Dr Rivett Outline Response to Updated Statement of Common Ground and Jenny Lightfoot Proof of Evidence

15 /11/2021

Re: Appeal APP/M1900/W/21/3278097 (Nov. 2021) on rejection of proposed quarrying activity, Hatfield Aerodrome

For the attention of: Sue Meehan, Mike Hartung (EARA)

Dear Sue, Mike

In response to the very recently received updated Statement of Common Ground (SoCG) and Jenny Lightfoot Proof of Evidence, I have gathered together a non-exhaustive set of slides to provide some response to these documents. In the Round Table discussion it would be helpful to ideally present this information as a time-limited Powerpoint presentation or have the document made available so it can be referred to. The document would serve as an addendum to my own Witness Statement, responding to the above documents recognisng time to do so has been limited

Whilst parts of the SoCG can be agreed with, other parts do not always appear to fully support the final conclusions drawn and do not always convey the complete picture in my opinion.

As you will also see, I have made some graphs of the temporal bromate data around the southern bromate plume boundary to help better understand the (alledged) bromate plume behaviour. The above and other documents we have received provide many statements on the bromate plume behaviour, but can be thin on providing the supporting evidence detail which is clearly important. Perhaps some resides in other

Cont.

Cont.

Reports. Although, I am not convinced that is always the case as I have not seen any real detailed interpretation of the Site and nearby plume data and behaviour in the LMH versus the chalk to fully understand the bromate plume dynamics on or near Site and the claimed stability of the bromate plume which needs to be better examined at the near site scale.

It has been helpful to now see the HATF abstraction rates time series which I have tried to incorporate in the graphs at a simple level to understand the plume response to the low rate abstractions. Also, critically the slow times for lateral re-orientation of the bromate in the LMH especially when HAFT abstraction rates increase again (which does not seem appreciated in the SoCG). I have looked at rainfall impacts via the available Rothamsted Herts data up until 2018 as reliable data that I could quickly access – it provides some useful insights. My interpretation is that some aspects of the above documents are supported and some much less so.

The above documents in my opinion have not fully appreciated the low permeability backfill / barrier issue and are far too dismissive of it. Interestingly though in the updated Lightfoot proof claim credit for the “Backfill in phases A to F with lower permeability material will also form a partial barrier on the plume side of the quarrying operations.” in the ‘new application’. This area remains a central issue in my opinion in both the current and new application.

Finally, I do very much share your concerns that there has been a lot of information thrown at you of late with shifting goalposts too. I trust though this outline response gathered and my examination of the actual bromate data is useful, albeit not exhaustive given the timeframes.

Kind regards

Dr Michael Rivett FGS

Director, GroundH2O Plus Ltd

Document aims

- This document provides an Outline Response to some of the key points raised by the recently received:
  - Statement of Common Ground (updated)
  - Jenny Lightfoot – Proof of Evidence (and its update)
- It also provides some analysis of the bromate plume data undertaken by myself to help support this response
- It is intended to contribute and ideally be made available to as a time-limited presentation and, or document at the Round Table discussion of the Hearing session – Hydrogeology (17/11/2021)

To note

Red text = Text of the Statement of Common Ground potentially an issue

Blue text = My response

Statement of Common Ground

- 4.3

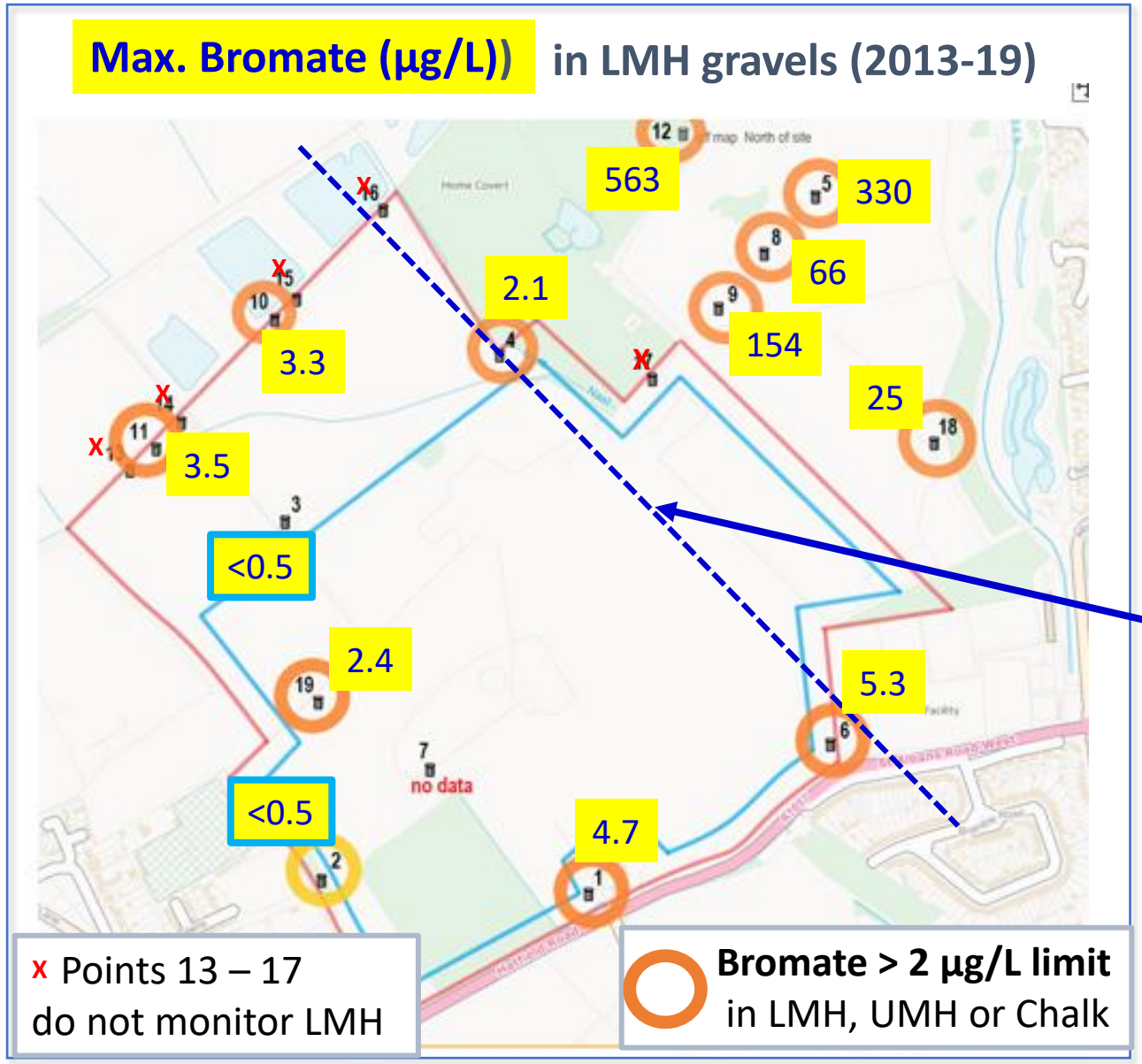
Despite the fact that in the main part of the plume (to the north of the proposed quarry) the LMA can also have bromate-rich water, the primary mechanism for bromate scavenging at HATF is through the Chalk with minimal downward leakage through the LMA [aka LMH].

- In fact, since 2018 when the HATF abstraction became more stable at c4.5Ml/d, the bromate ratio between LMA and Chalk has stabilised, indicating that a steady state condition has been reached with fixed leakage between LMA and Chalk.
- The bromate concentration at both the LMA and the Chalk is primarily influenced by rainfall/recharge resulting in greater dilution during wet years and less during dry years.
- HATF abstraction is considered to be a secondary influence on the bromate plume at the proposed quarry, as demonstrated by the water quality data collected since 2018 (with stable abstraction).

Some of my responses:

- BUT, this still does NOT negate the fact that all bromate in the Site LMH and in the LMH to the immediate north of the Site falling in the shown capture zone in the LMH (water table maps) will be draining into the Chalk and be scavenged.
- The percentage split of bromate mass scavenged by HATF between (i) that has passed through the chalk-LMH-chalk pathway versus (ii) chalk only, has not been estimated (and would be subject to quite a lot of uncertainty) and needs to be estimated to fundamentally support this statement.
- My analysis of data further below does not fully support this stabilisation has occurred – the ratios are still quite variable in time and between points. My impression is that the time (2-3 years) for stabilisation of the bromate plume in the LMH gravels in response to the changes in abstraction rate before and after 2018 is NOT appreciated (see later) and is critically important.
- My analysis of data further below provides a fair number of instances where this primary influence is NOT followed and the reverse is true. The LMA and Chalk can show quite different behaviours and each requires consideration.
- I also contest this, my analysis below suggest that for some wells in the LMH in or close to site (eg. 104, 108) that the HATF abstraction rates are the primary control on bromate occurrence
- Given these and other concerns, I do hold reservations that bromate plume behaviour in the LMH (LMA) is inadequately conceptualised.

Bromate plume occasionally already found in Site LMH gravels



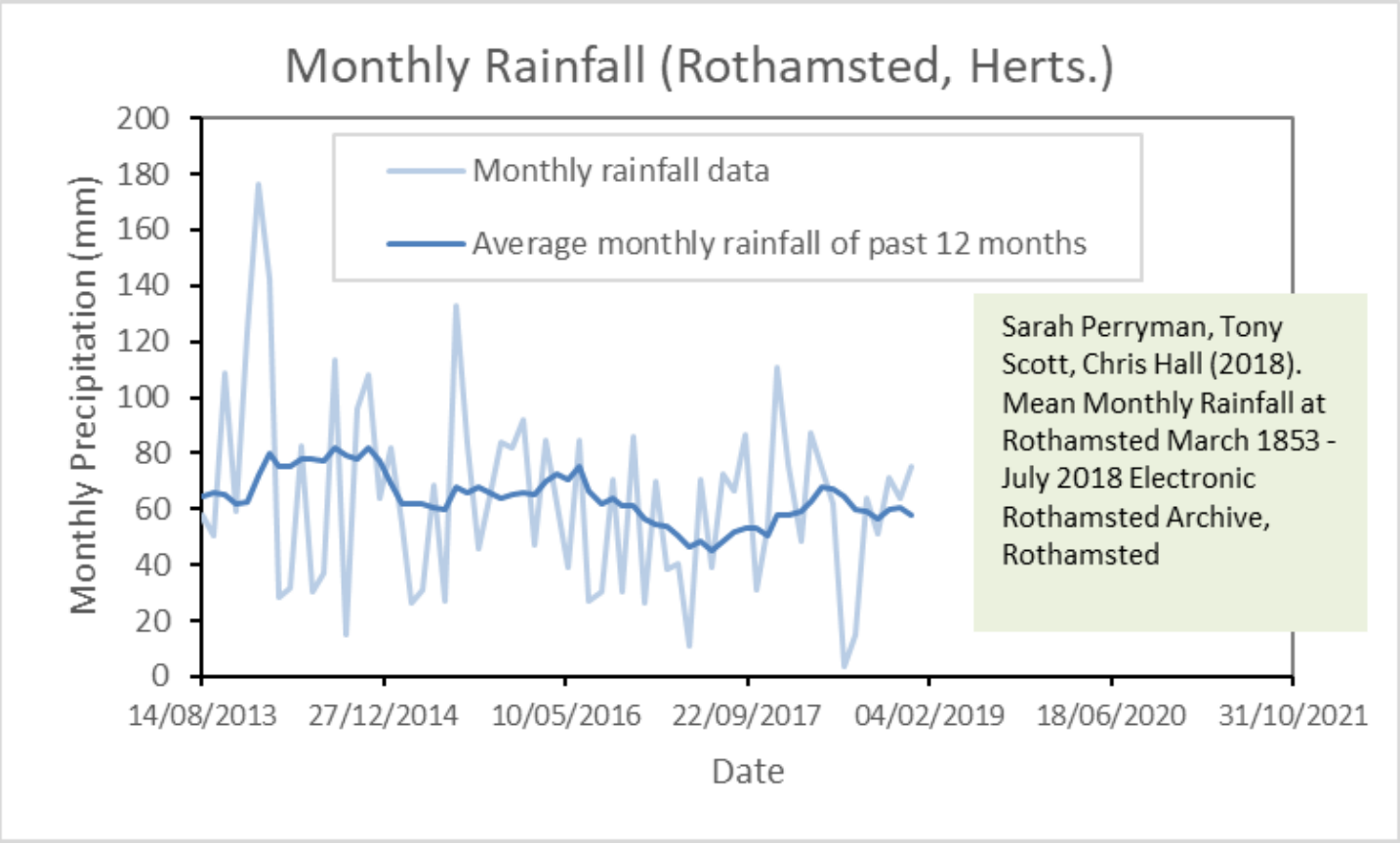
- Rather than ignored, the occurrence of sporadic low bromate occasionally detected across the Site LMH needs to be adequately explained in the site conceptual model?
- Quarry Site north-east is extremely close to high concentration bromate plume in LMH gravels and chalk
- All monitoring wells on Quarry Site except two wells have exceeded the 2 µg/L bromate regulatory limit at some point
- This critical near-site boundary only has 2 monitoring wells sampling the LMH gravels – why was a "half-a-mile gap" in monitoring agreed to where plume entry is most likely?
- Site abstraction focused in the LMH for quarrying will inevitably further draw the bromate plume into the Site LMH. It will exert a much stronger "pull" into the Site LMH unit than that exerted by HATF that causes a subdued, gradual 'drift' of bromate into the Site L.MH

