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HYDROGEOLOGICAL RISK ASSESSMENT

BROCKLEY WOOD QUARRY INERT RECOVERY APPLICATION

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GENERAL NOTES

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1 INTRODUCTION

1.1 Report context

Brockley Wood Quarry (the site) is located approximately 2 kilometres (km) to the southwest of Ipswich and 1.4 km southwest of Belstead. The town of Capel St Mary is located 2.2 km southwest of the site. The National Grid Reference (NGR) for the approximate site centre is NGR TM 117 403, and the site location is shown on *Drawing 3777/HRA/01*.

Sand and gravel extraction will be undertaken in four phases and it is proposed to restore the voids using imported inert fill to achieve the final restoration landform.

This report sets out the Hydrogeological Risk Assessment (HRA) that has been prepared in support of the Bespoke Environmental Permit Application for restoration via an inert waste Deposit for Recovery (DfR) activity. The HRA has been prepared with due regard to the Environment Agency (EA) guidance on what to include in your HRA, published in January 2020 and updated 17th January 2024.

The proposed design of the site and background information regarding the site setting are provided within the Environmental Setting and Site Design (ESSD) report (Hafren Water, 3777/ESSD dated January 2026), which should be read in conjunction with this report.

1.2 Proposed operations

1.2.1 Extraction stage

Mineral extraction will be undertaken in four phases, in numerical order as shown in *Drawing 3777/HIA/02*.

Sand and gravel will be extracted to approximately 10 mbgl or at least 0.5 m above the watertable, whichever is higher. Groundwater elevations decrease from approximately 35.5 mAOD in the west of the site, near Phase 2, to 32 mAOD in the east of the site, near Phase 4.

Phases 1 to 3 will be located adjacent to each other, whereas Phase 4 will be located in the north of the site on the opposite side of a west-east oriented watercourse.

1.2.2 Restoration stage

The restoration will be undertaken concurrently with extraction, and will be achieved using placement of imported inert fill under a DfR scheme.

All waste will be placed above the watertable, hence groundwater control measures are not needed during infilling operations or post-restoration.

Raw mineral aggregate and imported inert waste will be stockpiled before processing and handled in accordance with the Waste Acceptance Procedures (WAP) (Ref: 1542/J05 December 2025) and will comply with Inert Waste Acceptance Criteria (WAC).

The waste codes that will be accepted at the site are provided in Table 3 of the ESSD.

It is considered that an Artificial Geological Barrier (AGB) will be required beneath the base and sides of the infill to prevent the fill material being placed directly against the residual sand and gravel deposit. The required design specification (permeability and thickness) of the AGB will be determined by the outcome of this HRA (see Section 3.6).

It is proposed to construct the AGB using filter cake generated from the proposed on-site mineral washing plant, which will process both site-derived virgin aggregate and imported inert waste for recycling. In addition, it is also proposed to use site-derived clay material (interburden) in the construction of the AGB.

There are no historic landfills or permitted waste sites in the vicinity of the site. The surrounding land use is primarily agriculture, however the A12 Road boarders the northeastern site boundary.

Due to local agricultural land use, it is possible that elevated concentrations of such chemicals as ammonium, phosphate and nitrate may be present in the groundwater in the vicinity of the site. The A12 may be a source of chloride and hydrocarbons, however much of this would be collected by the road drainage.

2 CONCEPTUAL SITE MODEL

2.1 General

The Conceptual Site Model (CSM) describes the likely source-pathway-receptor relationship for the proposed restoration scheme which forms the basis for the assessment of the impact of the scheme on the local water environment, in this case the groundwater beneath the site and surrounding water environment.

The baseline environmental information is provided in the ESSD (Hafren Water, 3777/ESSD).

The CSM is shown in plan form in *Drawing 3777/HRA/02* and a conceptual cross-section is provided on *Drawing 3777/HRA/03*.

2.2 Source

The inert waste material that will be imported into the site for recycling under the proposed DfR scheme represents the source of potential risk posed by the site that is considered in this HRA.

2.2.1 Quantity of infill

Phases 1, 2 and 3 are estimated to have a combined footprint of 220,132 m^2 and Phase 4 is estimated to have a footprint of 72,311 m^2. This equates to a total area of 29.2 hectares (ha). The depth of mineral extraction will be to a maximum of 10 mbgl or 0.5 m above the watertable, whichever is higher, therefore the maximum volume of fill that could be placed at the site is approximately 2.92 million cubic metres, although the construction of the AGB will reduce this capacity.

