

Technical note to support BATC, WESY and THEG temporary licence variation

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1 Executive Summary

- 1.1.1 This technical note presents the context for the applications by Affinity Water Limited to vary the peak abstraction licensed rates for BATC, WESY (BLAF group licence) and THEG (Watford group licence) pumping stations on a temporary basis during the construction of High Speed 2 (HS2)'s Colne Valley Viaduct. As part of this proposed variation at peak, Affinity Water also request an extension to the current 88MI/d annual licensed volume of the BLAF group to the end of AMP7 (31/03/2025).
- 1.1.2 During HS2 construction, Affinity Water's BLAF pumping station source will be out of use due to the significant risk of nearby piling work adversely affecting groundwater quality, principally via the generation of extremely high turbidity levels.
- 1.1.3 In order to maintain public water supply during peak demand periods and ensure the same level of service is maintained for Affinity Water customers throughout the HS2 construction period in the Colne valley, 20 MI/d of water is required from elsewhere to replace that capability from BLAF source. The replacement solution plan is to secure ~10 MI/d from Thames Water as an import and the remainder of the requirement from additional pumping at the three groundwater sources identified above. Whilst securing the 10MI/d from Thames Water is feasible, it is possible that this volume may not be available to Affinity Water at all times (or as total daily volume) and/or other issues may arise from neighbouring sources being impacted by HS2 operations resulting in the capacity of the turbidity treatment plants in those other sources being exceeded. As such, a total volume up to 18MI/d is sought to be secured from the three groundwater sources as a temporary solution whilst encountering peak demand periods. The new peak daily volume requested for THEG is 29.78MI/d (uplift of 8.50MI/d from the current daily peak of 21.28MI/d). This also protects the Affinity Water customers in providing replacement water under different circumstances of where the supply issues are occurring in the context of source and network availability within the Affinity Water system.
- 1.1.4 Key aspects of the application to vary the licences in question are:
- The variations are only to enable Affinity Water to meet short-term (days) peak demand spikes when all other sources in the BLAF group licence are fully committed (excluding STOC and ICKE sources that are not in service due to water quality issues). Note that WAFI, on the Watford group licence with THEG is also not in service for similar reasons;
 - No 'new' water is required, i.e. no increase in annual average licensed quantities for either the BLAF or the Watford group licences;
 - The import of water from Thames Water as part of the replacement water solution means that the peak Deployable Output (DO) from BLAF Group under this variation will be less than the current 2012 Peak DO (see Table 1);

- Even if the Thames Water import were unavailable and THEG, WESY and BATC were abstracted at the maximum rate being applied for, then the total daily abstraction across both groups for that peak period would remain below the peak DO currently available with BLAF source in operation;
- The variations would be temporary, only during the period in which the HS2 construction phase of the Colne Valley Viaduct impacts on water quality.

1.1.5 In terms of environmental impact, the key points are:

- No significant groundwater or surface water impacts were detected during the pumping tests, with the possible exception of a Thames Water borehole at Juniper Hill sewage pumping station near BATC, for which a consent to derogate is being sought (see HS2, 2018a).
- The duration of the pumping tests was comparable to or greater than the peak demand pumping period that would be needed in reality;
- The total volume (as Megalitres) abstracted from BATC and THEG above current licensed quantities during the pumping tests is equivalent to >15 consecutive days at the peak licensed rates being requested. This is due to the prolonged duration of the pumping tests in relation to the 10-consecutive-day peak demand typically encountered.
- The surface water system in the Gade and Middle Colne catchments is hydrologically complex with the river, lakes and canal being in direct hydraulic connectivity in numerous places. The Grand Union Canal (GUC) has been engineered for drought resilience and is subject to high volume inputs from sewage treatment works (e.g. from Maple Lodge and Berkampsted) and Canal & River Trust discharges to support its flow all year round;
- Sustainability reductions of 15.22 Ml/d (BOWB, PICC/MARL, AMER) at average have already been implemented in the catchments upstream of BATC, WESY and THEG (excluding AMER) in AMP6, with further reductions to follow by 2024.

1.1.6 This technical note should be read in conjunction with the following reports:

- BATC Source – Hydrogeological Assessment of Proposed Abstraction Licence Variation (document number 1D107-EDP-EV-REP-CS01-000001) (HS2, 2018a)
- WESY Source – Pumping Test Appraisal (document number 1D107-EDP-REP-CS01-000002) (HS2, 2018b)
- THEG Source – Pumping Test Appraisal (document number 1D202-EDP-EV-REP-CS01-000001) (HS2, 2018c)

- 1.1.7 These reports provide the detail of the pumping rates during the tests, the prevailing hydrological conditions, monitoring data, environmental data and conclusions.

2 Proposed licence variation

2.1 Requirement

During part of the construction phase of the Colne Valley Viaduct, groundwater abstraction operations at Affinity Water's BLAF pumping station will cease. For that temporary period, the 20 MI/d output capacity from BLAF needs to be replaced using other sources of water to enable Affinity Water to meet its statutory duty under section 37 of the Water Industry Act 1991 to develop and maintain an efficient and economical system of water supply and to ensure that all necessary arrangements have been made for providing supplies of water and ensure that their customers receive the same level of service.

