

HATFIELD ROAD QUARRY

Planning Application PL/0232/21

Groundwater and Water Management and Monitoring Plan (GWMMP)

FINAL DRAFT

Prepared for:
Brett Aggregates Limited

SLR Ref: 403.09885.00024
Version No: FINAL DRAFT
September 2022



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ABBREVIATIONS

Agency	The Environment Agency
Affinity	Affinity Water plc
Brett	Brett Aggregates Limited
CQA	Construction Quality Assurance
HCC	Hertfordshire County Council
IB	Interburden
UMA	Upper Mineral Aquifer
UMH	Upper Mineral Horizon
UML	Upper Mineral Lagoon
LMA	Lower Mineral Aquifer

LMH	Lower Mineral Horizon
LML	Lower Mineral Lagoon
mAOD	metres above ordnance datum
bgl	Below Ground Level

1.0 Introduction

This Groundwater and Water Management & Monitoring Plan (GWMMP) presents how groundwater and surface water will be managed prior to, during and following operation of the proposed Hatfield Road Quarry.

1.1 Background

In 2016 Brett Aggregates Limited (Brett) applied for planning permission for the establishment of Hatfield Road Quarry, a new quarry on land at the former Hatfield Aerodrome (the 2016 planning application).

Draft planning conditions issued by Hertfordshire County Council (HCC) (Reference PL/0755/16) in 2016 requested supporting information relating to the management of water; HCC draft condition 26 - Groundwater Management Plan, and draft condition 30 - A Water Management Plan.

The 2016 GWMMP was submitted in support of the 2016 planning application, forming an Appendix to the Water Chapter in the Environmental Statement (ES).

The 2016 planning application was refused by HCC in September 2020. Brett submitted a revised planning application with a new ES (the 2021 ES) and revised GWMMP in September 2021 (reference PL/0232/21) and appealed against the September 2020 refusal, with the appeal heard at a public inquiry in November 2021.

This 2022 version of the GWMMP builds upon previous submissions, incorporating amendments relating to new Conditions resulting from the Planning Inspectors comments during the appeal, and subsequently presented in the Inspectors Report.

1.2 Planning Conditions

This section is a summary of HCC's draft planning conditions prepared during the 2021 appeal and the Planning Inspectors Appeal Decision, dated 25 January 2022. Specific references to the draft conditions and stakeholder requests are included in other sections of this document. A full copy of Inspectors Appeal Decision and HCC's draft planning conditions are included in **Appendix A**. Only those Conditions relating specifically to groundwater and water monitoring and management are included in the sections **1.2.1** and **1.2.2** below.

1.2.1 Appeal Decision APP/M1900/W/21/3278097

In his Appeal Decision, the Planning Inspector comments on matters that have been used to direct HCC Conditions discussed previously in this section.

Paragraph 54 refers to HCC Condition 25 through 31 being accepted by the stakeholders as a means of avoiding unacceptable effects on groundwater, any adverse effect on the bromate plume and being effective in detecting any adverse movement of the plume.

Paragraph 55 discusses how HCC Condition 25 requires approval of construction and water management associated with the lagoons and UML back-drain and HCC Condition 26 requires prior approval of the GWMMP which includes monitoring requirements, phase-specific boreholes, and water management by the infiltration lagoons. Paragraph 55 also mentions Condition 27 (the need for Phase specific GWMMP's), and HCC Conditions 28 and 29 requiring trigger levels and Action and Response Plans.

Paragraphs 56 and 59 relate to HCC Condition 31 *"No pumping of groundwater from the lower mineral horizon is permitted within any part of the mineral working"*. Together with HCC Condition 28 and 29 HCC indicated that there was now no reason for refusal based on groundwater impacts and the safety of the public water supply.

In Paragraph 60 the Inspector returns to the need for trigger levels and action/response plans as a means of managing the risk of exacerbating bromate pollution, but that the EA's requirement that activities do not interfere with remediation would require further consideration including that of additional boreholes (to define

the presence of bromate). In Paragraph 61 the Inspector discusses how action/response plans linked to monitoring locations include explicit provision of cessation of LMH excavation if evidence of interference with the remediation of bromate pollution, and furthermore, cessation of mineral extraction could only be overturned by the MPA if there is compelling evidence demonstrating no adverse effect on the bromate remediation. These points, together with the analysis of data in the context of triggers, action and response levels is addressed in HCC Conditions 26, 28 and 29.

The Inspector expresses his opinion in Paragraph 62 that subject to such conditions he was satisfied that the risk from bromate pollution could be reduced to an acceptable level.

1.2.2 HCC Draft Conditions (2021)

HCC Condition 25 - Groundwater

Construction and water management during construction of the infiltration lagoons and details of the UML back drain upon restoration.

HCC Condition 26 – Groundwater Management Plan

Prepare and submit a GWMMP, to include:

- Surface water and groundwater monitoring locations, sampling and analysis plan and reporting timetable
- Locations of 4 existing and 2 proposed monitoring wells for long term monitoring

In respect of Phase A

- Details of lagoon water management and a mechanism for review
- A method to establish statistical confidence of laboratory results which are relied upon as trigger levels, validation procedures, non-detects and arrangements for informing stakeholders and an escalation process

HCC Condition 27 – Groundwater Management Plan – Phasing

Prior to LMH mineral extraction in each phase, prepare and submit to the MPA a phase specific GWMMP to include new data arising for the site, existing and phase specific borehole data, chalk elevation and groundwater monitoring data.

HCC Condition 28 – Groundwater Management – Action Plan

Develop and submit for approval an action plan and programme should bromate exceed the $2\mu\text{g/l}^{-1}$ trigger level at a stated confidence level, in the LMH in the active phase.

HCC Condition 29 – Groundwater Monitoring – Response Plan

Develop and submit for approval a response plan should bromate exceed the $5\mu\text{g/l}^{-1}$ trigger level at a stated confidence level, in the LMH in the active phase. LMH excavation will cease until the MPA approve the response plan.

HCC Condition 31

No pumping of groundwater from the LMA within any part of the mineral working.

HCC Condition 37 – Water Management Plan

Prior to commencement, develop and submit for approval a phase-specific water management plan to the MPA. The plan shall detail water management procedures and processes associated with lagoon operation and a mechanism for periodic review (this topic is also included in Condition 26).

HCC Condition 61 – Groundwater Protection

No solid matter to be deposited into or is likely to be deposited into a surface water course.

HCC Condition 62 – Discharge of groundwater to surface water Courses

A condition related to prior approval by the MPA of any water discharge to other storage facilities or any ordinary water course.

1.3 GWMMP Structure

This GWMMP includes the following sections:

1.3.1 Introduction

A historical background to the Hatfield Road Quarry GWMMP.

1.3.2 Physical Environment

A brief description of the site's physical environment (geology, hydrogeology) together with groundwater quality data relating to bromate and bromide.

1.3.3 Bromate Management Plan

This section is subdivided into 5 subsections:

- A pre-commencement investigation to assess the presence/absence of bromate in phase specific locations, plus additional perimeter monitoring wells previously agreed with Affinity.
- Pre-commencement commitment to develop a phase specific GWMMP in advance of working each phase, which is to be agreed in writing by the MPA before works begin.
- A methodology for statistical analysis of existing bromate concentrations for assessing statistically significant bromate concentrations for comparison with trigger values requiring action and response plans to be developed.
- A commitment to no pumping of groundwater from the LMA at the mineral site
- Regular performance and operational review meetings with the MPA, EA, Affinity, and Brett

1.3.4 Operational Plan

An operational summary that describes the:

- Purpose of the lagoons and their design and construction
- River Nast culvert relocation
- UMH buttress design, drainage, and mineral extraction
- LMH mineral excavation scenarios and wet working method
- LMH and UMH Backfilling and Reinstatement
- Mineral processing water demand
- Operational water management – sources and volumes
- Lagoon discharge management
- Restoration Phase water management

1.3.5 Monitoring Plan

- A detailed description of purpose and objectives, sampling schedules and laboratory analysis plan (frequency, testing suites, detection levels)
- Reporting programme and contingency actions

1.3.6 Notes on Drawings

Drawing 1 – UMA piezometric surface for April 2021 representing a seasonal high groundwater level in the UMA. It also depicts the monitoring wells (existing and proposed) that will be routinely monitored in accordance with permit requirements and additional wells for the UMA. The drawing also makes note of that will be used to replace existing wells

Drawing 2 – As Drawing 1 but for a period of low seasonal UMA water levels.

Drawing 3 – UMA piezometric surface for April 2021 representing a seasonal high groundwater level in the LMA. It also depicts the monitoring wells (existing and proposed) that will be routinely monitored in accordance with permit requirements and additional wells for the LMA.

Drawing 4 – As Drawing 3, but applies to Chalk aquifer

Drawing 5 – Regional Affinity abstraction wells and source protection zones. Provides context for the rigger and action level discussions.

Drawing 6 – Chalk aquifer, most recent (January 2022) groundwater sampling data for bromate during a high groundwater level period.

Drawing 7 – As Drawing 6, but for the LMA

Drawing 8 – shows the proposed locations for 8 temporary phase-specific monitoring wells to determine the presence/absence of bromate and its significance in relation to trigger concentrations, and 2 permanent monitoring wells located outside of Phase A and C to provide greater definition of bromate presence/absence once wells in the phases 1, 2 and 3 are permanently destroyed.

Drawing 9 – shows the location and design footprint of the proposed UML and LML, together with a cross sectional profile of the excavations

Drawing 10 – shows the seasonal variation of groundwater levels in all geological units

Drawing 11 – presents the typical buttress design sections for the lagoons and the perimeter buttress

Drawing 12 - Post restoration plan for the entire site

2.0 Physical Environment

This section presents a brief introduction to the sites physical environment which draws from more detailed descriptions included in the 2021 ES Water chapter (ES paragraphs 6.25 – 6.33, 6.34 – 6.61, 6.60 – 6.66)

2.1 Geology

The solid geology beneath the application site comprises undifferentiated Lewes Nodular Chalk Formation and Seaford Chalk Formation that dips to the south-east.

