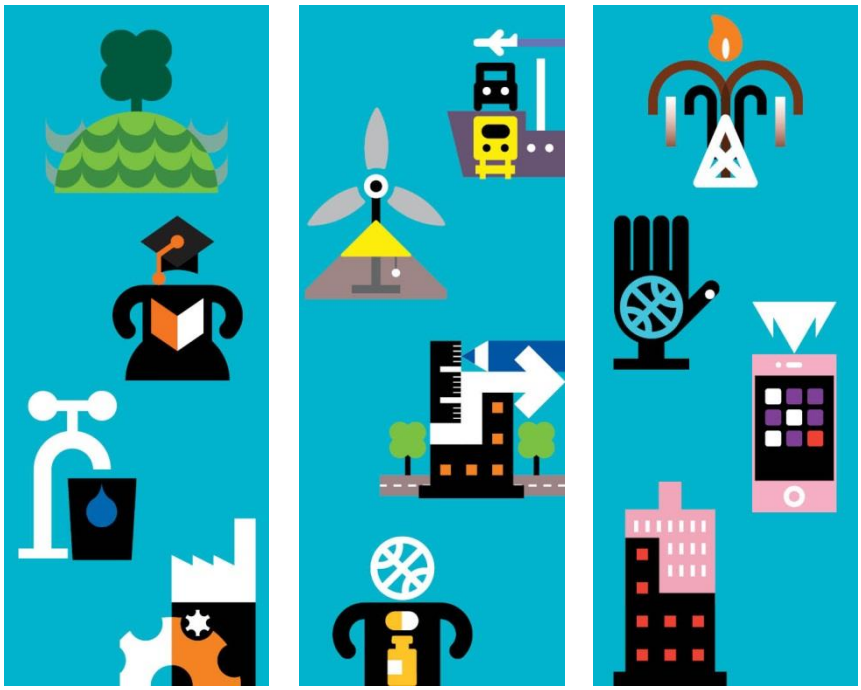

Monk Lakes Groundwater Assessment

November 2016

Maidstone Borough Council

Mott MacDonald

Monk Lakes Groundwater Assessment

November 2016

Maidstone Borough Council

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Revision	Date	Originator	Checker	Approver	Description
A	03 November 2015	R Hardisty		S Watson	Draft for client comment
B	21 November 2016	S Watson	R Hardisty	S Watson	Final

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Contents

Executive Summary

Maidstone Borough Council (MBC) appointed Mott MacDonald to undertake an assessment of a groundwater investigation carried out by Peter Brett Associates (PBA) in conjunction with BAM Ritches Ltd for a recreational fishing site known as 'Monk Lakes', at Staplehurst Road, Marden, Maidstone, Kent, TN12 9BU.

The objective of the project was to provide the Council with an objective expert evaluation and advice on the groundwater information submitted by BAM Ritches Ltd /PBA together with any consultation responses, including evaluation of the evidence, advice on its appropriateness, advice on any further requirements, advice on any necessary mitigation or planning conditions, and advice on any potential details submitted pursuant to conditions.

PBA's groundwater investigation was carried out to address concerns that the Monk Lakes development has adversely affected land to the west of their site owned, primarily by Mr Padden. Mr Padden has commissioned ESI to carry out his own investigation on his own land.

Following review of the documentation, a number of recommendations for further work were given, the most important of which are considered to be:

- Between one and three new trial pits/boreholes should be dug on the western boundary between BH2 and BH4 in an attempt to define the southern limit of the River Terrace Deposits. Groundwater levels should also be monitored to more accurately establish the groundwater contours in this area and provide confirmation as to whether groundwater is really moving towards the west. Without a clear understanding of the groundwater system to the west, it is impossible to reach a firm conclusion.

- The cause of the change in contours in this location, if corroborated by further borehole testing, should be investigated and explained.

- A source-pathway-receptor table should be included to present how the Monk Lakes development could be affecting groundwater, and identify all the ways in which groundwater could be affecting Mr Padden's land.

- PBA make no mention of groundwater quality. Therefore it is not possible to assess whether the site works have adversely impacted groundwater quality.

- PBA do not attempt to establish a baseline for 2003 with which to compare their monitoring results. Although evidence is limited and mostly anecdotal prior to this date, this information should be included in an attempt to address the concerns of KCC, the EA and Mr Padden regarding the baseline. However, given the lack of quantitative evidence prior to 2003 at the site, (and very limited prior to 2015), the potential to definitively assess impacts of the development on the groundwater in the area is always likely to be subject to uncertainty.

- Mr Padden indicated in a letter dated 16th December 2014 that ESI would be 'robustly reviewing' PBA's report on his behalf. It is unknown at the time of writing whether ESI are in the process of conducting this review. However, it is advised that any additional work at Monk Lakes should give ESI's recommendations consideration wherever possible if the investigations are to be accepted by both parties and progress is to be made.

- In the absence of one combined monitoring initiative encompassing both Monk Lakes Ltd and Mr Padden's land, taking both PBA and ESI (2015)'s findings into account is considered to be essential to gain the most complete understanding possible of groundwater movement across the area. In light of this, it is recommended that, if possible, further work be carried out by a neutral consultant acceptable to both parties (for example, a consultant selected by the LPA).

1 Introduction

1.1 Background

Maidstone Borough Council (MBC) appointed Mott MacDonald to undertake an assessment of a groundwater investigation carried out by Peter Brett Associates (PBA) in conjunction with BAM Ritches Ltd for a recreational fishing site known as 'Monk Lakes', at Staplehurst Road, Marden, Maidstone, Kent, TN12 9BU.

In September 2003 planning permission was granted for a change of use of land and physical works to create an area for recreational fishing. The application involved the formation of ponds and lakes, the erection of a building, and car park.

After this was granted, the then owners of the site carried out significant engineering works including below ground works and land-raising through bringing large quantities of soil, construction and demolition waste on site. This was judged as not in accordance with the 2003 permission by the Council, and an Enforcement Notice was issued in 2008.

The site was sold in 2008 and the new owners submitted a planning application (Ref. 11/1948) in 2011, in an attempt to rectify the situation through seeking retrospective permission for some of the lakes, and permission to create three others through remodelling of the earthworks on site.

The Council approved the application subject to conditions on 06/09/12. It included a condition that full details of proposed groundwater controls be submitted to the Council before any more material was brought on site.

This decision was subject to judicial review by a neighbour (Mr Padden) to the site and quashed by the High Court on 22/01/14. In the ruling, amongst other reasons, the judge found that the Council had unlawfully failed to have proper regard to groundwater flooding matters within the application/EIA process before making a decision. The application must now be re-considered by the Council.

Site works have been carried out by BAM Ritches Ltd /PBA, including:

- The sinking of a total of eight boreholes, including permeability testing where appropriate, and recovery of soil samples of the soils encountered.
- Excavation of some shallow (<2m) trial holes to confirm the geological profile.
- The installation of groundwater monitoring wells in each borehole to allow monitoring of groundwater levels and to facilitate sampling of groundwater for forensic chemical analysis on one round of sampling.
- Baseline monitoring including monitoring the adjoining principal surface water features (the adjoining lakes and river).
- Interpretative reporting - the production of a baseline monitoring report with outline recommendations for mitigation where required.

BAM Ritches Ltd /PBA's baseline monitoring report was completed in July 2015, with the evidence submitted to the Council.

1.2 Objectives

The objectives of the project are:

- To provide the Council with an objective expert evaluation and advice on the groundwater information submitted by BAM Ritches Ltd /PBA, including evaluation of the evidence, advice on its appropriateness, advice on any further requirements, advice on any necessary mitigation or planning conditions, and advice on any potential details submitted pursuant to conditions.

  Ultimately, it is understood that Mott MacDonald's advice will be used to inform the Council's decision on whether the groundwater impacts of the development are acceptable in planning terms or not, any necessary mitigation and advice on any mitigation put forward during or after any decision on the application.

- To provide the Council with an objective expert evaluation and advice on any consultation responses received from the Environment Agency (EA) and Lead Local Flood Agency (LLFA) relating to the BAM Ritches Ltd /PBA report.
- To carry out a walk-over site visit to become familiar with the site and meet with the site owner and Maidstone Borough Council representative.
- If necessary, to assist in defending the Council's position at any future planning appeal or judicial review proceedings. This objective is not within the scope of this report.

1.3 Scope and Methodology

Mott MacDonald has carried out the following work within this report in order to address the requirements of the Council:

- Evaluation of the evidence provided by the site works regarding geology of the area.
- Evaluation of the evidence provided by the site works regarding groundwater levels in the area and interpreted direction of any groundwater movement.
- Evaluation of the evidence provided by the site works regarding groundwater quality.
- Evaluation of the evidence provided by baseline monitoring, including adjoining surface water features.
- Review of any recommendations for mitigation proposed by BAM Ritches Ltd /PBA, including suggestions for alternative solutions or planning conditions where appropriate.
- Assessment of the information submitted by the developer to comply with conditions set out upon him in the planning consent.
- Carrying out a walk-over site visit with the site owner and representative of Maidstone Borough Council.

2 Data Availability

2.1 Introduction

A wide variety of information was available for this study dating back to the submission of the original planning permission application in 2003. This was made available to Mott MacDonald via the Council's website under reference numbers 11/1948 and 13/1866 (Maidstone Borough Council 2015).

2.2 Reports

The main document under review, and the focus of this report, is:

- Peter Brett Associates (2015). Monk Lakes, Marden Kent Groundwater Monitoring Report.

  PBA's report details the findings of a groundwater investigation undertaken by BAM Ritches Ltd at the site, a nine month groundwater monitoring programme and the potential implications of the data obtained on the site and its environs. Peter Brett Associates' report is discussed in detail in Section 4 of this report. The investigation was limited to the Monks Lakes site only.

This report was submitted as Part H, Volume 3 within the Supplementary Environmental Statement (ES) towards the site's planning permission.