- 2.1.1 The 20 MI/d replacement supply capacity is required to enable Affinity Water to maintain the supply-demand balance during short-term (typically around 7 days) peak demand periods. These are likely to be during the summer, typically occurring during June-July.
- 2.1.2 Any additional pumping from BATC or WESY to help meet such demand would only occur when all other sources of water within the BLAF Group are being used to their maximum capability excluding for unplanned outages or limitations. It is Affinity Water's company requirement that planned outages are not undertaken between May and September, so as to maintain that capability to support peak demand periods in line with existing peak licences.
- 2.1.3 The duration over which the replacement water and hence the proposed licence variation would be needed, is dictated by HS2's programme. Currently, the aspect of Colne Valley Viaduct construction that creates a risk to the aquifer is anticipated to last 24 months. With an additional six months added to that period to enable BLAF to come back into supply, the duration of the licence variation needs to be longer than this to cover every possibility given the uncertainties of the HS2 construction programme. The final construction programme has yet to be confirmed so a six year period (up to 31/03/2025) has been suggested by Affinity Water to cover all possibilities.

2.2 Sources of replacement water

- 2.2.1 While there is sufficient spare average capacity within the BLAF Group licence to cover the outage at BLAF, due to the time constraints of the HS2 programme and the complexity of the water quality issues at the sites, it was not feasible to rehabilitate the STOC and ICKE pumping stations, which are part of the Group licence but are currently not used for supply owing to water quality issues. The same logic applies to the WAFI pumping station within the Watford group.
- 2.2.2 That early options screening work concluded that the 20 MI/d required as replacement supply capacity to support peak demand periods, could be best obtained from a combination of an

import of around 10 MI/d from Thames Water, with the remainder delivered through additional peak groundwater pumping from other Affinity Water groundwater sources.

2.2.3 There are a number of uncertainties or potential limitations regarding the Thames Water import, such as:

- Resolving whether the provision of 10 MI/d would be as a constant supply or as an average over a set period;
- Water quality issues associated with chloraminated water arising from the import of surface water into our supply system;
- The reservoirs and/or the districts into which this water will be pumped into supply are not the same as the ones fed by BLAF source, so this will not be a like for like replacement.
- The reliability of the supply of water (practical and commercial arrangements are in development);
- Thames Water's requirement for notice periods for the provision of 10 MI/d.

2.2.4 As a result of these factors, and also noting that unplanned failures in elements of the wider water supply system may occur at any time, Affinity Water requires the flexibility to abstract more than the nominal additional 10 MI/d from BATC, WESY and THEG to ensure that peak demand periods can be satisfied.

2.2.5 An anticipated approach to manage the delivery of replacement water would be to prioritise the import from Thames Water over the additional groundwater abstraction on a 'best endeavours' basis, recognising the potential complexity of supporting peak demand events and the uncertainties noted above. This will be subject to the operational readiness of this water to be delivered from Thames Water to Affinity Water at the time of request.

2.2.6 Further to the above, and despite the fact that turbidity treatment plants will be installed at NORO, AMER and WESY groundwater sources sized up to a certain removal capability, there is a residual risk that the HS2 operations may still exceed the maximum capability of the treatment at those sites, hence impacting on their output. To overcome this uncertainty, a volume in excess of 10MI/d is required to replace the loss of BLAF source (assuming the remainder 10MI/d is imported from Thames Water) and also mitigate the risks associated with the turbidity treatment plants to be installed in the aforementioned sources. The proposed volume across THEG, BATC and WESY is 18MI/d at peak. This peak volume needs to be available to mitigate the risks mentioned above (Thames Water import and turbidity) should such events take place during peak demand periods.

2.3 Recent pumping tests

- 2.3.1 During 2017 and 2018, pumping tests were carried out at BATC, WESY and THEG pumping stations, to:
- Determine if those sources could deliver suitable additional volumes of water (above current daily licence maxima); and
 - Monitor any environmental impact of such short-term additional pumping on the nearby receptors and the surface and groundwater features.
- 2.3.2 BATC and WESY belong to the same licence group as BLAF (BLAF Group, licence number 28/39/28/0480). THEG belongs to the Watford Group licence, licence number 28/39/28/0270. See Table 1 for further details.
- 2.3.3 The detail of the pumping rates during the tests, the prevailing hydrological conditions, monitoring data, environmental data and conclusions are presented in the following reports:
- BATC Source – Hydrogeological Assessment of Proposed Abstraction Licence Variation (document number 1D107-EDP-EV-REP-CS01-000001) (HS2, 2018a);
 - WESY Source – Pumping Test Appraisal (document number 1D107-EDP-REP-CS01-000002) (HS2, 2018b);
 - THEG – Pumping Test Appraisal (document number 1D202-EDP-EV-REP-CS01-000001) (HS2, 2018c).
- 2.3.4 These reports include details of the practical and operational restrictions encountered that limited the pumping rates that Affinity Water were aiming to achieve.
- 2.3.5 As can be seen in Table 1, a combined additional quantity of 10.8 Ml/d was proven by the pumping tests, but this quantity would leave very little scope for contingency/flexibility in response to the uncertainties relating to Thames Water import or other unplanned operational constraints linked to HS2 operations or unforeseen supply issues while BLAF is offline.
- 2.3.6 The results of the pumping tests, combined with Affinity Water’s broader knowledge of the behaviour of the individual boreholes at the three pumping stations in terms of drawdown and water quality changes, leads to the conclusion that there is nothing to suggest that non-linear responses would occur during abstraction at the higher rates required, above those proven during the testing. Hence Affinity Water are confident in delivering the yield they are requesting upon removal of the operational constraints encountered during the testing period.
- 2.3.7 The environmental assessments of the water features and receptors within the vicinity of the abstraction sites also indicate that there is nothing in the results to suggest that a non-linear response would be seen at any of the receptors due to the increased abstraction rates.

2.3.8 Table 1 summarises the existing daily abstraction limits, the pumping rates proven during the tests at BATC, WESY and THEG, and the additional volumes proposed by Affinity Water based on their understanding of borehole responses to pumping, the lack of environmental impact observed at the pumping rates that were achieved and the flexibility required to ensure public water supply during peak demand periods due to uncertainties described in Section 2.2 above.