The superficial geology is the Lowestoft Formation comprising a sequence of glacial deposits including boulder clays and sands and gravels deposited in a paleo-valley cut into the Chalk.

The Lowestoft Formation comprises four units above the Chalk. These include an upper and lower granular formation (sands, gravels referred to as the Upper Mineral Horizon (UMH) and the Lower Mineral Horizon (LMH) respectively), separated by boulder clay, referred to as Interburden (IB). The geological sequence is summarised in **Table 2-1**. Site borehole logs are included in **Appendix G**.

Table 2-1
Geology and Groundwater Occurrence

Geological Unit	Description	Thickness	Groundwater
Overburden	Clayey, silty sand and gravels	0m – 2m	Variable and seasonally saturated by groundwater in the UMA
Upper Mineral Horizon (UMH)	Silty sands and gravels	1.7m – 6.7m	Upper Mineral Aquifer (UMA) (Perched on clay aquitard below)
Interburden (IB)	Boulder Clay (Stiff glacial clay)	3m – 4m	Aquitard (Barrier to groundwater flow)
Lower Mineral Horizon (LMH)	Sands and gravels	5m – 7m	Lower Mineral Aquifer (LMA) (Hydraulically connected with the underlying Chalk aquifer)
Chalk Bedrock (Lewes Nodular Chalk)	Weathered at its surface increasing competency with depth	Unproven thickness on site	Chalk Aquifer

2.2 Hydrogeology

2.2.1 Groundwater Occurrence and Flow

Groundwater in the UMA is a perched aquifer resting on the surface of the IB. Groundwater flow direction is general west to east but is more variable than the underlying chalk/LMA as the piezometric head is influenced by local recharge, interaction with surface water and the dip of the IB surface but is broadly towards the east-southeast (**Drawing 1** and **Drawing 2**).

The IB rests beneath the UMH and is laterally continuous across the application site. It is a barrier to vertical groundwater flow meaning there is no hydraulic connection between the LMA below the IB and the UMA above the IB. The groundwater levels are different with the UMA groundwater level being higher than the LMA.

The IB is underlain by the LMH which contains a vertically continuous water body with the underlying chalk. The piezometric surface of the Chalk/LMH aquifer rests in the LMH or sometimes in the overlying low permeability IB. When this occurs the IB acts as a confining layer to the Chalk/LMH aquifer. Groundwater levels vary seasonally by c.2m between the high level (typically April) and its low level (typically November).

The effective thickness of the combined Chalk/LMH aquifer is approximately 60 to 70m. The average thickness of the saturated LMH is 5.8m representing 8% to 9.6% of the combined aquifer thickness.

The groundwater flow direction in the chalk/LMA is from the northwest towards the southeast beneath the site (**Drawing 3 and Drawing 4**).

The application site is located within the Total Catchment Zone (SPZ3) and Outer Source Protection Zone (SPZ2) of two Public Water Supply (PWS) well fields: Bishops Rise in Hatfield – (HATF) located 1,500m south-east, and Roestock (ROES) located 2,200m south-south-east from the application site (**Drawing 5**).

2.3 Bromate Plume

2.3.1 Bromate Occurrence

The Chalk aquifer to the north and east of the Site is impacted by a bromate and bromide plume. The plume source has been traced to the former Steetley chemical works in Sandridge (now St Leonard's Court) approximately 2.6km northwest of the northern application boundary. As stated in Section 2.2.1 chalk groundwater also crosses the interface with the overlying LMH and as a result bromate is also found.

There is a difference in bromate concentration in groundwater in the chalk and in the overlying LMA with the LMA typically recording lower levels than in the chalk, although this varies locally in accordance with factors such as geological boundaries, seasonal fluctuation of groundwater levels and offsite abstraction well pumping.

The middle (core) of the bromate plume in the chalk and the LMA is located approximately 800m north-east of the eastern application boundary. The southwest edge of the plume is defined as 2ug/l bromate and broadly aligns with the site's northeast boundary (**Drawing 6 and Drawing 7**).

2.3.2 Bromate Remediation

Affinity has been operating a bromate plume scavenging (pump and treat system) at its HATF boreholes since 2005 located c.1,600m southeast of the application site (**Drawing 5**).

The objective of plume scavenging is to capture the bromate plume and reduce its impact on other hydraulically downgradient Public Water Supply (PWS) locations along the River Lea, in particular the Essendon PWS (ESSE). A second remedial objective is to reduce bromate mass in the groundwater.

Affinity's plume scavenging operations has been relatively continuous and at a stable discharge rate Since 2018, which appears to have achieved a balanced outcome of maximum sustainable plume capture to protect ESSE while reducing bromate mass and at a rate that can be treated before discharge.

2.4 Groundwater Pumping Test and Groundwater Abstraction Licence

A groundwater pumping test was carried out in 2018 to validate and refine previous assumptions and facilitate future assessment and design, and to support a licence application for:

UMA - groundwater transfer license for pumping from the UMA for dewatering purposes prior to mineral extraction, with the water returned to the UMA via the UML and/or the LML

LMH – groundwater transfer license to support LMH mineral excavation by lowering the groundwater level and discharging the water directly into the LML. This purpose is no longer required.

UMA – groundwater abstraction license from the UMA to support mineral washing, dust suppression and wheel washing

The pumping test report (SLR report ref: 402.01009.00226.01_v2, Sept 2018) is included in **Appendix B**.

An abstraction licence was applied for and issued following completion of the pumping test. Brett Aggregates Ltd Licence Serial No. TH039/0028/054 is active from 02/11/2018 to 31/03/2026 and is included in **Appendix C**.

3.0 Bromate Management

3.1 Post-Planning, Pre-Commencement Investigations

3.1.1 Phase Specific Monitoring Wells

In accordance with HCC draft conditions 26 and 27 and as set out by the Planning Inspector in Paragraph 55 of the Appeal Decision, Brett shall install phase-specific monitoring wells to support preparation of Phase specific GWMMP's. Phase-specific monitoring wells will be used to:

- Supplement existing data and prove elevations for the overburden, IB (upper surface and base) and the base of the LMH/top of the chalk in support of mineral extraction operations, and
- Provide access for monitoring groundwater levels in each phase which is a go/no-go decision on whether the LMH is workable, and
- Enable the monitoring of bromate, if any, in groundwater and determine whether Phases meet the requirements of trigger level compliance, at an appropriate confidence level.

Brett is proposing a total of 10 monitoring wells (2 monitoring wells per phase) to be installed in association with Phases A, B, C and D encompassing the initial c.16 years of operation and spanning the eastern half of the active mineral site (**Drawing 8**).

Each borehole will comprise a dual installation monitoring well screened in the UMA and the LMA. Each borehole shall also 'tag' the top of the chalk for depth/elevation purposes.

Brett also proposes two additional monitoring wells just beyond the northern (C-2) and southeast (A-1) mineral excavation perimeter. C-2 and A-1 will be permanent and will fill data gaps when phase-specific monitoring wells are decommissioned during progressive phase development.

Additional monitoring wells in Phase E, F and G may be added at suitable locations and times as working phases are gradually worked, filled, and closed but for now we wish to focus on the eastern side of the development.

3.1.2 Affinity Monitoring Wells

At the request of Affinity, Brett has agreed to install additional site perimeter monitoring wells at three site perimeter locations, also as shown on **Drawing 8**. These will also be drilled and installed as part of the post-planning, pre-commencement drilling programme.

- BH303 (UMH, LMH, Chalk) east of the UML
- BH304 (UMH, LMH, Chalk) east of the LML
- BH401 (LMH, Chalk) west of Phase E

3.1.3 Monitoring Schedule

The monitoring schedule for the pre-planning and commencement and the Affinity wells has been added to the site wide monitoring programme described in **Section 5** of this GWMMP and shown on **Table 5-1**.

Regular sampling is required in Phase A and B monitoring wells which will be sampled monthly for 1 year prior to commencing mineral extraction in the LMA, and only if the technical requirements spelt out in **Section 3.2** is met and approved in writing by the MPA. Phase C and D monitoring wells will be sampled quarterly during the same period, as well as the regular site-wide monitoring programme.

3.2 Bromate Concentrations and Trigger levels at 95% Confidence Level

Brett has been testing for bromate in groundwater in on-site and off-site monitoring wells in the chalk, LMA and the UMA since 2012. This report section presents the complete bromate dataset, on-site and offsite, including an interpretation of the plume location relative to the site, the range of concentrations recorded and how Brett will respond to future bromate detections should they occur.

Table 3-1 is a summary of Brett's bromate monitoring results between 2014 and 2022 for the LMA only. It is also divided by on-site and off-site monitoring wells. Laboratory analysis was carried out by Affinity Water. A statistical assessment of the data is presented below the sample data table.