Other documents used for background knowledge are listed below. Of particular note is ESI (2015), which describes pertinent investigations into the groundwater regime on Mr Padden's neighbouring land to the west. This is referenced in PBA's report and included by them as Appendix F. Regretfully no single groundwater investigation encompassing both the Monk Lakes site and the neighbouring land has been carried out. Therefore, to gain as full an understanding as possible with the current information of the groundwater system in the area it is considered critical to read both reports in conjunction.

Table 2.1: Data sources - reports

Nr	Author	Date	Title	Summary
1	Peter Brett Associates	10/07/2015	Monk Lakes, Marden, Kent Groundwater Monitoring Report	Groundwater investigation at Monk Lakes
2	ESI (Dr Paul Ellis)	30/03/2015	The potential for groundwater flooding resulting from the unauthorised development at the neighbouring property known as Monk Lakes	Groundwater investigation at Hertsfield Barn (Mr Padden's land to the west of Monk Lakes)
3	NextPhase Development	July 2015	Supplementary Environmental Statement	A three volume ES submitted on behalf of Monk Lakes Ltd in their application for part retrospective planning permission. Volume 1, Section 6 and Volume 3, Part H are the most relevant to groundwater.
4	Royal Courts of Justice	22/01/2014	R vs Maidstone Borough Council	Case number CO/12225/2012 A legal challenge to the lawfulness of the part retrospective planning permission of the lakes.

2.3 Consultee and third party responses

The following consultee and third party responses to Peter Brett Associates (2015) were also reviewed as part of this report:

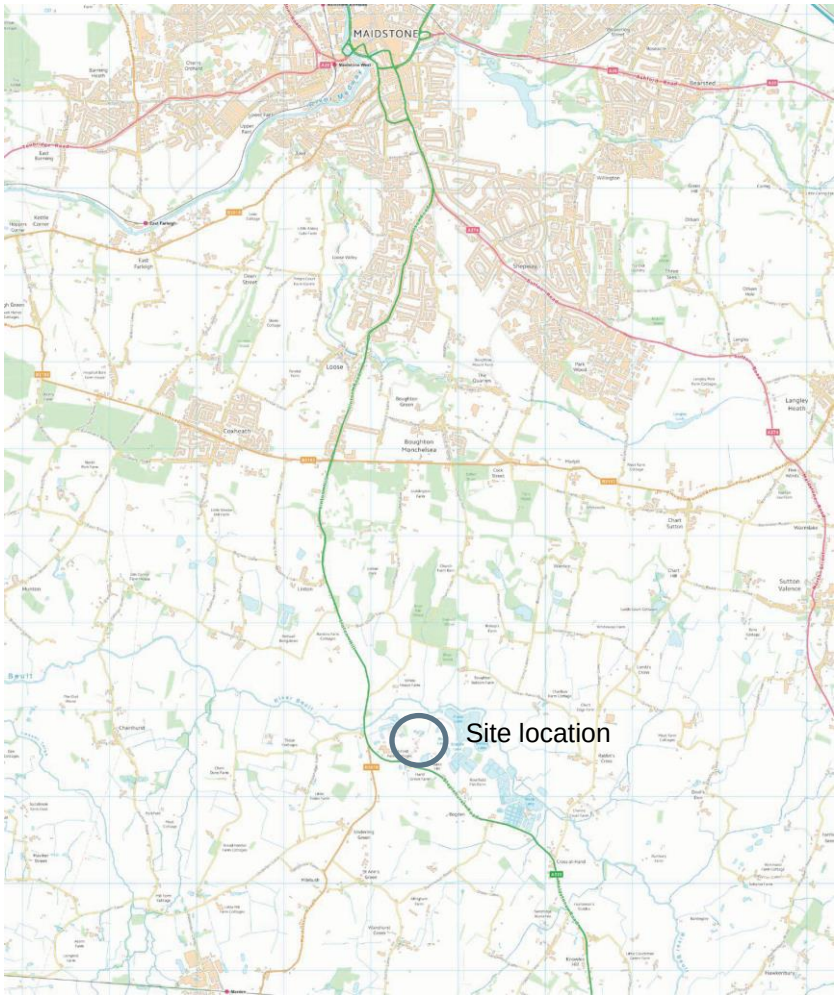
- Cllr S McLoughlin (09 September 2015)
- Kent County Council Ecological Advice Service (21 August 2015)
- Kent County Council Flood Risk Officer (08 September 2015)
- Natural England (09 September 2015)
- The Environment Agency (08 September 2015)
- Mr Padden (03 September 2015)

3 Site Background

3.1 Site description

The Monk Lakes site is located in Kent at grid reference TQ 768 476, about 4 km north-northeast of Staplehurst. Most of the surrounding land is agricultural. A site location plan is shown in Figure 3.1.

Figure 3.1: Site location plan



Source: Peter Brett Associates 2015 Figure 2

The site comprises a series of fishing lakes, some of which are operational, and some of which are still under construction. These lakes are:

Operational lakes located to the east of the site

- Puma Lake
- Bridge Lake
- Match Lake

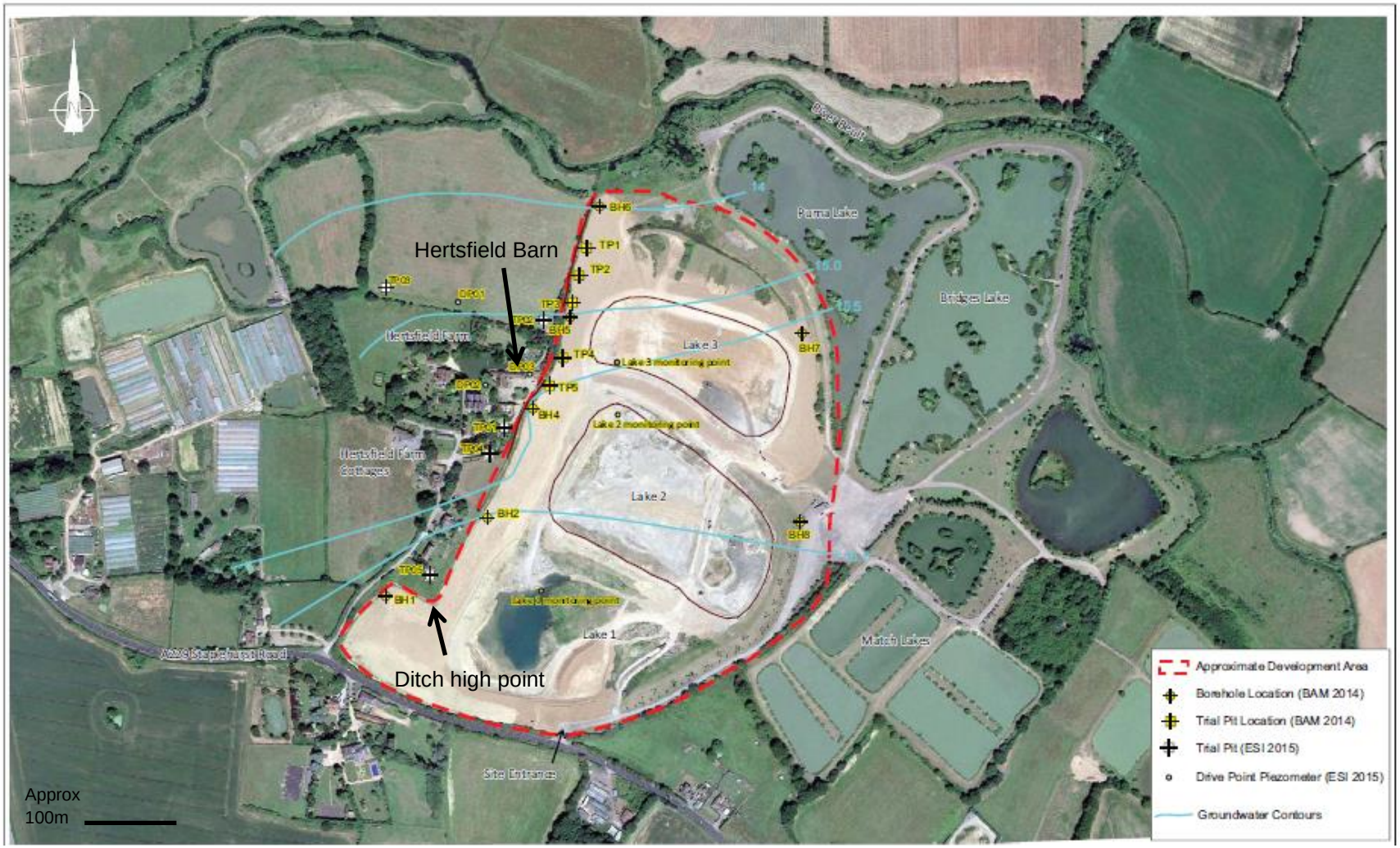
Non-operational lakes located to the west of the site

- Lake 1 (construction incomplete)
- Lake 2 (construction complete but non-operational)
- Lake 3 (construction complete but non-operational)

The planning permission application submitted to the Council pertains primarily to Lakes 1-3. This area is known throughout this report as the development area. The lakes are shown on Figure 3.2.

The development area is bounded by the River Beult to the north. To the west lies residential/farm land, and this boundary is marked by a drainage ditch. Staplehurst road (A229) is located to the south, with the three operational lakes to the east.

Figure 3.2: Monk Lakes site



Source: Peter Brett Associates 2015 Figure 9 with additions by Mott MacDonald

3.2 Topography

Two topographical surveys of the site have been undertaken (in 2008 and 2014).

The natural topography falls towards the north (towards the River Beult, at which the ground is about 12.5mAOD). However, this is masked by the considerable amount of earthmoving that has been undertaken.

The lakes are largely constructed above the original ground surface. An earth embankment has been constructed to enclose Lakes 1-3 within the development area which is between 4 and 6m above the original ground level.

The drainage ditch on the western boundary drains to the north towards the River Beult until it reaches a high point next to Lake 1 (labelled on Figure 3.2) where it begins to drain to the south into another ditch parallel to the southern boundary of the site.

