (D8 OEMP D-CH32). These are being widely used for tunnelling in Chalk (see examples in response to the summary section at the end of this table).
	We did ask recently (14 August) for more information on borehole data etc. but this has, so far, not been forthcoming.	As noted in the hearing the requested data consists of some 4000 pages of borehole information and raw data. The information, has not yet been subject to analysis but most

		<p>importantly, is not required to understand, and does not inform the assessment carried out in, the Environmental Statement or anything else in the Application, which was based on the information set out in the Preliminary Ground Investigation Report (GIR) [APP-273]. Submission of this data to the Examination is therefore not necessary or appropriate.</p>
	<p>Nevertheless, from Dr Reeves' on-going analysis of what has been supplied to date, I understand that the presence of impermeable/semi-impermeable Whitway Rock has apparently not been positively identified by Highways England (perhaps because the coring was not deep enough in places to encounter it) but it does appear to be present from the lower levels of some cores.</p>	<p>Highways England and Dr Reeves are using the same information. It is agreed that the Whitway/Stockbridge Rock is mapped by the British Geological Survey in the Seaford Formation approximately 5 to 10 m below the base of the Newhaven Chalk Formation. The Stockbridge Rock is not recognised or mapped to the north of Great Durnford around Amesbury and Stonehenge as shown by the geological map presented by Dr Reeves. It is also agreed that there is evidence in some of the A303 ground investigation boreholes of hard bands.</p> <p>Highways England does not agree that the hard bands are continuous for the following reasons:</p> <ul style="list-style-type: none"> i) there is no evidence of hard bands in boreholes in Stonehenge Bottom. ii) there is the possibility of hard bands in the valley sides but these are not continuous west to east because the Stonehenge Bottom valley cuts through the geological profile iii) the erosion associated with the phosphatic chalk removes the hard bands and iv) the presence of numerous faults reduces the continuity of hard rock bands.

	<p>This Whitway Rock horizon could have a profound effect on groundwater movement</p>	<p>There is no reason why the Whitway Rock would have a 'profound' effect on groundwater movement. Groundwater flows through a tortuous network of fractures and fissures and hard bands can locally concentrate flow but there is no evidence of the implied continuous zone of high flow for the reasons given above. Highways England's advisor Rory Mortimore has stated that "the evidence for concentrated groundwater along such horizons, including flint bands, is usually seen in field sections and borehole cores associated with karst features (especially tubular karst, Lamont-Black and Mortimore, 2000; Mortimore, 2014) and increased orange or black iron staining and mineralisation. There is virtually no evidence of heavy staining on joints and bedding found so far in the A303 Stonehenge area boreholes and trial pits". This implies that there is no evidence of significant karst features.</p>
	<p>which has crucial implications for tunnelling</p>	<p>As stated by Mr Turney at the hearing, in terms of tunnelling Highways England can see no impediment to tunnelling in this area for any of the reasons that Dr Reeves has attempted to set out in his presentation. Further details are provided in our response to Dr Reeves' summary text below.</p>
	<p>As I understand it, without full knowledge of the actual situation, then it might be argued that planned provisions for certain strategies might not be appropriate.</p>	<p>Highways England consider that there is sufficient information available within the application to understand the key impacts and have explained in more detail below why Highways England does not agree with the interpretation that has been made by Dr Reeves.</p>
	<p>If, in the event, it is not possible for Dr Reeves to speak to his presentation next week, I hope that his slides and notes will be accepted by the ExA as a written submission, as you indicated to me by email on Monday.</p>	<p>No comment.</p>

