7-Sep-2017

HS2 Response to River Chess Association

Questions received from Paul Jennings 11/8/17 following meeting with members of River Chess Association on 10/08/17 that required clarification, and Comments on these replies by Paul Jennings, River Chess Association :

1	**Face pressure control. What heard the pressure of the drilling fluid would be less than the pressure of the surrounding aquifer. As I understood it this was to ensure drilling fluid did not enter the formation. If my understanding correct?**
	Under the water table the Contractor is likely to utilise water as the 'drilling fluid' combined with the excavated chalk rather than bentonite (or more appropriately an approved additive for use inside a Source Protection Zone). The water chalk slurry at the face of the Tunnel Boring Machine (TBM) will be maintained at a pressure varying +/- on either side of the prevailing hydrostatic pressure to control the outward spread/loss of the slurry and limit the amount of groundwater entering the TBM. It is normally anticipated that slurry pressure should not exceed +1 bar (above hydrostatic pressure) to limit groundwater entering the TBM. Having read your response it would appear that there is a distinct possibility that drilling fluid could enter the aquifer. Would a significant loss in circulation of the drilling fluid be reason to stop drilling and who would make that decision?
2	**The boring operation will be moving at 120m per week?**
	The maximum advance rate for the TBM is expected to be around 120-130m per week. At the outset of tunnelling, close to the south portal, the advance rate will be much slower as the operatives and systems go through a 'learning curve' until the TBM is commissioned to full capacity. At full speed it is possible for the TBM to slightly exceed 120m per week, but this is very much dependant on a number of factors including how fast materials (pre-cast concrete segments, grout etc.) can be delivered to the TBM from the south portal worksite and the speed at which the excavated material is treated by the filter press plant to remove water. Once drilling starts is it a continuous process?
3	**The casing of the tunnel is a continuous process following immediately behind the boring operation?**
	The tunnel structural lining will consist of precast concrete segments with each segment having a complete gasket so that when the segments are erected within the back of TBM they form a complete ring. The ring is designed to cater for all loads including erection and ground loads and be fully watertight. Once a ring is erected the bolts will be installed and the TBM will be advanced by shoving off the newly erected ring. As this ring leaves the shield Environment Agency approved cementitious grout will be injected between the ground and the outside of the ring to fill the void and assist in achieving the water tightness of the lining.
4	**The pressure of the "Grout" used to hold and seal the casing to the tunnel wall would be greater than the surrounding pressure to ensure grout filled all areas around the outside of the casing?**

	The grout will be injected through the tail skin of the TBM at a pressure slightly higher than the hydrostatic pressure. To make the grouting effective it must overcome the water pressure behind the linings. The purpose of this grout is to seal the excavated annulus between the back of the pre-cast concrete linings and the chalk strata. In this annulus the grout effectively displaces the groundwater, closes the gap and structurally stabilises the pre-cast concrete linings. The location and spread of the grout is carefully controlled. So the pressurised grout will fill any void sitting behind the lining? What happens if you find a large void or channel behind the lining?
5	**You did not use a seismic survey to better map the fracture patterns of the aquifer, can you explain why?**
	The use of vertical seismic profiling and crosshole tomography is not widely used for hydrogeological investigations. It would normally be applied to localised problems in hard rocks rather than an area of several square kilometres with the issue of the number of boreholes required and the practicalities of positioning them. Most fractures are too small to be sensed individually by seismic waves, especially given the closely spaced fracturing in the Chalk. The best that such surveys could be expected to establish would be to differentiate between areas of variable fracture intensity (We would have thought this would be valuable information which would help you plan your tunnel boring activity), and not to produce a detailed 3D model pinpointing individual fractures which could be responsible for carrying high groundwater flows. Also, there are several forms of seismic investigation techniques, but principally they all work by searching for large differences in response in the geology. For example, seismic refraction and reflection (which is explained within our non-technical guide to the ground investigation 3.6 here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/412948/HS2_ground_investigations_-_a_non-technical_guide.pdf) works similar to sonar for bats – you send out a signal and then monitor for the response. This is very good at identifying major changes in geology – such as from sandstone to mudstone. However, if there is a gradual change or small rock fracture of a few millimetres, it is unlikely to pick this up. (But it would pick up large fractures? Again valuable information to assist with the tunnel boring activity) This is especially true when considering that the chalk aquifer is deep (Affinity Water boreholes are almost 100m) and three dimensional, with fractures occurring over depth. We understand that there are 3D and even 4D seismic techniques that would help in the mapping of the fracture matrix of the aquifer? A further issue, is that you do not know what the reflection is (it could be differences in geology, a flint band or fracture) and you do not know if the fracture is actually carrying groundwater. (We were of the impression that seismic processing and interpretation has moved on and subtle differences in the reflectors can now be identified.) Therefore, as the groundwater in the chalk aquifer will predominately flow through fractures of a few millimetres (not from what we understand, some of these fractures can be very big and carry large volumes of groundwater), it is not possible to accurately identify them, using seismic methodologies, and this technique would not be very effective. We would suggest that you take further advice on this before dismissing the technique.
6	**The 322 exploratory well bores that have been drilled, how have they been logged? Have you used downhole tools to map the area surrounding the well bores?**