Table 3-1
Bromate Concentrations in LMA Groundwater – Statistical Assessment

Sample Date	Bromate Concentrations - On-Site (ug/l)									Bromate Concentrations - Off-Site (ug/l)					
	BHG	BH101	BH102	BH103	BH104	BH106	BH107	BH301	BH302	BHB	BH201 L (S)	BH201 L (D)	BH108	BH105	BH305
Jun-14	ND	4.7	ND	ND	ND	ND	ND	ND		7.2	110	90	7.3	180	
Jul-14		ND			ND		ND			3.3	154.2	86.3	4.5	310.6	
Oct-14	ND	ND	ND	ND	2.1	ND	ND			13.3	120	86.5	4.8	278.6	
Jan-15	ND	ND	ND	ND	1.8	ND	ND			10.8	125.9	86	49	299.7	
Apr-15	ND	ND	ND	ND	0.9	0.6	ND			16.2	130.9	89.7	65.7	301.8	
Jul-15	ND	ND	ND	ND	1.9	ND	ND			18.6	112.3	76.1	1.4	265.4	
Oct-15	2.4	ND	ND	ND	1.9	ND				15	122	77	37.4	307.2	
Jan-16	ND	ND	ND	ND	ND	ND				17	118	65	0.25	199.9	
Apr-16	ND	ND	ND	ND	ND	ND	ND			16.8	129.9	81.8	57.5	298.3	
Aug-16	ND	ND	ND	ND	1.5	ND				17.8	118.8	76.9	41.4	276.9	
Nov-16	ND	ND	ND	ND	0.8	ND		3.3	ND	25.3	116.3	83.6	40.9	271.5	557.4
Feb-17				ND	ND	ND		ND	ND	0.25	112.3		20.4	0.25	
May-17		ND		ND	ND	ND	ND	ND	ND	23.4	78.2	ND	22.4	247.8	579.4
Aug-17		ND		ND	ND	ND		ND	ND	27.6	86.2		0.25	186.4	653.3
Nov-17	ND	ND	ND	ND	ND	ND		ND	ND	29.3	106.5		19.2	238	623.1
Feb-18		ND	ND	ND	ND	5.3		ND	3.5	25.2	103.2		0.25	232.7	608.9
May-18	ND	ND	ND	ND	ND	ND	ND	ND	0.5	28	110.2	76.2	0.25	235.9	454.3
Aug-18	ND	ND		ND	0.6	ND		0.7	0.5	24.1	170.2	84.1	0.25	104	560.3
Nov-18	ND	ND	ND	ND	0.8	ND		ND	0.5	10.1	96.4		1.3	240.3	602.6
Feb-19	ND	ND	ND	ND	ND	ND		ND	ND	13.9	92.6		0.25	233.8	563.1
May-19	ND	ND	ND	ND	1.1	ND		ND	ND	23.3	81.4		18.7	210.9	531.3
Aug-19	ND	ND	ND	ND	1.5	ND		1.1	ND	23.1	40.8		20.9	74.5	495.9
Nov-19	ND	ND	ND	ND	1.2	ND		ND	ND	24.2	75.4		22.5	101.2	516.8
Aug-20				ND	1.7	ND		ND	ND	16.6	77.9		28.6	98.2	487.3
Apr-21	ND	ND	ND	ND	0.7	ND	ND	ND	ND	17.2	0.15		60.9	178.7	468.4
Jan-22	ND	ND	ND	0.5	0.7	1.1	ND	0.5	0.7	12.7	77.4		43.3	157.8	404.9
Samples	20	24	20	25	26	25	8	16	16	26	26	13	26	26	15
Maximum	2.40	4.70	0.25	0.50	2.10	5.30	0.25	3.30	3.50	29.30	170.20	90.00	65.70	310.60	653.30
Upper Quartile	0.25	0.25	0.25	0.25	1.43	0.25	0.25	0.31	0.50	23.93	119.70	86.30	40.03	275.55	591.00
Median	0.25	0.25	0.25	0.25	0.70	0.25	0.25	0.25	0.25	17.10	110.10	83.60	19.80	234.85	557.40
Lower Quartile	0.25	0.25	0.25	0.25	0.25	0.25	0.23	0.25	0.25	13.45	82.60	76.90	1.33	179.03	491.60
Minimum	0.15	0.15	0.15	0.15	0.25	0.15	0.15	0.15	0.15	0.25	0.15	65.00	0.25	0.25	404.90
Critical Conc	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Mean	0.35	0.43	0.24	0.25	0.84	0.49	0.23	0.53	0.52	17.70	102.58	81.48	21.91	212.71	540.47
Std Deviation	0.48	0.91	0.03	0.06	0.65	1.02	0.05	0.78	0.81	7.56	33.92	7.01	21.37	81.92	69.32
IQR	0.00	0.00	0.00	0.00	1.18	0.00	0.03	0.06	0.25	10.48	37.10	9.40	38.70	96.53	99.40
95% conf															
Upper	0.57	0.81	0.25	0.28	1.11	0.91	0.26	0.94	0.95	20.75	116.28	85.71	30.54	245.79	578.85
Lower	0.12	0.04	0.23	0.23	0.58	0.07	0.19	0.11	0.08	14.65	88.88	77.24	13.28	179.62	502.08

Note: ND represents a Non-Detect at the laboratory detection limit for bromate.

Laboratory detection limits have changed over time. Between 2014 and November 2019 the detection limit was 0.5ug/l whereas from August 2020 the detection level was reduced to 0.3ug/l.

When undertaking statistical data analysis (**lower half of Table 3-1**), values for non-detections were assumed to be half of the laboratory detection limit (i.e., 0.25ug/l or 0.15ug/l depending on date), which is reflected in the values in the statistical section of the table.

3.2.1 LMA Plume Boundary

The lateral extent of the bromate plume in the chalk and the LMH is discussed in **Section 2.3.1**. The interpreted boundary of the plume in the LMA is shown on **Drawing 6**.

3.2.2 Bromate Trigger Levels

The Environment Agency has stated that *“For the purpose of practicable regulation of the existing CEMEX Hatfield Quarry we have taken the position that bromate concentrations of concern in groundwater are ≥ 2 ug/l (0.002mg/l) and that it was consistent to apply this definition to neighbouring planning and permit applications for mineral extraction and landfill”* (**Environment Agency letter to HCC, 18/12/2019, Ref NE/2016/124652/05-L01**). Brett therefore interpret the edge of the bromate plume to be represented by a concentration of 2ug/l.

Trigger levels were discussed at length in the 2021 Appeal and are the topics addressed in HCC Condition 28 and 29 as set out below.

Groundwater Management – Action Plan

28. In the event that monitoring results indicate that bromate concentrations in the LMH extraction phase exceed the trigger level of $2\mu\text{g/l}^{-1}$ at the confidence level in the approved GWMMP, then an action plan (that should detail further assessment of groundwater levels and chemistry) and programme to reduce the levels below $2\mu\text{g/l}^{-1}$ including a timetable for implementation shall be submitted for approval of the MPA. The action plan shall be implemented as approved.

Groundwater Monitoring – Response Plan

29. In the event that monitoring results indicate that bromate concentrations in the current LMH extraction phase exceed the trigger level of $5\mu\text{g/l}^{-1}$ at the confidence level in the approved GWMMP, then a response plan shall be submitted for the approval of the MPA. Lower Mineral Horizon excavation shall cease until the MPA has approved a response plan. The response plan shall be implemented as approved.

Brett shall comply with Affinity Water Conditions 28 and 29.

3.2.3 Laboratory Analysis

Brett has historically contracted Affinity Water plc laboratory to undertake its bromate and bromide water sample analysis and hopes to continue this relationship going forward. Affinity currently provides a bromate reporting limit of 0.3ug/l.

Considering the importance of proposed response and action levels described further in **Section 3.2.5 and 3.2.6** it is important that data can be validated so Brett will look to Affinity for the development of a suitable laboratory QA\QC reporting package.

3.2.4 Statistical Confidence Level

A 95% confidence interval is a range with an upper and lower value calculated from a set of samples. The range describes possible values that the mean value could be. The wider the range the less confident we are that a concentration statistically varies from the mean. Factors affecting the width of the confidence interval are sample size and variability in the sample.

In this case, we wish to determine whether a sample concentration in an active phase is statistically less than or greater than the proposed bromate trigger values of 2ug/l and 5ug/l at the stated confidence level.

Trigger values are to be applied to active phases so we will develop a statistical baseline for each phase to assess trigger level compliance. This will be achieved by installing phase-specific monitoring wells as stated in **Section 3.1.1** followed by regular monthly monitoring in order that seasonal variability can be evaluated.

3.2.5 2ug/l Trigger Exceedance - Action Plan and Programme

Bromate analysis data will undergo a review and data validation process:

- Field procedures – a review of the field sampling method and conditions, stabilisation of field parameters, samplers' notes
- Sample validation data – trip blanks and duplicate sample results
- Laboratory QA/QC - chain of custody review, sample handling and sample temperature on receipt, laboratory holding times and extraction, laboratory instrument calibration records

Assuming the data is valid, and the mean exceeds the 2ug/l trigger value at a 95% confidence level, Brett shall:

- Submit results to the MPA, the Agency and Affinity Water
- Re-sample the appropriate Phase monitoring wells, including duplicates and trip blank
- Validate 2nd sample data
- Enter bromate, bromide and other groundwater chemistry data into the groundwater chemistry data base; prepare Time-Concentration Plots for trend analysis; update groundwater hydrographs
- Prepare a brief interpretive status report including Action Plan

If the 2nd sample exceeds 2ug/l possible actions could include selective increase of sampling frequency, assess data in the light of seasonal trends and the groundwater level cycle.

3.2.6 5ug/l Trigger Exceedance - Response Plan and Programme

All bromate analysis data will undergo an initial review and data validation process as per the 2ug/l exceedance described in **Section 3.2.5**.

Assuming the data is valid and mean exceeds the 5ug/l trigger value at a 95% confidence level we shall initially adopt a similar assessment to that adopted for a 2ug/l exceedance, i.e.,

- Submit results to the MPA, Agency and Affinity Water
- Re-sample the appropriate Phase monitoring wells, including duplicates and trip blank
- Validate 2nd sample data
- Enter data into the groundwater chemistry data base, prepare Time-Concentration Plots for trend analysis, update groundwater hydrographs

In addition,

- Assess the local and regional context of the detection - Data will be reviewed in context with other bromate/bromide sampling data from the same sampling period – is it anomalous (an outlier); have similar rising concentration changes been observed in other monitoring wells; has the concentration been rising in previous sampling events and does the detection stand out or align with the wider plume location.