Notes to accompany Slides/Presentation on fundamental Issues of Groundwater Conditions relating to the proposed A303 Stonehenge Tunnel by Highways England. August 2019. Notes provided by Dr GM. Reeves.		
<p>Slide 1 - Introduction and purpose of contribution.</p>	<p>This set of slides and accompanying presentation is intended to supplement that given to the ExA on June 11th, and results from some considerable further work done by the author on available borehole logs, wireline geophysics and core information, tied in with local and regional geological maps and data (published by BGS, Soley et al., Mortimore et al. and other sources), to explain the relevance of the Whitway Rock horizon, from its outcrop at Blick Mead/Amesbury Abbey springs (which are fed by this significant sub-horizontal hydrogeological feature), westwards along the proposed A303 Tunnel route.</p>	<p>Highways England and Dr Reeves are using the same data sources. The Wessex Basin groundwater model relies on the work of Soley and this is the model used for the A303 assessment. The ES uses the same sources of data as Dr Reeves. Professor Rory Mortimore, whose geological interpretation is referred to by Dr Reeves, is an advisor to Highways England for the A303 Scheme.</p> <p>The comment that the Blick Mead/Amesbury Abbey springs are fed by a significant sub-horizontal hydrogeological feature is unfounded. If the rock band referred to as the Whitway Rock (also known in some areas as the Stockbridge Rock) was present it would be at an estimated height of around 95-100 mAOD because of where it is located in the geological sequence. This is tens of metres higher than the land surface at Blick Mead which is at an elevation of around 70 mAOD and explains why there is no outcrop of the Whitway Rock at Blick Mead/Amesbury Abbey springs.</p> <p>The Blick Mead Tiered Assessment (Annex 3, APP-282) sets out Highways England's conceptual groundwater model for Blick Mead.</p>
	<p>Relevant Topics to be addressed.</p> <p>i. Groundwater Issues. Relevant evidence that the Amesbury Abbey/Blick Mead spring system arise at the Whitway Rock/Barrois' Sponge Bed/Stockway Rock horizon is presented.</p>	<p>Highways England disagrees with this interpretation of the source of the Blick Mead spring system (see response to Slide 1).</p>

	<p>ii. Presentation of Data The likely hydrogeological conditions relevant to this major sub-horizontal marker bed are discussed and presented.</p>	Highways England's interpretation is that the marker bed is discontinuous and does not have a profound effect on groundwater flow.
Slide 2 - Relevant Topics to be addressed.	<p>iii. Unpublished Information. The importance of availability to unavailable data will be demonstrated (see Letter to ExA from Stonehenge Alliance dated 14th August 2019).</p>	As noted in the hearing, the requested data consists of some 4000 pages of borehole information and raw data. The information, has not yet been subject to analysis but most importantly is not required to understand, and does not inform the assessment carried out in, the Environmental Statement or anything else in the Application, which was based on the information set out in the Preliminary GIR [APP-273]. Submission of this data to the Examination is therefore not necessary or appropriate.
	<p>iv. Consequences. The absence of adequate investigations in both depth and detail of groundwater conditions arising from the identification of a significant horizontal controlling groundwater feature, together with the combined effects of major identified significant vertical features (major faults and fractures at Stonehenge Bottom and further west, for example) will be raised.</p>	Investigations are adequate to support the findings of the ES. The groundwater modelling work has been reviewed and accepted by the Environment Agency and Wiltshire Council.
Slide 3 - Relevance of controlling horizon (Whitway Rock) to hydrogeology of entire proposed tunnel route.	<p>A conceptual model of the structural and hydrogeological properties of the Whitway Rock Horizon is presented, as interpreted from the borehole data available. Sub horizontal fracture systems lying above the less permeable Whitway Rock/Barrois sponge bed horizon provide a faster conduit for southward and eastward groundwater movement below the Newhaven Chalk.</p> <p>The less permeable layer of Whitway Rock consequently gives rise to the Blick Mead/Amesbury Abbey springs. Note: The Whitway Rock is known further to the east as Stockbridge Rock. (See Slide No. 7)</p>	<p>See response to Slide 1. It is agreed that fracture flow systems are associated with the Whitway Rock but this formation is not present as a continuous feature across the A303 Scheme.</p> <p>Highways England disagrees that there is a conduit for faster flow. There is no evidence of karst features (see comments to cover letter above). There is also no evidence for eastward groundwater movement. Groundwater flow is</p>