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Table 1. BLAF group and Watford group Licences, Deployable Output and proposed Deployable Output during HS2 construction (all values Ml/d)

Source	Group	Licence Number	Avg. Ann. Licence	Max Daily Licence	Revised 2012 DO		Indicative DO during HS2 construction		Output proven during pumping test	Difference between proven output and Max Daily Licence	Difference between proven output and Proposed Peak Licence
					Average DO	Peak DO	Average DO	Peak DO			
Affinity Water									Peak DO		
BATC	BLAF	28/39/28/0480		20.46	16.00	19.00	20.00	28.00	26.00	5.54	2.00
BLAF	BLAF	28/39/28/0480		20	16.00	20.00	0.00	0.00			
CHOR	BLAF	28/39/28/0480		9.09	8.20	9.09	8.20	9.09			
ICKE	BLAF	28/39/28/0480		12.5	0.00	0.00	0.00	0.00			
MILE	BLAF	28/39/28/0480		18.18	13.30	13.30	13.30	13.30			
NORO	BLAF	28/39/28/0480		18.18	14.50	17.00	16.50	17.00			
SPRW	BLAF	28/39/28/0480		18.18	4.50	16.00	12.00	16.00			
STOC	BLAF	28/39/28/0480		9.09	0.00	0.00	0.00	0.00			
WESY	BLAF	28/39/28/0480		20.46	15.50	20.46	18.00	22.46	21.60	1.14	0.86
BLAF Group	BLAF	28/39/28/480	88	146.14	88.00	114.85	88.00	105.85			
THEG	Watford	28/39/28/270		21.28	20.50	20.50	20.50	29.77	25.40	4.12	4.37
WAFI	Watford	28/39/28/270		8.5	0.00	0.00	0.00	0.00			
Watford Group	Watford	28/39/28/270	21.88	29.78	20.50	20.50	20.50	29.77			
TOTALS										10.80	7.23

2.4 Abstraction licensing context

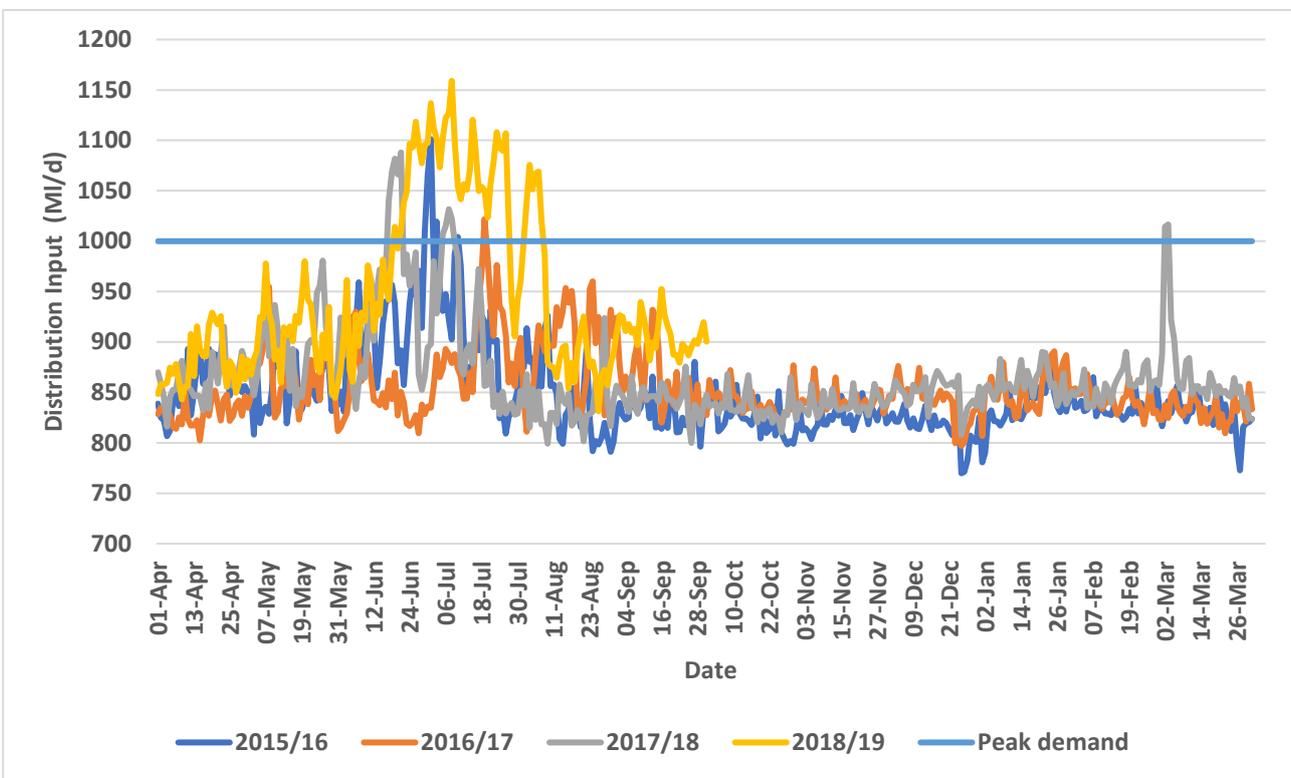
- 2.4.1 As these sources are part of a group licence with a lower annual total than the sum of individual peaks, it is not in Affinity Water's interest to increase abstraction for long periods of time as this would decrease the allowance for the remainder period in the reporting year. As stated above, under the proposed licence variation there would be no change to the current BLAF group or Watford Group licences' annual average abstraction quantities. Any increases in short-term peak daily pumping would be balanced by periods of reduced pumping to remain within existing licence limits by the end of the reporting year (1st April to 31st March).
- 2.4.2 Currently, during any peak demand event, up to 114 Ml/d (+26Ml/d difference from the 88Ml/d annual average licence) could be supplied under the BLAF group licence, including from BLAF. Without 20 Ml/d supplied from BLAF and with up to 10 Ml/d of that water being provided via Thames Water import, even with the ability to supply more from BATC and WESY via licence variation, the overall short-term peak deployable output from the group licence would be lower than currently possible, by around 9 Ml/d (see 'Peak DO' under 'Indicative DO during HS2 construction' for the BLAF Group in Table 1).
- 2.4.3 As is already the case, any additional peak pumping from BATC or WESY to cover high demand periods will be balanced by periods of lower abstraction to ensure the existing 88 Ml/d group annual average is maintained. This existing group annual average (88 Ml/d) is also requested to be extended to the end of AMP7 (31st March 2025) as detailed in forms WR330 and WR332 for the BLAF Group licence application.
- 2.4.4 The Watford Group licence comprises two sources – THEG and WAFI. WAFI is not currently used for supply and any additional water pumped from THEG would remain within the maximum daily licensed quantity for the group. In licence terms, the proposal here is to transfer WAFI's licensed capacity to THEG for peak purposes during HS2 construction. Table 1 also shows the licence and DO for the Watford Group.
- 2.4.5 As discussed, there will be priority use of the Thames Water import where possible and practical. However, even without the Thames Water import and if THEG, WESY and BATC were abstracted at the maximum rate being applied for, then the total daily abstraction across both groups for that peak period would remain below the rate currently available with BLAF in operation; As mentioned above, the Thames Water import prioritisation would be subject to operational readiness and availability at the time of request.