- Operational review: investigate on-site (Brett) and third-party (principally Affinity) operations leading up to the sampling event to determine whether a local or regional cause and effect can be determined in which case an action plan can be developed to mitigate the possible cause. Other third-party discussions may include the Agency and the MPA.
- Re-sample appropriate Phase monitoring wells, including duplicate analysis
- If the validated mean concentration exceeds 5ug/l trigger level at a 95% confidence level (i.e., the third consecutive >5ug/l detection) is recorded then an assessment of the possible cause and a response plan will be prepared and submitted to the MPA, the Agency and Affinity Water for review and agreement, during which time mineral extraction will be temporarily halted in the active phase.
- Stakeholders agree to fast-track their evaluation of the proposed response plan and enter into discussions with Brett on the next steps.

3.3 Adverse Impact on Bromate Remediation

The Planning Inspector (Paragraph 61) refers to an action/response plan ceasing mineral excavation from the LMH if bromate concentrations are breached, or there is evidence of interference with the remediation of bromate. He adds that mineral extraction will not recommence until the MPA (i.e., HCC) is satisfied, based on compelling evidence that excavation in the LMH can resume without any adverse effect on the remediation of the bromate plume.

The response described in **Section 3.2.5** and **Section 3.2.6** describes the proposed mechanism for addressing exceedance of the trigger levels.

Adverse interference with bromate remediation is an outcome that is not foreseen but if there is evidence for it occurring and is attributed to Brett operations, then mineral excavation in the LMH will temporarily cease until Brett undertakes further assessment and evaluation of the evidence and is able to demonstrate to the satisfaction of the MPA and other stakeholders that mineral excavation can recommence without adverse effect on the remediation of the plume.

There are a variety of response options such as changes to on-site operations, quantitative risk assessment and plume capture modelling.

3.4 Phase Specific Water Management Plan

HCC draft conditions 27 and 37 requires that a phase specific water management plan be produced in advance of the excavation of each phase, to be approved in writing by the MPA.

Planning a new phase of development will start between 1 and 2 years in advance of the works and will be planned in a manner that takes advantage of seasonal conditions, changes created by the preceding phase of work, types and quantities of available stockpiled materials and the commercial objectives for the site. Fundamental differences in the approach between phases are not expected but physical conditions will change, and this will require planning and adapting the method to fit the new situation.

Each phase of the site will undergo a detailed evaluation of ground and groundwater conditions based on previous investigations and the most current hydrogeological data including water levels, water quality, and lagoon performance data gathered from preceding phase of work, plus the time taken to achieve certain milestones in the development of each phase in the past. The time taken to prepare a new phase will start while the previous phase is still being worked.

Brett will prepare a phase specific Water Management Plan for the MPA's review and would expect the Performance Review meetings described in **Section 3.6** to be the forum for discussion and presenting the future development plans, followed by submission in writing for approval.

3.5 Groundwater Pumping from the Lower Mineral Horizon

In accordance with HCC draft condition 30 there will be no pumping of groundwater from the LMH within any part of the mineral working.

3.6 Performance Reviews and Progress Meetings

Careful management of all operational procedures is fundamental to the successful operation of the site and will require the understanding and integration of many environmental and operational factors. Examples include:

- Review of groundwater monitoring data collected during the pre-commencement phase of investigations and subsequent monitoring
- Developing a seasonally controlled operating plan that minimises as far as reasonably possible, the need to pump and discharge water
- Seasonal changes in groundwater levels and its impact on water discharge volumes from back drain flow and UMA dewatering requirements
- Third party influences such as Affinity pumping rates
- Lagoon performance with water level changes
- Operational factors such as siltation of lagoons and maintenance
- Water discharge changes due to product demand changes; and
- Site wide monitoring results for Bromate and Bromide and any other compounds of interest

The GWMMP is therefore unlikely to be static and as a result will be under constant internal review and amendment in response to findings.

Brett proposes 6 monthly review meetings to be attended by Brett, the Agency, the MPA and Affinity for the duration of the development to:

- Share any changes to the GWMMP, pre-commencement investigation data, operational statistics relating to the guiding principles listed above, and trigger, action, and response plans
- Monitor system performance:
 - water level changes
 - water volumes being pumped and discharged
 - lagoon performance
 - flow in the Nast
 - flow from back drains
 - water quality data; and
 - any local concerns or other environmental issues.

The frequency of these meetings will not be reduced unless all parties agree and additional meetings or sharing of data will occur as and when required to discuss any issues that arise, significant changes in monitoring results, or proposed significant changes to operational practice.

4.0 Operational Plan

The application site has been divided into seven mineral development phases (Phase A through Phase G), two water infiltration lagoons and a mineral stockpile and processing area. A site layout and phasing plan is illustrated on **Drawing 1** through **Drawing 8**, each Phase represents c. four years of mineral extraction.

4.1 Pre-Mineral Development Site Investigations

As described in **Section 3.1** Brett is proposing the installation of 8 groundwater monitoring wells within the mineral working areas starting with Phase A through D, plus 2 wells outside the mineral working area and the installation of 3 additional perimeter monitoring wells requested by Affinity.

The in-phase monitoring wells will be monitored for so long as they remain in place but will be gradually removed as mineral excavation and filling progresses. These monitoring wells will be used to assess bromate concentrations in accordance with the action and response plans described in **Section 3.2**.

Phases E, F and G will require additional monitoring wells, which Brett propose to install closer to their development period, and at a date to be agreed by the stakeholder group.

4.2 Water Infiltration Lagoons

Two water infiltration lagoons will be constructed on the hydraulically down gradient, northeast perimeter of the site (**Drawing 9**). The Upper Mineral Lagoon (UML) will only discharge water into the UMH, the Lower Mineral Lagoon (LML) will only discharge into the LMH, but both lagoons will only accept UMA groundwater and runoff from restored phases of the quarry until such time as the connection to the Nast is reinstated as part of the restoration scheme. Both lagoon locations are sited hydraulically down gradient of the mineral works for the respective aquifers.

The UML is the primary location for the infiltration of water originating from the UMA during the process of bund construction, perimeter back drain flow, control of incident rainfall entering the operational phase and runoff from the restored phases.

Continuous monitoring of UMA groundwater levels has been carried out since 2013 and records across 8 seasonal water level cycles indicate that maximums vary but typically occur between November and March.

In Chapter 6 of the 2021 ES, it is described how surface water ponding occurs adjacent to Home Covert directly north of the UML. This water should discharge into the Nast culvert beneath the former airfield but generally fails to do so for several reasons including blockage of the ditch/channel feeding the culvert and damage or collapse of the culvert over the years. This results in the ponding of surface water which is recorded on the hydrograph for BH104U as a local anomalous feature. This situation will be rectified as part of the proposed Nast drainage works and replacement culvert.

4.2.1 Lagoon Construction

Precise details of the construction and water management are subject to the methodology provided by the successful contractor who will undertake the work, although the proposed sequence of construction and an outline of the management of surface water and groundwater is given below.

Lower Mineral Lagoon

The LML will be constructed first and will be isolated from the surrounding UMH by the construction of an engineered clay buttress anchored into the IB. This will involve local dewatering of the UMH to allow the clay buttress to be constructed in a dry excavation, with water being recharged back into the UMH in an adjacent temporary infiltration area on the location of the UML. The clay buttress will be constructed in relatively small

sections to minimise the extent of dewatering of the UMA required to construct it and to manage the water volume being returned to the aquifer.

When the clay buttress is complete the UMH remaining within the perimeter of the clay buttress of the lagoon will be dewatered and the UMH extracted from the lagoon in a dry state.

The optimum seasonal period for working the UMH is June through November when natural UMA groundwater levels are at their lowest, which will further reduce dewatering requirements during this commencement phase.

The IB will be excavated down to its base where the excavation will stop as we intend exposing the LMH surface only and will not excavate the LMH. Based on historical groundwater monitoring data (**Drawing 10** - Hydrograph for BH106L) water levels in the LMA at the location of the LML rarely rise above the base of the IB (c. 66.5 mAOD). There will be no pumping of LMA groundwater so if groundwater rises above the IB then excavation will be temporarily halted until the water level naturally falls.

Upper Mineral Lagoon

The UMH lagoon will be constructed after the LMH Lagoon.

The UML will be isolated at its entire boundary by the construction of an engineered clay buttress anchored into the IB. This will involve local dewatering of the UMA to allow the clay buttress to be constructed in a dry excavation, with water being recharged back into the adjacent LMA. The clay buttress will be constructed in relatively small sections to minimise the extent of dewatering and to manage the water volume being returned to the LMA.

When the entire clay buttress is complete the overburden and unsaturated UMH within the perimeter of the clay buttress will be extracted from the lagoon area in a dry state. Once the lagoon is prepared some of the northern and all the eastern clay buttress will be removed to allow lateral hydraulic connection of the lagoon and the UMA east of the lagoon. The western, southern, and part of the northern buttress will remain in place.

A shallow engineered buttress will be installed from ground level to a depth of approximately 2m (74.5 mAOD) to prevent erosion of the overburden when the lagoon is operational.

The optimum seasonal period for working the UMH is June through November when natural UMA groundwater levels are at their lowest, which will further reduce the scale of dewatering during the commencement phase.

R. Nast Culvert

The backwall (western side) of the UML and the LML buttress will contain the re-routed River Nast culvert, which will have to be moved when the lagoons are constructed. The existing and proposed R. Nast route is described in additional detail in **Section 4.7.1.0**. **Drawings 1, 2, 3, 4, 6, 7, 8** all show the existing and proposed route of the R. Nast.