		predominantly north to south as shown by Dr Reeves' earlier presentation [REP4-088].
Slide 4 - Methods of geoscientific data presentation and interpretation and their shortcomings.	The problems of assessing, integrating and correctly interpreting very complex geological, geotechnical and hydrogeological information to a proposed tunnel environment are presented and summarised.	HE has created both 2-D plans and sections, and also looked at the variability of the Chalk below the site in three dimensions. (See, for example, the conceptual illustrations and sections in Section 5 of the Groundwater Risk Assessment and the Figures (plans) in the same document [APP-282].
Slide 5 - A representation of available site data.	An example of "old fashioned" OS map, pen, pencil (and eraser) approach to assessing the extent, in plan and to depth of Site Investigation (SI) data is presented.	No comment.
Slide 6 - Publicly available relevant SI data.	From the publicly available records (the BGS Geology of Britain online Geological Map Viewer), some borehole locations and data can be downloaded by the user.	HE has noted and accepts that this information is available.
Slide 7 – The Whitway/Stockbridge Rock, representation and recognition on published BGS maps.	Little is known of the Whitway Rock horizon west of Amesbury since adequate exploratory work has not been undertaken at sufficient depth and detail until recently. This, and the superficial Drift cover west of Countess Roundabout explains its absence on published maps.	The response to slide 7, 8 and 9 is covered below in the response to slide 9.
Slide 8 - The Barrois' Sponge Bed/Whitway Rock horizon, its stratigraphical position and hydrogeological relevance along the proposed tunnel route.	The stratigraphic level of the Whitway Rock in the Upper Seaford Chalk, approximately 5 metres below the base of the overlying Newhaven Chalk can be seen in this figure from Mortimore et al. 2017. Note: Borehole R11 is a significant distance west of Stonehenge Bottom: see Section in Slide 10, from AWM report.	The response to points 7, 8 and 9 is covered below in the response to slide 9.

<p>Slide 9 - Details of evidence for the Whitway Rock horizon, it's hydrogeological relevance, importance and significance to the proposed tunnel route.</p>	<p>The Whitway Rock horizon, a complex zone of contrasting permeabilities, is up to 5 metres thick and occurs in the Upper Seaford Chalk approximately 5 metres below the base of the overlying Newhaven Chalk. It is a “marker horizon” in the Upper Seaford Chalk, with greater and lesser degrees of imprint on the borehole records through the tunnel line. Some of the best features can be seen on Optical Televiwer geophysical logs (OPT), porosity (POR) and Formation Density logs (Den), as well as in some core box images and drill logging comments (e.g. “Orange staining”, “sponge bed possible horizon”, etc.)</p> <p>Additional, more relevant DTH/Wireline logging geophysical techniques should have been used which would undoubtedly give improved supporting logging data (e.g. DTH Resistivity/SPR logs; Gamma Spectrometer & Caliper).</p>	<p>The Applicant agrees that the Stockbridge Rock is shown to the east of Amesbury on the published BGS map (Sheet 298 – Salisbury). HE also agrees that it is variously called the Whitway Rock and Barrois Sponge Beds, depending upon the where in the UK the rock is found. The Drift cover to the west of Countess Roundabout comprises the Alluvium and Alluvial Gravels, with occasional lenses of Head Deposits present in some of the valleys. The nearest outcrop of the Stockbridge/Whitway Rock is shown on the BGS sheet as being around 2.5km to 3km south of Stonehenge.</p> <p>Point 8 refers to the stratigraphic level of the Whitway Rock being approximately 5m below the base of the Newhaven Chalk. The BGS sheet describes it as “Porcellaneous Limestone” up to 5m thick, yet in his discussion at the hearing, Dr Reeves states that this layer is present between 60m to 80m AOD, continuously or intermittently along the tunnel route. It is shown on the slide as “glaucanitic hard ground” in BH R11, where it is around 0.2m (20cm) thick.</p> <p>Downhole optical records are available from the earlier investigations and more recent investigations have been undertaken using DTH/Wireline logging geophysical techniques.</p> <p>With regard to the presence of the Whitway Rock (Stockbridge Rock), consultation with Professor Rory Mortimore has indicated that in his considered opinion (he has been acknowledged by Dr Reeves as an expert in chalk geology and hydrogeology) ‘ there is no Stockbridge Rock or equivalent in the tunnel profile beneath Stonehenge Bottom that could cause a high flow zone.</p>
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		<p>There is the possibility of a hardground/rock band correlating at a high level in the interfluves on the east (boreholes R18, R7 1907) and west side (R614, R13, R146, R11, R611 and R607) of Stonehenge Bottom dry valley. The dry valley cuts through this profile so any rock band will not be continuous.</p> <p>The boreholes with thick phosphatic chalks (R142, R501, R602) have no 'rock-band'. Any such band may possibly have been removed by phosphatic chalk channel erosion. This is, therefore, a second cause of loss of continuity of possible rock bands across the Stonehenge Tunnel profile. Such a rock band may be present at higher elevations at the extreme east and west of the tunnel alignment.</p> <p>Further west on the higher ground levels of the interfluve a hardground/rock band similar to that identified in point 2 above on the western interfluve is present in boreholes P502B, P505, R9 and R138. This rock band may be present in the proposed tunnel portal areas.</p> <p>In addition to the points above the presence of numerous faults will also reduce the continuity of any rock band as a specific flow horizon.'</p>
<p>Slide 10 - Critical Review/Discussion on AWM figure from "Groundwater Modelling Report".</p>	<p>This section (from the AWM Groundwater Modelling Report) shows that the author(s) were aware of the possible importance of the Whitway Rock horizon and associated groundwater conditions to their model, and the tunnel line. This again emphasises the absence of the necessary detailed groundwater investigations at appropriate depths and detail to adequately characterize these significant groundwater conditions as the "possible" horizon which controls west to east groundwater movement and is not considered in, or important to, the groundwater models.</p>	<p>The Figure referred to is Figure 2: Chalk Stratigraphy with Tunnel and Chalk Rock Elevations (adapted from Mortimore (2012)) as presented in [AS-017] 'Additional Submission accepted at the discretion of the Examining Authority -Stage 4 - Implications of 2018 Ground investigations to the groundwater risk assessment'.</p> <p>This figure refers to the inferred elevation of the Whitway Rock if present (not proven). It is stated as not proven because it has not been found as a hard band continuously across the area.</p>