Assuming a 1 m thick barrier is required, the total volume of material necessary to construct the AGB is estimated as 333,249 m^3.

2.2.2 Chemical composition

Inert waste is defined as material which has a maximum amount of leachable solids for all the specified chemicals as given in *Table 3777/HRA/T1*, referred to as inert Waste Acceptance Criteria (WAC). The results as solids (mg/kg) represent the maximum leachable amount contained within 10 litres of eluate (water) and therefore the maximum leachable concentration per litre (mg/l) is one tenth of the solids value.

3777/HRA/T1: Inert Waste Acceptance Criteria		
Chemical	***Inert WAC****	***Maximum potential leachate concentration***
	mg/kg	*mg/l*
Antimony	*0.06*	*0.006*
Arsenic	*0.5*	*0.05*
Barium	*20*	*2*
Cadmium	*0.04*	*0.004*
Chromium	*0.5*	*0.05*
Copper	*2*	*0.2*
Mercury	*0.01*	*0.001*
Molybdenum	*0.5*	*0.05*
Nickel	*0.4*	*0.04*
Lead	*0.5*	*0.05*
Selenium	*0.1*	*0.01*
Zinc	*4*	*0.4*
Chloride	*800*	*80*
Fluoride	*10*	*1*
Sulphate as SO4	*1000*	*100*
Total Dissolved Solids	*4000*	*400*
Phenol Index	*1*	*0.1*
Dissolved Organic Carbon	*500*	*50*
Note: total soluble solids (mg/kg) from 1 kg of sample in 10 litres of leachability test eluate* *Note**: conversion to liquid concentrations (mg/l) derived from one tenth the inert WAC total solids*		

It should be remembered that, in reality, the chemical composition of any leachate contained within the site is expected to be at a significantly lower concentration for all chemicals than the maximum concentrations shown above. As such, the above source term is considered to be highly conservative.

The source term for the site is considered further in the risk assessment described in Section 3.5.2.

2.3 Pathway

It is considered that there are two principal potential contaminant migration pathways through which the site could have an impact on water environment receptors:

1. Vertical infiltration of rainfall into the imported material, potentially mobilising dissolved contaminants, and downwards through the underlying AGB, into the residual unsaturated sand and gravel beneath the site, to the watertable

2. Horizontal migration of contaminants dissolved in groundwater contained within the sand and gravel down the hydraulic gradient in the aquifer to a nearby receptor

The London Clay, underlying the sand and gravel and the site at a depth of around 21 mbgl, is considered to be a barrier to vertical flow, therefore it is considered that there is no viable groundwater flow pathway to the deeper Chalk aquifer. The presence of the London Clay therefore promotes horizontal groundwater flow within the saturated sand and gravel aquifer.

The sand and gravel deposit represents the primary potential pathway by which site-derived contamination can migrate into the surrounding water environment. The average saturated thickness of the sand and gravel is estimated to be 11 m based on the depth to the top of the London Clay recorded in BGS borehole records from near the site.

2.4 Receptors

The groundwater contained within the sand and gravel deposit is considered to be the primary receptor in this assessment, being both a Controlled Water, along with being a potential pathway to the down-gradient water environment.

Within the site, based on the relative elevation of the ground level and the watertable, it is considered that there is no hydraulic continuity between the two streams which cross the site flowing east and groundwater, ie the streams are fully supported by rainfall run-off.

It is considered that baseflow to the watercourse can only occur further east, approximately 270 m east from Phase 3. This watercourse flows into the Alton Reservoir approximately 2 km southeast of the site, which subsequently discharges into the River Stour Estuary. Therefore the watercourse east of the site is considered to be a secondary receptor.

The following potential receptors are therefore considered in this HRA:

1. Groundwater quality in the sand and gravel aquifer beneath the site
2. Groundwater quality at the unlicensed water abstraction located at Charity Farm located around 130 m east of the site
3. Surface water quality within the downgradient watercourse east of the site

Alton Reservoir and the Stour and Orwell Estuaries RAMSAR site are considered to be of sufficient distance from the site to preclude their representation as receptors in this assessment.