2.5 Environmental impact

- 2.5.1 In terms of groundwater/environmental stress, the requirement for additional water would most likely be during peak summer demand in June-July, based on historical experience (see Section 2.1). The additional volumes of water required during a peak demand period is not fixed – it varies throughout the day and from one day to the next. The length of the peak demand period can also vary but is typically limited to 7-10 consecutive days (Water Resources Management Plan Guidelines). During some years there are no significant peak demand

periods in either magnitude (above 1,000MI/d) or duration, but during others a number of peak demand periods occur. Peak demand is defined based on the historic demand profile at 1,000 MI/d and above. It is referenced in Figure 1 to clearly highlight the timing and duration of the peak demand periods from 2015-2018. In relation to the most recent peak demand period, summer 2018, there were 45 days where the demand exceeded the 1,000 MI/d mark (Figure 1). The length of the peak demand period is greater compared to recent years. For other recent years, the number of peak demand days ranged from 1 to 11. This data shows how unpredictable water demand can be, making it very difficult to explicitly state how long the peak utilisation of the new proposed licence will be required, as it is largely weather driven.

2.5.2 Figure 1. Water demand profile for the last four years.



2.5.3 Depending on weather conditions, peak demand spikes may also be experienced in May or August, but these are less frequent. There is also the potential that the flexibility to support short-term peak demands would be needed during unforeseen emergencies outside of the expected peak demand periods, such as in December-March during severe cold weather (as was experienced in March 2018 during the freeze/thaw incident) or during unplanned outages owing to water quality issues at other sources or plant failures.

- 2.5.4 October-November is typically the time of lowest groundwater levels and highest groundwater-related stress; it is less likely that additional short-term pumping from BATC, WESY or THEG would be required at these times.
- 2.5.5 The BATC and WESY pumping tests were conducted during periods when regional groundwater level conditions (highlighted by the red circles in Figures 2-5 below) were below average and relatively close to recent drought minima (in spring 2012).
- 2.5.6 No significant impacts on the water environment were recorded during the BATC and WESY pumping tests, the data having been shared and reviewed with the Environment Agency.

Figure 2 Groundwater level conditions during the BATC pumping test, March 2017 (test period circled)