4.3 Phase Mineral Working Plan

The mineral working area is split into 7 phases (A-G) with each phase to be worked over c.4 operational years, and as such each phase will be divided into 4 operational areas.

Preparation for excavation will commence at least 2 years before commencement of mineral extraction operations. This allows time for gathering baseline statistical data, discharging the bromate trigger condition, and planning and preparing the Phase specific GWMMP for submittal and approval.

4.4 Upper Mineral Horizon

The UMH sits above the low permeability IB which is a perching layer for overlying groundwater in the UMA. The UMA will be dewatered inside each phase or sub-phase to allow the mineral to be worked dry.

The outer sidewall geological barrier/clay buttress will be constructed using standard engineering practice and will be subject to Construction Quality Assurance (i.e., specification, CQA Plan, independent supervision, and validation report).

4.4.1 UMH Outer Perimeter Buttress

Each phase will be constructed with an outer perimeter buttress as shown on **Drawing 11**. The outer perimeter buttress of the mineral development site will remain in place in perpetuity, whereas internal buttresses will be progressively removed, and materials reused as the phases are sequentially developed.

UMH Outer Buttress and Back Drain

The back drain will be constructed to manage the groundwater level and maintain the stability of the landfill perimeter buttress until site restoration. The drain shown on **Drawing 11** comprises a collection pipe and a granular blanket across the cut face of the UMH and partially the overburden.

The recorded UMA groundwater level will be reduced by c.1m by gravity flow and/or pumping and will discharge to the mineral processing area silt lagoons to provide mineral washing water with any excess transferred, after settlement, to the UML for recharge back into the UMA.

Drawing 11 does not refer to topographic levels in Ordnance Datum as it is intended to show design principles and the proportions of the different features, so is not to scale. Detailed construction drawings which reference Ordnance Datum will be prepared following granting of planning permission as part of the Specification and CQA Plan for construction.

4.4.2 UMH Internal Sidewall Buttress

A 4m - 10m wide sidewall geological barrier will be keyed into the underlying IB surface and will form a clay buttress around the perimeter of each phase. The engineered geological barrier will allow isolation of the UMA within each phase in order that it can be dewatered without drawing in water from the wider UMA allowing the UMH to be worked dry. Some internal sidewall buttresses will also be equipped with a back drain to temporarily maintain the groundwater level c. 1m below ground level as described in **Section 4.4.1**.

Groundwater abstracted from the UMA during the construction of each Phase and its subsequent operation will be transferred to the silt lagoons in the processing plant area to provide mineral washing water (under licence issued by the Agency). Water which is not required for mineral washing will be transferred into the UML where it will infiltrate back into the UMA outside of the mineral working area.

4.4.3 UMH Mineral Extraction

When groundwater levels are low dry mineral extraction will occur across the active phase. When the mineral is below the groundwater level then active pumping will dewater the UMA entirely or in localised sub-areas in order that dry UMH excavation can continue.

4.5 Lower Mineral Horizon

The LMH underlies the IB and is partially or fully saturated depending on seasonal precipitation and phase location. There are three hydrogeological/operational scenarios for each phase/sub-phase and a methodology for mineral extraction has been devised for two. The third scenario results in no LMH mineral extraction taking place.

4.5.1 Hydrogeological Scenarios and LMH Extraction

Assessment of hydrogeological conditions in and surrounding each sub-phase will be continuous and will be achieved using transducers to monitor water levels. At least 22 monitoring wells are currently designated for continuous monitoring which together with manual dipping of water levels will provide the site wide data required for planning and commencing LMH extraction.

Each phase will be worked for four years, so each phase will be divided into four annual working areas. Each sub-phase will be assessed according to the 3 hydrogeological scenarios listed below and a programme of work using a 'wet' campaign basis will be developed. The LMH will have been fully or partially worked and the IB surface exposed across the proposed active annual sub-phase. There will be no pumping of groundwater from the LMH during any of the hydrogeological scenarios.

LMH is Unconfined – piezometric surface is within the LMH

- The clay IB will be removed from above the LMH in small operating cells of c.100m x 30m in area
- The IB above the piezometric surface will be excavated and removed to stockpile for re-use in backfilling/restoration in a controlled manner and within designated areas of the active phase
- IB will be stored for re-use in backfilling / restoration,
- The exposed mineral will be excavated 'wet' using the dry surface of the mineral as an operating platform,
- At least 1m of LMH mineral will be left in place above the chalk surface,

LMH is Confined – piezometric surface rests within the IB horizon

- The clay IB will be removed from above the LMH in small operating cells of c.100m x 30m in area
- The IB above the piezometric surface will be excavated and removed to stockpile for re-use in backfilling/restoration
- With the equipment working from the remaining IB bench, the IB above the LMH will be removed in strips and placed to stockpile for re-use in backfilling / restoration,
- Simultaneously, mineral from the LMH will be excavated and placed to form a raised working bench above the surface of the water table which will be used as an operating platform for the wet extraction of the LMH.
- At least 1m of LMH mineral will remain in place above the chalk surface,

LMH is Confined – piezometric surface rests above the IB horizon.

- No removal of the IB or extraction of the LMH will take place when these conditions exist within an operational phase.

4.5.2 LMH Backfill

Backfilling of the LMH void will be undertaken using site won overburden and IB material only. The LMH void will be filled concurrently with the mineral extraction process in small areas as defined above and will self-consolidate when placed beneath the water. LMH mineral will be left in place if there is insufficient site won overburden and IB to backfill all the phases of the LMH.

Site won backfill will be placed in the LMH void until it is a minimum of 1m above the groundwater level or at the base of the IB, at which point it will form the subgrade for construction of the basal geological barrier for the inert landfill.

As the filling proceeds and given the hydraulic properties of the chalk/LMH aquifer any mounding of the groundwater surface created by the infilling process will be slight and short-lived.

4.5.3 Geological Barrier Placement

The subgrade will be prepared, and the geological barrier constructed using standard engineering techniques and will be subject to Construction Quality Assurance (i.e., specification, CQA Plan, independent supervision, and validation report). The basal geological barrier will in essence reinstate the IB layer separating the UMH from the LMH, which together with the sidewall geological barrier will form a continuous engineered seal across each phase and the entire site.

4.5.4 UMH Backfilling

Once each area is lined, inert waste can then be placed into the void above the basal geological barrier and adjacent to the sidewall geological barrier/UMH perimeter buttresses.

The site will be restored with subsoil and topsoil to a similar level as the unworked site in accordance with the approved restoration plan.

4.6 Mineral Processing

Mineral processing will occur in the site area north of the active mineral extraction area. Operations will require a water supply for the washing of mineral to remove silt and fines and grading of mineral:

- 3 lined mineral lagoons will be constructed to remove silt and fines
 - Lagoon 1 – active mineral washing
 - Lagoon 2 – undergoing de-silting
 - Lagoon 3 – maintain the water reservoir for supply to lagoon 1 and 2

Other support activities on site that require a water include:

- Dust suppression
- Vehicle wheel wash

4.6.1 Water Demand Estimates

- | | |
|----------------------------------|-----------------------------|
| • Annual initial fill of lagoons | 40,500m ³ /annum |
| • Mineral processing (washing) | 270m ³ /d |
| • Dust suppression | 100m ³ /d |
| • Vehicle wheel wash | 50m ³ /d |

4.6.2 Water Sources

The water demand listed above will provided from two site sources:

- UMA - back drain flow, dewatering the UMA in the active phase and maintenance pumping of precipitation in the active phase, and

- UMA groundwater supply well inside the mineral working area. Brett has an abstraction license and a transfer license for these activities (Abstraction license TH/039/0028/054, Transfer license TH/039/0028/051)

The water provided by the back drain, dewatering and maintenance pumping from the UMA will be the primary source of supply, supported by an abstraction borehole in the UMA, for which there is already a license.

4.7 Operational Water Management

4.7.1 Water Discharge Sources

The water sources to be managed on the site when the site is operational are listed in **Table 4-1**.

Table 4-1
Sources of Discharge

Source	Point of Discharge (UMA & LMA via lagoons)	
	UML	LML
1. Incident rainfall and runoff	Yes	Yes
2. Dewatering discharge from the UMH (if not used for mineral processing)	Yes	Yes
3. Discharge from back drain behind UMH clay buttresses (if not used for mineral processing)	Yes	Yes
4. River Nast (Existing and Proposed)	No	No

Incident rainfall and runoff

Rainfall and runoff from the mineral processing area will predominantly infiltrate into the ground in which case it will be incorporated into shallow UMA groundwater that could ultimately recharge the River Nast although not significantly. When diverted the River Nast will flow through the site via open ditch and culvert and will by-pass the lagoons ultimately discharging into the Ellenbrook, as existing (see points 5 and 6 below).

Rainfall and runoff within each individual UMH mineral development phase will be incorporated into the dewatering discharge from the UMA, which will be discharged to the UMA or via the UML into the LMA in accordance with conditions described in **Section 4.7.3, Point 3**.

Runoff from each of the restored phases will drain to the UML, which will be discharged to the UMA or via the UML into the LMA again in accordance with conditions described in **Section 4.7.3, Point 3**.

Dewatering discharge from the UMH

Groundwater pumped from the UMA during dewatering in each phase will be transferred by overland pipeline and discharged to the silt lagoons in the mineral processing area to provide mineral washing water. Any excess to this requirement will instead be transferred to the UML.

Discharge from back drain behind clay buttresses in UMH

Groundwater captured by the perimeter back drain will be transferred from pumping stations by overland pipe and discharged to the silt lagoons in the mineral processing area to provide mineral washing water; again, any excess to this requirement will instead be pumped to the UMA or the LMA via the UML and/or LML.

