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Dear Sam

High Speed 2 and the Chiltern Tunnel

Thank you for your letter dated 14 September setting out the EA answers to the 7 questions raised in our letter of 15th June. Unfortunately, the references do not give certainty, but raise further questions. We have highlighted various comments from the text, which we consider material in judgement terms. Our further comments and questions are in *italics*.

Question 1

You state that this was assessed in Para 6.3 of the GW Assessment for Construction Tasks - Tunnel & Cross Passages 1MC05-ALJ-EV-NOT-CS02_CL04-400048_C04.

6.3.1 recognises that there is potential to change flow paths and to reduce yields at public and private water supplies.

6.3.2 only deals with the impact of tunnel construction and does not address permanent changes.

6.3.3 to 6.3.5 deal with cross passage construction. As such as these are between the two tunnels, the risks of changing flows are lower.

6.3.6 to 6.3.12 consider the impacts of constructing the tunnels.

6.3.6 recognises that the impact from the tunnels could be changes to flow routes, due to the obstruction of preferential flow paths and/or reduction in the flow through the aquifer.

6.3.7 recognises that changes in hydraulic heads may occur and assesses this in 6.3.8 as low risk. *However, this is on the assumption that the tunnels are perpendicular to the groundwater flow. This is not the case where the tunnels cross the river and is unlikely to be elsewhere along the tunnel route. We suggest that this needs to be re-examined.*

6.3.9 deals with a reduction in hydraulic conductivity. It recognises a risk but dismisses it as the water table is generally 10m below ground level. *However, this needs to be looked at area by area. At Little Missenden, the water table is generally 1m below ground level. (You should be aware that there were a significant number of springs at Little Missenden, which mainly disappeared, with the construction of the main sewer to Maple Cross). A change in hydraulic conductivity due to the tunnel traversing the valley needs to be assessed to see whether this will have a severe impact on Little Missenden. At Chalfont St. Giles the water table has been stated to be 7 metres below ground level, it is very unlikely to be as low as 10 metres below ground level.*

6.3.10 appears to deal with the situation at Little Missenden. It states that the likelihood of a large reduction in transmissivity due to the tunnels and cross passages is relatively low (but uncertain). *This is an opinion. As such further investigation is needed to eliminate the uncertainty.*

It goes on to say it could reduce groundwater movement along the valley and so further assessment of the potential effects on each of the Affinity Water sources has been undertaken in Section 7. *See comments at Section 7 below.*

6.3.12 deals with water leakage into the tunnels, cross passages and vent shafts of between 200 & 450m /day. *It states that a Schedule 33 approval will be required to abstract the water, and an Environmental Permit to return this water to the aquifer. Has this been applied for and/or granted?*

6.3.13 states 'Therefore, although the tunnels and cross passages will change flow directions and rates, these will be localised around the tunnels and will not be laterally extensive across the aquifer'. *This is an assumption that does not recognise the fractured nature of the aquifer. The tunnel will be in the Lewes and New Pit formations for the major part of its length. Mortimore (2021) has just published a table indicating that fracturing within these formations will be, on average, 4 fractures per M3.*

Section 7 looks at potential impacts on ground water abstractions. *Much of the assessment is about the impact of turbidity, rather than a careful assessment of the risk of diverting water away from PWS.*

Most of the assessments are based on assumptions rather than evidence. 7.1.7 is a good example.

Based on this evidence there are unlikely to be any significant/rapid flow paths from the tunnel to the Colne Valley, although there is a degree of uncertainty associated with this. The risk to the West Hyde PWS from turbidity is therefore assessed as low, but due to the uncertainty associated with the role that the dry valley at Tilehouse Lane has, this could increase to moderate.