The SPZ 3 that the site is located within is considered to be associated with abstractions from the deeper Chalk aquifer. These abstractions are not considered to be receptors as the London Clay forms a barrier to the deeper groundwater system.

2.5 Summary of CSM

Identified receptors and pathways are summarised in *Table 3777/HRA/T2* below.

3777/HRA/T2: Summary of identified sources, receptors and pathways	
Source	Imported inert materials used to restore the site, conservatively assessed at the maximum theoretical concentration to simulate a worst case potential risk
Primary pathway	Vertical infiltration of rainfall into the imported material, downwards through the AGB and into the unsaturated sand and gravel to the watertable Horizontal migration through groundwater in the sand and gravel downgradient towards the watercourse east of the site
Primary receptor	Groundwater in the sand and gravel aquifer
Secondary receptor	Groundwater exploited by unlicensed abstraction at Charity Farm Watercourses adjacent to site
Compliance points	For hazardous substances – groundwater within the sand and gravel aquifer immediately adjacent to the site (ie at the down-gradient site boundary) For non-hazardous substances (pollutants) – the abstraction at Charity Farm and the confluence of the on-site watercourses downstream of the site

3 HYDROGEOLOGICAL RISK ASSESSMENT

3.1 Nature of the Hydrogeological Risk Assessment

EA guidance proposes a tiered approach to risk assessment such that the degree of effort and complexity reflects the potential risk posed by a particular site or situation, the sensitivity of the site setting and the degree of uncertainty and likelihood of the risk being realised. The following tiers of risk assessment have been undertaken:

- Tier 1 risk screening – to identify the degree of dilution in the underlying aquifer and to determine if an AGB is required to provide sufficient groundwater protection
- Tier 2 Generic Quantitative Risk Assessment (GQRA) – to assess the effect of an AGB on the degree of potential risk posed by the site

3.2 Methodology

The assessment has been undertaken using ESI's (now Stantec) Risk Assessment Model 3 (RAM3) in order to determine the specifications of the AGB to prevent pollution of the water environment from occurring, due to the restoration at the site under a permit for waste recovery.

One source has been modelled for Phases 1, 2 and 3, and a separate source has been included for Phase 4. This is due to the phases being separated by a watercourse. Additionally, a water supply borehole is located downgradient of Phase 4, whilst Phases 1, 2 and 3 are considered to provide baseflow to the watercourse at a point downgradient of the site. Hence modelling different sources allows the compliance points to be assessed individually. This is illustrated on *Drawings 3777/HRA/02* and *3777/HRA/03*.

3.3 Tier 1 risk screening

3.3.1 Environmental Assessment Levels

Environment Assessment Levels (EAL) are used to determine the sensitivity of the groundwater near a DfR site and are a measure against which the results of the risk assessment can be compared. The EALs for the determinands within the screening assessment have been selected based on the most stringent of values for Drinking Water Standards (DWS), Environmental Quality Standards (EQS) and Minimum Reporting Values (MRV) for hazardous substances.

The Environmental Permitting (England and Wales) Regulations 2016 (EPR, 2016) require there to be no discernible discharge of hazardous substances to groundwater. Therefore, the

appropriate EAL would be the concentration at which they become 'discernible' in laboratory analysis, ie the Minimum Reporting Value (MRV).

The EPR (2016) requires there to be no groundwater pollution caused as a result of discharges of non-hazardous substances (potential pollutants). As the closest and most sensitive receptor to the site is water supply borehole the DWS have been used as the EAL for non-hazardous substances in the screening assessment.

The EALs used for the screening assessment are provided in *Appendix 3777/HRA/A1*.

3.3.2 Risk screening

The inert fill deposited within the site is considered to have a low potential for generating a potentially contaminating leachate. The Tier 1 screening assessment compares the simulated concentrations of the potentially polluting chemicals in groundwater at the down-gradient side of the site, ie after dilution in groundwater, with respective water quality standards.

Within the inert WAC, the limits for the following determinands exceed their respective EALs. These therefore have the potential to impact the water environment depending on the hydrogeological characteristics of the site.