EA Condition i "*No mineral is extracted from within the existing plume of bromate and bromide groundwater pollution*"

Some bromate data analysis

- There still appears a pressing need to better interrogate/model the LMH versus chalk bromate occurrence around the Southern plume boundary nearing the Site to improve conceptualisation of the bromate plume to evaluate the proposed quarrying impact.
- Quite often statements are being made without data evidences always being provided in my opinion (I recognise some may be in supporting reports, but some perhaps not?).
- Fundamentally what controls the bromate occurrence on or near the Quarry site? Is it a “stable plume”?
- My brief analysis of temporal bromate data follows below
- My analysis variously supports or does NOT support elements of the Statement of Common Ground

Rainfall influence assessed via



- Monthly rainfall record added to bromate temporal plots to examine rainfall influence on concentrations
- ‘Rolling average’ over past 12 months added to bromate plots to help smooth out the monthly data and better indicate proceeding dry or wet year influence

HATF abstraction rate influence

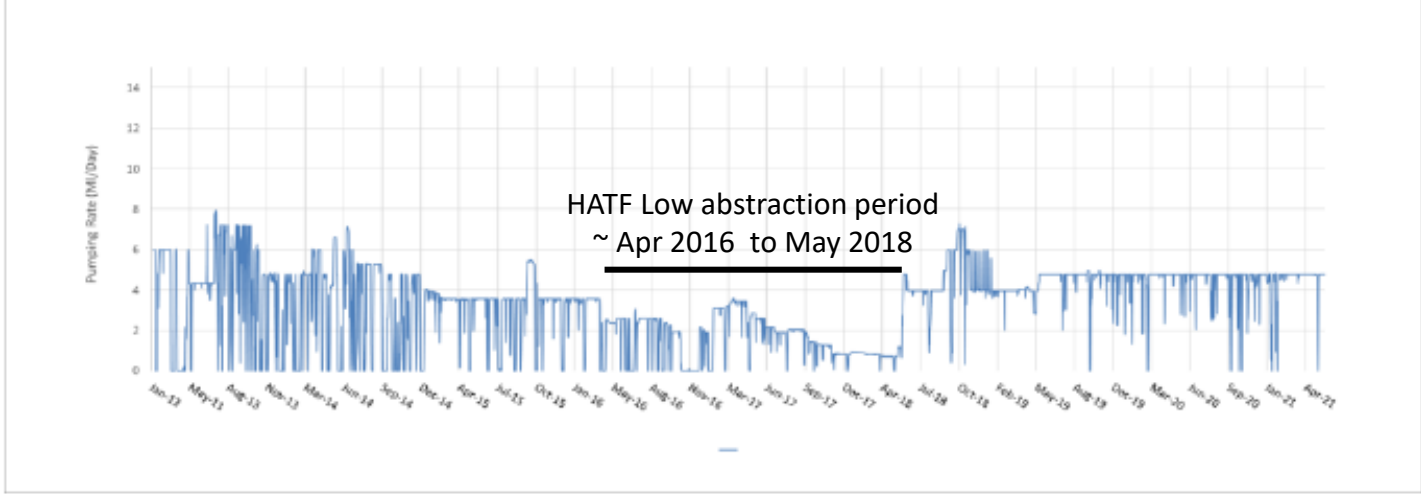


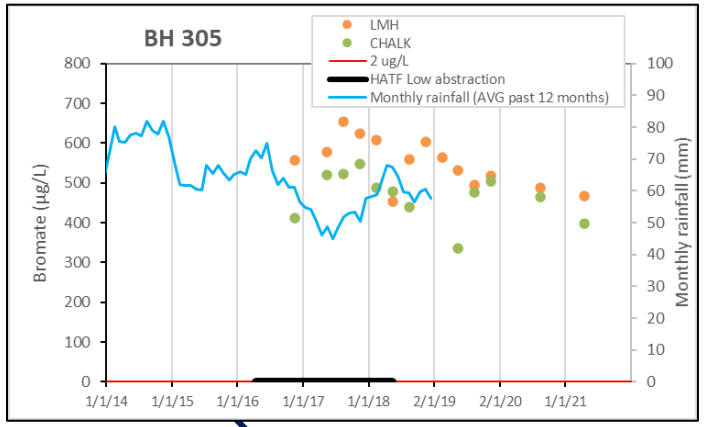
Figure 7
Bromate concentrations over time at BH104 screened in the LMA and in the Chalk (located at the northern boundary of the proposed quarry) plotted against HATF abstraction (SLR data)

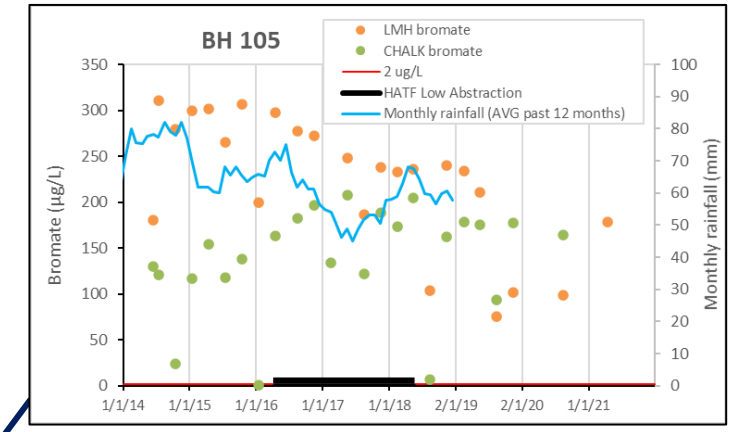
- HATF (Bishops Rise) low abstraction period from around April 2016 to May 2018 added to bromate plots to assess its influence on concentrations both during and after this period

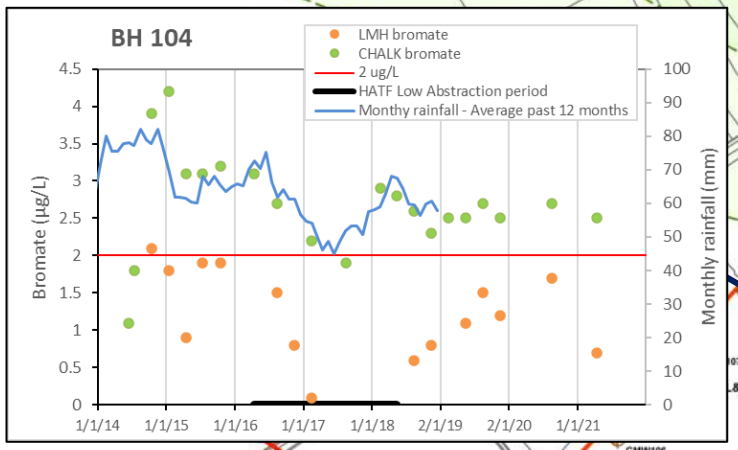
Bromate time series in LMH and Chalk

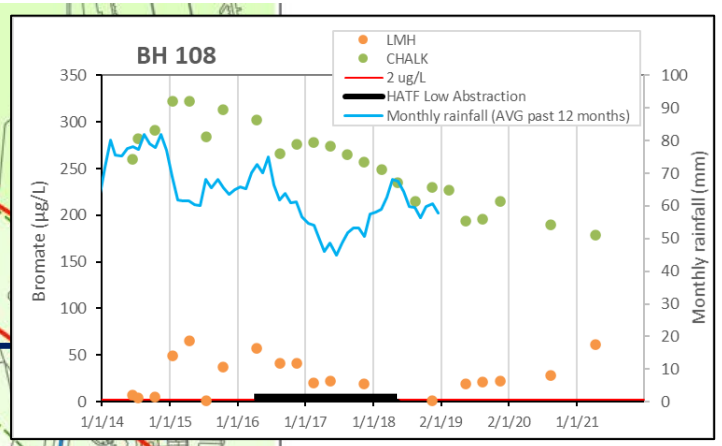
Legend

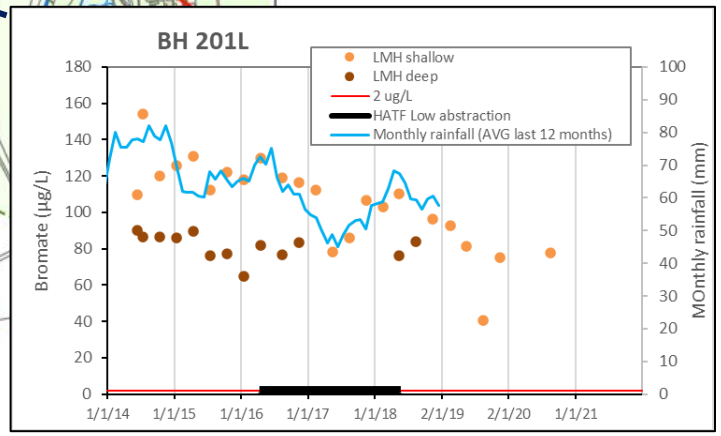
- LMH bromate
- CHALK bromate
- 2 ug/L
- HATF Low Abstraction period
- Monthy rainfall - Average past 12 months