		<p>Highways England do not agree that there is an absence of detailed groundwater investigations. The groundwater modelling work undertaken has been reviewed and accepted by the Environment Agency and Wiltshire Council.</p> <p>Dr Reeves refers again to 'west to east groundwater movement'. There is no evidence for eastward groundwater movement. Groundwater flow is predominantly north to south as shown by Dr Reeves earlier presentation [REP4-088].</p>
<p>Slide 11 - Available/Unavailable Basic SI data</p>	<p>This is as listed in Stonehenge Alliance's letter of 14th August to the ExA, detailing known possible additional sources of Site Investigation data which are likely to enhance the above interpretations of the important stratigraphy, and its control on hydrogeology along the proposed tunnel line: specifically,</p> <ul style="list-style-type: none"> i. All drill logs, drilling data, groundwater measurements and test data from all boreholes drilled for the project, subsequent to the last release of information to us in the December 2017 Final Report from Structural Soils (Report No. 731823; Vs.3). ii. All original ground investigation data (drilling records, borehole logs, geophysical logs, unpublished groundwater testing data) which support the published "Groundwater Reports". iii. All drilling and testing geological, geotechnical and hydrogeological data from continuing field and drilling investigations commenced in May/June this year, up to and subsequent to the announced Project Tender date of 15th July 2019. 	<p>As noted in the hearing the requested data consists of some 4000 pages of borehole information and raw data. The information, has not yet been subject to analysis but most importantly, is not required to understand, and does not inform the assessment carried out in the Environmental Statement or anything else in the Application, which was based on the information set out in the Preliminary GIR [APP-273]. Submission of this data to the Examination is therefore not necessary or appropriate.</p>