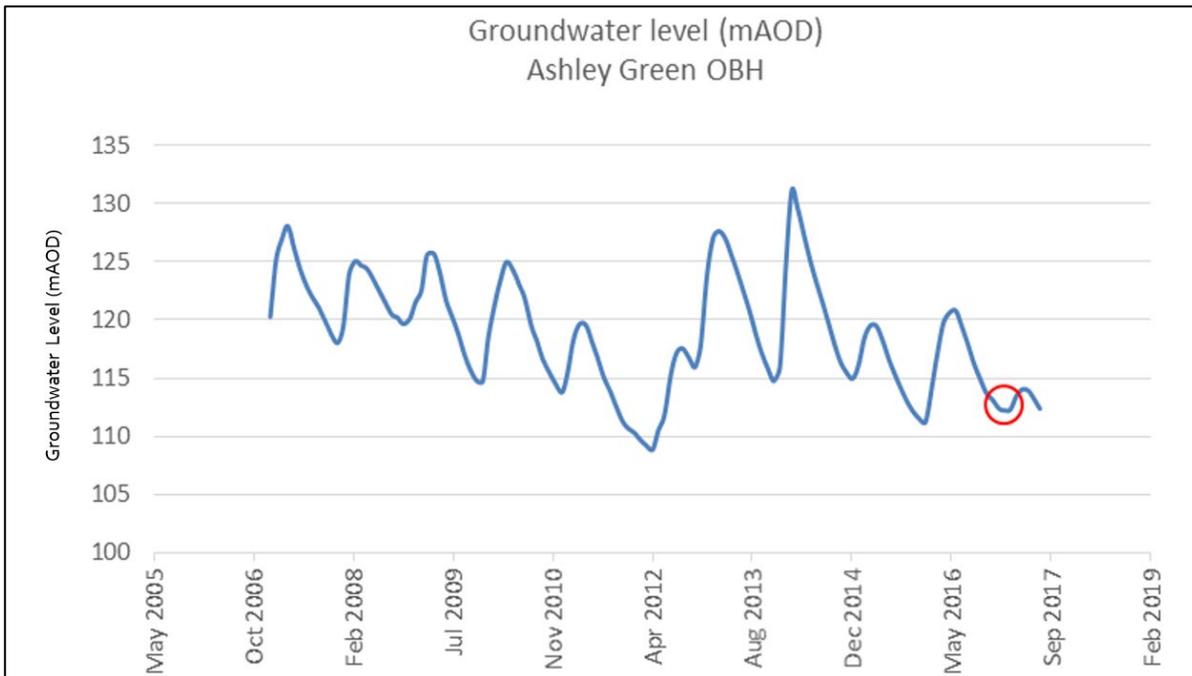


Figure 3 Surface water conditions during the BATC pumping test, March 2017 (test period circled)

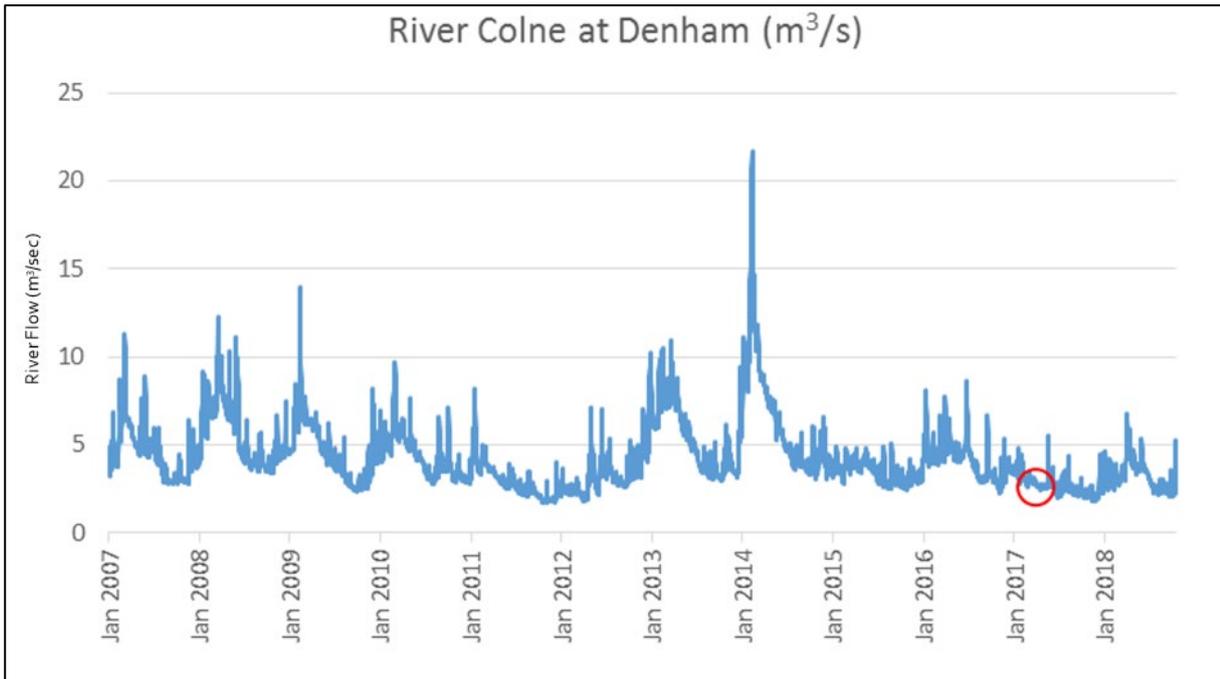


Figure 4 Groundwater level conditions during the WESY pumping test, November 2017 (test period circled)