- Arsenic
- Cadmium
- Copper
- Total Chromium
- Chromium VI+
- Nickel
- Mercury
- Lead
- Selenium
- Chloride
- Sulphate
- Benzene
- Benzo-a-pyrene

Assessment of the above parameters is therefore required of their potential impact on the groundwater within the residual sand and gravel aquifer beneath the site. The risk screening assessment allows estimation of the dilution of seepage from the base of the site within the underlying groundwater system along with the concentrations of the simulated chemicals in

groundwater at the down-gradient site boundary. Calculations are provided in *Appendix 3777/HRA/A1*.

3.3.3 Results

Dilution in groundwater

The risk screening also allows for estimation of the potential dilution of any seepage through the base of the site within the underlying groundwater system. This is based on the estimated volume of the discharge, hydrogeological characteristics of the aquifer and the observed groundwater levels and hydraulic gradient.

A saturated thickness of 11 m has been assumed, this is based on the average groundwater elevation at the site, and the depth to the London Clay, which was recorded within nearby BGS borehole logs.

Groundwater flow is east-southeastwards. Approximately 90% of incident rainfall was assumed to infiltrate across all of the infill phases, which is considered conservative (ie to produce an overestimate of the potential risk)

Based on the above, a dilution factor of 2.25 was calculated at the compliance point.

Groundwater quality

The inert WAC concentrations for the selected parameters were divided by the dilution factor to determine whether dilution is sufficient to reduce concentrations below the respective EALs. For all of the selected parameters the diluted concentrations remained above inert WAC. Therefore dilution alone would not be sufficient to prevent an adverse impact on the water environment. Hence, the inclusion of a geological barrier is required within the design of the site. More detailed quantitative assessment has therefore been undertaken to determine the required specifications for the barrier.

3.4 Generic quantitative risk assessment

3.4.1 General

The results of the risk screening identified that dilution within the sand and gravel aquifer is not sufficient on its own to protect the surrounding water environment from being polluted by the site. Therefore a degree of site engineering is required.

A Generic Quantitative Risk Assessment (GQRA) has been undertaken to determine the required specification for the AGB that would provide sufficient attenuation of dissolved

contaminants migrating from the site to afford sufficient protection to down-gradient groundwater.

The risk model was run for a minimum time period of 3,000 years. This is significantly longer than the time period that is likely to be required to achieve Permit Surrender and, hence, is considered to be a conservative upper time limit for the simulation.

3.4.2 Revised source term

As in the risk screening, the source term for the GQRA conservatively assumes all of the waste is at inert WAC concentrations. The source concentrations have been modelled as porewater concentrations, rather than soil concentrations.

The following hazardous and non-hazardous substances are considered representative and have been selected to be modelled in the GQRA based on their potential to be present within the waste codes that are proposed to be accepted at the site. The modelled substances and justification for their selection is summarised in *Table 3777/HRA/T3*.

3777/HRA/T3: Modelled substances and justification	
Hazardous	
Arsenic	Potentially present within waste codes containing ash and slag, representative heavy metal
Benzene	Potentially present within waste codes containing ash and bituminous mixtures, representative aromatic hydrocarbon
Benzo(a)Pyrene	Potentially present within waste codes containing ash and bituminous mixtures, representative poly aromatic hydrocarbon
Non-hazardous	
Sulphate	Present within waste codes containing gypsum. Conservative, non-reactive substance
Nickel	Potentially present within waste codes containing ash and slag. Can be particularly impactful to aquatic environments

3.4.3 Revised EALs

The EPR (2016) requires there to be no groundwater pollution caused as a result of discharges of non-hazardous chemicals (potential pollutants). For conservatism, the appropriate EAL is therefore deemed to be the most stringent water quality standard, except where background groundwater concentrations exceed those standards.

Site specific EALs have been derived for the substances selected in Section 3.4.2

Hazardous Substances

Relevant quality standards for the selected hazardous substances are presented in *Table 3777/HRA/T4* together with the derived EAL, equivalent to the MRV in each case.