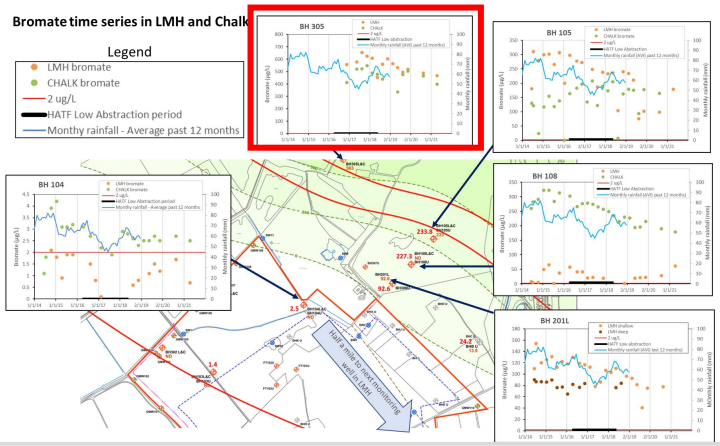


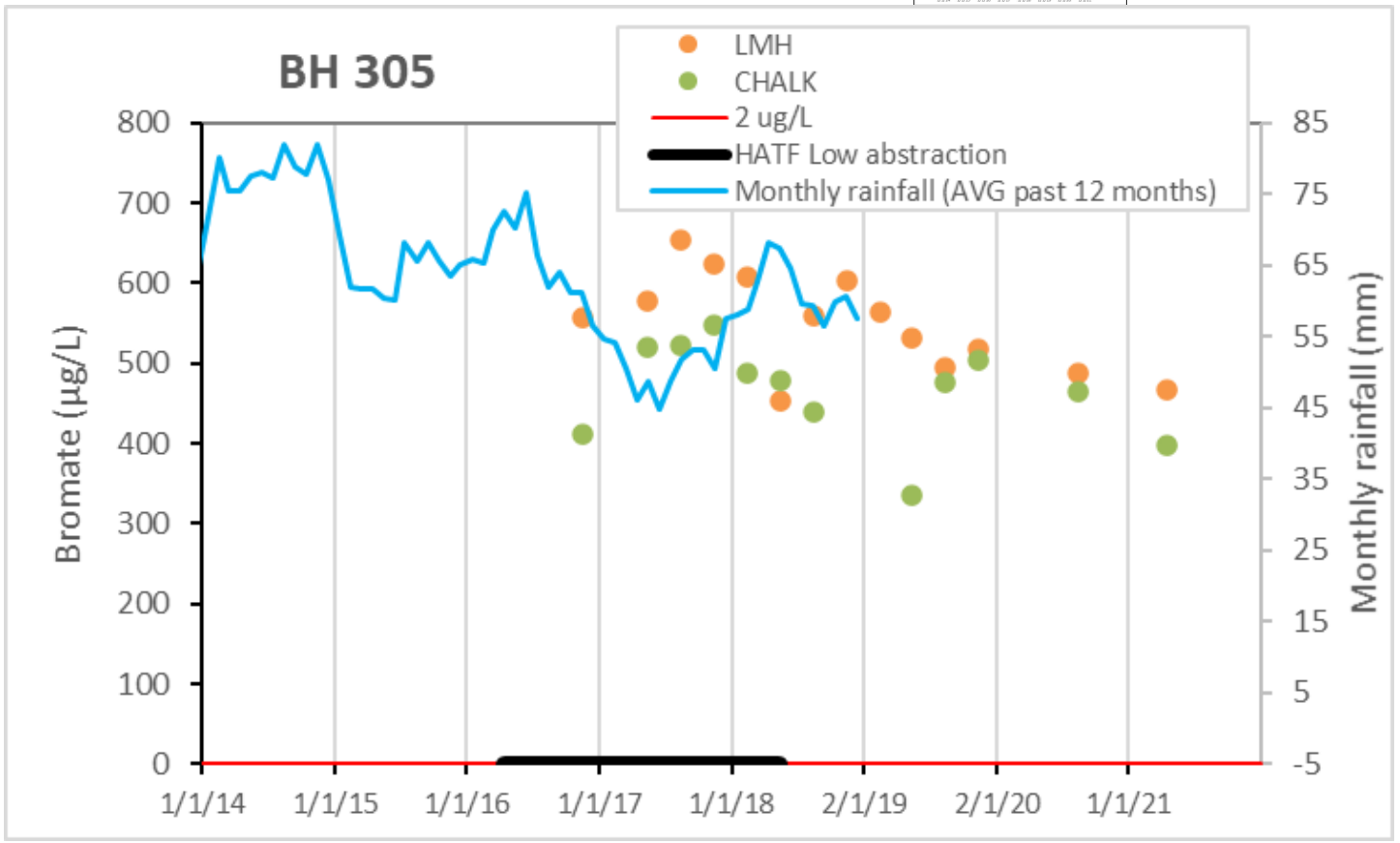






See individual slides for plot detail
(very occasional non-detects not plotted)

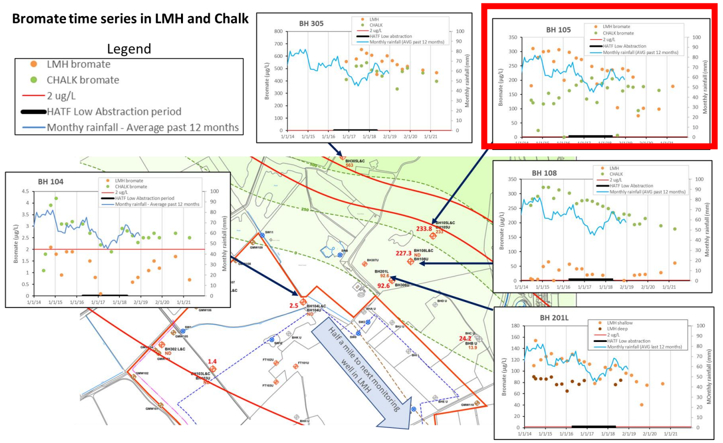


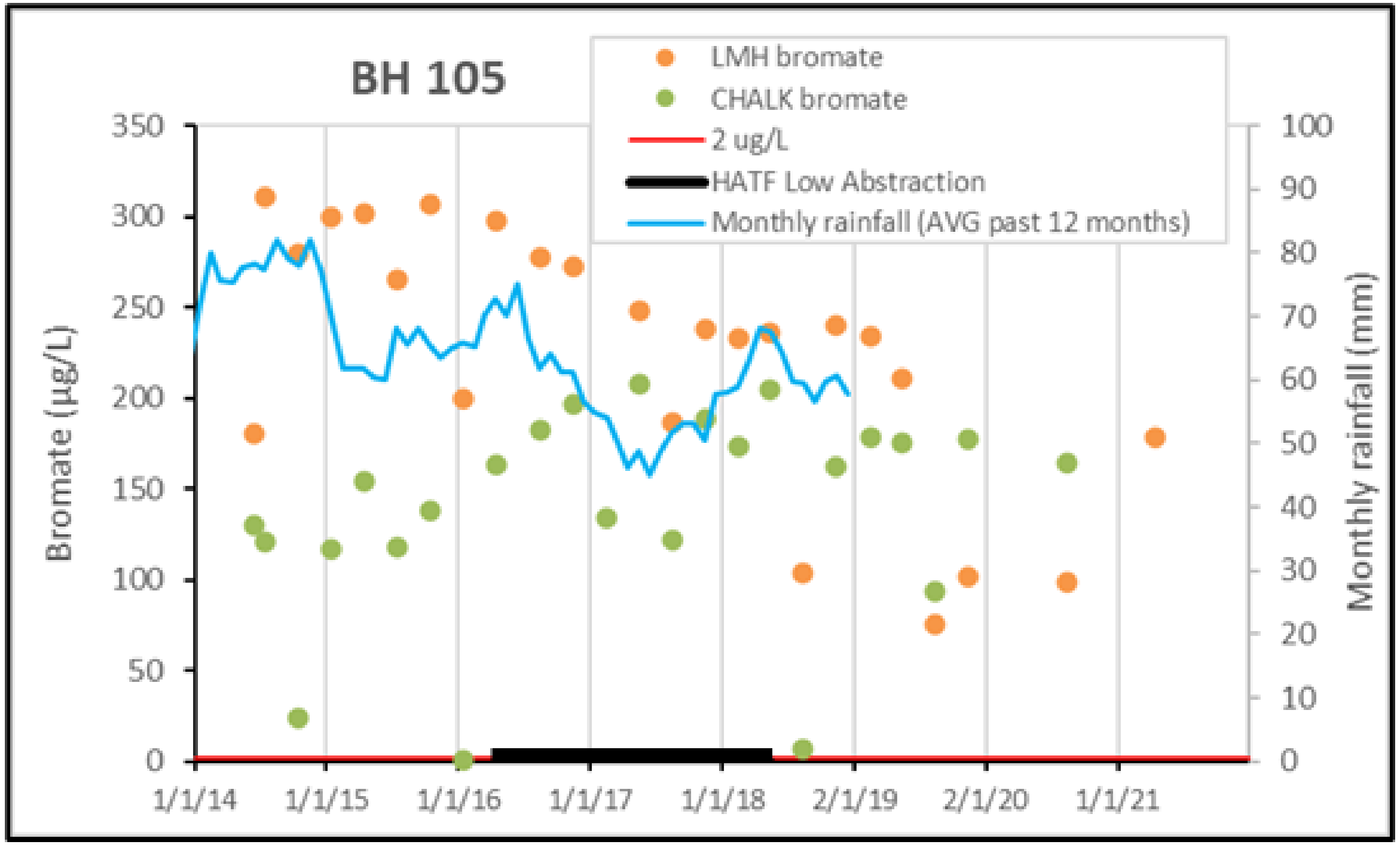


- Bromate plots are shown in order moving from the plume core laterally across the southern plume boundary in to the quarry Site

BH305

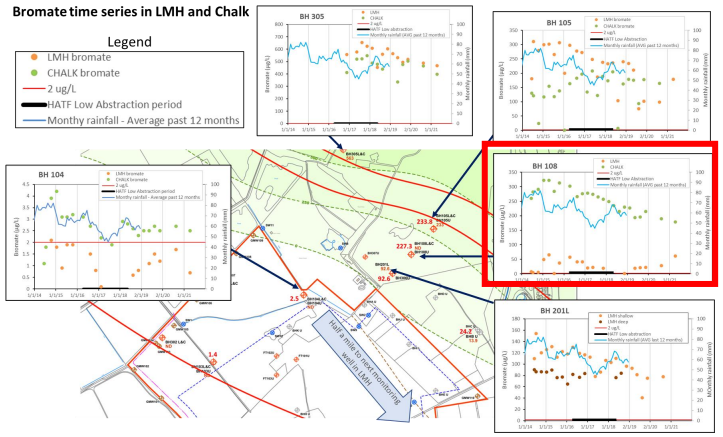
- Plume core area showing similar bromate concentrations in the LMH and chalk – hydraulic continuity between LMH and chalk possible
- LMH concentrations except once always greater than chalk
- Temporal variations show some similarity between LMH and Chalk
- Relationship to rainfall (limited data)
  - Not obvious for LMH
  - Possibly for Chalk – lower bromate in wetter period
- Relationship to HATF low abstraction:
  - LMH Bromate possibly declines with increased abstraction after

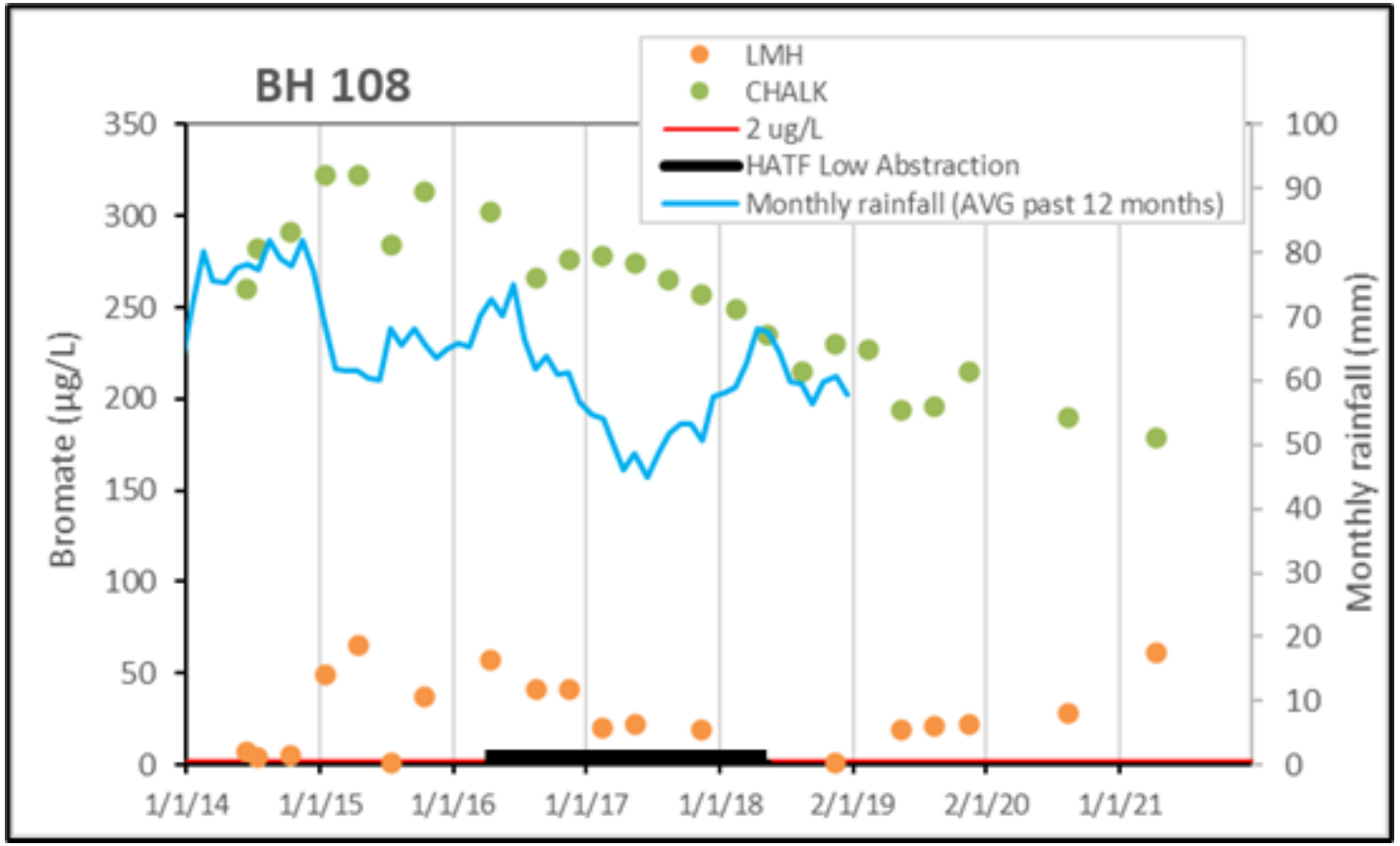




BH105

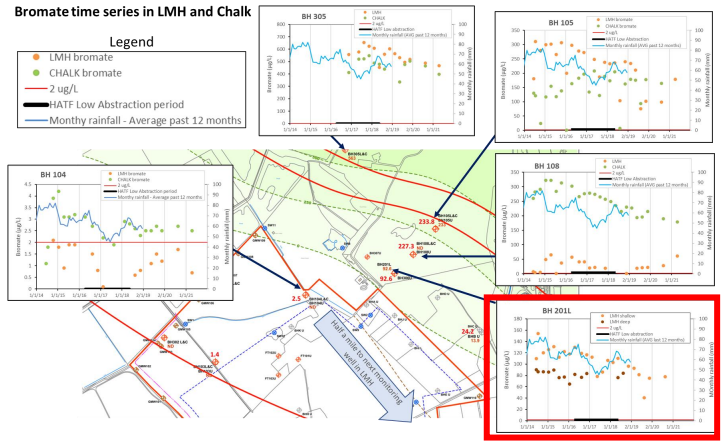
- Until recently LMH concentrations usually higher than Chalk, can be around double
- Trends are notably different in LMH and chalk –not suggest local hydraulic continuity between LMH and Chalk
- Relationship to rainfall
  - Not obvious for LMH
  - Not obvious for Chalk (?)
- Relationship to HATF low abstraction:
  - LMH Bromate tends to decline (?)
  - Chalk bromate tends to increase (?)
- Recent period – rather confusing unclear relationships