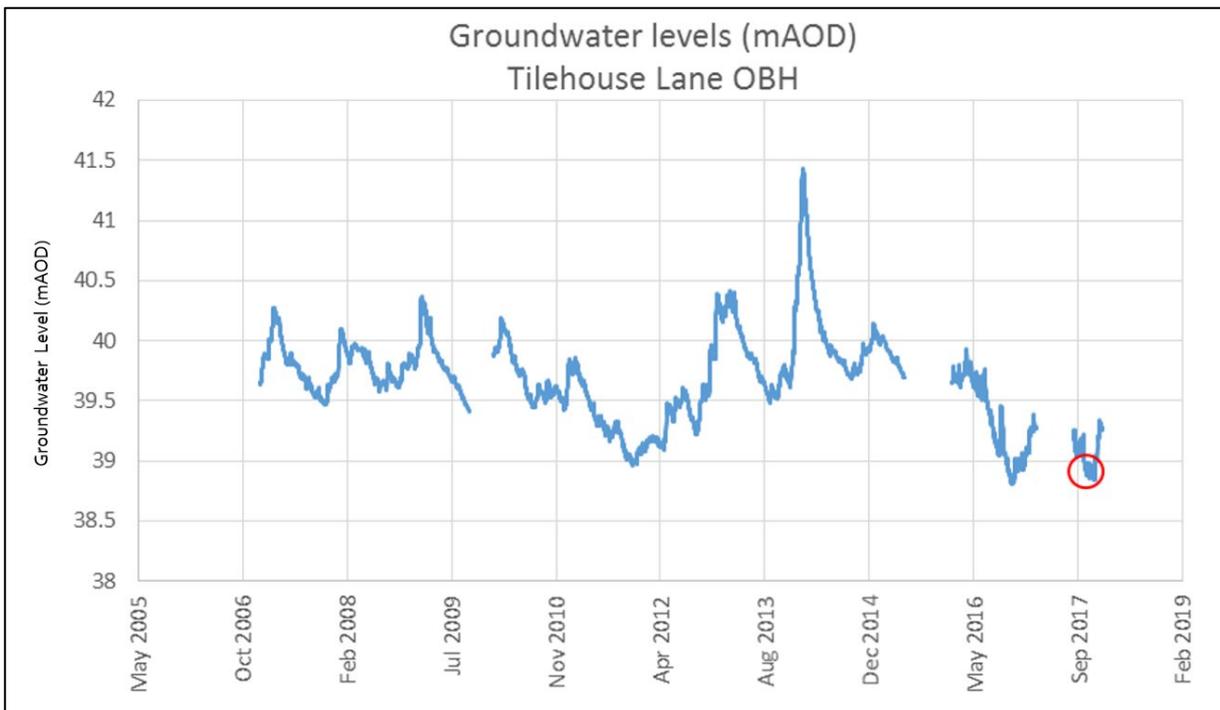
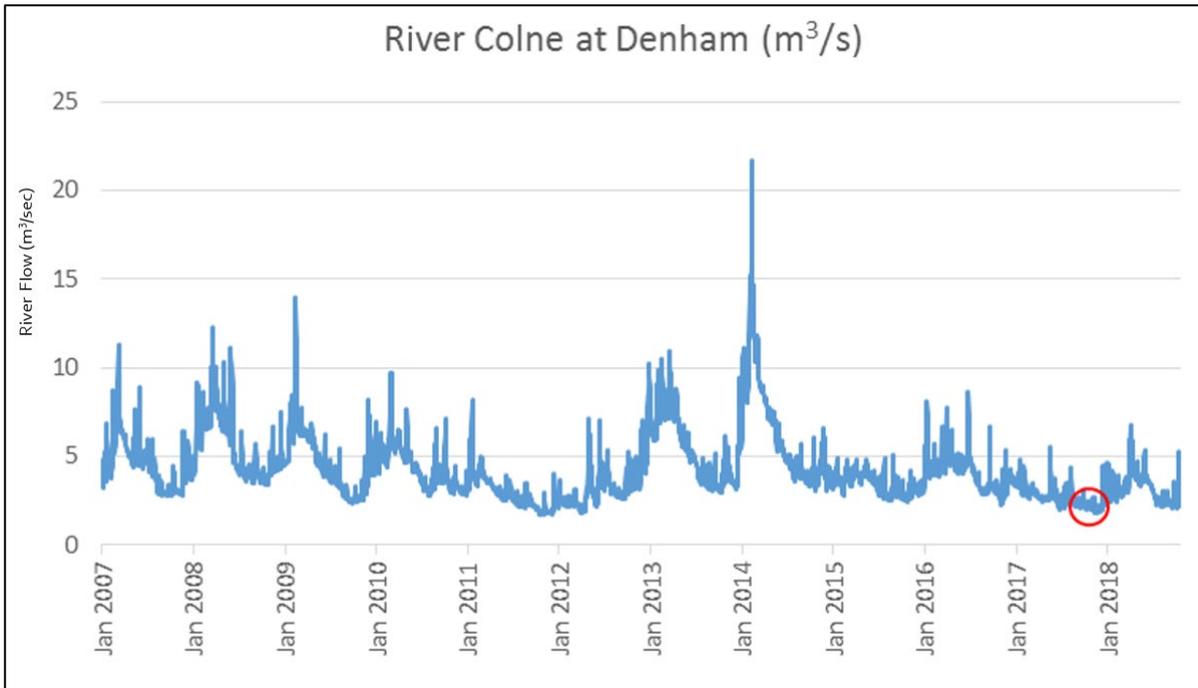


Figure 5 Surface water conditions during the WESY pumping test, November 2017 (test period circled)



- 2.5.7 THEG pumping test was undertaken at a time (May 2018) when groundwater levels and river flows were around normal for the time of year (Figures 4 and 5), but close to the likely timing of peak demand periods (typically June/July).
- 2.5.8 No significant impacts on the water environment were recorded during THEG pumping test, the data having been shared and reviewed with the Environment Agency.

Figure 6 Groundwater level conditions during THEG pumping test, Apr-May 2018, test period circled