Chalfont St Giles Abstraction - 7.1.10 to 7.1.16.
7.1.10 identifies that the tunnels are approx. 200m to SW of the CSG PWS. *The tunnels run slightly NW, with some dry valleys on the way. Dry valleys are known to act as preferential routes for water flow.*

7.1.11 states that the CSG water supply is thought by MWH to be directly connected to a "karst flow system" aligned along the Misbourne valley with little radial flow occurring to the abstraction. If this is correct, the dominant source of water to the PWS would be along the valley of the Misbourne from the north.

The valley runs Northwest to Southeast not north. Thus, the tunnel north of the PWS is likely to have some impact on the flow of water to the PWS. This needs to be clarified to ensure that there is no impact on the PWS.

7.1.14 & 7.1.16 talks about the risk of turbidity, with an assessment that the risk is low. *That raises the question of why was it felt necessary to build a pipeline to move water from CSG to the turbidity treatment plant at Amersham? It states that the tunnel is down stream of the PWS, however as it proceeds north it is upstream of the CSG PWS.*

Amersham Abstraction – 7.1.17 to 7.1.6
MWH estimate that there is strong evidence for a karst conduit that extends for more than 3.7 km both upstream and downstream from the Amersham site. It was considered likely that the PWS would draw the majority of its flow from this "karst conduit". *3.7km upstream takes one to the LM Vent Shaft and thus the tunnels crossing the valley. The volume of water being provided to the PWS needs to be assessed (see 6.3.1 above) as this could have a significant impact on supplies of water to the PWS.*

'210428 - Chiltern Tunnel Construction Water Environment Assessment 1MC05-ALJ-EV-REP-CS02_CL04-000142_C02, 28.04.2021' Para 4.3 deals with 'Risks to Groundwater Movement' but does discuss the impact of the tunnels diverting water away from the existing flows in particular to the Amersham PWS.

Question 1 continued

You state that this is assessed in '210428 - Chiltern Tunnel Construction Water Environment Assessment 1MC05-ALJ-EV-REP-CS02_CL04-000142_C02, 28.04.2021', sections 2.2.8, 4.2.8, 4.2.9.

In 2.2.8 we note the comment with regard to 5-chloro-2-methyl-2H-isothiazol-3-one that it is an EU banned substance for release to groundwater, which is why we raised the subject, even if it is considered to be a small amount. We understand that bentonite also is considered a hazardous substance to be added to water. This represents just under 2% of the tunnel grout

4.2.8 & 4.2.9 deal with tunnel grout. *These sections do not deal with the fact that if the grout is introduced to active water, it does not gel. This is not an unexpected issue in the aquifer, which has lots of fractures / fissures and an identified karst system. 4.2.10 & 4.2.11 deal with controls based on usage, but do not identify what to do if turbulent water is found. This is a concern bearing in mind the comment above re the Amersham Abstraction. Further the evidence of the loss of 3000 M3 of bentonite slurry at Chalfont St Peter Vent Shaft increases the level of concern.*

Question 2

Part 1
Para 8 of '200504 - GW Assessment for Construction Tasks - Tunnel & Cross Passages 1MC05-ALJ-EV-NOT-CS02_CL04-400048_C04 sets out

- potential enhanced leakage from the River Misbourne to groundwater by induced fractures, washout of infilled voids or other changes to flow paths caused by tunnelling activities, including settlement;

- potential reduction in baseflow during operation as a result of disturbance to groundwater flow paths caused by the construction of the tunnel;
- potential contamination by chalk turbidity which could migrate within groundwater which subsequently discharges at the River Misbourne; and/or
- an increase in flows at the tunnel crossing points due to increases in hydraulic heads up gradient of the tunnels (as assessed in Sections 6 and 7).

This shows the concerns that we have raised. Unfortunately, it does not answer the question as to the level of competent rock that the EA considers necessary to avoid significant settlement from vibration.

Para 4.4 of '210428 - Chiltern Tunnel Construction Water Environment Assessment 1MC05-ALJ-EVREP-CS02_CL04-000142_C02, 28.04.2021' sets out Risks to the River Misbourne.