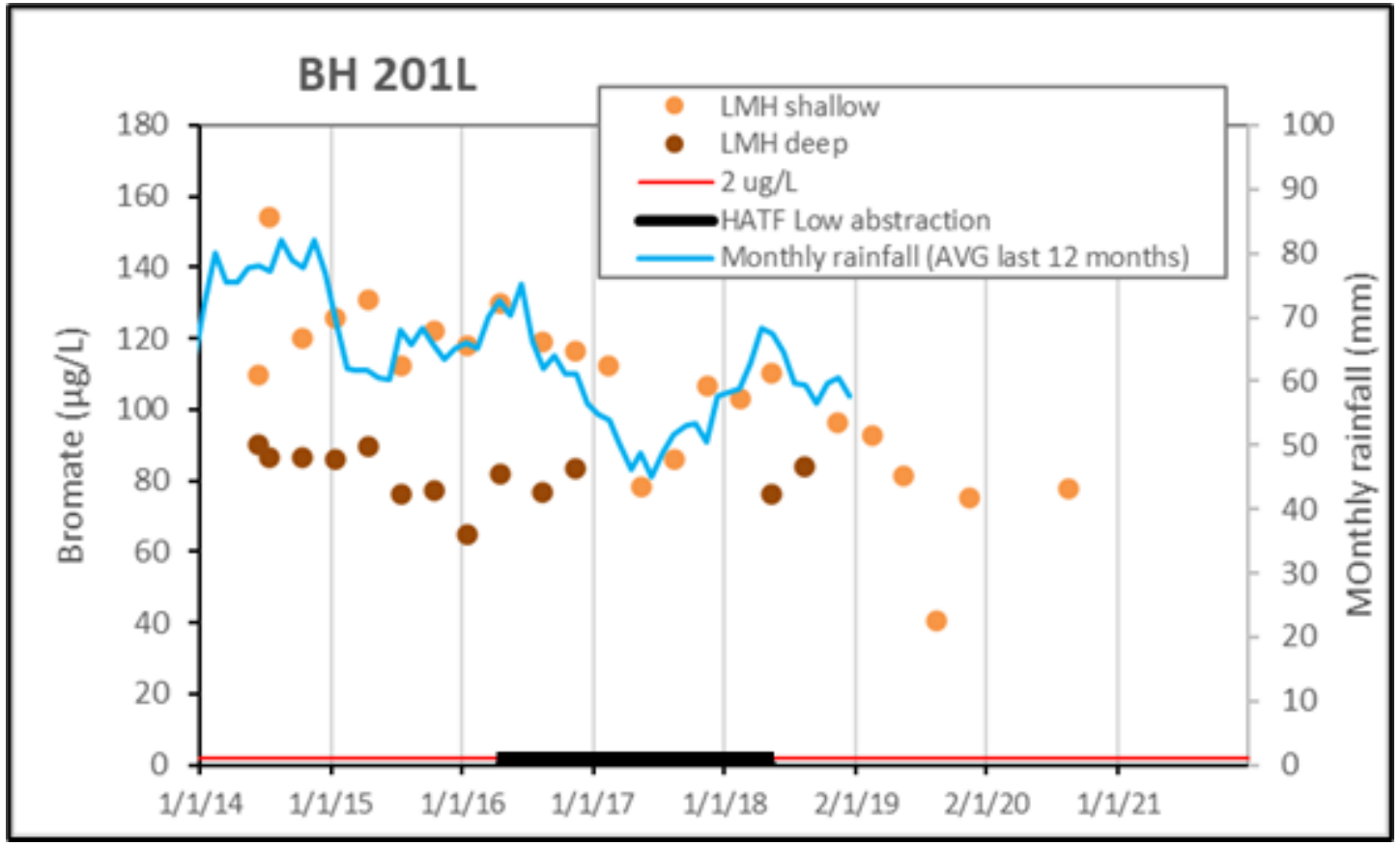




BH108

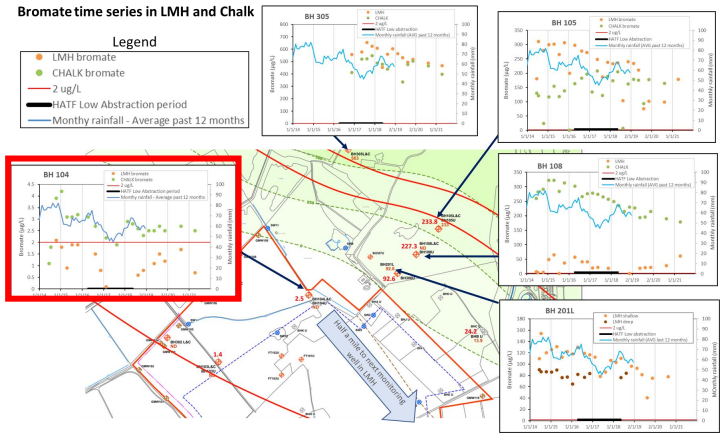
- LMH bromate appears anomalously low compared to the chalk compared to other boreholes
- Chalk shows a declining trend overall that is not shown by the bromate – recently bromate is increasing as chalk declines
- Bromate concentrations do not fit trend of adjacent lateral boreholes spatially (201 L data higher bromate)
- Trends are notably different in LMH and chalk – not suggest local hydraulic continuity between LMH and Chalk
- Relationship to rainfall
  - Not so obvious for LMH, possibly earlier period shows increased bromate in drier years
  - Possibly for Chalk – some higher bromate in drier years (?)
- Relationship to HATF low abstraction:
  - Chalk – not obvious against other trends(?)
  - LMH – **yes:** Bromate appears to gradually decline during abstraction low followed by **a gradual increase over 2 to 3 years back to pre low-abstraction period concentrations as pumping increased. This may be very reasonably interpreted as a SLOW lateral drift of the plume transversely across 108 back and forth away from and then towards the Site.**
  - LMH behaviour is very distinct from Chalk

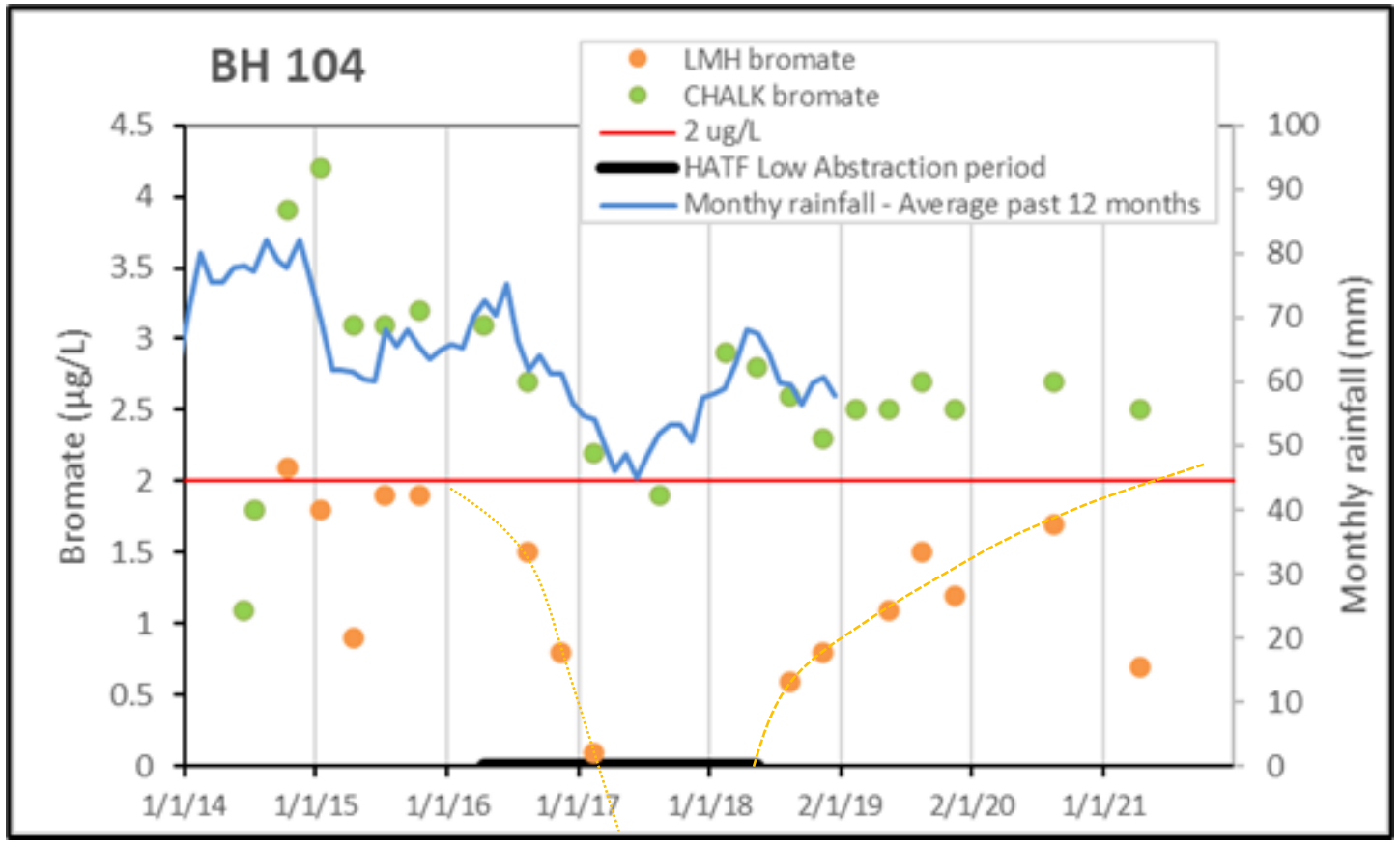




BH201L

- Comparison here is of shallower and deeper points in the LMH (and not with chalk)
- The borehole is very close to the Site perimeter and shows much higher concentrations around 100 ug/L bromate than Borehole 108 considered above laterally close to the plume core. Hence shows heterogeneity of plume edge and issues with the half-a-mile gap in the moniotring
- Bromate in the shallow LMH is consistently higher and more variable than the bromate in the deeper LMH – showing the importance of higher shallow contamination in the LMH
- Together they suggest high bromate concentrations over the LMH thickness around 50 times the 2 ug/l plume threshold that is very close to site and highly likely to be pulled in to Site by quarry abstraction in the LMH
- Deeper LMH shows quite constant bromate and contrasts with the shallow LMH bromate that shows declining bromate with time
- Relationship to rainfall
  - Not obvious for deeper LMH
  - **Yes – for shallow LMH – there appears good correlation with the rainfall trend with increased bromate observed with increased rainfall – this would suggest increased leaching of shallow source area bromate with increased rainfall and water levels – it shows the importance of the LMH gravels receiving such contamination from the Chalk extremely close to the quarry site at very high concentrations**
- Relationship to HATF low abstraction:
  - Deeper LMH – not obvious
  - Shallow LMH not obvious against other trends