Slide 12 - Current BGS GeoIndex Database for the Stonehenge area.	The current BGS GeoIndex Borehole Database Borehole Locations are shown on this figure. "Commercial In Confidence" borehole logs (which are numerous) and unavailable are shown in Black.	Noted. No comment.
Slide 13 - Commentary	This slide summarises current work by Dr. GM Reeves, (also correcting some previous depth errors e.g., in Borehole R142 (last submission to ExA) from detailed examination of Borehole Core Logs/Core photographs and Wireline Logging interpretations, identifying evidence showing possible identification of the Whitway Rock Horizon, going from east to west along the proposed tunnel line. This research work is continuing.	<p>There is no dispute about the presence of hard bands in boreholes. Highways England does not agree that the hard bands are continuous and does not agree that they exert a profound effect on groundwater flow.</p> <p>Highways England is continuing with ground investigations for the purpose of detailed design. This information will also be used to update the groundwater risk assessment secured through the dDCO and OEMP.</p>
Slide 14 - An example from Borehole R20: Corebox images.	From about 29.00m to the suggested level of the Barrois' Sponge Bed at 32.56m, as identified on the 2001 borehole log, core box photographs and geophysical logging of Borehole R20 (to the east of Stonehenge Bottom), a zone of heavily fractured Seaford Chalk (extending from 74.68m down to 71.30m AOD) can be identified. Along this fractured zone, groundwater flow is concentrated, moving from the recharge area to the west and Stonehenge Bottom, to discharge into the River Avon via the Blick Mead area and the Amesbury Abbey Springs.	<p>As for slide 13, there is no dispute about the presence of hard bands in boreholes. Highways England does not agree that the hard bands are continuous and does not agree that they exert a profound effect on groundwater flow.</p> <p>There is no evidence for west to east groundwater movement. Groundwater flow is predominantly north to south as shown by Dr Reeves earlier presentation [REP4-088].</p>
Summary	In summary, therefore, there is convincing evidence of a sub-horizontal zone of elevated permeability in the upper 10 metres of the Seaford Chalk which is likely to adversely affect groundwater inflows to the proposed tunnelling, with possible considerable chance of delays and requirements for much additional grouting and groundwater control by dewatering.	Highways England disagrees that there is convincing evidence of a zone that will adversely affect groundwater flows across the Scheme. The proposed tunnelling will be carried out with a closed face tunnel boring machine and will be unaffected by groundwater flow. It is reiterated that the current proposed Scheme is different to the 2004 Scheme and control of groundwater by dewatering is not required for tunnelling.

		<p>In his presentation, Dr Reeves referred to the A303 Stonehenge project as being unlike any other UK chalk tunnelling project and in this respect the Applicant agrees with this statement; each tunnelling project is bespoke and designed on the unique combination of geology and hydrogeology at the specific location with the Tunnel Boring Machine (TBM) and means of tunnelling selected as appropriate to these conditions. The Applicant has referred to other UK Chalk tunnelling projects to help the ExA and others understand the context of what has been done previously in situations and at locations they may readily understand, such as:</p> <p style="padding-left: 40px;">Tunnelling through chalk at low-cover below the River Thames on Crossrail C310 with construction of cross-passages without the need for dewatering, as presented at ISH10 item 6.i Tunnelling and included in the Written Summary of the Oral Hearing.</p> <p style="padding-left: 40px;">Tunnelling through the varying chalk on the Lee Tunnel which included tunnelling through fault zones and through aquifers with direct hydraulic continuity with the River Thames, as presented at ISH4 item 5.1 i-iii Methodology and Modelling [REP4-032].</p> <p>As stated by Mr Turney, in terms of tunnelling we see no impediment to tunnelling in this area for any of the reasons that Dr Reeves has attempted to set out in his presentation. The Applicant's understanding of the geology has been informed by the expert assessment of Professor Rory Mortimore, the acknowledged expert in this field, and differs to the assessment made by Dr Reeves. The unique combination of geology and hydrogeology will be considered by the specialist tunnelling Contractor in significant detail during the development of the detailed design including the bespoke TBM selection and</p>
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		<p>specification. This will include further detailed ground investigation and specialist interpretation, in particular at proposed cross-passage locations, as best practice for the risk management of the works.</p> <p>In our numerous responses to date, the Applicant has made repeated reference to best practice and risk management through the development of the preliminary design which will continue through the detailed design and construction of the works, including</p> <ul style="list-style-type: none"> • BTS/ICE (2005): Closed-face Tunnelling Machines and Ground Stability, A guideline for Best Practice. • BS 6164: 2911: Code of Practice for Health & Safety in Tunnelling in the Construction Industry. • ABI/BTS (2003): The Joint Code of Practice fir Risk Management of Tunnel Works in the UK. <p>As explained in response to Examining Authority Questions Fg 1.5 [REP2-031], Fg 2.40 [REP6-028] and at ISH4 [REP4-032], a closed-face TBM as secured in the OEMP at D-CH32 is considered the best option for tunnelling in the chalk geology found in this location as it fundamentally:</p> <ul style="list-style-type: none"> • Supports the ground allowing for the variation in geology and faults and provides greater control on settlement. • Supports the groundwater pressure and removes the need for dewatering during the main tunnel construction. • Removes the exposure of workers to an unsupported ground interface.
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