3777/HRA/T4: Derivation of EALS for Hazardous substances				
Substance	**UK Drinking Water Standard**	**Fresh Water EQS[1]**	**Minimum reporting value (MRV)**	**Resultant EAL**
Arsenic[2]	10 µg/l	50 µg/l	5 µg/l	5 µg/l
Benzene	1 µg/l	10 µg/l	1 µg/l	1 µg/l
Benzo(a)Pyrene[2]	0.01 µg/l	1.75×10^{-4} µg/l	5×10^{-5} µg/l	5×10^{-5} µg/l
1 EQS = Environmental Quality Standard 2 MRV assumed as Limit of Quantification				

Non-hazardous substances

Background groundwater quality monitoring has been undertaken at nine locations. A total of 11 samples have been collected from across the site. The 95th percentile for the results have been used to define the background concentrations. A summary of the date used to define the background concentrations are provided in *Appendix 3777/HRA/A2*.

A drinking water source is located down-gradient of Phase 4. The background concentrations are lower than the UK Drinking Water standards, hence the background concentrations for sulphate and nickel have been used for the assessment of this phase.

For Phases 1, 2 and 3 the nearest down-gradient receptor is a watercourse, hence the EQS value for Nickel has been used. The background concentration for sulphate has been used as it is lower than the EQS limit. The relevant standards are provided in *Table 3777/HRA/T5*.

3777/HRA/T5: Derivation of EALS for Non-hazardous substances					
Substance	**UK Drinking Water Standard**	**Fresh Water EQS[1]**	**Background concentration[2]**	**Phase 1, 2 & 3 Resultant EAL**	**Phase 4 Resultant EAL**
Sulphate	250 mg/l	250 mg/l	74 mg/l	74 mg/l	74 mg/l
Nickel	20 µg/l	4 µg/l	18.5 µg/l	4 µg/l	18.5 µg/l
3 1 EQS = Environmental Quality Standard (Annual average) 2 Based on 95th percentile of monitoring data					

3.4.4 Modelled Pathways

Pathways have been modelled separately for each source. For hazardous substance the pathway is vertically through the AGB and unsaturated sand and gravel, with the compliance point being the base of the unsaturated zone.

For non-hazardous substances a pathway has been modelled from the source, assumed to be the completed waste mass, vertically through the AGB and unsaturated sand and gravel, into the underlying saturated sand and gravel aquifer, and then with the hydraulic gradient to the down-gradient receptor. The path to the down-gradient receptor for each phase is shown on Drawing 3777/HRA/02.

3.4.5 Model parameterisation

Input values for the various elements of the CSM described in above are described, together with justifications, in *Table 3777/HRA/T6* and included in *Appendix 3777/HRA/A3*.

3777/HRA/T6: Model input parameters

Parameter	Value	Justification
SOURCE TERM		
Waste volume (m^3)		
Phases 1, 2 and 3	1,981,188	Area of extraction phases and an average thickness of waster of 9 m. Assumed 1 m thick AGB
Phase 4	650,799	
GENERAL CONTAMINANT INFORMATION		
Free water diffusion coefficient (m^2/s):		
Arsenic	9.05×10^{-10}	Arsenic from Allison & Allison, 2005
Nickel	1.0×10^{-9}	Sato H, Yui M & Yoshikawa H (1996)
Sulphate	2.8×10^{-11}	Hill, D (1984)
Benzene	6.90×10^{-10}	CLAIRE Research Bulletin RB15 (Sep 2011)
Benzo(a)pyrene	3.67×10^{-10}	
HYDROGEOLOGICAL UNITS		
Thickness (m):		
AGB Phase 1, 2 and 3	1.0	Assumed
AGB Phase 4	1.0	Assumed
Unsaturated sand and gravel	0.5	Mineral extraction to 0.5 m above watertable
Saturated sand and gravel	11	Groundwater monitoring data and depth to top of London Clay in BGS borehole records
Hydraulic conductivity (m/s):		
AGB Phase 1, 2 and 3	1×10^{-8}	Calculated
AGB Phase 4	1×10^{-8}	Calculated
Unsaturated sand and gravel	1.2×10^{-4}	Minor Aquifers Manual (Red Crag Formation) and
Saturated sand and gravel	4.5×10^{-4}	Bricker & Bloomfield (2014) (Lowestoft Formation)
Hydraulic gradient:		
AGB	1	Assumed vertical
Unsaturated sand and gravel	1	Assumed vertical