The northern part of the ditch is approximately 1m deep relative to the land to the west. The high point of the ditch next to Lake 1 is approximately 0.3m deep relative to the land to the west.

The area around Hertsfield Barn (also labelled on Figure 3.2) is a localised depression feature. A similar feature is also noted approximately 200m to the west of Hertsfield Barn.

3.3 Lake Construction

Lakes 1, 2 and 3 are described as being lined with clay. Further material has been imported to the site to form the embankments prior to lining works. Peter Brett Associates (2015) does not specify what material was used to form the embankments but it is stated in Royal Courts of Justice (2014) to be construction waste including glass, plastic and asbestos.

Lake 1 is currently an open excavation and is not yet lined.

3.4 Site history

The history of the Monk Lakes site is complex. The timeline below summarises development of the site.

Table 3.1: Timeline of the development of the Monk Lakes site

Date	Activity
17 September 2003	Planning permission granted by Maidstone Borough Council to Mr & Mrs Hughes to develop Monk Lakes subject to various pre-commencement conditions that were not submitted for approval.
2003-2008	Works were carried out on the fishing lakes in a form that was not judged to be in compliance with the original planning permission, including importation of large volumes of material to form the lake embankments
Early 2006	Works progressed to within 50m of Hertsfield Barn
Early 2008	Monk Lakes was sold by Mr & Mrs Hughes to Emily & Guy Harrison and Monk Lakes Ltd, who continued the works
April 2008	Issue of a temporary stop notice. Works halted.

Date	Activity
Summer 2008	Mr Padden reports that he began to notice a change in groundwater conditions at Hertsfield Barn, indicated by the requirement to continuously pump from Hertsfield pond to reduce water levels, even during the summer. His other concerns since 2008 include: - Flooding to the pond requiring repair works to the pond banks - Groundwater ingress to the foul drainage package treatment unit for the barn and neighbouring properties - The soakaway system not operating correctly and backing up of his toilets - Damp problems inside the Hertsfield Barn.
12 September 2008	Issue of an Enforcement Notice by Maidstone Borough Council
9 December 2011	Application seeking retrospective permission submitted by Monk Lakes Ltd to Maidstone Borough Council
6 September 2012	Retrospective permission granted by Maidstone Borough Council for development at Monk Lakes including a condition requiring groundwater investigation (later quashed)
May 2013	Re-profiling works undertaken along the western site boundary
August 2014	Mr Padden reports flooding and water ingress into Hertsfield Barn A monitoring scheme was devised by PBA on behalf of Monk Lakes Ltd
September 2014	Groundwater monitoring begun by PBA
February 2015	ESI commissioned to carrying out site investigation works by Mr Padden
July 2015	Issue of supplementary ES to support planning permission application , incorporating PBA's groundwater investigation report

3.5 Site visit

A walk-over of the site was carried out on Thursday 15th October 2015 at around 1400 by Rachel Hardisty (Mott MacDonald), Richard Timms (Maidstone Borough Council) and Morgan, a Monk Lakes employee.

The weather was cool and overcast. There was no rainfall during the actual site visit, although it had been raining earlier that morning.

The walk-over included walking along:

- the entire length of the western boundary ditch
- the western crest of Lakes 1 and 2
- the Lake 2 crest between Lakes 2 and 3
- observing all seven investigation boreholes.

Photographs from the visit are included in Appendix A.

It was noted during the visit that:

- The western boundary ditch was dry between the SW site boundary to a point approximately in line with the most northerly point of Lake 2 in line with Hertsfield Barn.
- North of this point, varying amounts of standing water were observed, although as a generalisation increased towards the north.
- From around where the standing water was first observed, the ditch was very overgrown.
- The pipe that is used to discharge pumped water from Mr Padden's pond was observed. The pump was not operational at the time.
- The land around BH6 and east towards Puma Lake was damp and boggy.
- Standing water was observed on top of the Lake 2 and Lake 3 crests on the north and eastern sides.

- No surface water was visible running down the lake embankments. The embankments were vegetated, predominantly with grass and clover.
- Lake 1 was not complete although contained low levels of water (assumed to be mostly rainwater).
- Lakes 1 and 2 are at approximately the same elevation. Lake 3 is at a lower level.
- The material used to construct Lakes 1, 2 and 3 extended to the western boundary ditch.

No investigatory works were carried out during the site visit.

4 Peter Brett Groundwater Monitoring Report

4.1 Introduction

This chapter provides a summary of the work carried out by Peter Brett Associates and BAM Ritches Ltd (2015), where relevant to the groundwater system. At the end of each section, an evaluation of the evidence is given together with any further requirements that should be considered. Where further information is required for the neighbour's land to the west of the site, reference is made to ESI 2015, which is included in Peter Brett Associates (2015) as Appendix F.

4.2 Geology

4.2.1 British Geological Survey

The 1:50 000 BGS map (BGS 2000) indicates that the site is underlain by the Weald Clay Formation. River Terrace Deposits are present on the northern half of the site, extending about 430m from the River Beult to the south of Hertsfield Barn. There is also some Alluvium immediately adjacent to the river. These deposits are marked on Figure 4.1.

The Weald Clay comprises mainly clays and shales, frequently with silt laminae. At some horizons, discontinuous beds of sands, ironstone and limestone occur. The clay is expected to be at least 150m thick and is underlain by the Tunbridge Wells Sand Formation.

4.2.2 Ground investigations

Three groundwater investigations are summarised in Peter Brett Associates (2015). These are listed below.

SW 2010

This investigation comprised ten trial pits (TP1 to TP10) to investigate the nature of the near-surface materials.

BAM 2014

This investigation comprised seven boreholes (BH1, 2, 4, 5, 6, 7 and 8) and five trial pits (TP1 to TP5), with details provided to the Environment Agency and the council on 3rd September 2014. The aim was to provide a baseline for groundwater levels across the site. Figure 4.1 shows the location of these boreholes and trial pits.

As can be seen from the figure, the boreholes were mostly positioned along the western edge of the site. The trial pits were mostly positioned in the northern half of the site to give a better understanding of the River Terrace Deposits. The base of the River Terrace Deposits is variable, even across small distances, from 11.84mAOD (BH6) to 16.139mAOD (TP5).

The original monitoring strategy included BH3, to be positioned close to Hertsfield Barn, plus water level monitoring from Hertsfield Barn pond. However, as this land is not owned by Monks Lakes Ltd this borehole was never drilled.

From this investigation alone, it is not sufficiently clear where the southern limit of the River Terrace Deposits is located, other than that it is somewhere between BH 2 and 4.

ESI 2015

This investigation comprised eight trial pits, three of which contained drive point piezometers (TP01 to TP05, and DP01 to DP03). These are shown on Figure 4.1.

The geological findings broadly agreed with the SW 2010 and BAM 2014 investigations.

Most notably, TP01 and TP04 were found to contain River Terrace Deposits.

The River Terrace Deposits are described as very sandy, gravelly clay.

4.2.3 Geology for surface water features

Lake 1 is expected to be constructed entirely in the Weald Clay and has been excavated to about 7.5m below the original ground level. The lake embankments are around 6m above the original ground level.

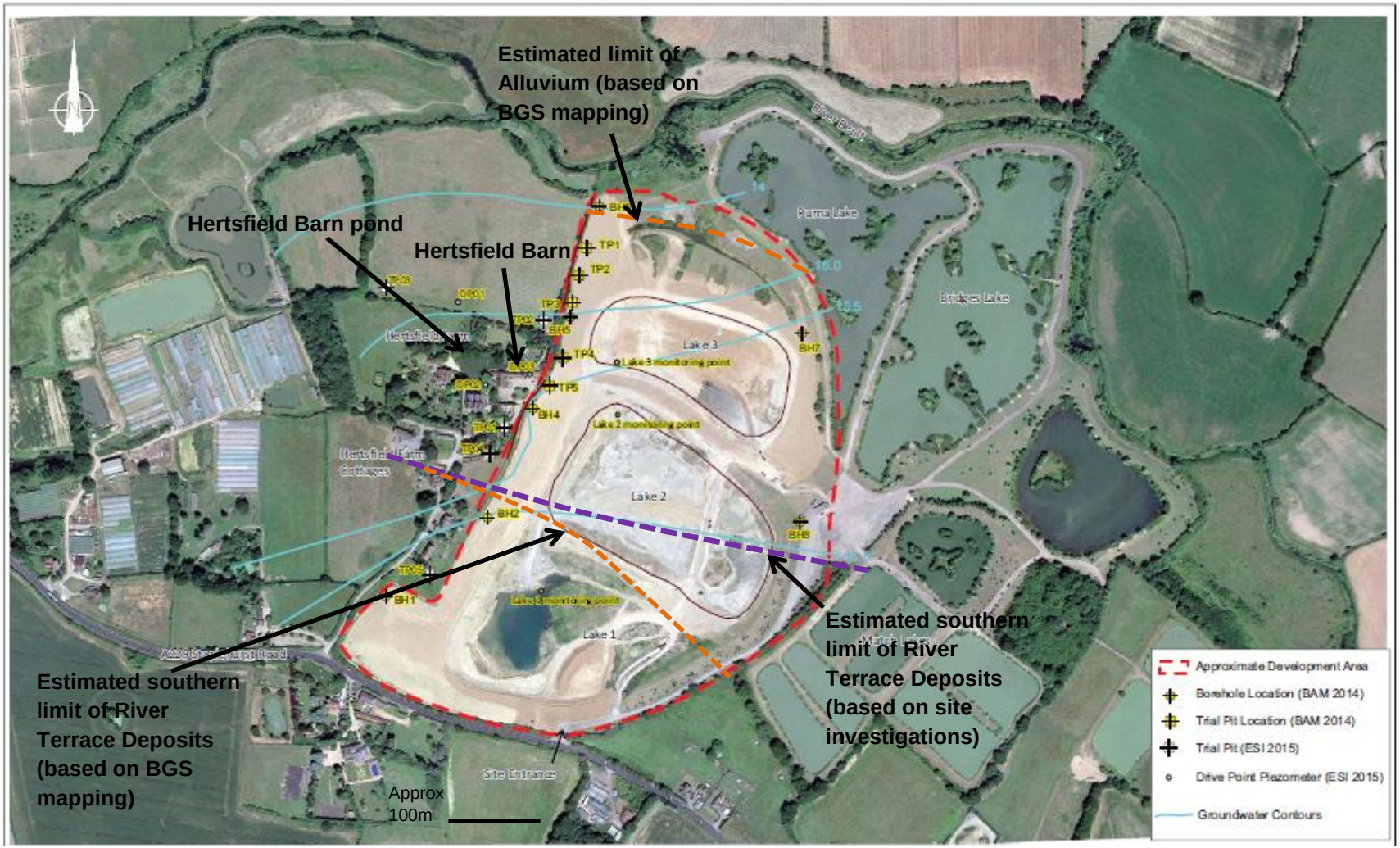
Lake 2 is expected to be underlain by Weald Clay in the south and River Terrace Deposits in the north. The base of the lake is thought to have been constructed by raising the original ground level by about 3m using fill placed on top of these deposits. The lake embankments are around 5.5m above the original ground level.