4.4.3 covers the issue of settlement. This is predicted to be between 10mm and 30mm and talks about that this could potentially result in limited opening up of some fractures in competent chalk above the tunnels. *However, this is irrelevant as the latest GI show that there is no competent chalk above the tunnels at either crossing of the river.*

It goes on to say that the competent chalk is overlain by weathered chalk which is likely to behave similarly to a clay and so is not likely to result in a significant increase in openings. *You will note that in Dr Bailey's opinion the weathered chalk will not act like a clay.*

We agree that the level of the water table in the Misbourne Valley does vary. However, at Chalfont St Giles this is generally between 6m and 10m below ground level, although last winter saw it reduced to less than 2m for a couple of months. However even in this circumstance damage to the riverbed would result in loss of the river.

Our questions have not been answered with regard to

- *The depth of competent rock you consider should be above the tunnel apex*
- *the impact of vibration on settlement on unstructured chalk exposed directly to the tunnel panels.*

Please answer these.

Question 2 continued – Part 2

S10 of '200504 - GW Assessment for Construction Tasks - Tunnel & Cross Passages 1MC05-ALJ-EV-NOT-CS02_CL04-400048_C04' deals with monitoring. *As we said, this looks like a 'Wait and See' exercise, which is not appropriate when dealing with a WFD waterbody.*

10.1.4 states that monitoring of river flows and water quality within the River Misbourne will be required to check if any significant effects are experienced as a result of construction activities. If there is a significant negative effect then localised stream lining may be necessary. *Please confirm what the EA considers to be a significant effect and that the remediation will be to reline the river to return the flow to its previous volumes?*

Question 2 continued – Part 3

This deals with the crossing at Little Missenden. *Our question with regard to the depth of competent rock you consider should be above the tunnel apex has still not been answered.*

Question 2 continued – Part 4

This question deals with potential impacts on the supply of water to Amersham PWS. **7.1.17** states

MWH's review of available pumping test hydraulic data indicated the presence of "…strong anisotropy with high transmissivity aligned along the valley. Within the valley MWH contend that both the hydraulic and turbidity responses provide strong evidence for a karst conduit that extends for more than 3.7 km both upstream and downstream from the Amersham site". It was interpreted that a well-developed fracture network was present around the Amersham supply, but that the boreholes were not directly connected to the valley conduit, as early time-drawdown data indicated radial flow to the boreholes. Nevertheless, it was considered likely that the PWS would draw the majority of its flow from this "karst conduit"

3.7km upstream takes one to the LM Vent Shaft and the tunnels crossing the valley. We can find no analysis of the impact of this or a requirement for further investigation of a potentially severe impact on a PWS.

4.3 deals with the impact on Groundwater. The relevant subsections appear to be

- 4.3.4 which recognises there could be a vertical groundwater migration. This would particularly be the case where the tunnel passes through marl bands that would otherwise act as aquicludes and hard bands (such as the Chalk Rock) that are highly transmissive strata.
- 4.3.6 states 'The effects of the tunnel on lateral groundwater movement have been assessed in detail in Report 1 and are not repeated here. The report concluded that there will be changes in water levels and flow patterns immediately adjacent to the tunnel but that these will not be laterally extensive across the aquifer'.
- 4.3.7 states 'The water level / flow changes associated with construction of the tunnel are unlikely to have a significant effect on any sensitive receptors'
- 4.3.8 states 'Any changes that do occur in the aquifer are likely to be far more localised than those associated with quality changes and so the risk assessment only considers a 50m zone around the tunnel for changes to groundwater movement rather than the 500m considered for groundwater quality'.

The assessments appear to rely on Report 1 and fails to deal with the impact of the tunnel on faults, fissures and karst system shown by recent GI to exist in the Misbourne Valley. Should these be blocked, there is the potential for the water to be diverted away from the Amersham PWS.

The assessment does not appear to take into account the high-water table in the Little Missenden area. It is rarely more than 1m below ground level. There are still springs in the area, though substantially less than before the main sewer to Maple Cross was installed. There needs to be a full assessment of the risk of flooding.