3777/HRA/T6: Model input parameters		
Parameter	**Value**	**Justification**
Saturated sand and gravel	0.0027	Estimated from groundwater monitoring data (3777/ESSD)
Porosity:		
AGB	0.4	Generic value for clay
Unsaturated sand and gravel	0.2	Generic value for sand
Saturated sand and gravel	0.2	Generic value for sand
Tortuosity	5	Assumed generic value for all hydrogeological layers
Horizontal travel distance (m) to:		
Private water supply	133	Distance from edge of Phase 4
Watercourse	270	Distance from edge of Phase 3
ATTENUATION PARAMETERS		
Dispersivity	Unit thickness/10	Standard assumption
Mixing depth (m) in saturated sand and gravel	11	Saturated thickness. Based on water level and depth to top of London Clay
Bulk density (kg/m^3):		
AGB	1600	Generic value for clay
Unsaturated sand and gravel	1800	Generic value for sand and gravel
Saturated sand and gravel	1800	Generic value for sand and gravel
Fraction of organic carbon (foc)		
AGB	0.05	EA 2004, Table 7.2
Unsaturated sand and gravel	0.002	US EPA default concentration for foc of subsurface soils
Saturated sand and gravel	0.002	
<u>Arsenic</u>		
Partition coefficient (k_d) (L/kg)	2222	Middle of range from Brouwere, Smolders and Merckx, 2003
<u>Nickel</u>		
Partition coefficient (k_d) (L/kg)	270	Middle of range from Reddy and Dunn, 1986
<u>Sulphate</u>		
Partition coefficient (kd) (L/kg)	0	Assumed conservative
Half life (days)	No decay	
<u>Benzene</u>		
Koc	67.6	EA SR7 report (2008)
Partition coefficient (k_d) (L/kg)	calculated	
Half life in groundwater (days)	300	EA 2002 R&D Technical Report P2-228/TR Table 4.2; Benzene Shallow sand and gravel. Middle of range
<u>Benzo(a)pyrene</u>		
Koc	1.17 x 10^6	USEPA 1996 Part 5: Chemical Specific Parameters
Partition coefficient (k_d) (L/kg)	Calculated	UK Soil and Herbage Pollutant Survey, Report No 9. June 2007. Middle of range
Half life in groundwater (days)	830	
WATER BALANCE		
Precipitation (mm/yr)	555	EA Chantry Rain Gauge
Effective Precipitation (mm/yr)	222	Estimated 60% run-off

3.4.6 Results

The results of the GQRA are provided in *Table 3777/HRA/T7*. The results indicate that no chemical was simulated to exceed its respective EAL in groundwater at the receptor. Therefore the simulated AGB is considered sufficient to mitigate potential risk posed by the site to groundwater.

3777/HRA/T7: Results of the GQRA		
Phase 1, 2 and 3		
Determinand	**EAL at the compliance point**	**Peak concentration at the compliance point (time to peak in years)**
Non-hazardous: Nickel Sulphate	 4×10^{-3} mg/l 74 mg/l	 1.53×10^{-5} (>3000) 15.6 (5 years)
Hazardous: Arsenic Benzene Benzo(a)pyrene	 5×10^{-3} mg/l 1×10^{-3} mg/l 5×10^{-8} mg/l	 2.47×10^{-6} (>3000) 1.02×10^{-4} (10 years) None detected
Phase 4		
Determinand	**EAL at the compliance point**	**Peak concentration at the compliance point (time to peak in years)**
Non-hazardous: Nickel Sulphate	 1.85×10^{-2} mg/l 74 mg/l	 1.93×10^{-5} mg/l (>3000) 8.47 (5 years)
Hazardous: Arsenic Benzene Benzo(a)pyrene	 5×10^{-3} mg/l 1×10^{-3} mg/l 5×10^{-8} mg/l	 2.47×10^{-6} (>3000) 1.02×10^{-4} (10 years) None detected

It should be noted that the whole of the source is assumed to be at the maximum inert WAC limits, which is extremely unlikely to occur. Therefore the results of the simulation represent a highly conservative (worst case) assessment of the potential risk posed by the site. In reality, the expected peak concentrations of chemicals in down-gradient groundwater are expected to be significantly lower.

3.4.7 AGB composition

As filter cake from on-site processing (washing) will be used in the construction of the AGB, the AGB itself is considered very unlikely to contribute significantly to the potential risk posed by the site as a whole.