Existing Nast

The Nast is an ephemeral stream which has been recorded to flow between approximately January and April although only five times in the last 9 years (2014, 15, 16, 20, 21 with no-flow in 17, 18, 19, 22). It is approximately 1m wide and 0.4m deep and flow is only recorded when the upper mineral water table reaches the invert level of the ditch i.e., c. 0.4mbgl.

Flow in the ditch rises near the northwest site boundary with CEMEX Hatfield Quarry. When flow occurs, it connects to a network of local shallow ditches for storage and enhanced infiltration across the area reserved for Brett's processing plant. The Nast follows a straightened route towards Home Covert Wood where it joins with the Home Covert ditch into which CEMEX seasonally discharge surface water.

The combined flow should enter a culvert that passes beneath the former Hatfield Aerodrome runway and the University playing fields, however, a lack of drainage maintenance results in surface water backing up near the confluence of the Nast and the Home Covert ditch and has recently causing localised surface water flooding during some winter months.

Diverted River Nast

The current route of the Nast passes through the proposed mineral processing area for the site, so to facilitate plant construction it will be re-routed along the northern site boundary towards Home Covert Wood and then south along the western side of Home Covert wood.

The diverted Nast will flow in a culvert and will combine with Home Covert ditch after which the combined flow will enter a replacement culvert constructed within the engineered buttress between the infiltration lagoons and operational Phases A and B. It then follows its existing route under the University playing fields to the road ditch on the Hatfield – St Albans Road. This diverted route for the River Nast is not substantially different to that existing today and as experienced in the past, we expect flow in the Nast to be seasonal.

The infrastructure built for the Nast diversion will not be used for transfer of pumped UMA groundwater.

4.7.2 Estimated Water Discharge Volumes

Detailed design of the lagoons will ensure they have capacity to manage the predicted volumes of water and to recharge water back into the UMA and LMA during the operational phase. Details of the geology and the range of groundwater levels for each phase, and the estimated water discharge volume calculations and infiltration capacity are presented in **Appendix D** and summarised in **Table 4-2**. Several analytical approaches have been applied to the water management scenarios. The values presented in **Table 4-2** are at the conservative end of the range.

Table 4-2
Summary of Predicted Operational Water Volumes

Source of Water	Approximate Volumes (m3/day)	Discharge Location
Dewatering discharge for UMH clay buttress construction	Up to 350	Mineral Washing Lagoon and/or UMH Lagoon (LMH Lagoon if required)
Back drain flow	110 - 360	
UMH groundwater and daily average rainfall (based on an annual average rainfall) in each phase	110 -150	
Back-drain discharge from restored site (open external ditch along Phase E and G)	Up to 450	UMH Lagoon (enlarged to include footprint of LMH Lagoon)

Source of Water	Approximate Volumes (m3/day)	Discharge Location
Total estimated discharge to Mineral Washing Lagoon or UMH Lagoon	1,100 – 1,800	Mineral Washing Lagoon or UMH Lagoon
UMH Lagoon Infiltration Capacity	300 – 3,300m ³ /day	
LMH Lagoon Infiltration Capacity	1,200 – 7,200m ³ /day	
UMH Restoration Lagoon Storage Capacity	91,000 (Winter) - 165,000m ³ (Summer)	
UMH Restoration Lagoon Infiltration Capacity	475 – 8,640m ³ /d	

4.7.3 Lagoon Discharge Management

As described in **Section 4.7.1** the UML is designed to accept pumped groundwater from the UMH. The following principles will manage the lagoon discharge:

1. The three water discharge sources (Back drain, dewatering for buttress construction, UMH groundwater control in operational phase) are all manually controlled by pumps; there will be no automatic or uncontrolled discharges into the UML
2. Groundwater from the UMH will be discharged to the silt lagoons in the mineral processing area, and into the UML
3. In exceptional circumstances groundwater from the UMA, rainfall and runoff may be discharged into the LML via the UML only following water quality analysis and discussion within the regular review meetings or through on-line discussion with the stakeholder representatives depending on urgency. Authority to discharge will be provided by the Brett Managing Director
4. A manually operated spillway will be installed between the UML and LML at an elevation of **74.85m AOD** to allow water to discharge from the UML to the LML. The spillway will be locked in the closed position when not in use and will only be opened and used upon completion of the procedure described in item 3 above
5. Water levels will be continuously monitored in the UMA recharge lagoon using a pressure transducer and data logger system. The system will include telemetry and automatic alarms which will notify operational staff when pre-set maximum levels are reached
6. Water from the UML will only be released when the approvals described in Point 3 above are satisfied
7. If the pre-determined maximum water level in the LML is reached (74.85m AOD) all pumping will stop until water levels fall. Water levels in the lagoons will be recorded continuously using transducers, with an alarm set if the maximum level is reached
8. A comprehensive programme of water level monitoring and water quality sampling is being implemented at the site. Further details are presented in **Section 5.0** of this document.

4.8 Restoration Phase Water Management

Details of the restored landform are shown on **Drawing 12**. The landform comprises a gentle easterly sloping surface with surface water ditches and pond features including the retained and enlarged UMA infiltration lagoon.

Water Discharge Sources

Once the site is restored no pumping of groundwater in the UMH will take place, the dewatering discharge from the UMA will stop and back drains on the outside of the clay buttresses will no longer be required although will remain in situ.

Water sources to be managed on the restored site include:

1. Shallow UMA groundwater from the west and northwest of the site which will be diverted around the site due to the nature of geological barrier and inert material used to fill the site
2. Incident rainfall and runoff
3. River Nast.

Western Back Drain

A back-drain comprising a 500mm deep open channel will be constructed on the western margin of the Phase D and E perimeter buttress (**Drawing 12**). The function of the 'western back drain' is to intercept shallow groundwater during exceptionally wet periods when UMA groundwater levels have risen to near ground level.

The western back drain will slope north and south from its mid-point directing any flow along the outside of the northern and southern perimeter buttress. The northern and southern perimeter parts of the western back drain will extend east to the location where the restored ground elevation is 76mAOD at which point the back-drain channels will direct flow into swales leading to the interior of the site and onward to the enlarged recharge lagoon in the UMH. Runoff will then be re-infiltrated into the UML.

Surface Water Runoff

The greatest increase in surface water runoff from the proposed development will be during the restored phase as this will comprise the largest area of less permeable surface due to the underlying fill and restoration soils. Runoff will be directed to a network of swales, ditches, and pond features towards the enlarged UMLs where the water will be re-infiltrated into the UMA.

Preliminary modelling of the impact of a range of rainfall events varying in severity up to and including the 1% (1 in 100) AEP storm including an allowance for climate has been considered and is presented in the FRA included in **Appendix 6-9 of the ES**. This indicates that there is sufficient capacity in the Restored UMLs to fully retain the runoff from the restored quarry when the infiltration rate into the UMH and the attenuated outflow to the Nast is exceeded by the inflow.

River Nast

The alignment of the River Nast will not fundamentally change around the mineral processing site following restoration. The Nast will remain in its diverted form and will continue to discharge to the Ellenbrook.

4.8.1 UMA Infiltration Lagoon

Surface water runoff generated by the western back drain and from incident rainfall will be directed to the existing onsite UML and a reconfigured LML where water will be re-infiltrated into the UMA. Water levels in the lagoons can be expected to rise and fall with seasonal fluctuations in the UMA groundwater level.

The perimeter buttresses which during the operational phase impeded free and continuous discharge of water into and from the UMLs will be removed to allow lateral migration into the UMA. These works will be subject to CQA.

River Nast Exceedance Outfall

An outfall will be provided from the enlarged and restored UMLs into the Nast at the southeast boundary of the site to allow for management of groundwater and surface water should the inflow exceed the infiltration rate into the UMH. However, the discharge will be limited to the runoff that would arise from the undeveloped site in response to a 100% (1 in 1) AEP storm (the 'greenfield' runoff rate).

5.0 Monitoring Plan

This section describes the proposed groundwater and surface water monitoring plan for the site. This encompasses monitoring being proposed under draft planning conditions 26 and 30, itself reflecting the requirements of key stakeholders, but also

- the requirements associated with the Environmental Permit (EB3808HD) for inert landfilling in the UMH, and
- some additional monitoring, principally off site, volunteered by Brett in support of the wider Operational Plan

5.1 Monitoring Purpose and Objectives

The purpose of monitoring links to several statutory and planning requirements including:

- Protecting controlled waters throughout the mineral extraction and the landfilling phases to ensure there is no deleterious impact to groundwater quality in accordance with Policy 16 (Soil, Air and Water) of the Hertfordshire Waste Core Strategy 2012.
- Meeting requirements of the National Planning Policy Framework¹ (NPPF, Paragraph 143) to ensure that the development will not have an unacceptable impact on flood risk or on the flow and quality of surface water and groundwater.
- Demonstrating that the site will be compliant with the Environmental Permitting Regulations 2016 which require that certain substances (Hazardous Substances) will not be discharged from the landfill to groundwater such that they are discernible, and that the discharge of other substances (Non-Hazardous Pollutants) is limited “so as to prevent pollution”. A hydrogeological risk assessment (HRA) was undertaken to accompany the application for an environmental permit for the site which included ‘requisite surveillance’, i.e., proposals for the monitoring of groundwater and surface water level and quality.

It is also the objective of this plan to provide data to Affinity who are actively capturing the bromate plume by pumping from a scavenging well field.

This Monitoring Plan is based upon the monitoring proposals presented in the HRA, but the proposals have also been extended to include:

- Monitoring of impact during the extraction phase, including the construction and operation of the infiltration lagoons, and
- Monitoring of pre-existing contaminants including bromate, bromide and other compounds not related to the mineral development.