Exploratory holes have been logged in accordance with relevant standards, i.e. BS EN ISO14688-1+A1, BS EN ISO14689-1+A1, supplemented by BS5930 and guidance in CIRIA Report C574. Logging masterclasses were held for the contractors, including several by Professor Rory Mortimore. Downhole logging of particular boreholes was undertaken, selected from acoustic and optical televiewer, caliper, natural gamma, gamma-gamma/formation density and OYO P-S. (What data is the logging activity expected to collect and how will it help you to protect the aquifer?)

7	**HS2 will start tunnelling before you have a clear understand of the aquifer. Is our understanding correct?**

Detailed analysis of, and correlation between, the large numbers of boreholes undertaken as part of the ground investigation programme is providing a high level of detail of ground conditions along the tunnel route. This visualisation of the complexity along the tunnel alignment is a significant step forward in the understanding of aquifer conditions at a local scale. At a larger scale, catchment behaviour, particularly river-aquifer interaction, is well understood (That is debatable, everything we hear from the water companies this is not the case and we believe this is what has driven Affinity to seek a multi million £ Government indemnity for the potential loss of a water supply) and the input from local experts, such as Affinity Water and the Environment Agency, continues to be of great value to us. (They will be the first people to tell you this is not simple or easy to understand.)

Tunnelling can only commence when we have the robust understanding of the interaction with the aquifer, to satisfy the Environment Agency that any risks and their impacts have been suitably mitigated. So would you be prepared to offer a financial indemnity to all stakeholders who rely on the aquifer not just Affinity Water?

8	**If these understandings are correct this is our main concern. If you tunnel through a major aquifer migration path there is a real danger that your grout will cement or block that pathway. This would cause a major disruption to the flows of water and could damage the availability of water for the rivers. It could also depressure the aquifer causing flows at surface to slow or stop. This could have a major impact on both rivers.**

No response needed at this point in time. This is the key critical issue and we need answers. We are confused as to why there is "No response needed at this point in time." If what you are saying is that you are unable to answer the question at this time then we are very worried.

9	**We also note that in your presentation you say that the Chess catchment is unlikely to be affected by the tunnel construction, we know the Misbourne and Chess aquifers are connected so what evidence do you have for your statement?**

The Chalk aquifer underlies the catchments of the rivers Chess and Misbourne, and many others to the NE and SW. The additional distance of the River Chess from the line of the tunnel and the prevailing groundwater flow directions in the Chalk that support river flow, lead to the conclusion that the River Chess is unlikely (not a word that gives us comfort, if it is affected there is no way of correcting this other than by expensive artificial means) to be affected by tunnel construction. Notwithstanding that, existing monitoring in the Chess catchment and the continued input from local experts will provide useful baseline information. We have a large collection of photographs over many years of the artesian well flows and we can assure you will be able to notice any drop in output.

10	**What operational controls will the EA have over your tunnelling activity. Under what circumstances or criteria would the boring process be stopped?**
	Under the Act, we require permission from the Environment Agency (the regulatory authority) for tunnelling in the chalk aquifer. Prior to carrying out any tunnelling, the Environment Agency would need to be satisfied that any environmental impacts from the works have been identified and that any appropriate protective measures have been put into place. (You do not appear to have answered the question can you reread it and respond accordingly.)
11	**Speaking for the River Chess Association we would rather there was no tunnel, if there is a an impact on the environment at surface it can be corrected. If it goes wrong subsurface there is little chance of correcting it.**
	No response needed at this point in time