Lake 3 is expected to be underlain by River Terrace Deposits. The base of the lake is thought to have been constructed by raising the original ground level by about 1.5m using fill placed on top of these deposits. The lake embankments are around 4m above the original ground level.

Peter Brett Associates (2015) does not specify what material was used to form the embankments but it is stated in Royal Courts of Justice (2014) to be construction waste including glass, plastic and asbestos.

Hertsfield Barn Pond was not accessible by Peter Brett Associates for their study. However, the base of the pond is stated by ESI (2015) to be around 14.04mAOD. Given the base elevations of the River Terrace Deposits found in Peter Brett Associates (2015) and ESI (2015), the pond is expected to be constructed on and connected to the River Terrace Deposits as stated in ESI (2015), who concluded that the pond was most likely to be groundwater fed. The pond is not connected to any surface watercourse.

Figure 4.1: Monk Lakes site with southern limit of River Terrace Deposits



Source: Peter Brett Associates 2015 Figure 9 with additions by Mott MacDonald

4.2.4 Evaluation of geological evidence

The ground investigations carried out by BAM Ritches Ltd agree with the geology expected from BGS mapping under the site itself. However, as no boreholes or trial pits were constructed by them on land not owned by Monk Lakes Ltd, the geology of the land to the west is unproven by them. Evidence is presented in ESI (2015) and so this evidence should be used in conjunction.

No trial pits or boreholes were constructed by BAM Ritches Ltd between BH2 and BH4, and thus the southern limit of the River Terrace Deposits was poorly constrained. Using ESI's (2015) data in addition constrains the southern limit of the River Terrace Deposits more precisely, and provides evidence that approximately the northern half of Lake 2 is constructed on River Terrace Deposits, with the southern half on Weald Clay. The extent of the River Terrace Deposits is important to define as it informs whether Lake 2 was mostly constructed on the River Terrace Deposits or Weald Clay, how close to Hertsfield Barn the boundary lies, and how it relates to the notable change in the 15.5mAOD groundwater contour discussed in Section 4.3.2.

Without knowing the geology between BH2 and BH4, and also the geology around Hertsfield Barn where there is thought to be a natural depression feature, it is difficult to assess the likelihood that works in the development area will cause groundwater flooding to the west. It is considered to be possible for groundwater to flow from the site towards the west within the River Terrace Deposits. This is discussed further in Section 4.3.

Similarly, without knowing the composition of the fill material that was used to construct the lakes, it is difficult to assess the potential for groundwater to move through this fill material.

4.2.5 Recommendations for geological evidence

It is recommended that:

1. At least one more trial pit/borehole should be dug on the western boundary between BH2 and BH4 in order to better constrain the southern limit of the River Terrace Deposits and corroborate the information from ESI (2015). Suggested locations for this borehole are shown on Figure 4.3.
2. The nature of the fill used to construct the lakes should be ascertained.
3. A geophysical survey could be carried out across the site, in an attempt to better define the extent of the River Terrace deposits. However, additional boreholes are likely to achieve this in addition to providing groundwater level information.
4. The statement in 4.3.2 of Peter Brett Associates (2015) that access permission was not granted on Mr Padden's land should be rephrased as, from available correspondence between the two parties, who refused access to whom appears to be contentious.

4.3 Hydrogeology

4.3.1 Hydraulic properties

The ground investigation data (Peter Brett Associates 2015) indicates that:

- The Weald Clay is of low permeability.

  No measurable groundwater movement was found during falling head tests over the course of one hour and the permeability was thus too low to measure. No groundwater strikes or seepages were noted. An extensive field drainage network existed within the near surface materials on site prior to development, suggesting poor infiltration drainage. The Weald Clay is classified by the EA as unproductive strata.

- The River Terrace Deposits are of significantly higher permeability than the Weald Clay.

  Permeability values were measured to be in the range of $1x10^{-5}$m/s to $1x10^{-7}$m/s. The variation is likely to be due to stratification within the River Terrace Deposits, with each stratum comprising different amounts of sand, silt and gravel. Numerous groundwater strikes and seepages were noted during investigations. The River Terrace Deposits are classified by the EA as a Secondary A Aquifer.

- Made Ground, where present, is also relatively permeable (around $8x10^{-7}$m/s), comprising a variety of soil materials.

Peter Brett Associates (2015) therefore concludes that groundwater has the potential to flow within the River Terrace Deposits, but not the Weald Clay. The Weald Clay is considered to act as an aquitard preventing any significant downward flow of groundwater.

The report does not comment on the permeability of the material used to construct the lake embankments.

4.3.2 Groundwater levels and flows

BAM Ritchie Ltd monitored groundwater levels for a period of nine months on a monthly basis. BH1 and BH2 (the two boreholes in locations without River Terrace Deposits) show the greatest seasonal differences in groundwater level (varying by up to 0.64m at BH1. This represents groundwater levels between around 15.9mAOD and 16.5mAOD, ie 2.8 to 2.2mBGL).

No groundwater monitoring was carried out by BAM Ritchie on land not owned by Monk Lakes Ltd. The only groundwater readings available for Mr Padden's land are those stated in ESI (2015).

Figure 4.2 of this MM Report shows groundwater contours of the area as constructed by Peter Brett Associates (2015), including ESI (2015)'s data. This shows that groundwater levels are generally higher in the south of the area and fall towards the north. Groundwater flow is thus also expected to be towards the north, towards the River Beult, as would be expected. The River Beult itself flows towards the west.

However, it is notable that the 15.5mAOD contour shows a very large change in direction to the west of Lake 2, and the contour is predicted to run along the western boundary. The shape of this contour implies that in this area groundwater will flow from east to west, rather than north towards the river. This contour implies that groundwater levels at Hertsfield Barn are around 0.5m higher than expected.

The change in contour shape in this area is not directly commented on, nor explained in PBA's report. It is implied that it may be a result of the western boundary ditch acting as a source of groundwater recharge. This is also stated in ESI (2015).

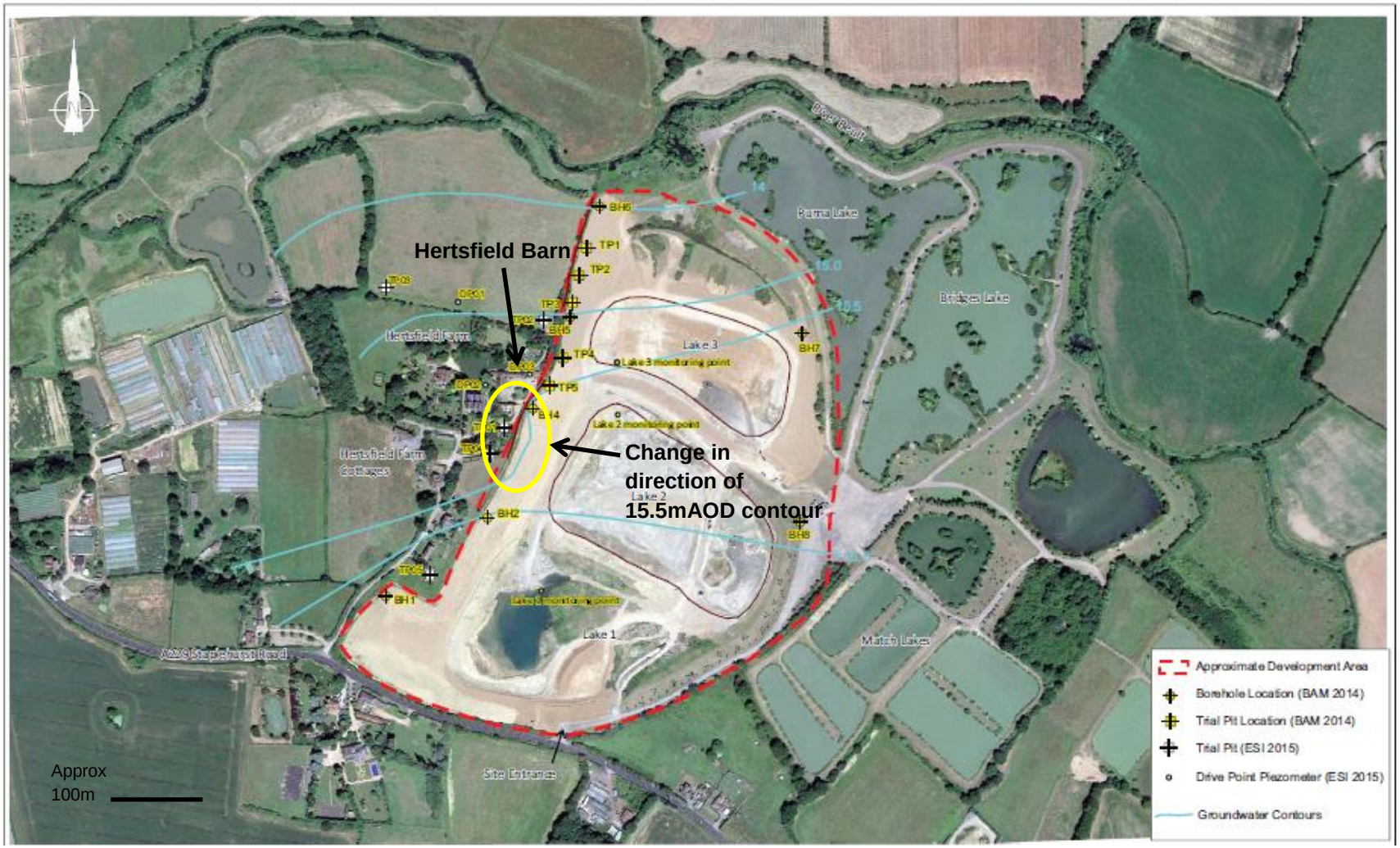
The contours are based partly on groundwater readings from the ESI 2015 study. PBA state that the ESI data may be unreliable as the piezometer installation methods are not considered to be in accordance with standard practice. Water levels at the ESI boreholes were only measured once. The change in direction of the 15.5mAOD contour is not apparent by plotting PBA's data in isolation. However, there is no alternative data available to the west to justify discounting ESI's readings.