5.2 Monitoring Locations and Sampling Schedule

The locations of the monitoring points and their respective monitoring zones (UMA, LMA, Chalk, Surface Water, Lagoons) are shown on **Drawings 1 to 4**. The drawings show the August 2019 and April 2021 groundwater piezometric surface level contours for each respective aquifer unit so the reader can determine whether the monitoring location is up, -cross or down-gradient relative to the site and its operational areas for low and high groundwater levels, respectively.

¹ Department for Communities and Local Government (2012, updated 2021). National Planning Policy Framework.

Each monitoring well and geological zone, and surface water monitoring point is summarised in **Table 5-1** together with the proposed laboratory analysis suite to be undertaken, the sampling frequency (monthly, quarterly, other) and the frequency and method of water level recording monthly or quarterly by the default manual dip method or hourly by dedicated logger.

Borehole logs for each of the monitoring wells are provided in Appendix 06. Boreholes BH303, BH304 and BH401 are due to be installed upon planning approval.

5.3 Water Level Monitoring

The method and frequency of water level monitoring depends on the location and purpose of the well. The default regime applicable to most boreholes is that water levels are dipped manually on a quarterly basis and the borehole base dipped annually.

Groundwater levels in monitoring wells being sampled monthly will also be dipped at the time of sampling.

Several boreholes are already fitted with data loggers set to record water levels on an hourly basis that is subsequently validated by manual monitoring. The data will be downloaded monthly.

The infiltration lagoons and other operations-critical monitoring wells will also be equipped with water level loggers, and some with telemetry links for real-time data analysis. It may be necessary to install a shallow stilling well within the LML because the water level is typically below the base of the IB.

The monitoring wells to be equipped with loggers are listed in **Table 5-1** but the wells to be equipped with real-time telemetry systems will be decided in consultation with the MPA, Affinity and the Agency. This data will also be reported quarterly in graphical form.

Table 5-1
Groundwater and Surface Water Monitoring Plan

MONITORING WELL	LANDFILL PERMIT	ADDITIONAL	LOCATION RELATIVE TO GROUNDWATER FLOW DIRECTION	WATER LEVEL MONITORING REGIME ²					WATER SAMPLING & ANALYSIS					
				WATER	WATER	BASE	BASE	LOGGER	SUITE 1		SUITE 2	SUITE 3	SUITE 4	SUITE 5
									M	Q	A	M	H	M
UMA ¹														
BHA			Down gradient of lagoons and extraction area		✓	✓				✓		✓		✓ VOCs
BHE* ^a			Down gradient of extraction area		✓	✓						✓		
BHJ* ^b			Down gradient of extraction area		✓	✓						✓		
BH101U			Down gradient of extraction area	✓		✓					✓		✓	
BH102U			Up gradient of extraction area	✓		✓		✓			✓	✓		
BH103U			Cross-gradient of extraction area		✓	✓				✓		✓		
BH104U			Cross-gradient of extraction area		✓	✓		✓		✓		✓		
BH105UX			Cross gradient		✓	✓				✓				
BH106U			Down gradient of extraction area	✓		✓		✓			✓		✓	
BH108U			Cross gradient		✓	✓				✓				
BH306U			Cross gradient		✓	✓				✓				✓ VOCs
BH307U			Cross gradient		✓	✓				✓				
BH303U ³			Down gradient of UML	✓		✓		✓	✓			✓		
BH304U ³			Down gradient of UML	✓		✓			✓			✓		
BH401U ³			Up gradient		✓	✓					✓		✓	
GMW102			Up gradient											
GMW103			Up gradient	✓		✓					✓		✓	
GMW103L			Up gradient		✓	✓							✓	✓ Metals
GMW104			Up gradient		✓	✓								
GMW105			Up gradient		✓	✓							✓	✓ Metals
GMW106			Up gradient											
GMW107			Up gradient		✓	✓							✓	✓ Metals
GMW108			Up gradient											
GMW109			Up gradient		✓	✓							✓	✓ Metals
A1			Pre-Phase Development Monitoring (permanent)						✓					
A2, A3			Pre-Phase Development Monitoring	✓					✓					
B1, B2			Pre-Phase Development Monitoring	✓					✓					
C1			Pre-Phase Development Monitoring (permanent)	✓						✓				

MONITORING WELL	LANDFILL PERMIT	ADDITIONAL	LOCATION RELATIVE TO GROUNDWATER FLOW DIRECTION	WATER LEVEL MONITORING REGIME ²					WATER SAMPLING & ANALYSIS					
				WATER	WATER	BASE	BASE	LOGGER	SUITE 1		SUITE 2	SUITE 3	SUITE 4	SUITE 5
				M	Q	A	M	H	M	Q	M	Q	Q	Q or 6M
C2, C3			Pre-Phase Development Monitoring	✓						✓				
D1, D2			Pre-Phase Development Monitoring	✓						✓				
UML			Infiltration lagoon					✓	✓			✓		
LMA¹														
BHB			Down gradient of extraction area		✓	✓			✓					
BHG			Up gradient of extraction area		✓	✓				✓				
BH101L			Down gradient of extraction area	✓		✓		✓			✓	✓		
BH102L			Up gradient of extraction area	✓		✓		✓			✓		✓	
BH103L			Up gradient of extraction area		✓	✓				✓		✓		
BH104L			Up gradient of extraction area		✓	✓			✓			✓		
BH106L			Down gradient of extraction area	✓		✓		✓	✓			✓		
BH303L ⁵			Down gradient of UM Lagoon	✓		✓			✓			✓		
BH304L ⁵			Down gradient of LM Lagoon	✓		✓		✓	✓			✓		
BH105L			Off site		✓	✓			✓					
BH108L			Off site		✓	✓								
BH201L(u) ⁴			Off site		✓	✓			✓					
BH201L(l) ⁴			Off site		✓	✓								
BH301L			Up gradient of mineral processing area		✓	✓			✓				✓	✓ Metals
BH302L			Up gradient of mineral processing area	✓		✓		✓			✓		✓	
BH305L			Off site		✓	✓								✓ Bromate 6M
BH401L ³			Up gradient	✓			✓	✓			✓		✓	
A1			Pre-Phase Development Monitoring (permanent)											
A2, A3			Pre-Phase Development Monitoring					✓	✓					
B1, B2			Pre-Phase Development Monitoring					✓	✓					
C1			Pre-Phase Development Monitoring (permanent)											
C2, C3			Pre-Phase Development Monitoring					✓		✓				
D1, D2			Pre-Phase Development Monitoring					✓		✓				
LML			Infiltration lagoon					✓	✓			✓		
CHALK¹														
BH101C			Down gradient of extraction area	✓			✓	✓			✓	✓		
BH102C			Up gradient of extraction area	✓			✓	✓			✓		✓	

MONITORING WELL	LANDFILL PERMIT	ADDITIONAL	LOCATION RELATIVE TO GROUNDWATER FLOW DIRECTION	WATER LEVEL MONITORING REGIME ²					WATER SAMPLING & ANALYSIS					
				WATER	WATER	BASE	BASE	LOGGER	SUITE 1		SUITE 2	SUITE 3	SUITE 4	SUITE 5
				M	Q	A	M	H	M	Q	M	Q	Q	Q or 6M
BH103C			Up gradient of extraction area		✓	✓				✓			✓	✓ Metals
BH104C			Up gradient of extraction area		✓	✓		✓	✓			✓		
BH106C			Down gradient of extraction area	✓			✓	✓			✓	✓		
BH105C			Off site		✓	✓			✓					
BH108C			Off site		✓	✓			✓					
BH301C			Up gradient of mineral processing area		✓	✓			✓				✓	✓ Metals
BH302C			Up gradient of mineral processing area	✓			✓	✓			✓		✓	
BH303C ³			Side gradient of mineral extraction area	✓		✓			✓			✓		
BH304C ³			Down gradient of LML	✓		✓		✓	✓			✓		
BH305C			Off site		✓	✓								✓ Bromate 6M
BH401C ³			Up gradient of extraction area	✓			✓	✓			✓		✓	
SURFACE WATERS														
SW1			R. Nast (up gradient)	✓		✓			✓			✓		
SW7a			R. Nast (down gradient) – Hatfield Road	✓		✓			✓			✓		
SW11			Discharge into site from Hatfield Quarry	✓		✓			✓			✓		

*a – BHE is in footprint of the perimeter bund and will be re-drilled to the southeast by the site boundary – landfill permit to be varied to reflect this

*b – BHJ is in the footprint of the perimeter bund and will be replaced by existing BHA – landfill permit to be varied to reflect this

¹ Flow direction in the UMH is west/northwest to east/southeast, and in the LMH & chalk is northwest to southeast (See Drawings 01, 02, 03)

² Basic water level monitoring regimes: quarterly manual dip to water level plus annual dip to base of borehole.

³ To be installed 2022

⁴ BH201 has 2 well screens installed in the LMA, they are separated by a clay horizon, but the purpose of screening was to assess whether there is a vertical concentration gradient for bromate in the granular aquifer.

P – Permit

M – Monthly

Q – Quarterly

A – Annual

H – Hourly

6M – Semi Annual (some shallow monitoring wells contain no groundwater during late Spring and Summer, so the decision to sample alternative locations is made locally by the Brett environmental team)

	Permit Wells/Surface Water
✓	Data logger installed since 2013
✓	Data Logger to be installed
	Additional voluntary monitoring wells

5.4 Laboratory Analysis

Table 5-2 describes the proposed laboratory testing rationale that has been built around the specific analyses referenced in Permit EB3808HD, draft planning conditions 26 and 30, site specific conditions such as the regional bromate plume and other local offsite issues. Five suites have been devised to simplify the implementation of the sampling programme.