Question 3

Part 1. *Thank you.*

Part 2

You referenced Construction of Little Missenden Ventilation Shaft WEA 1MC05-ALJ-EV-REP-CS02_CL04-000131_C01, 24.05.2021 '. *We read this with interest and note that lessons have been learnt from the significant losses at the Chalfont St Peter Vent Shaft. We are pleased to see that grouting will be carried out before the bentonite slurry is used to help construct the D walling at the other VSs. There are a number of questions which arise from this document.*

2.5.19 Grout gelling time is around 6 hours with the setting time less than 24 hours, although the gelling and setting times can be markedly increased by the addition of sodium silicate which acts as a set accelerating admixture. Where voids are encountered setting times are likely to be reduced.

3.1.1 The shaft will be located upon Chalk Principal aquifer, which is a Drinking Water Protected Area and part of the Mid Chilterns Chalk Water Framework Directive (WFD) waterbody. The Great Missenden public water supply (PWS) is located approximately 2.5km west-north-west of the shaft site but is uphydraulic gradient and so is not anticipated to be impacted by the works and is not discussed further in this report.

3.1.2 The shaft site is located within Source Protection Zone (SPZ)2 for the Amersham PWS, which is situated approximately 3.4km south-east of the shaft site. Both Little Missenden shaft and the Amersham PWS are situated within the Misbourne valley, which is a dominant flow zone and where the Amersham PWS draws the majority of the water that it abstracts. Pumping test data obtained from Little Missenden shaft indicated highly permeable strata even at the depth of the base of the shaft and support the conclusion that the Misbourne valley is highly transmissive to groundwater. A dry valley is located immediately to the east of the shaft site trending south-south-west towards the River Misbourne and is likely to function as a preferential pathway for groundwater to move into the high flow zones of the Misbourne valley. The shaft site is therefore in a sensitive location with regard to groundwater.

3.1.3 The latest ground model (Figure 5) indicates a circa 1–4m thickness of superficial deposits across the shaft site, consisting of sandy gravelly clay. Underlying this is a circa 6–10m thick layer of structureless chalk, which is likely to be clay like and tends to increase in thickness towards the valley floor and the River Misbourne. Beneath this is a thick layer (circa20 –60m) of weathered chalk, again with the thickest deposits located closest to the River Misbourne. Competent chalkrock is located approximately 35–70m below ground level (bgl). The current water level is within the boundary of the weathered and structureless chalk, with the competent chalk fully saturated.

3.1.4 Ground investigation (GI) data identified some areas of increased fracturing, core loss and possible voiding, with one such area located at the shaft position between circa 80 and 100m AOD (i.e.,15mbgl), with a second more widespread area identified from circa 45–65m AOD stretching from the base of the shaft to the vicinity of ML042-RC014 (Figure5). Potential dissolution features were also identified in the vicinity of the shaft at circa 90m AOD and circa 65m AOD, with two further possible voids or dissolution features identified at the location of ML042-RC014at elevations of circa 85m AOD and 60m AOD (approximately 30m bgl and 45 m bgl).

2.1.5 talks about the grout gelling time being 6 hours and the setting time 24 hours with the potential to shorten these. Given the nature of the ground set out in 3.1.2, this would indicate that there is a severe risk of grout being washed away in the high flow water zones of the valley, with a potential impact on both the Amersham PWS and the River Misbourne.

These paragraphs indicate that the ground around the LM VS is highly fractured with a number of dissolution features. This would suggest that there is risk of water being diverted laterally by the tunnels crossing the valley. 3.1.2 makes it clear that the latest thinking is that the Amersham PWS draws the majority the water it abstracts from the Misbourne Valley. As such this suggests that further assessments are needed to establish that water will not be directed away from an important PWS. Will you recommend that work stops until these assessments are complete?