4.3.3 Groundwater quality

There is no reference to groundwater quality in Peter Brett Associates (2015).

There is no reference to groundwater quality in ESI (2015) beyond visual observations that water flowing into Mrs Highwood's septic tank (of 3 Hertsfield Cottages) was clear and thus not thought to be foul water.

Figure 4.2: Monk Lakes site with groundwater contours



Source: Peter Brett Associates 2015 Figure 9 with additions by Mott MacDonald

4.3.4 Evaluation of hydrogeological evidence

The groundwater investigations are considered to provide reasonable evidence of the hydrogeology across much of the site within the Weald Clay and River Terrace Deposits, with the exception of the western area between BH2 and BH4. However, as BAM Ritches Ltd did not carry out monitoring on land not owned by Monk Lakes Ltd, the hydrogeology of the land to the west is limited to that presented in ESI (2015).

The evidence is strong that groundwater movement within the Weald Clay is extremely limited. Peter Brett Associates (2015) offers sufficient evidence to show that the Weald Clay acts as an aquitard. As such, no groundwater flooding can occur by groundwater infiltrating and moving through this stratum. The planned developments at Monk Lakes would therefore have no impact on groundwater flooding from the Weald Clay.

However, the reported variation in groundwater levels of up to 0.64m at BH1 and BH2, which are the two boreholes without River Terrace Deposits, is unexpected given that these boreholes are constructed in Weald Clay and that no groundwater strike occurred during construction. An explanation for this should be explored as it is not clear from this what aquifer body BH1 and BH2 are recording and how this variation is possible.

Peter Brett Associates (2015) does not include groundwater readings from BH1 or BH2 in their report Figure 8 (which only shows contours within the River Terrace Deposits). However, in their Figure 9 contours (also reproduced in Figure 4.2 of this report) groundwater contours are shown extending through BH2, where the River Terrace Deposits are absent. The justification for extending the contours outside of the River Terrace Deposits is not explained.

The report does not comment on the permeability of the material used to construct the lake embankments. If this material is permeable, like the River Terrace Deposits or other Made Ground, then it could be possible for groundwater to travel through this towards the west.

It is evident that groundwater is able to flow through the River Terrace Deposits. Section 4.2 of this report notes that it is not clear exactly how far south the River Terrace Deposits extend south from the River Beult, although there is evidence suggesting that the southern limit lies somewhere between PBA's BH2 and ESI's TP04 and cuts half-way through Lake 2.

Groundwater monitoring has shown that generally groundwater flow in the River Terrace Deposits is approximately north towards the River Beult. This is as would be expected. However, the change in the shape of the 15.5mAOD contour to the west of Lake 2 is notable, and implies that groundwater has the potential to flow towards the west in this area. This could have implications for groundwater flooding on land to the west where the land is also known to be locally depressed. This change in contour direction is additionally near the limit of the extent of the River Terrace Deposits in a part of the site that is less well understood owing to the absence of any boreholes. The shape of the 15.5mAOD contour is developed based on a single measurement from the ESI (2015) investigation integrated with the PBA (2015) data. Further work needs to be carried out in this area.

The unexpected contour shape in this area is not commented on, nor explained in PBA's report. If further work confirms the presence of this change in contour shape, possible causes that should be investigated include:

- Leakage from Lake 2.
- Infiltration of surface water into the Lake 2 embankment, and subsequent movement of this water through the embankment and River Terrace Deposits towards the ditch.
- The ditch acting as a linear source of groundwater recharge in that area.

Peter Brett Associates (2015) do not present a conceptual source-pathway-receptor model to demonstrate the potential mechanisms by which groundwater levels could have been impacted by construction, or for groundwater to flood Hertsfield Barn and pond.

It would be expected within an Environmental Statement to present an assessment of the validity and risk associated with each source-pathway-receptor based on the evidence available, and whether the evidence is adequate. This assessment is commonly presented as a table for clarity.

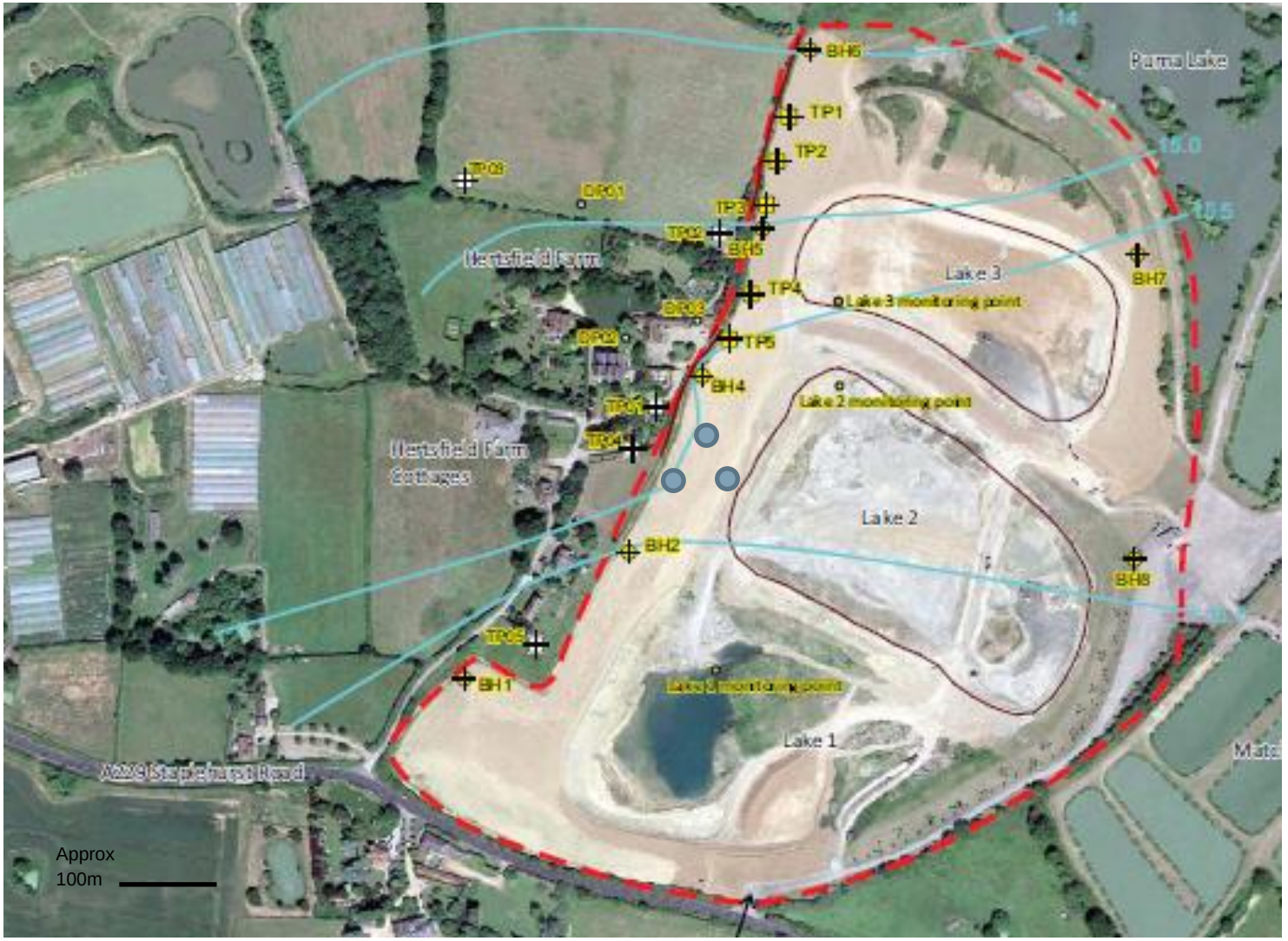
4.3.5 Recommendations for hydrogeological evidence

It is recommended that:

1. PBA should offer clearer justification as to why they believe ESI's results may be unreliable.
2. PBA should attempt to corroborate ESI's data, particularly in the area between BH2 and BH4 where this should be achievable without requiring access to Mr Padden's land. Without a clear understanding of the groundwater system to the west, it is impossible to reach a firm conclusion. It is recommended that:
   - Between one and three boreholes are dug on the western boundary between BH2 and BH4, within the River Terrace Deposits.
     - Borehole(s) should be constructed to ensure that imported fill material or Made Ground are cased out and only water levels in the River Terrace Deposits are observed.
     - Suggested locations for three new boreholes are shown on Figure 4.3.
   - Borehole(s) is/are monitored together with the previously installed boreholes for a period of at least three months and this should also include a period when groundwater levels would be expected to be high (e.g. January – March).
     - This aims to more accurately establish the groundwater contours in this area and provide confirmation as to whether groundwater is really moving towards the west.
3. If ESI's trial pits and boreholes still exist, these should be regularly monitored at the same time as the PBA boreholes if possible (either by PBA, by ESI with the results made available to PBA, or by a neutral third party consultant). Single groundwater measurements are less reliable than those taken over the course of months and any variations in groundwater levels will not have been captured.
4. The cause of the change in contours in this location, if corroborated by further borehole testing, should be investigated and explained. Possible causes that should be investigated include:
   a. Leakage from Lake 2
   b. Infiltration of surface water into the Lake 2 embankment, and subsequent movement of this water through the embankment and River Terrace Deposits towards the ditch. However, if this were the case, it might be expected that groundwater movement was towards the west at Lake 3 too. This does not seem to be occurring.
   c. The ditch acting as a linear source of groundwater recharge.
5. The new borehole(s) should be tested to calculate the permeability of the River Terrace Deposits in that area.
6. The permeability of the embankment material should be ascertained.