The material will need to below the inert WAC leaching limits for non-hazardous substances and not result in the direct discharge of hazardous substances.

3.5 Review of technical precautions

Due to the nature of the waste it is considered that the proposed essential and technical precautions detailed below are appropriate and sufficient to prevent any unacceptable discharge from the site:

i) Strict control of waste types sourced and accepted
ii) Strict adherence to Waste Acceptance Criteria and Procedures for specified waste codes
iii) Construction of a structure that encourages surface water run-off and minimises water ingress
iv) Provision of a 1 m thick geological barrier placed at a maximum permeability of $1x10^{-8}$ m/s
v) Monitoring of groundwater quality at the site boundary

It is considered that leachate monitoring and management is not required due to the nature of the waste.

Details of the Waste Acceptance Criteria and Procedures are considered elsewhere in the application.

3.6 Emissions to groundwater

The principal purpose of the HRA is to establish whether the predicted discharge from the site complies with the requirements of the Environmental Permitting (England and Wales) Regulations (EPR 2016) Schedule 22 Groundwater activities.

3.6.1 Hazardous substances

The HRA must demonstrate that the proposed technical precautions will prevent hazardous substances from entering groundwater. Consequently it must consider whether there is likely to be a discernible discharge of hazardous substances to groundwater. The compliance point is, therefore, the watertable prior to any dilution occurring.

Hazardous substances are not expected to be present in the imported material at concentrations that are likely to cause a breach of the EPR (2016) and risk assessment modelling indicates that hazardous substances, included in the waste up to maximum WAC concentrations, will not breach the appropriate EAL at the watertable. However, it is considered that the majority of material imported to the site will be at much lower concentrations than the inert WAC limits. It is therefore considered that the technical precautions discussed in Section 3.5 above are sufficient to ensure that during normal operation and through to long-term post-closure, there would be no discernible discharge of hazardous substances from the waste into groundwater.

3.6.2 Non-hazardous pollutants

The HRA must also demonstrate that technical precautions will limit the introduction of non-hazardous pollutants into groundwater so as to avoid pollution. Consequently it must consider whether predicted concentrations of non-hazardous pollutants are likely to exceed relevant standards and other environmental quality criteria or cause an unacceptable deterioration in groundwater quality following dilution.

A pathway exists for non-hazardous pollutants to a receptor, namely the private water supply source down-gradient of Phase 4 and the watercourse down-gradient of Phases 1, 2 and 3. Risk assessment indicates that non-hazardous pollutants included in the waste up to maximum WAC concentrations will not breach the appropriate EAL at the receptor. The precautions outlined in Section 3.5 and the dilution within the aquifer are considered to be sufficient such that non-hazardous pollutants would be sufficiently low as to avoid derogation of nearby receptors.

3.7 Emissions to surface water

There is no direct link between the site and surface watercourses. A pathway exists via groundwater only. Berms and ditches will be constructed as necessary to direct surface water run-off away from the active working area during its operational and post-operational phase.

3.8 Rogue load

Interim guidance has been provided by the Environment Agency detailing leachate concentrations to use for rogue load assessments at inert sites based on water quality monitoring results (*Appendix 3777/HRA/A4*). The guidance states that the three most mobile non-hazardous contaminants that could leach from deposited soils are sulphate, ammoniacal nitrogen and nickel. The guidance also states that either arsenic or lead should be used to assess the impact of hazardous substances. Inorganic substances were not addressed within the guidance.

The values provided by the EA, with the exception of those for sulphate, are less than the inert WAC limits. Using the mostly likely value for sulphate of 1200 mg/l results in a peak after 5 years, with concentrations of 187 mg/l downstream of Phases 1, 2 and 3, and 102 mg/l downstream of Phase 4. These peak concentrations are higher than background concentrations but lower than the DWS and EQS limits. It should be noted that the modelling assumes all waste is deposited instantaneously, therefore in reality peak concentrations would be lower.

It is considered that, in the unlikely event that a rogue load is accepted at the site, it would not pose an unacceptable risk to water quality.

4 PROPOSED MONITORING

4.1 General

As the site will be operated as a DfR site, there is no automatic requirement for monitoring. However, groundwater monitoring has been proposed as the site is considered to be in a sensitive location due to the presence of a down-gradient drinking water abstraction.