In addition, 3.1.2 talks about a dry valley east of the VS running SSW towards the River Misbourne. This tends to confirm Dr Bailey's opinion that the chalk bloom seen in Shardeloes Lake came from the pressure testing at the VS, which occurred at the time the bloom appeared. It also raises the question of turbidity reaching the river from the construction of the VS and the tunnels. With the identified dissolution features present and the now identified highly permeable strata this raises the question as to whether bentonite will reach the river. As discussed earlier bentonite is considered hazardous when introduced to water.

3.1.3 sets out the ground layer structure at the VS. Competent chalk is shown to be located at 35 – 70m below ground level. It also refers to structureless chalk being claylike. This raises two issues

- *How much competent rock should there be above the tunnel to reduce the impact of vibration on structureless and weathered chalk?*
- *The assumption that structureless chalk will act like clay. This assertion is disputed by Dr Bailey, an eminent geologist. This needs to be demonstrated if HS2 is to rely on it.*

Question 5

Thank you for your assurances that Affinity will not exceed the volumes allowed under their extraction licence. *As you will be aware, there is great concern over the existing level of abstraction. We note that Affinity have closed a number of pumping stations to help flows in certain streams. The closure of the PWS in the Hughenden Valley is good example. Our concerns relate to increasing abstractions elsewhere and the potential impact on other chalk streams such as the River Gade, with the proposed increase in abstraction near Watford.*

Question 6

Part 1 – *Thank you*.

Part 2

With the information available in the 200504 - GW Assessment for Construction Tasks - Tunnel & Cross Passages 1MC05-ALJ-EV-NOTCS02_CL04-400048_C04' and Construction of Little Missenden Ventilation Shaft WEA 1MC05-ALJ-EV-REP-CS02_CL04-000131_C01, 24.05.2021. a clear picture has emerged of how fractured the chalk is and the risk of dissolution features. This confirms the results from the British Geological Survey.

Question 7

Part 1 – *Thank you. We were concerned by apparent discrepancies between HS2's borehole readings and the monthly readings taken by the CS near the Chalfont St Giles Vent Shaft. Also, HS2 refer to the groundwater level being approx. 7m below ground level at the point where the tunnels will cross the Misbourne, as in recent months the CS readings show between 3.5m and 5.5m. We trust that you can confirm that you have not found any other discrepancies.*

Part 2 – *the regular groundwater readings from near Mill House in Little Missenden show very little variation with the below ground level depths varying from 0.25 – 1.26m over the last few years.*

Again, thank you for the information provided. What is clear is that there are still two areas of concern potentially affecting Water Bodies and PWS identified by the Water Framework Directive.

1. *The potential impact on the Amersham PWS through the potential diversion of water away from the PWS catchment area from the construction of the tunnels under the Misbourne at Little Missenden and the Little Missenden Vent Shaft.*
2. *The risk to the River Misbourne through*
    a. *Damage to the riverbed causing the river to lose flow at both Chalfont St Giles and Little Missenden*
    b. *The potential for turbidity being introduced to the River Misbourne from the construction of the Little Missenden Vent Shaft*
    c. *The risk of introducing grout and /or cement to the river because of dissolution holes and fats flowing water preventing the grout or cement from setting*

We believe that further work needs to be done to establish the reliance of the Amersham PWS on water from the Misbourne Valley and establishing where the strong water flows are in the valley to ensure that construction of the tunnels and both the Little Missenden Vent Shaft and the Amersham Vent Shaft.

We would also like to understand what the EA's stance is in regard to the level of competent rock which should be above the apex of the tunnels to reduce the risk to vibration causing settlement at the surface.

We look forward to your response to the questions raised above. We believe there are enough unanswered questions with regard to the risks to the Amersham PWS and the River Misbourne for the tunnelling to be stopped, until assessments have been made. This would give the opportunity for the tunnels to be taken deeper to eliminate / substantially reduce these risks.

Yours Sincerely

Simon Kearey
Chairman

CC
Tom Beeston – Chief Officer
John Gladwin – Trustee/Specialist Advisor