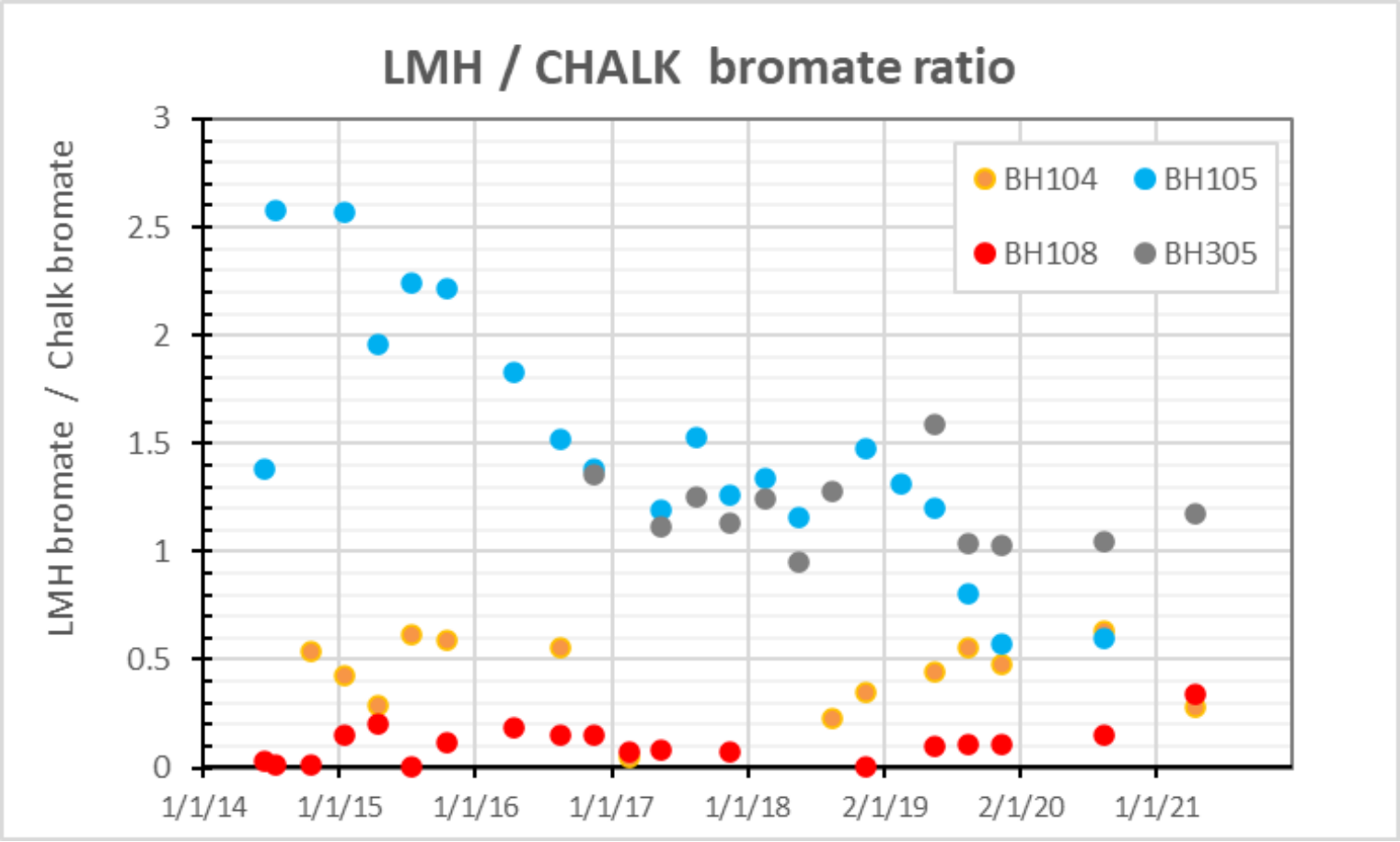




BH104

- Boreholes at site NE corner perimeter
- Chalk bromate at 2 – 4 ug/l just above plume threshold
- LMH bromate usually below but may approach 2 ug/L threshold
- Trends are notably different in LMH and chalk –not suggest local hydraulic continuity between LMH and Chalk
- Relationship to rainfall
  - Not obvious for LMH
  - Yes – very obvious for chalk bromate with higher rainfall and higher water levels having higher bromate suggesting again the importance of leaching shallow source zones of bromate at high water table
- Relationship to HATF low abstraction:
  - Chalk not obvious
  - LMH Bromate – Yes, similar to 108. Bromate appears to gradually decline during abstraction low followed by **a gradual increase over 2 to 3 years back to pre low-abstraction period concentrations as pumping increased.** This may be very reasonably interpreted as a SLOW lateral drift of the plume transversely across 108 back and forth away from and then towards the Site.
  - LMH behaviour is very distinct from Chalk

LMH / Chalk Bromate ratio – not stabilised?



SoCG:

In fact, since 2018 when the HATF abstraction became more stable at c4.5Ml/d, the bromate ratio between LMA and Chalk has stabilised, indicating that a steady state condition has been reached with fixed leakage between LMA and Chalk.

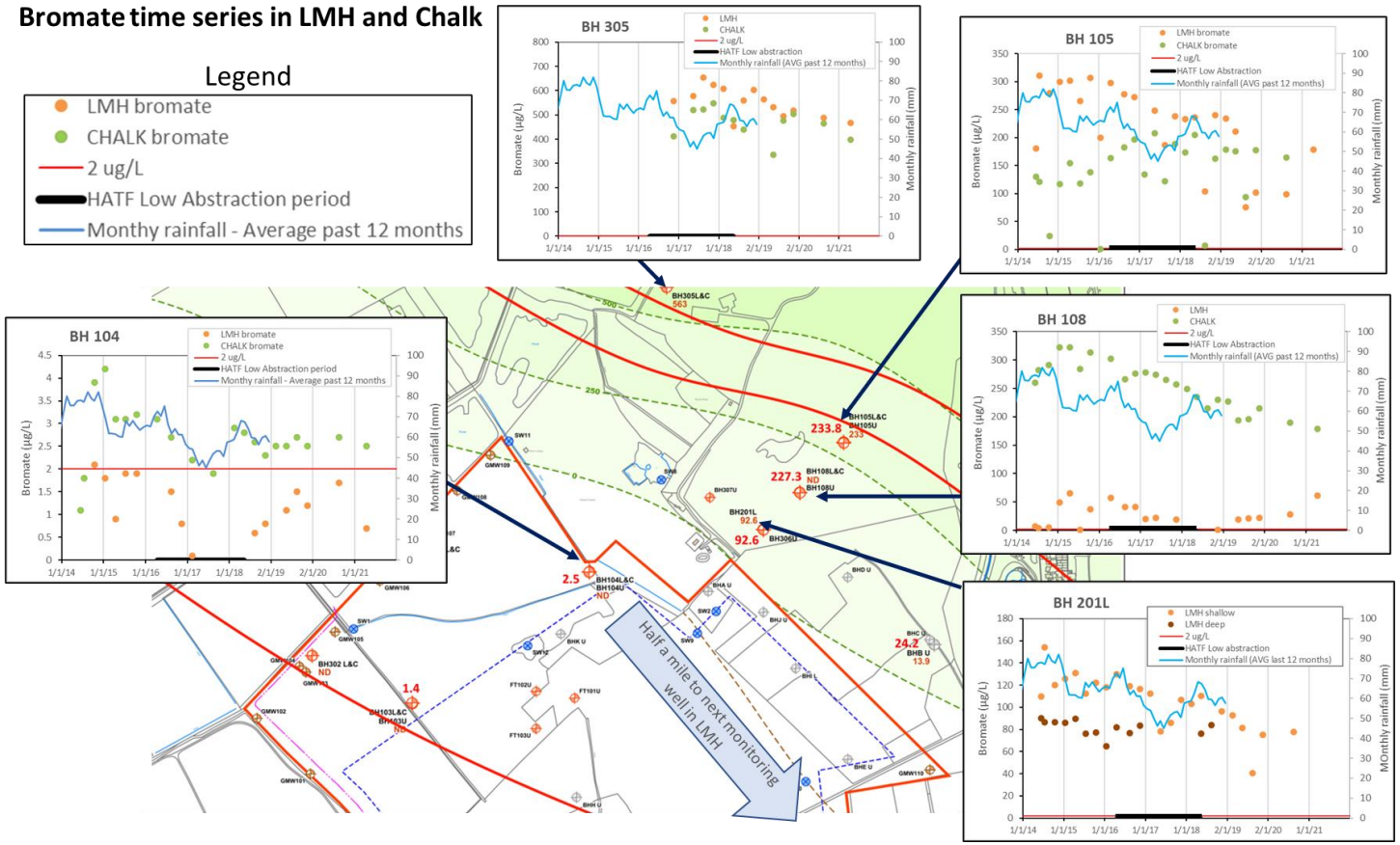
My response

- The ratio of LMH Bromate / Chalk bromate does not look as stable as the SoCG suggests?
- There are quite a lot of factors controlling this ratio evidenced by the spatial and temporal variability in these ratio
- These ratio are important and need to be understood better at tee local and regional levels to help understand the chalk and LMH plume relationships in space and time

What bromate is currently abstracted by HATF?

- What is the percentage of bromate abstracted from:
  - the Chalk-LMH-Chalk pathway
  - versus Chalk only pathway

Bromate time series in LMH and Chalk



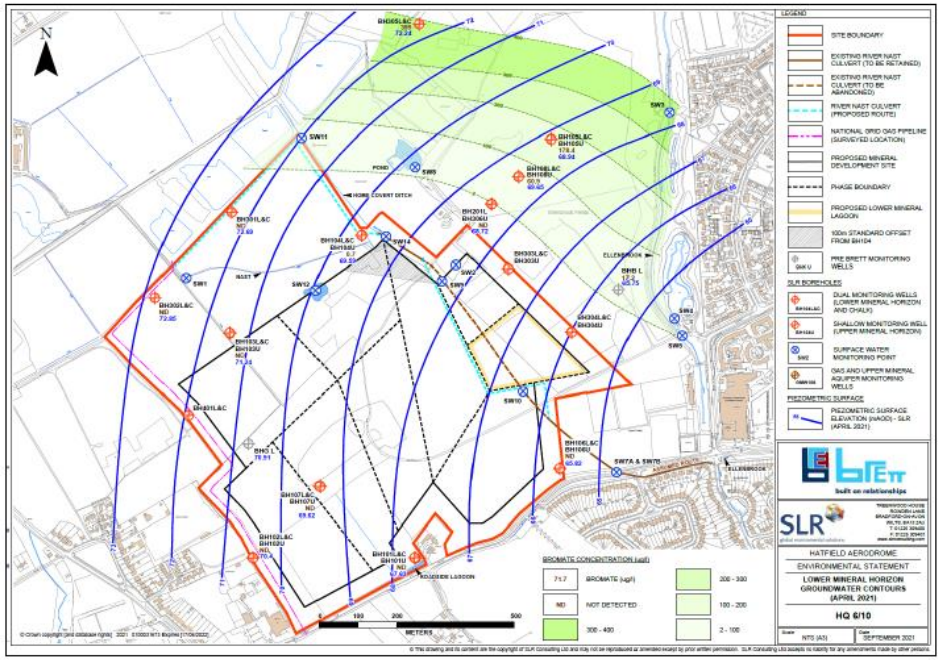
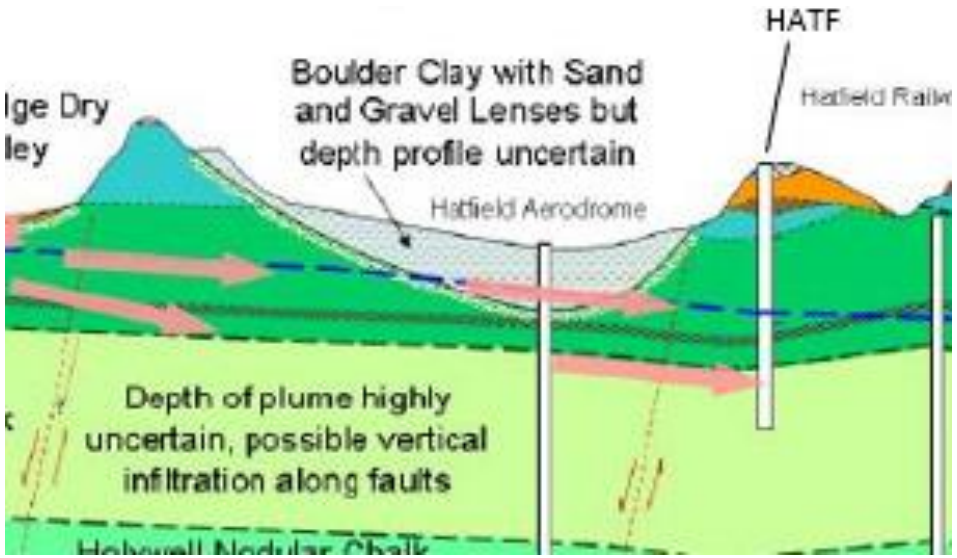
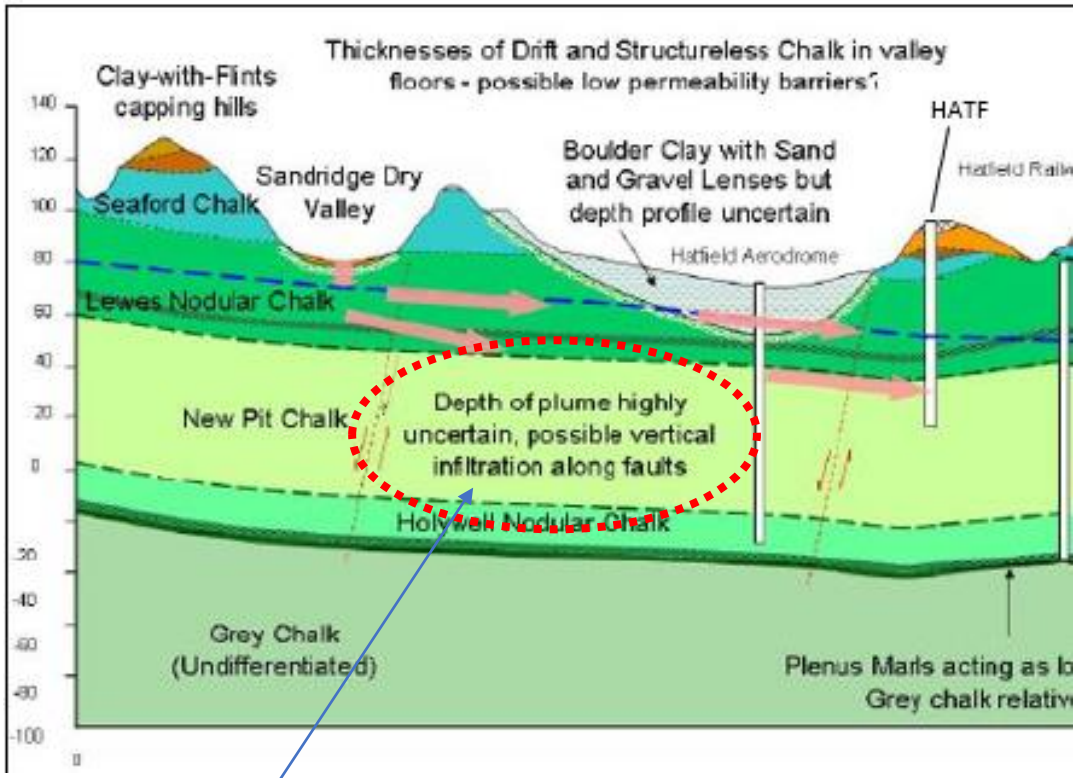