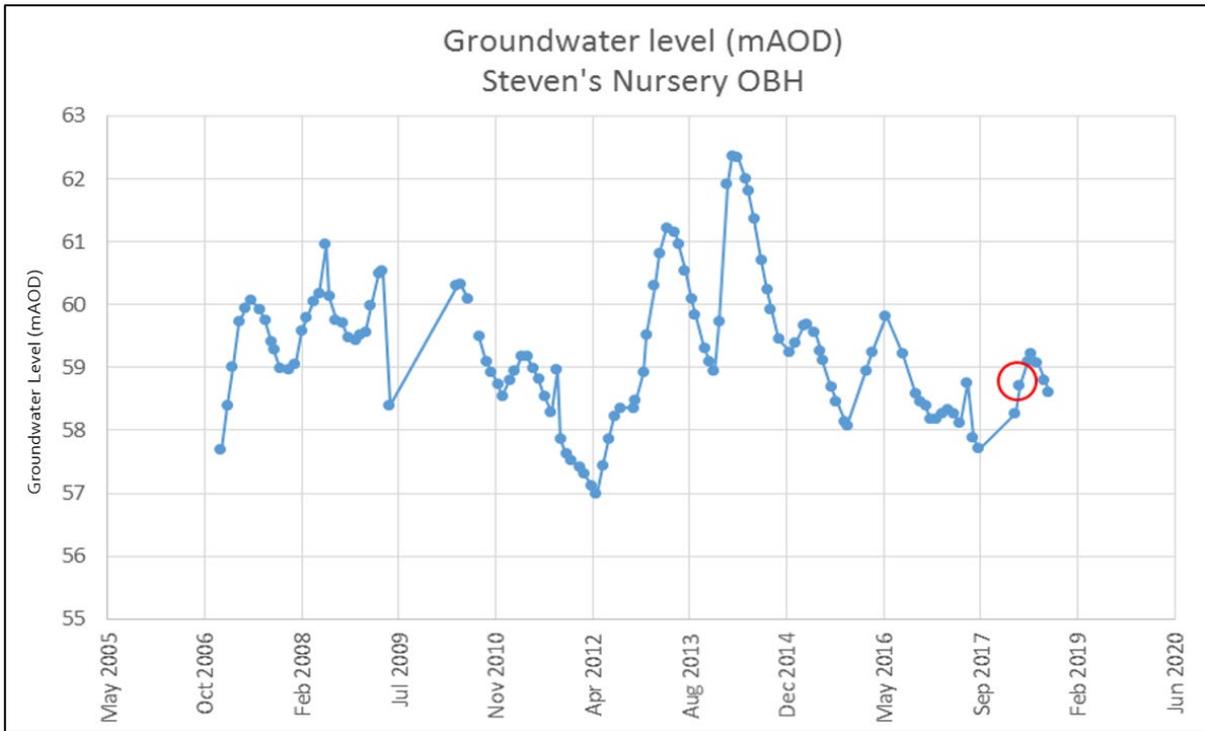
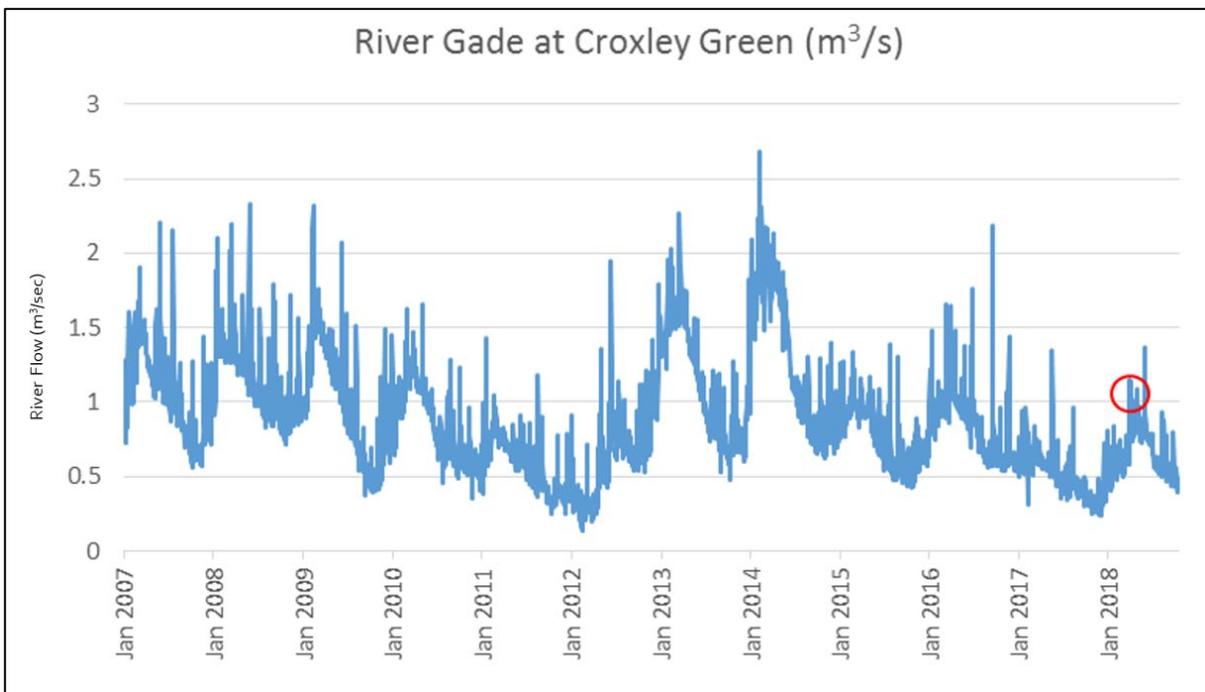


Figure 7 Surface water conditions during THEG pumping test, Apr-May 2018 (test period circled)



2.5.9 In addition to analysing the data included in the individual pumping test reports and what they indicate in terms of impacts on the local water environment, it is important to understand the wider catchment context. The proposed licence variations are unlikely to have any discernible impact on the wider catchment for the following reasons:

- At BATC, the confluence of three rivers in this area (Colne, Gade and Chess) provides a large volume of surface water flow, greatly exceeding the volume of water that could be pumped under the proposed licence variation;
- Across the three pumping test locations the integrated river and canal system is designed to provide a high degree of resilience to drought conditions in relation to the river, ensuring that water is retained in the system;
- The rivers Colne, Gade and Chess receive large sewage treatment works effluent inputs at a number of locations (Chesham Sewage Treatment Works (STW) on the Chess, Blackbirds STW on the Colne, Berkhamsted STW on the Grand Union Canal/Bulbourne/Gade system) again much larger than the proposed additional groundwater abstraction. WESY is located downstream of a large discharge from Maple Lodge STW;
- The Canal and River Trust provides additional discharges to the Bulbourne/Gade catchment from its groundwater abstractions at Cow Roast and Northchurch along with surface water from their reservoirs in the Tring summit to ensure drought resilience. The effluent from Berkhamsted STW is also discharged to the Grand Union Canal (GUC) in the Bulbourne catchment; the Rivers Bulbourne and Gade flow into the GUC in various reaches but the outflow from the GUC back to these rivers is typically weir-level controlled;
- These river valley locations are areas of high transmissivity within the Chalk aquifer, meaning additional abstraction at the scale of the proposals generates little discernible drawdown and natural seasonal fluctuation in groundwater level is low (typically <1m, see HS2,2018a). This highlights that these are areas of high transmissivity within the aquifer.