7. The reported variation in groundwater levels of up to 0.64m at BH1 and BH2, which are the two boreholes without River Terrace Deposits, should be explained. Given that these boreholes are constructed in Weald Clay and that no groundwater strike occurred during construction it is not clear from this what aquifer body BH1 and BH2 are recording and how this variation is possible.
8. The contours drawn by PBA in Figure 9 of their report extend through BH2, where there are no River Terrace Deposits present and no groundwater was found. It is recommended that the River Terrace Deposit geology is shown on this figure and that contours are either not interpolated outside of this geological area, or justification for them is presented.
9. A source-pathway-receptor table is included to present how the Monk Lakes development could be affecting groundwater, and identify all the ways in which groundwater could be affecting Hertsfield Barn. This should also include assessment of risk, whether the evidence is adequate, and, where risks are unacceptable, then measures should be proposed to mitigate the risk or impacts.
10. Two cross-sections should be drawn: the first cutting through the centre of Lakes 1, 2 and 3; and the second through the centre of Lake 2, BH4 and Hertsfield pond. These cross-sections should show ground elevation, water levels within the lakes, the underlying geology and groundwater levels all together. This will allow clearer visualisation of the geological and hydrogeological situation.
11. The water quality is tested in Lakes 1, 2 and 3, the River Beult, in each of the boreholes and at several locations in the western boundary ditch. It is recommended that at least three rounds of testing are carried out to provide a baseline for any future changes. The water quality in Hertsfield Barn pond together with testing any flood water that may appear on Mr Padden's land during the monitoring period should also be tested. This may offer evidence regarding the origin of these waters.

Figure 4.3: Monk Lakes site with suggested additional borehole locations



Additional suggested boreholes

Source: Peter Brett Associates 2015 Figure 9 with additions by Mott MacDonald

4.4 Hydrology

4.4.1 Surface Water levels

4.4.1.1 Lakes 1, 2 and 3

Water levels in Lake 1 were measured from September to December 2014. Water levels were around 13.25mAOD, which is above the expected base of the Weald Clay in that location but below the level of Hertsfield Barn pond (14.04mAOD). However, after this date monitoring stopped as water levels overtopped the measuring gauge. It is assumed that water levels in Lake 1 have the potential to have risen by 0.79m, to now be above the level of the pond.

Water levels in Lakes 2 and 3 were significantly higher than Hertsfield Barn pond, at around 20.7mAOD and 18.5mOAD respectively. These water levels are 3.7m and 3.5m above the original groundwater respectively. Peter Brett Associates (2015) does not specify potential mechanisms for water to travel from these lakes to impact on any receptors.

The lakes are lined with clay and this should theoretically prevent water leakage. Water levels did not decrease over the monitoring period and Monk Lakes Ltd have stated that they did not top them up.

Peter Brett Associates (2015) notes that reviewing the design and construction of the lakes was outside of the scope of their report. They consider that significant leakage from the lakes is unlikely, as a Reservoir Panel Engineer was involved with reviewing the design and construction of the lakes and water levels did not decrease over the monitoring period.

4.4.1.2 Hertsfield Barn pond

Hertsfield Barn Pond was not accessible by Peter Brett Associates for their study. The base of the pond is stated by ESI (2015) to be around 14.04mAOD. Given the known base elevations of the River Terrace Deposits stated in Peter Brett Associates (2015) and ESI (2015), the pond is thought to be connected to the River Terrace Deposits and therefore is able to receive groundwater inflow from that horizon.

A single reading is reported for the water level in Hertsfield Barn Pond (ESI 2015). This was approximately 14.70mAOD.

Historical conditions at the pond appear from Peter Brett Associates (2015) to be limited to two statements made by Mr J Dorkings and Anthony Francis Graham-Wilkinson and flooding at the pond appears to pre-date development at Monk Lakes. However, anecdotal evidence has also been presented by Mr Padden from Tim Privett (a surveyor) and by the local residents in the past (see Section Mr Padden5.6). This is not included as an Appendix in the report.

4.4.1.3 Drainage Ditches

The western drainage ditch was noted to contain standing water throughout the monitoring period (as it was during the site walk-over undertaken for this report).

It is also noted that infiltration of water to ground may be possible where the ditch is constructed in the River Terrace Deposits. The borehole and trial pit groundwater levels were mostly measured to be above the base of the drainage ditch. It is therefore considered that the drainage ditch is not draining due to inadequate falls and the fact that it intersects the water table in places.

4.4.2 Evaluation of hydrological evidence

Water levels measured in Lake 1 in December 2014 were approximately 0.79m below those found at Hertsfield Barn pond. Given that after this date monitoring stopped as water levels overtopped the measuring gauge, it is assumed that water levels in Lake 1 may have now risen above the pond level. Lake 1 is uncompleted and currently unlined. Although it is constructed on Weald Clay, and not River Terrace Deposits, the material used to build the lake embankments is unspecified. It is considered to be unlikely that water levels have risen sufficiently to be able to travel through the embankment material (which is believed to have been placed on top of the original ground surface at 17.5mAOD), but monitoring water levels in Lake 1 is still considered to be of value to prove this.

Given that Lakes 2 and 3 are lined with clay and that water levels did not decrease over the monitoring period, it seems reasonable to assume that leakage is negligible from the lakes, however the 15.5mAOD contour to the west of Lake 2 (discussed in Section 4.3) should be investigated before ruling out leakage from Lake 2. The possible reasons for the shape of this contour should be presented and investigated.

The report does not attempt to investigate any relationship between flooding of the pond and rainfall. This evidence is, however, presented in ESI (2015).

Although flooding at Hertsfield pond is stated to pre-date development on the Monk Lakes site, this does not mean that the development has not exacerbated flooding problems.

Infiltration of water from the ditch into the ground is considered to be possible where the ditch is constructed in the River Terrace Deposits. It is also considered likely that the drainage ditch is not draining due to inadequate falls and the fact that it intersects the water table in places. In addition, the ditch was observed to be very overgrown during the site visit on Thursday 15th October 2015.

4.4.3 Recommendations for hydrological evidence

It is recommended that:

1. The monitoring gauge at Lake 1 is replaced so that it is no longer at risk of over-topping for future measurements.
2. Water levels at Lake 1 are measured to see whether levels have risen above the level of Hertsfield Barn pond or the original ground level.
3. The permeability of the material used to construct Lake 1 is tested.
4. All the historical anecdotal evidence should be included.
5. Any relationship between rainfall and flooding at Hertsfield Barn Pond should be investigated, or referenced from ESI (2015). This would offer further evidence to corroborate the anecdotal statements presented regarding flood events.
6. Appropriate maintenance of the ditch.
7. Upgrade the ditch to ensure that it constantly falls towards the River Beult and is sufficiently large to prevent overtopping during significant flood events.

4.5 Discussion

In PBA's discussion, they make the following observations:

- ESI (2015) contains photographs of various flooding events which are likely to be a combination of groundwater and surface water flooding. Anecdotal evidence is given that similar flood events have been occurring since the mid 1980s and that the source of flood water includes catchments from the other side of the A229 in the south.
- A long-section through the base level of the western boundary ditch is presented showing the base of the River Terrace deposits.
- There is an absence or relatively thin band of River Terrace Deposits in the immediate area of Hertsfield Barn, causing water to potentially pool during storm events.
- There is a mechanism for recharge to occur from the western ditch into River Terrace Deposits around Hertsfield Barn as the ditch holds water at a higher level than groundwater level during storm events.

4.5.1 Evaluation of the Discussion

Flooding of the area around Hertsfield Barn may have been occurring since the mid 1980s, but it does not follow from that that the development of Monk Lakes Ltd has not made the situation worse.

The thickness of the River Terrace Deposits has been shown to be very variable on a local scale. It cannot be inferred from the small thicknesses measured at ESI DP03 that water around Hertsfield Barn is from the pooling of storm water rather than movement from Monk Lakes Ltd land.

It is agreed that there is a mechanism for recharge to occur from the western ditch into River Terrace Deposits around Hertsfield Barn.

Peter Brett Associates do not include any comparison of rainfall events with flooding events at Hertsfield Barn. ESI (2015) does include climatic information.

4.5.2 Recommendations for discussion

It is recommended that:

- A long-section through the base level of the western boundary ditch is presented with a larger scale on the Y axis than is shown in Peter Brett Associates (2015) Figure 4. At this scale it is difficult to see exactly where the ditch is falling and where it is rising.
- Precipitation should be compared to historic flood events, particularly those that are claimed to have caused significant problems.
- Monitored groundwater levels should be plotted together with rainfall data to allow comparison.
- Work is undertaken to mitigate flood risk from the ditch. This should include ensuring that the ditch base is not above the original ground level.

4.6 Peter Brett Associates (2015) Recommendations

The recommendations suggested by PBA to improve the groundwater drainage are:

- To upgrade the western boundary ditch to prevent it overtopping
  This is agreed to be required.
- An impervious lining at the base of the ditch is required to prevent percolation of water into the River Terrace Deposits

This would prevent water percolating into the River Terrace Deposits. However, typical concerns with lining would include creating a barrier to flow. This would be a particular concern where the ditch cuts through the entire thickness of the River Terrace Deposits. At these locations, groundwater may build up on the eastern side of the ditch and inflow to the pond may be reduced beyond that anticipated.