Figure 5
Location of the bromate plume in relation to the proposed quarry (adopted from SLR)



Statement of Common Ground

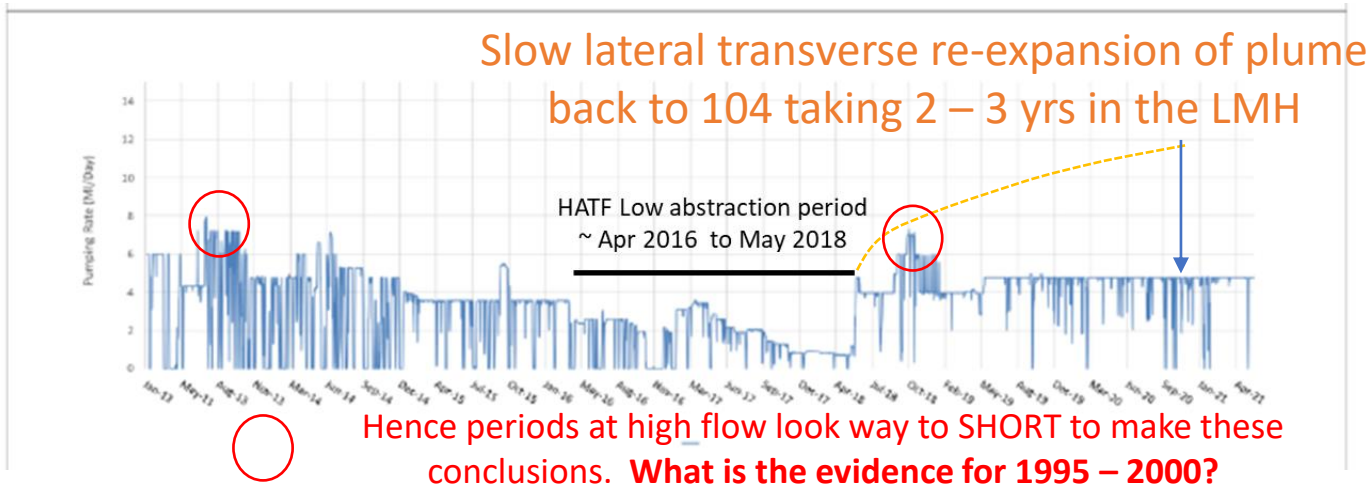
- 4.2
- The HATF abstraction location is at a higher elevation (102mAOD) than the proposed quarry site, and at some distance from the paleochannel (Figure 6). HATF boreholes are screened into and abstract from the Chalk at a total depth of c.100m (2mAOD), connected via adits spanning up to 174m at a depth of 82m (20mAOD). Adits were typically dug in the past to enhance the capture zone of a borehole, enlarging yield in the most productive part of the aquifer.
- This suggests that the HATF abstraction receives most of its bromate rich water at depth within the Chalk aquifer (i.e where the adits are located). These depths contrast with the top of the Chalk beneath the proposed quarry (60-63mAOD), which is approximately 40m above the adit elevation.

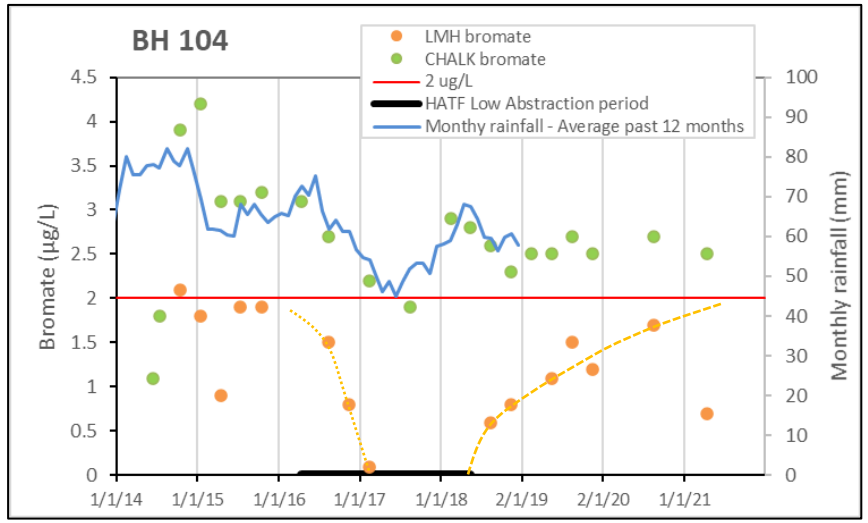


- To NOTE
- BUT, is the inference here somewhat misleading?
- The bromate in both the LMH and shallower chalk in the capture zone migrating towards HATF will ultimately drain down into the adit system and be abstracted by HATF?

Statement of Common Ground 4.1 (part of)

- Under low pumping at HATF the southern boundary of the plume moves north, while higher pumping rates cause this boundary to move south.However, even under scenarios where HATF has pumped at or near its maximum licensed volume (9Ml/d, in the past between 1995 and 2000 and more recently in 2013/14 and 2018), the southern plume boundary has been shown not to move onto the proposed quarry site.
  - **My response: The 2013/14 and 2018 conclusion looks in error**. BH 104 trends in the LMH strongly suggest that there is slow, lateral transverse re-expansion of plume in the LMH. It is slow as the movement is perpendicular to main flowline to HATF and also sideways motion in the high storage gravel will be slower than the chalk and also it is at distance from the adits) . **Pumping rates at 9 ML/d would have to be tested for far longer** to see this plume movement. The monitoring evidence has not been provided for the 1995-2000 period that would be important.





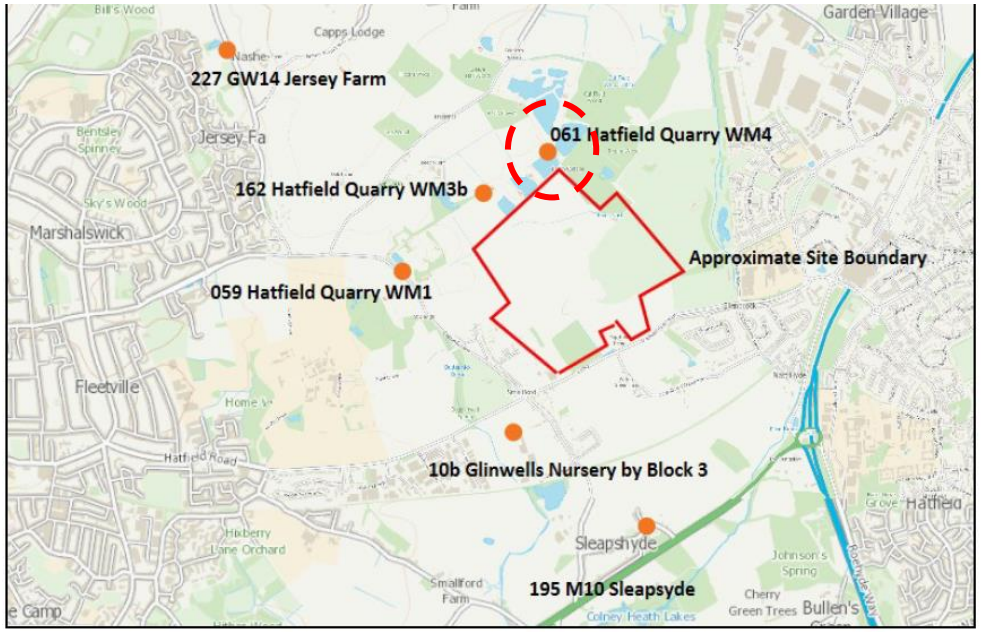
Updated opinion of Jenny Lightfoot

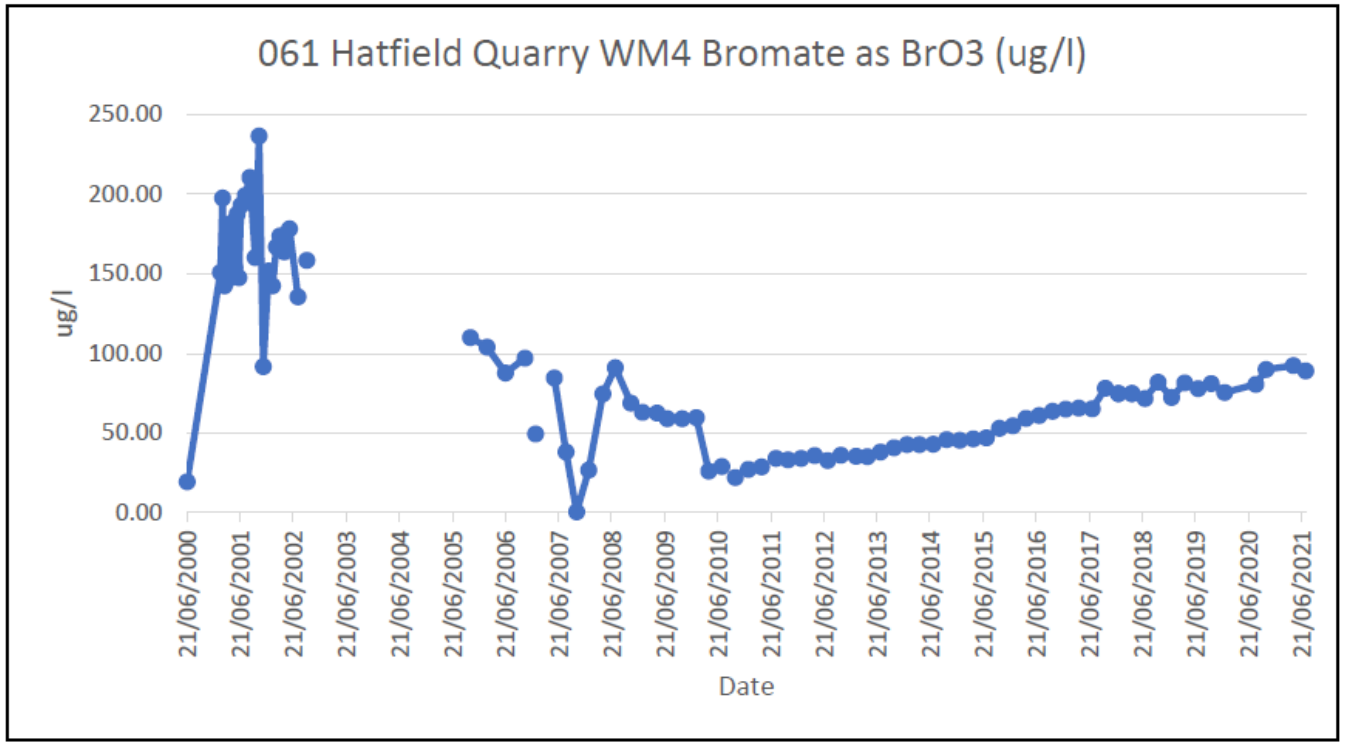
wells are influenced by HATF pumping and are therefore within the HATF catchment. This is summarised in the SoCG Figure 8. In periods when HATF has pumped at much higher rates than the current stable pumping rate the southern plume boundary has been shown not to move onto the proposed quarry. I consider this to be strong evidence that the plume is controlled by HATF and I have identified no foreseeable scenarios that will result in plume movement across the quarry site.