Table 5-2
Groundwater and Surface Water Analysis Suites

Name	Description
SUITE 1	Watching brief on Bromate and Bromide undertaken on a monthly or quarterly basis depending on monitoring location
SUITE 2	Based on stakeholder consultation and to be undertaken monthly at key locations
SUITE 3	Comprehensive Permit testing suite, although excludes bromate and bromide (not associated with inert waste which the Permit regulates). As a minimum this suite of analysis will be undertaken on samples from the Permit wells.
SUITE 4	Subset of the Permit suite with the addition of bromate and bromide for general groundwater quality surveillance.
SUITE 5	Selected offsite wells northeast of the site where certain compounds have previously been detected

Table 5-3 lists the analyses proposed and indicates the testing proposed for each of the suites.

This sampling and testing pattern ensure a broad testing suite for Permit monitoring wells, as well as good site-wide testing outside of Permit requirements. There is complete cover for bromate and bromide in all LMA and Chalk aquifer monitoring wells, including offsite wells and a significant proportion of UMA monitoring wells. Any monitoring location where more than one suite is indicated means that the cumulative analysis is undertaken, however no parameter is duplicated.

Table 5-3
Groundwater and Surface Water Analysis Suites

PARAMETER	SUITE 1	SUITE 2	SUITE 3	SUITE 4	SUITE 5
Bromate & Bromide	✓	✓		✓	✓
Conductivity			✓	✓	
pH			✓	✓	
Ionic Balance			✓	✓	
Alkalinity			✓	✓	
Chloride			✓	✓	
Sulphate			✓	✓	
Nitrate			✓	✓	

PARAMETER	SUITE 1	SUITE 2	SUITE 3	SUITE 4	SUITE 5
Calcium			✓	✓	
Sodium			✓	✓	
Potassium			✓	✓	
Magnesium			✓	✓	
Fluoride			✓		
Ammoniacal Nitrogen			✓	✓	
TON			✓		
TOC			✓		
COD			✓		
BOD			✓		
Cadmium		✓	✓		✓ ²
Chromium		✓	✓		✓ ²
Copper		✓	✓		✓ ²
Iron		✓	✓		✓ ²
Lead		✓	✓		✓ ²
Manganese		✓	✓		✓ ²
Mercury		✓	✓		✓ ²
Nickel		✓	✓		✓ ²
Selenium		✓	✓		✓ ²
Zinc		✓	✓		✓ ²
Naphthalene			✓		
Phenol			✓		
TPH (DRO, GRO)		✓	✓ ¹	✓	
VOCs					✓ ²
SS (Surface Water only)			✓	✓	

Notes

- 1 Not specified in Permit but suggested addition
- 2 May only be tested in selected monitoring wells based on previous results

Laboratory limits of detection for all quality parameters are given in **Table 5-4**.

Table 5-4
Water Quality Laboratory Limits of Detection

Determinant	Units	Limit of Detection
Bromate/Bromide	mg/l	0.0003 (Bromate) & 0.005 (Bromide)
TPH (GRO/DRO)	ug/l	10
Chloride	mg/l	0.3
Sulphate	mg/l	0.5
Ammoniacal Nitrogen	mg/l	0.03 (accredited) 0.01 (Low level)
Total Alkalinity	mg/l	1
Magnesium	mg/l	0.1
Manganese	ug/l	2 (1.5 Low level method)
Potassium	mg/l	0.1
Iron	ug/l	20 (4.7 Low level method)
Chromium	ug/l	1.5 (0.2 Low level method)
Calcium	mg/l	0.1
Sodium	mg/l	0.1
Electrical Conductivity	uS/cm	2
pH	pH Units	0.01
Fluoride	mg/l	0.3
Phenol	mg/l	0.01
TON	mg/l	0.2
TOC	mg/l	2
COD	mg/l	7
BOD	mg/l	1
Lead	ug/l	0.4
Zinc	ug/l	1.5
Copper	ug/l	3
Cadmium	ug/l	0.03
Mercury	ug/l	0.5
Nickel	ug/l	1.3
Selenium	ug/l	1.2
Nitrate	mg/l	0.2
Naphthalene	ug/l	0.1
VOCs (GC/MS)	ug/l	0.1 to 3 (compound specific)
Suspended Solids	mg/l	20

Note: Detection limits are those from laboratories currently used: Affinity Water for bromate and bromide and Element Laboratory for all other determinants.

5.5 Monitoring and Reporting Programme

The proposed programme of monitoring and analysis will continue throughout the operational life of the site and for at least 3 years post closure or until all parties are satisfied that it may cease e.g., surrender of the landfill permit.

The scope of monitoring will be reviewed periodically and is likely to be much simplified following formal closure of the landfill and restoration of the whole quarry site. However, provision is made to continue the approved monitoring (i.e., permit requirements and this GWMP) for a period of 10 years post closure.

A baseline monitoring report will be submitted to the MPA after 12 months of sampling. This report will review the initial rounds of results and propose management control levels for bromate/bromide and TPH. Note, boreholes BH401, BH303 and BH304 will be installed once planning has been granted and therefore the 12 months of baseline monitoring will commence once they are installed with the baseline report available 3 months later.

The baseline report will be copied to the Agency and Affinity.

In accordance with the landfill permit an annual report will be submitted to the Agency presenting the data required by the permit and assessing compliance with the permit.

Field, data logger and laboratory data arising from this monitoring programme will be submitted to HCC, the Agency and Affinity on a quarterly basis in line with the permit reporting timescales.

5.6 Contingency Actions

Any action required by the inert landfill permit e.g., in response to a breach of a permit compliance limit, will be undertaken in accordance with the permit. It is therefore proposed to only consider contingency actions as part of this monitoring plan for the non-landfill related determinants.

Given the setting and the proposed operations at the site, bromate and bromide will be the key compounds to monitor and track. TPH is included because it comprises a suite of compounds that relate to petroleum hydrocarbons and could therefore be traced to site operations (trucks, excavators, generators, pumps, fuel storage etc.).

The site sits hydraulically down gradient of an adjacent landfill so water quality data recorded on site will be reviewed considering the water quality entering the site at its hydraulically up-gradient boundary.

- Response Plans and Action Plans in relation to bromate are addressed in **Section 3.2.5 and 3.2.6** and no further contingency actions are proposed.
- We propose setting management control levels for TPH. These are an internal management tool and are not used as regulatory compliance concentrations. The control levels will be borehole specific and will apply to key groundwater monitoring points of those listed in **Table 5-1** and will be based on the results from previous rounds of sampling, plus 20% to account for natural variation (water level change, season etc.). Control levels will be reviewed in the annual monitoring reports to ensure they consider current background conditions.
- If following the start of the development results exceed the control levels, additional validation samples will be taken from the affected borehole and may be extended to adjacent locations to determine if the detections are localised or more widespread.
- A review of operations in the period prior to the exceedance will be made and an assessment of the likely cause identified, and if appropriate mitigation measures will be implemented. Notification of the exceedance will be provided to the Agency, HCC, and Affinity within one week of the exceedance being identified through receipt of laboratory data. Detailed analytical results, an assessment of the cause of the exceedance and mitigation measures implemented will be sent to the Agency, HCC, and Affinity

within six weeks of the initial exceedance being recorded. Any changes to operational practice will be agreed with these parties should the nature and source of the contamination relate to on-site operations.

- If visible oils and grease are observed at any of the surface water monitoring locations an investigation will be undertaken immediately to identify the cause. If the cause is related to operations at the site corrective actions will be undertaken to stop the release. Measures will also be undertaken to contain the extent of the spill/leak using absorbent booms and similar equipment and to remove any free product from the surface water and dispose of it to a suitably permitted waste facility.
- The procedures outlined in the QHEST management system (**Appendix E**) for the reporting accidents, incidents and complaints and taking corrective actions will be complied with.

DRAWINGS

Drawing 1: Monitoring Well Plan, Piezometric Surface (UMH), Lagoons and Surface Water 04/2021
Drawing 2: Monitoring Well Plan, Piezometric Surface (UMH), Lagoons and Surface Water 08/2019
Drawing 3: Monitoring Well Plan, Piezometric Surface (LMH), 04/2021
Drawing 4: Monitoring Well Plan, Piezometric Surface (Chalk), 04/2021
Drawing 5: Affinity Water Catchment Plan
Drawing 6: Chalk Aquifer – Bromate Concentrations
Drawing 7: Lower Mineral Aquifer – Bromate Concentrations
Drawing 8: Proposed Phase Specific Monitoring Well Locations
Drawing 9: Lagoon Site Plan and Cross Section
Drawing 10: Groundwater Hydrographs
Drawing 11: Conceptual Lagoon & Buttress Design
Drawing 12: Restoration Plan

Drawing 1
Monitoring Well Plan and UMA Piezometric Surface – 04/2021

Drawing 2
Monitoring Well Plan and UMA Piezometric Surface – 08/2019

Drawing 3
Monitoring Well Plan and LMA Piezometric Surface – 04/2021

Drawing 4
Monitoring Well Plan and Chalk Piezometric Surface – 04/2021

Drawing 5
Affinity Water, Abstraction Borehole Capture Plan

Drawing 6

Chalk Aquifer – Bromate Plume Plan

Drawing 7

LMA – Bromate Plume Plan

Drawing 8

Proposed Phase-Specific Groundwater Monitoring Well Locations

Drawing 9

Lagoons Site Plan and Cross Section

Drawing 10
Groundwater Hydrographs (UMA, LMA, Chalk)

Drawing 11

Typical Buttress Design

Drawing 12

Restoration Plan

APPENDIX A1

Planning Conditions (Planning Inspector Report, 2021)

APPENDIX A2

HCC Draft Planning Conditions

APPENDIX B

Groundwater Pumping Test Report, September 2018

Document included separately

APPENDIX C

Groundwater Abstraction Licenses

APPENDIX D

Phase Plan, Cross Sections and Water Operating Plan

APPENDIX E

QHEST Management System

APPENDIX F

Borehole Logs and Monitoring Well Construction Details

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