- Water may percolate through the embankments. A groundwater interceptor drain should be incorporated into the surface water strategy.
  This is agreed. The original drainage system that was present on the Monk Lakes site prior to 2003 has been disrupted and the presence of the lakes will have changed the way groundwater moves across the site. An appropriate groundwater drainage system should be put in place. Peter Brett Associates have developed a drainage strategy, but this has not been assessed as part of this current report due to the extent of additional work required to fully assess the groundwater impacts and the additional evidence required by the EA and LLFA to satisfy them that an appropriate assessment has been undertaken and hence an appropriate strategy is proposed.
- Planting of the embankments should take place
  Assessing the planting of the embankments and its potential impacts should be carried out by a suitably qualified person.

5 Responses to Peter Brett's Groundwater Monitoring Report

Following issue of Peter Brett Associates (2015), consultee and third party responses were received by Maidstone Borough Council. These responses, where relevant to groundwater, have been considered below.

5.1 Cllr S McLoughlin

Cllr S McLoughlin responded on 09 September 2015 following a meeting with the Hertsfield Residents' Association and made no comments directly regarding the groundwater assessment, other than to say that the Hertsfield Residents' Association do not consider that their concerns have been adequately addressed.

5.2 Kent County Council Ecological Advice Service

Kent County Council ecological advice service responded on 21 August 2015 and made no comments relevant to the groundwater assessment:

5.3 Kent County Council Flood Risk Officer

Kent County Council (KCC), as the Lead Local Flood Authority, responded on 08 September 2015 and made the following comments regarding groundwater:

We are unable to determine whether sufficient information has been submitted to demonstrate that the development already undertaken has not altered the groundwater flow regime or increased the risk of groundwater flooding off-site. We are also unable to determine whether the proposed interceptor drain will function as proposed, has been appropriately sized or how its southern-most extent has been established.

It should be clearly demonstrated that the development has not exacerbated the offsite risk from groundwater flooding, and is unlikely to do so in the future. We are unable to consider that the information submitted to date is able to provide this assurance.

We would recommend that a meeting is organised with representatives of Kent County Council, Maidstone Borough Council and the Environment Agency to discuss the best way to determine the complex inter-related flood risk management issues arising from this site.

To address these concerns it is recommended that further work is carried out as follows:

- PBA should establish a baseline for 2003 with which to compare their monitoring results. Although evidence is limited and mostly anecdotal prior to this date, this information should be included. Similarly, all data between 2003 and 2015 should be collected together in an attempt to quantify any changes in the groundwater regime that may have occurred whilst site works were being undertaken.
- Further information should be provided regarding how the interceptor drain will alleviate the problem, including: a description of the proposed base level of the drain compared with original ground levels and groundwater levels to the east and west of the ditch; and an explanation of how flow towards the river would be maintained to prevent standing water in the drain, particularly at high river levels when river water may back up into the ditch.
- A meeting should take place between KCC, Maidstone Borough Council and the Environment Agency as suggested. This recommendation is echoed by the Environment Agency in their response (see Section 5.4).

5.4 Natural England

Natural England responded on 09 September 2015 and made no comments relevant to the groundwater assessment:

5.5 The Environment Agency

The Environment Agency responded on 08 September 2015 and made the following comments regarding groundwater:

No information on drainage calculations has been submitted and there is no evidence on how the drainage scheme will or will not impact the fluvial flood plain. We also note that the groundwater monitoring report has found there to be groundwater flooding however no information on baseline flow has been submitted and the report has not demonstrated impact on fluvial, surface water and groundwater flows and whether there is any increased offsite risk. While any proposed mitigation needs to be to the satisfaction of the LPA, we strongly recommend that we meet with colleagues in Maidstone Borough Council and Kent County Council (as the Lead Local Flood Authority) to discuss all aspects of flooding and drainage implications prior to any decision being made.

These concerns are similar to those raised by KCC (see Section 5.3), and thus recommendations to address these concerns are also similar, as follows:

- PBA do not attempt to establish a baseline for 2003 with which to compare their monitoring results. Although evidence is limited and mostly anecdotal prior to this date, this information should be included. Similarly, all data between 2003 and 2015 should be collected together in an attempt to quantify any changes in the groundwater regime that may have occurred whilst site works were being undertaken.
- Further information should be provided regarding exactly how the interceptor drain will alleviate the problem, including quantitative calculations.
- A meeting should take place between KCC, Maidstone Borough Council and the Environment Agency as suggested. This recommendation is echoed by KCC in their response (see Section 5.3).

5.6 Mr Padden

Mr Padden responded on 03 September 2015 and noted that the timing of the consultation period had made it difficult to discuss the matter with the other local residents and consultants with whom he works. It is noted that in a letter dated 16 December 2014 that ESI would be 'robustly reviewing' Peter Brett Associates (2015) on his behalf. It is unknown at the time of writing whether ESI are in the process of conducting this review and, if so, when it might be available.

Mr Padden makes the following detailed comments regarding Peter Brett Associates (2015) groundwater report and the groundwater sections of the supplementary ES:

The methodology of the groundwater monitoring (7 boreholes) was not agreed with the EA, indeed informal advice was given that more boreholes were required.

It is disingenuous that the applicant's consultants criticise the information and reports on groundwater provided to the Council, the Court and in the planning appeal by ESI on my behalf….

The fact that the applicant's consultant has not been able to provide an explanation for this change [ie increase in groundwater conditions] does not negate the fact that there has been a change and this coincides with the unauthorised development.

I have provided evidence to the Courts that there is flooding at Hertsfield Barn, even when the ditch is not full and there has been no recent rainfall.

In reply to 6.72 [of the ES, which states that no factual information other than that provided by BGS is available prior to the construction taking place] factual information of ground condition is available from before 2003 in the public submissions I and my neighbours has made to the Courts, the Council and the Inspectorate….

There is no mention of when the River Beult is in spate and the ditch backfills from the river, how the proposed mitigation measures could divert any water away from the ditch.

To address these concerns it is recommended that further work is carried out as follows:

- One or two further boreholes be drilled in-between PBA's BH2 and BH4, as described in Section 4.3. This is the area of greatest uncertainty in groundwater movement, where the current contours imply that movement will be towards the west rather than towards the River Beult.
- In the absence of one combined monitoring initiative encompassing both Monk Lakes Ltd and Mr Padden's land, taking both Peter Brett Associates (2015) and ESI (2015)'s findings into account is considered to be essential to gain the fullest understanding of groundwater movement across the area possible.
- PBA do not attempt to establish a baseline for 2003 with which to compare their monitoring results. Although evidence is limited and mostly anecdotal prior to this date, this information should all be included (for example, the evidence provided by Mr Padden's engineer) in an attempt to address the concerns of KCC, the EA and Mr Padden regarding the baseline. However, given the lack of quantitative evidence prior to 2003 at the site, (and very limited prior to 2015), the potential to definitively assess impacts of the development on the groundwater in the area is always likely to be subject to uncertainty.
- Further information should be provided regarding exactly how the interceptor drain will alleviate the problem, including: a description of the proposed base level of the drain compared with original ground levels and groundwater levels to the east and west of the ditch; and an explanation of how flow towards the river would be maintained to prevent standing water in the drain, particularly at high river levels when river water may back up into the ditch. The functionality of the drainage ditch is also a concern of KCC and the EA.
- It is advised that, should ESI review Peter Brett Associates (2015) on his behalf, any additional work at Monk Lakes should include their recommendations wherever possible if the investigations are to be acceptable to Mr Padden and progress is to be made.

6 Conclusions and Recommendations

A summary of the recommendations from this review for further work is given below:

1. Between one and three new trial pits/boreholes should be dug on the western boundary between BH2 and BH4 in an attempt to define the southern limit of the River Terrace Deposits and corroborate the geological information from ESI (2015) in this area as far as possible if access to Mr Padden's land is not possible. A suggested location for this borehole(s) is shown on Figure 4.3.

2. Furthermore, this borehole(s) should monitor groundwater levels within the River Terrace Deposits together with the previously installed boreholes for a period of at least three months (including a period when groundwater levels would be expected to be high e.g. January to March). This aims to more accurately establish the groundwater contours in this area and provide confirmation as to whether groundwater is really moving towards the west. Without a clear understanding of the groundwater system to the west, it is impossible to reach a firm conclusion.

3. If ESI's trial pits and boreholes still exist, these should be regularly monitored at the same time as the PBA boreholes if possible (either by PBA, by ESI with the results made available to PBA, or by a neutral third party consultant). Single groundwater measurements are less reliable than those taken over the course of months and any variations in groundwater levels will not have been captured.

4. Any relationship between rainfall and flooding at Hertsfield Barn Pond should be investigated, or referenced from ESI (2015). This would offer further evidence to corroborate the anecdotal statements presented regarding flood events.

5. Monitored groundwater levels should be plotted together with rainfall data to allow comparison

6. The statement in 4.3.2 of Peter Brett Associates (2015) that access permission was not granted on Mr Padden's land should be rephrased as, from available correspondence between the two parties, who refused access to whom appears to be contentious.

7. The cause of the change in contours in this location, if corroborated by further borehole testing, should be investigated and explained. Possible causes that should be investigated include:
   a. Leakage from Lake 2 out of the western side
   b. Infiltration of surface water into the Lake 2 embankment, and subsequent movement of this water through the embankment and River Terrace Deposits towards the ditch. However, if this were the case, it might be expected that groundwater movement was towards the west at Lake 3 too. This does not seem to be occurring.
   c. The ditch acting as a linear source of groundwater recharge.

8. The new borehole(s) should be tested to calculate the permeability of the River Terrace Deposits in that area.

9. The reported variation in groundwater levels of up to 0.64m at BH1 and BH2, which are the two boreholes without River Terrace Deposits, should be explained. Given that these boreholes are constructed in Weald Clay and that no groundwater strike occurred during construction it is not clear from this what aquifer body BH1 and BH2 are recording and how this variation is possible.