Same issue

What is the story on this monitoring point?

- It looks relevant?
- What is the course of these temporal variations?
- Control of HATF (high rates?) / Other abstractions?





Statement of Common Ground 6.10

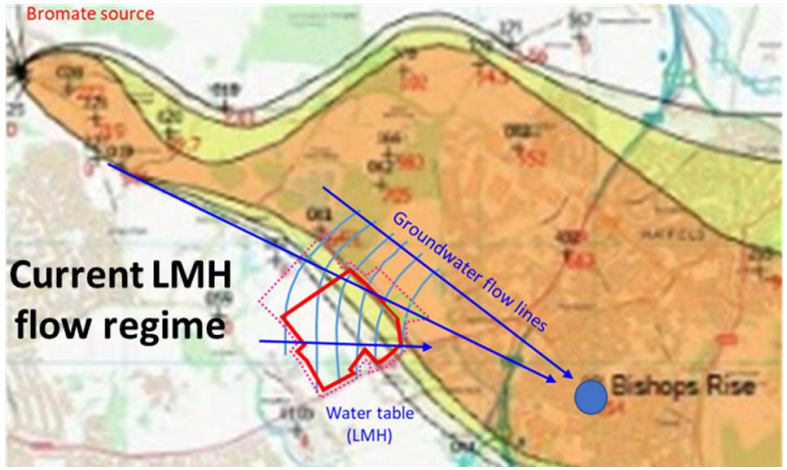
- **Point 5 - Risk to TYTT and ROES sources:**
- Dewatering will alter the plume's location and **backfilling the lower mineral void with a lower permeability material will permanently alter the plume and impact the ability of HATF to capture bromate,** particularly if pumping rates are increased. **This diversion of the plume could result in bromate impacted abstractions to the south (TYTT and ROES).**
- *Response 5:*

Concerns on this re above – what is the evidence base?

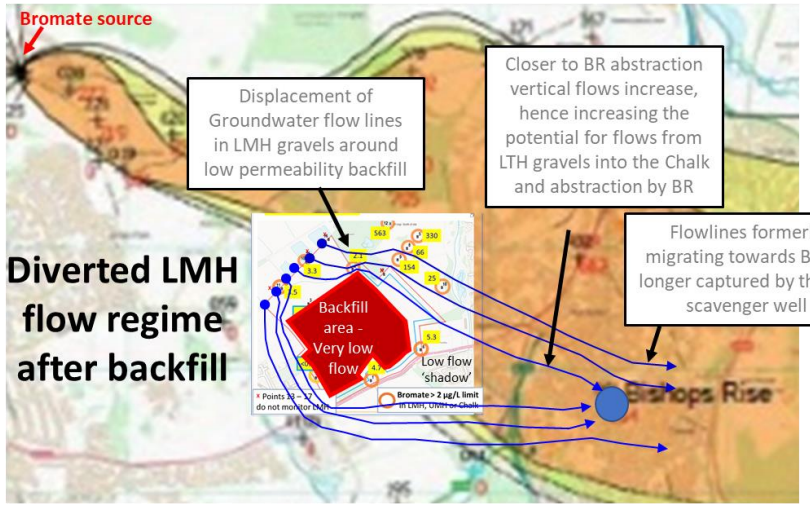
- One of the major controls over the plume is pumping at HATF. The available evidence indicates that the plume has never been drawn onto the proposed quarry site, even during periods when HATF was pumping close to 9Ml/d. Both TYTT and ROES are baseload sources and routinely pump close to their licensed volumes, but this has not drawn the plume towards these abstractions under various pumping regimes at HATF.
- While the **infilling with a lower permeability material will cause a localised change in groundwater flow in the LMA**, the area to be infilled is of limited thickness and lateral extent in relation to the total thickness of the Chalk aquifer in which the bulk of bromate transport occurs. It is therefore not considered that the backfilling would have the potential to cause changes to the plume's behaviour, even when pumping at HATF is at or near 9Ml/d. → I contest this reasoning – see further below
- **J. Lightfoot Proof of Evidence - The backfill/barrier issue is considered but dismissed as insignificant.**
  - However, the issues do not appear fully understood in Lightfoot's Section 3.3.2 and 3.3.3 and the case for its dismissal inadequate both here and in the Statement of Common Ground. The impact does NOT require the bromate plume to be on site, just fairly close to Site (which it is). Diverted clean groundwater that now passes through the site then displaced northwards will push the bromate plume north and part of it beyond the HAFT scavenger reach is the main issue.

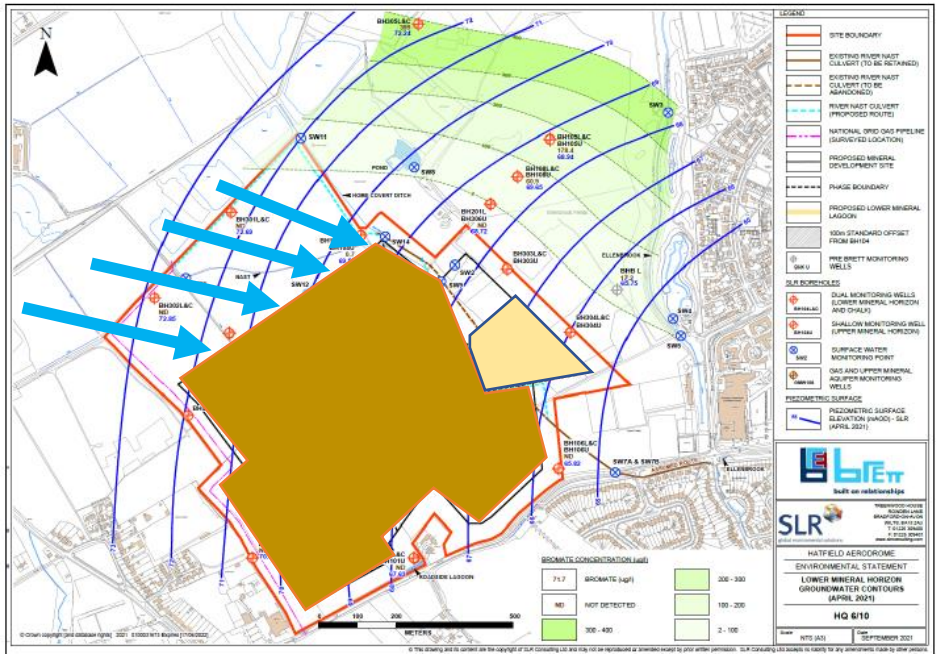
Low permeability Backfill impact

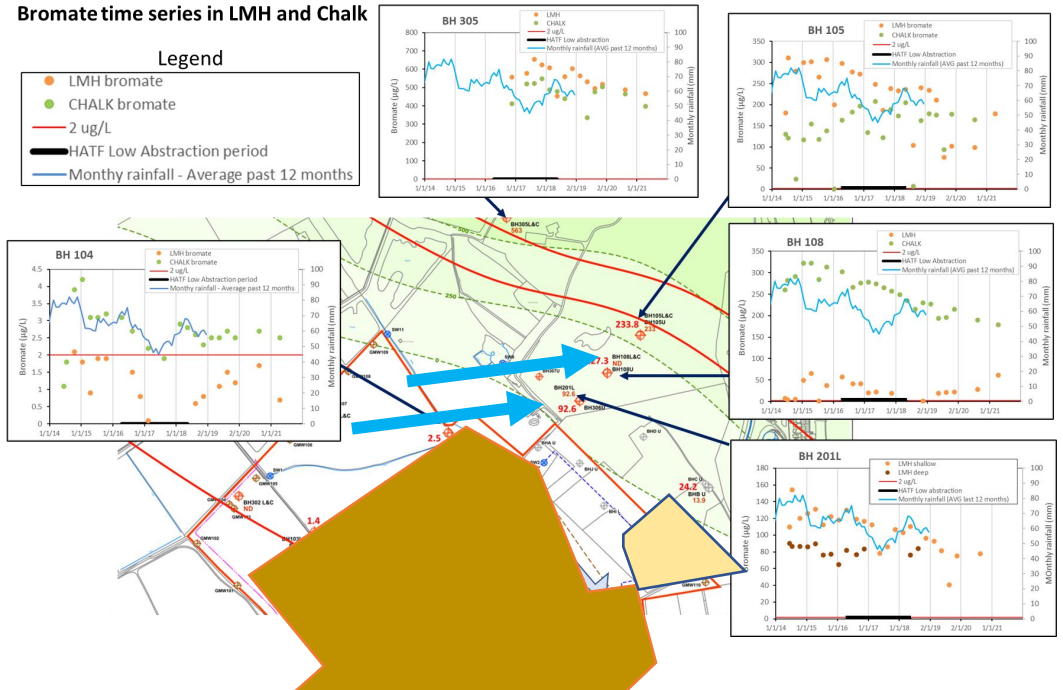
(a)



(b)







- Easier for groundwater to go around the side in the LMH?
- or to dive underneath in the sliver of LMH remaining / access the horizontal chalk fractures?
- or a bit of both?
- My expectation of the flowfield is that diverted flows would go north/eastwards pushing the bromate plume away from HATF to some extent

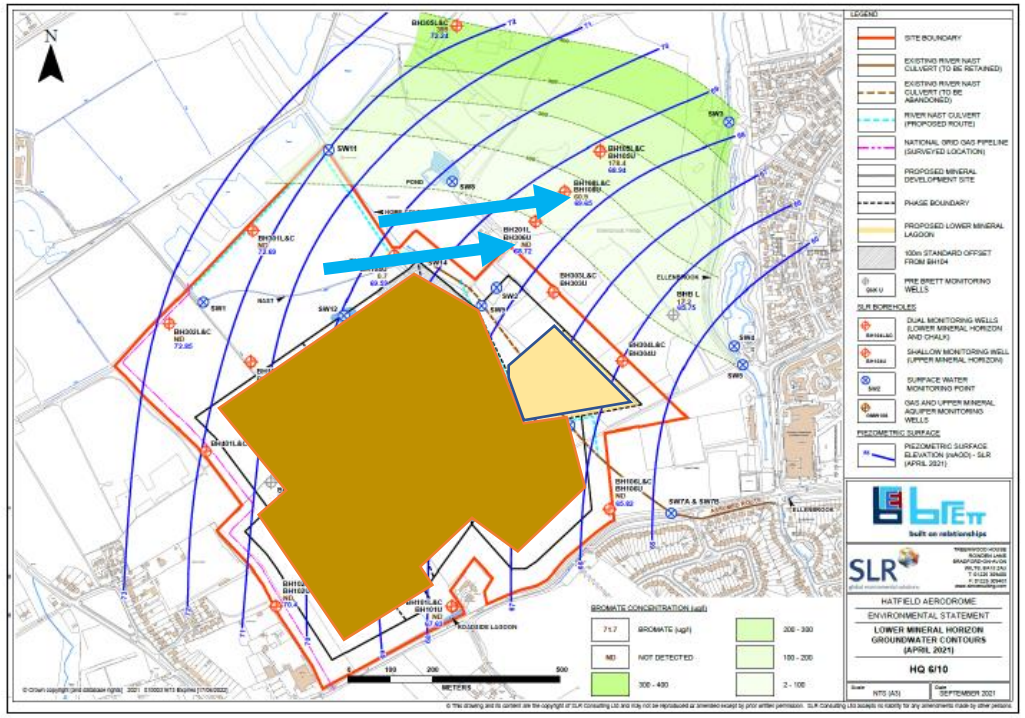
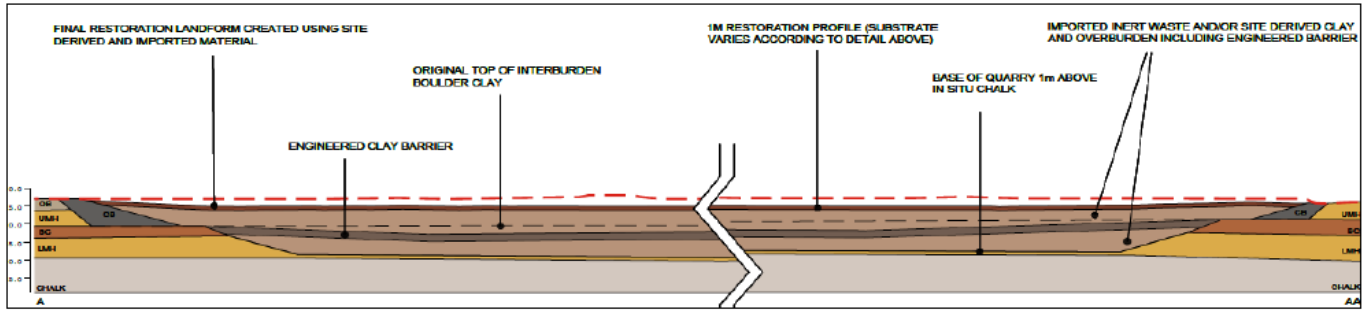
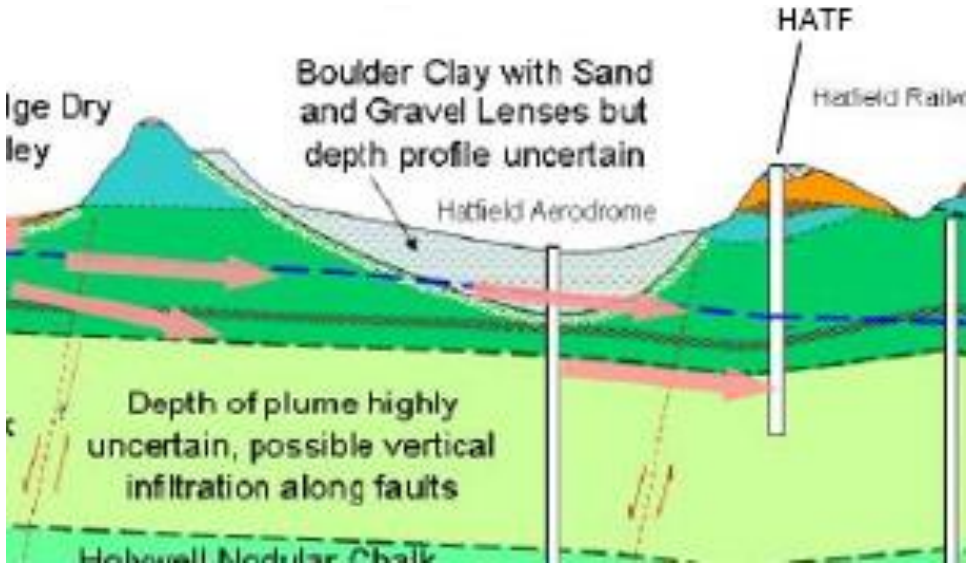