2.5.10 As an illustration of the potential impact on surface water from the small variations currently proposed, Affinity Water signal tests during AMP5 (see Section 2.6 below) did not generate observable responses. The inputs to the surface water system, which are many and varied, provide significant resilience to the Grand Union Canal. Discharge from Maple Lodge STW, typically in the range of at least 100-200 Ml/d following a diurnal pattern, drives water level changes in the River Colne and the lakes near WESY, which are in turn to a significant extent controlled by weir level settings between the lakes.

2.6 National Environment Programme (NEP) context

- 2.6.1 Separate to any HS2 considerations, Affinity Water has also undertaken extensive investigations under the AMP5 NEP which have analysed the impacts of significant changes in pumping regimes, greatly in excess of the changes proposed for these licence variations.
- 2.6.2 Under the NEP investigation, a 14-day shutdown at BATC, causing a drop of 20 MI/d in abstraction rate, resulted in no significant environmental effect. A similar step-reduction from 13 MI/d to 5 MI/d at WESY for 30 days also showed very little effect. As recorded in the Environment Agency sign-off document (Hertfordshire and North London team), no options appraisal was required for the Mid Colne River and Lakes following the AMP5 NEP investigation, as there did not appear to be significant impacts on local groundwater dependent ecosystems from the current licensed abstraction rates. The change in the aquifer system being sought through this proposal, is lower than the individual changes in abstraction seen during the signal tests undertaken in AMP5.
- 2.6.3 The AMP6 sustainability reductions in the wider Colne catchment need to also be taken into account in terms of the significance of the small temporary licence increases proposed to the catchment water balance – 15.2 MI/d at average (BOWB cessation & PICC/MARL & AMER reductions) have been implemented in April 2018 with further reductions to follow by 2024.

3 Conclusions

- 3.1.1 The proposed variation is to permit the three sources (THEG, BATC and WESY) to operate for short periods at higher peak rates of abstraction, in order to maintain the supply-demand balance while Affinity Water's BLAF source is taken out of supply during HS2 construction activities.
- 3.1.2 No change to current annual average abstraction under the group licences is proposed. An extension of the existing 88MI/d annual average BLAF group licence is also sought until 31 March 2025 (BATC and WESY are part of this group licence). Any short-term pumping at the proposed higher rates at BATC, WESY or THEG will be balanced by periods of lower abstraction in order to maintain current annual group limits.
- 3.1.3 The import of water from Thames Water as a potential option of the replacement solution for BLAF will mean that the peak DO from the BLAF Group will actually be lower than the 2012 peak DO, provided that it becomes available during peak demand periods and subject to any other water quality related limitations.
- 3.1.4 The three pumping tests have not shown adverse impacts on other licensed abstractions, surface water features or protected sites, with the possible exception of a Thames Water borehole at Juniper Hill sewage pumping station near BATC, for which a consent to derogate is being sought (see HS2, 2018a). This aligns with the findings of previous signal test monitoring at WESY and BATC that was performed during AMP5 NEP investigations. Details

of the environmental monitoring carried out during the pumping tests are reported separately.

- 3.1.5 The BATC and WESY pumping tests were carried out under regional groundwater level conditions that are comparable to recent drought experience. THEG pumping test was carried out under background groundwater level conditions likely to be typical of peak demand periods.
- 3.1.6 The surface water system adjacent to BATC, WESY and THEG is complex but has been engineered to be drought resilient and to maintain flows in the Grand Union Canal. There are significant and varied discharges to the canal/river system that are far greater than the volumes of water proposed for licence variation.
- 3.1.7 Operational constraints during the pumping tests limited Affinity Water's ability to pump at the higher rates they intended and which they would like to apply for. The requirement for the higher rates is to provide the flexibility to deal with current uncertainty around the delivery of imported water from Thames Water, combined with a precautionary view of the possibility of unforeseen outages resulting from HS2 operations or unforeseen supply issues, coinciding with peak demand periods. The pumping test results and Affinity Water's understanding of the construction and performance of their boreholes provides confidence that those higher rates are achievable and simple linear interpolation of groundwater drawdown is appropriate.
- 3.1.8 Regarding the duration of the temporary licence variation, the pre-application included a nominal duration of five years. The basis for this is the uncertainty about the duration for which BLAF will be offline. The current HS2 programme indicates a period of 24 months during which construction close to BLAF could impact on water quality. A nominal period of six months has been added to allow for recommissioning of the site. However, as the final HS2 programme has yet to be defined, a five year period has been suggested.

4 References

Reference	Title
Hs2, 2018a	BATC Source – Hydrogeological Assessment of Proposed Abstraction Licence Variation (1D107-EDP-EV-REP-CS01-000001)
Hs2, 2018b	WESY Source – Pumping Test Appraisal (1D107-EDP-EV-REP-CS01-000002)
Hs2, 2018c	THEG – Pumping Test Appraisal (1D202-EDP-EV-REP-CS01-000001)