10. The contours drawn by PBA in Figure 9 of their report extend through BH2, where there are no River Terrace Deposits present and no groundwater was found. It is recommended that the River Terrace Deposit geology is shown on this figure and that contours are either not interpolated outside of this geological area, or justification for them is presented.

11. The nature of the fill used to construct the lakes should be ascertained, and its permeability tested.

12. A geophysical survey could be carried out across the site, in an attempt to better define the extent of the River Terrace deposits. However, additional boreholes are likely to achieve this in addition to providing groundwater level.

13. Two cross-sections should be drawn: the first cutting through the centre of Lakes 1, 2 and 3; and the second through the centre of Lake 2, BH4 and Hertsfield pond. These cross-sections should show ground elevation, water levels within the lakes, the underlying geology and groundwater levels all together. This will allow clearer visualisation of the geological and hydrogeological situation.

14. A source-pathway-receptor table should be included to present how the Monk Lakes development could be affecting groundwater, and identify all the ways in which groundwater could be affecting Hertsfield Barn.

15. Peter Brett Associates (2015) makes no mention of groundwater quality. Therefore it is not possible to assess whether the site works have adversely impacted groundwater quality.

16. The water quality is tested in Lakes 1, 2 and 3, the River Beult, in each of the boreholes and at several locations in the western boundary ditch. It is recommended that at least three rounds of testing are carried out to provide a baseline for any future changes. The water quality in Hertsfield Barn pond together with testing any flood water that may appear on Mr Padden's land during the monitoring period should also be tested. This may offer evidence regarding the origin of these waters, but will also allow any future changes in water quality that may be caused by further development to be identified.

17. The monitoring gauge at Lake 1 is replaced so that it is no longer at risk of over-topping for future measurements.

18. Water levels at Lake 1 are measured to see whether levels have risen above the level of Hertsfield Barn pond or the original ground level.

19. PBA do not attempt to establish a baseline for 2003 with which to compare their monitoring results. Although evidence is limited and mostly anecdotal prior to this date, this information should be included (for example, the evidence provided by Mr Padden's engineer) in an attempt to address the concerns of KCC, the EA and Mr Padden regarding the baseline. However, given the lack of quantitative evidence prior to 2003 at the site, (and very limited prior to 2015), the potential to definitively assess impacts of the development on the groundwater in the area is always likely to be subject to uncertainty.

20. The ditch should be appropriately maintained.

21. Upgrade the ditch to mitigate flood risk from it. This should include ensuring that the ditch base is not above the original ground level, that it constantly falls towards the River Beult and is sufficiently large to prevent overtopping during significant flood events.

22. An impervious lining at the base of the ditch would prevent water percolating into the River Terrace Deposits. However, typical concerns with lining would include creating a barrier to flow. This would be a particular concern where the ditch cuts through the entire thickness of the River Terrace Deposits. At these locations, groundwater may build up on the eastern side of the ditch and inflow to the pond may be reduced beyond that anticipated.

23. A long-section through the base level of the western boundary ditch should be presented with a larger scale on the Y axis than is shown in Peter Brett Associates (2015) Figure 4. At this scale it is difficult to see exactly where the ditch is falling and where it is rising.

24. A groundwater interceptor drain should be incorporated into the surface water strategy. Further information should be provided regarding exactly how the interceptor drain will alleviate the problem, including: a description of the proposed base level of the drain compared with original ground levels and groundwater levels to the east and west of the ditch; an explanation of how flow towards the river would be maintained to prevent standing water in the drain, particularly at high river levels when river water may back up into the ditch; and quantitative calculations. Peter Brett Associates have developed a drainage strategy report, but this has not been reviewed as part of this report.

25. Potentially planting the embankments should be assessed and carried out by a suitably qualified person.

26. A meeting should take place between KCC, Maidstone Borough Council and the Environment Agency as suggested to discuss their concerns.

27. Mr Padden indicated in a letter dated 16th December 2014 that ESI would be 'robustly reviewing' Peter Brett Associates (2015) on his behalf. It is unknown at the time of writing whether ESI are in the process of conducting this review. However, it is advised that any additional work at Monk Lakes should give ESI's recommendations consideration wherever possible if the investigations are to be accepted by both parties and progress is to be made.

28. In the absence of one combined monitoring initiative encompassing both Monk Lakes Ltd and Mr Padden's land, taking both Peter Brett Associates (2015) and ESI (2015)'s findings into account is considered to be essential to gain the most complete understanding of groundwater movement across the area possible. In light of this, it is recommended that, if possible, further work be carried out by a neutral consultant acceptable to both parties (for example, a consultant selected by the LPA).

7 References

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ESI. 2015. “Report of Dr Paul Ellis - The potential for groundwater flooding resulting from the unauthorised development at the neighbouring property known as Monk Lakes.” RL1-63346R2.

Maidstone Borough Council. 2015. *Planning (ref 11/1948) .* October. http://pa.midkent.gov.uk/online-applications/.

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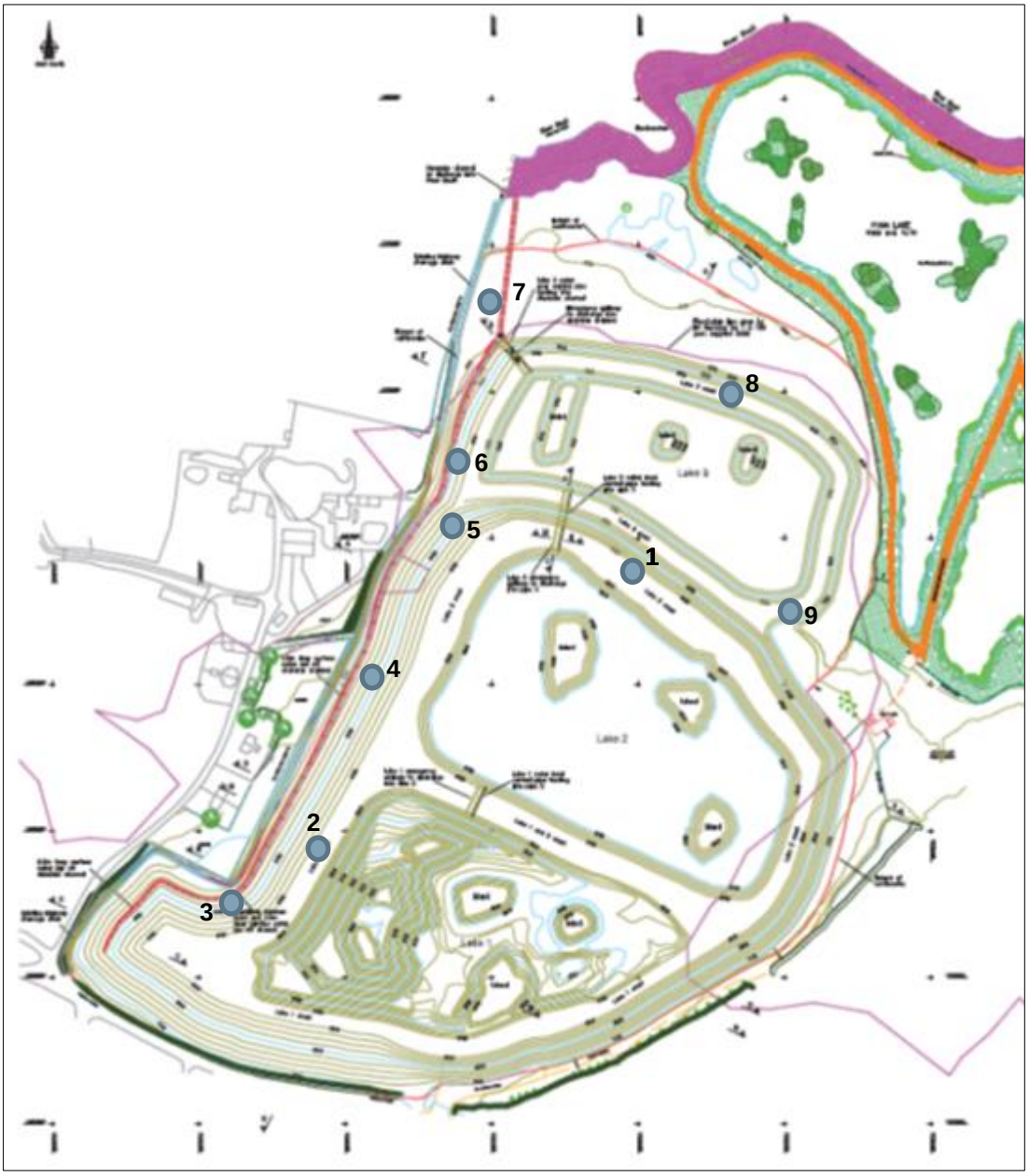
Peter Brett Associates. 2015. “Monk Lakes, Marden, Kent Groundwater Monitoring Report.”

Appendices

Appendix A. Site Visit Photographs

The following photographs were taken by Mott MacDonald on Thursday 15th October 2015. The viewpoints are labelled on Figure A.1

Figure A.1: Monk Lakes site showing viewpoints for photographs



Source: Peter Brett Associates (2015) with annotation by Mott MacDonald

Figure A.2: Looking NE over Lake 3 from viewpoint 1

Figure A.3: Looking SE over Lake 1 from viewpoint 2

Figure A.4: Western boundary ditch looking NE from viewpoint 3

Figure A.5: Western boundary ditch looking NE from viewpoint 4 towards orchard

Figure A.6: View W of Hertsfield Barn and the western boundary ditch from viewpoint 5

Figure A.7: Overgrown western boundary ditch near TP4 with small volumes of standing water. Viewpoint 6.

Figure A.8: Standing water in the western boundary ditch near TP1. Viewpoint 7.

Figure A.9: View S over Lake 3, including outfall. Viewpoint 8.

Figure A.10: Lake 3 (right) with crest of Lake 2 (left). Viewpoint 9.