Figure 5
Location of the bromate plume in relation to the proposed quarry (adopted from SLR)

33. Figure 3: Schematic cross section of the restored site[1] (SLR, 2015)



1Note: vertical exaggeration – LMH backfill thickness c.5m and chalk effective aquifer thickness c.60m



Flow going underneath (versus around)

- Very unreasonable to compare chalk versus LMH gravel on aquifer thickness alone
- Very thin LMH remaining - 5 lanes down to 1 lane
- Local hydraulic continuity with chalk horizontal fractures at the upstream backfill boundary - vertical fracturing to connect to lateral fractures?
- New, not established flow pathways (compared to existing flows between chalk and gravels)
- Plugging by backfilled sediment migration – worse under, non-pumped wet excavation?
- Turbidity risks to HATF?
- **Easier to flow around and stay in the LMH ?**

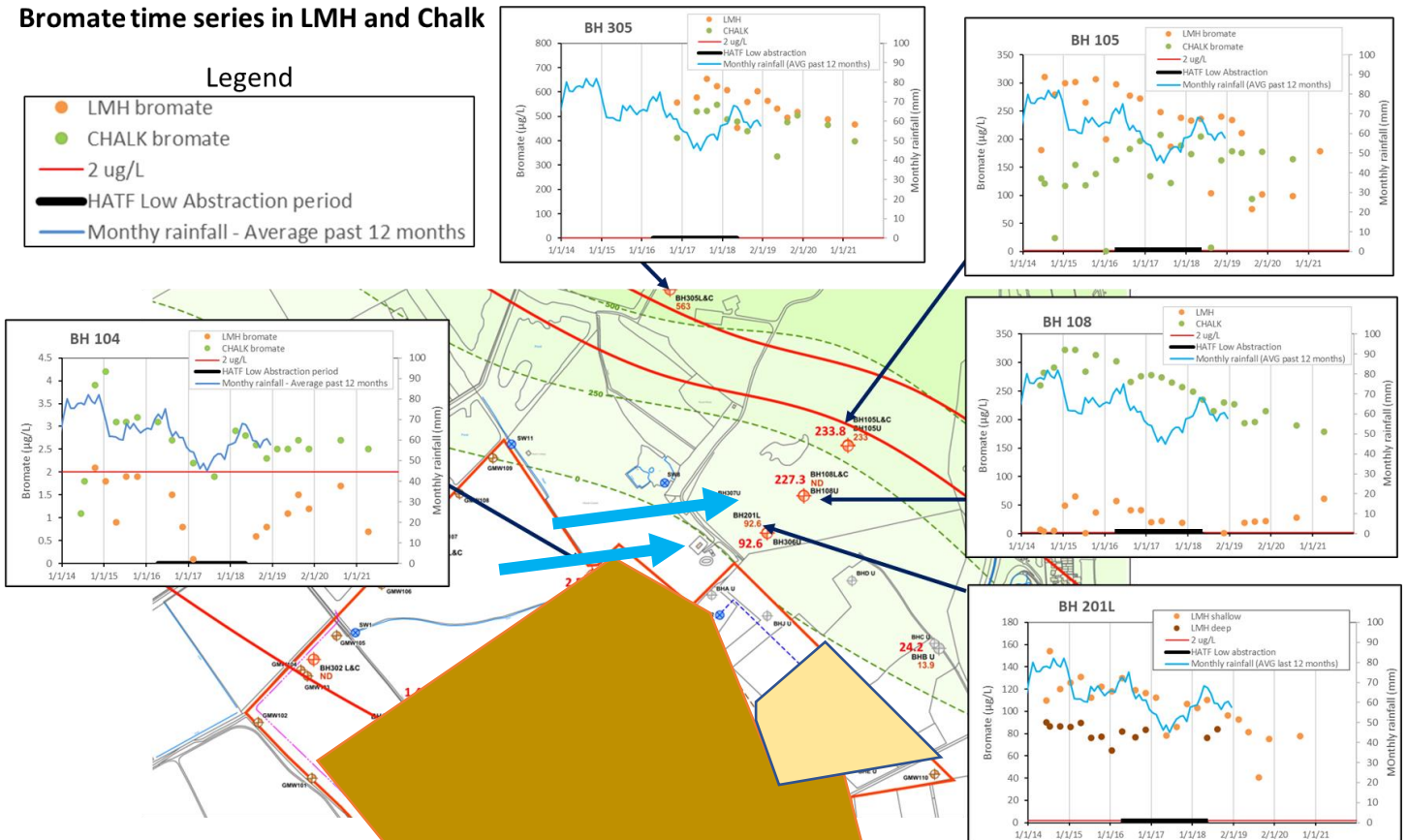
Backfill impact

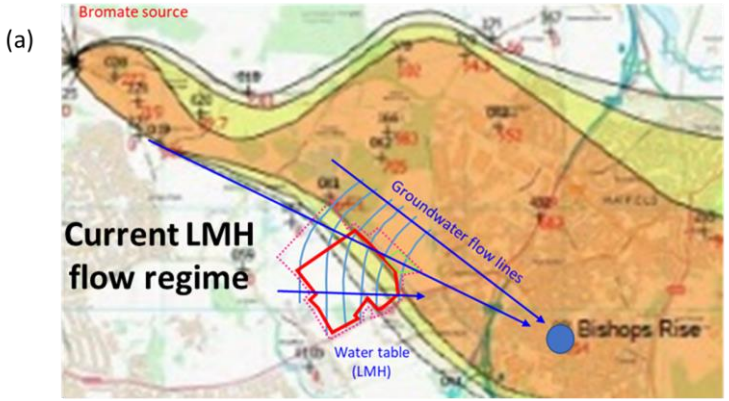
What bromate **will be** abstracted by HATF **after low permeability backfill of the LMH**?

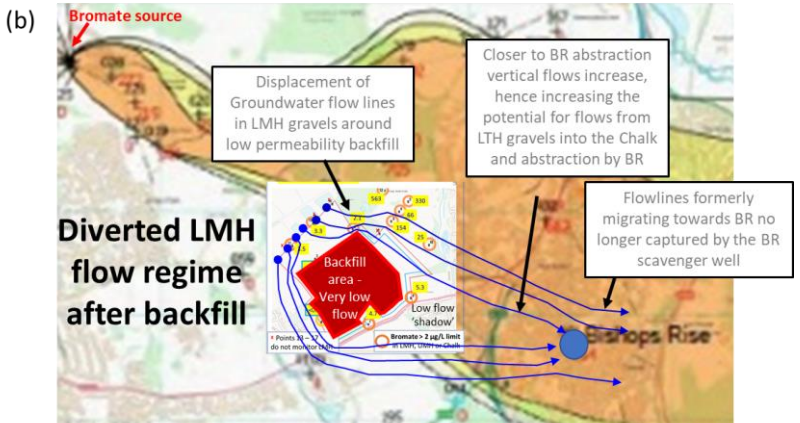
- In short, not as much as before backfill as the LMH plume will be pushed away from HATF

Will **increased bromate concentrations** be seen in the local Site's boundary monitoring?

- NO – it would predict concentrations would decrease local to the Site, hence triggers looking for concentration increases would not be appropriate in this case







Summary of issues

Context: Statement of Common Ground: 8.0 SUGGESTED EA CONDITIONS, the Reason common to all three Conditions is to protect controlled waters and **to not exacerbate the existing groundwater pollution**

In my opinion:

Backfill

- The permanent backfilled LMH void exacerbates the existing groundwater pollution by pushing a component of the bromate plume in the LMH that is presently abstracted by the HATF scavenger well beyond the reach of that well.
- The present remediation activity will hence be compromised by the backfill and perform at a lower efficiency than it presently operates (or is projected to operate in the future without the permanent backfill).
- The impact of the backfilling would manifest in local site monitoring as decreasing concentrations which may be mistakenly seen as a positive. Proving the backfill influence is not trivial and will require a different approach to monitoring than is currently proposed. If backfill causes this problem it is NOT reversible. There has been no modelling of this influence.
- Whilst others may claim the differences of remediation performance insignificant arising from the backfill-related lower abstraction of bromate from the LMH, the estimation (or modelling) of this would be quite uncertain. Also, I have seen no estimates of the current proportion of bromate abstracted by HATF that has passed though the LMH versus chalk alone. This is important and not quantified as far as I am aware.

Abstraction issues

- The present HATF abstraction rate of 5 Ml/d appears to bring the bromate plume at around 2 ug/L in the LMH to at least the edge of site (borehole 104) with some sporadic (not well explained) concentrations at most LMH Site boreholes at around, just over 2 ug/L. The critical north-east boundary of the Site is poorly monitored (half-a-mile gap) and bromate could currently be on site at higher concentrations in the LMH yet to be found.
- I am yet to see robust evidence that HATF abstraction at 8 – 9 Ml/d (licensed rates) would not cause increased bromate plume migration on to site – the evidence offered is inadequate for at least the 2013-14, 2018 cases with under appreciation of the long timeframes (low years) for bromate plume lateral transverse motion in the LMH and stabilisation in response to significant increases in abstraction rate. My anticipation is that bromate would increase on Site for these higher rates. The presence of the Quarry site is hence foreclosing the use of those high abstraction rates that if used would actually provide increased protection to downstream groundwater users, but would contaminate the Quarry Site.
- Due to the proximity of the bromate plume to the Site, quarry groundwater abstractions from the LMH are very likely to cause the bromate plume to enter the Site. The rate of bromate plume movement induced on to site in the LMH by quarry abstraction would be much greater than the slow lateral drift on to site LMH induced by the HATF abstraction.

Conceptual model deficiencies

- The conceptual model expected of processes controlling bromate occurrence currently on or near the Quarry Site and changes induced by the quarry application (e.g. abstraction and backfill) is not as well developed as it should be to support the proposed activity. There are significant controlling processes, modelling, field data and quantification gaps to be addressed to provide LMH – Chalk system understanding and better explain the bromate trends observed in the near Site vicinity.