4.1.1 Groundwater monitoring locations

The existing groundwater monitoring network provides coverage up-gradient and downgradient of the proposed mineral extraction phases. The locations of the monitoring boreholes are summarised in *Table 3777/HRA/T8* and their locations shown on *Drawing 3777/HRA/04*.

3777/HRA/T8: Groundwater monitoring network		
Borehole	**Coordinates**	**Up-gradient/ down-gradient**
BW17W	611761, 240506	Up-gradient
BW15W	611774, 239991	Down-gradient
GW25/01	612155, 240443	Down-gradient
GW25/02	611950, 240286	Down-gradient
GW25/03	611464, 239968	Down-gradient
GW25/04	611168, 239925	Up-gradient
GW25/05	612186, 240773	Down-gradient
GW25/06	611644, 240440	Up-gradient

4.1.2 Surface water monitoring

Surface water monitoring is currently undertaken at two locations. These are summarised in *Table 3777/HRA/T9* and shown on *Drawing 3777/HRA/04*. Culvert 2 has been recorded as dry during most of the visits undertaken to date, this is consistent with the conceptual understanding that the watercourse at this location is rainfall dependent. As such an additional monitoring location is proposed further downstream where it is anticipated that groundwater discharge from the site occurs. Monitoring at Culvert 1 suggests that the water quality within the southern watercourse is primarily influenced by runoff from the A12 Road.

3777/HRA/T9: Surface water monitoring network		
Location	**Coordinates**	**Existing/Proposed**
Culvert 1 – Phillip's Road (South)	610925, 239682	Existing
Culvert 2 – (North)	611710, 240496	Existing
Watercourse – (East)	612198, 240223	Proposed

4.1.3 Monitoring Schedule

A recommended monitoring schedule is given in *Table 3777/HRA/T10*. Preliminary results are provided in *Appendix 3777/HRA/A5*.

3777/HRA/T10: Recommended monitoring schedule	
Frequency	**Measurement/suite**
Monthly	Groundwater level
Quarterly	pH, conductivity, chloride, sulphate, ammoniacal nitrogen, arsenic cadmium, antimony
Annually	As above plus: total oxidised nitrogen, total organic carbon, alkalinity, calcium, sodium, magnesium, potassium, lead, copper, zinc, total chromium, chromium VI, iron, manganese, cadmium, nickel, antimony, PAH (EPA 16)

4.1.4 Assessment and compliance limits

The adopted compliance limits should be the MRV for hazardous substances. For non-hazardous substances the compliance limit should be the respective DWS limits for GW25/01, with the exception of the limits discussed in Section 3.4.2. The EQS limits should be used for all other down-gradient boreholes. The assessment limit should be set at 50% of the compliance limit. Assessment limits will be deemed to have been breached if the three point rolling average, relative to a particular control level, demonstrates a rising trend.

5 CONCLUSIONS

5.1 Compliance with the Environmental Permitting (England and Wales) Regulations (2016)

The risk assessment has demonstrated that, under normal operations and with the proposed WAC limits and monitoring in place, hazardous substances should not be present in groundwater adjacent to the site in concentrations discernible above background and non-hazardous pollutants will not be present in concentrations such that pollution of nearby groundwater is caused. **It is therefore considered that the site will be compliant with respect to the Environmental Permitting (England and Wales) Regulations (2016).**

6 REFERENCES

Allison JD & Allison TL, 2005. Partition coefficients for metals in surface water, soil and waste. United States Environmental Protection Agency, Report EPA/600/R-05/074

BGS, 2000. Technical Report WD/00/04. The physical properties of minor aquifers in England and Wales

Bricker SH & Bloomfield JP, 2014. Controls on the basin-scale distribution of hydraulic conductivity of superficial deposits: a case study from the Thames Basin, UK. Quarterly Journal of Engineering Geology and Hydrogeology, Vol 47, 2014, pp 223–236

CL:AIRE, September 2011. Research Bulletin RB15. Generic Human-Health Assessment Criteria for Benzo[a]Pyrene at Former Coking Works Sites. ISSN 2047-6450

CL:AIRE, September 2011. Research Bulletin RB16. Generic Human-Health Assessment Criteria for Benzene at Former Coking Works Sites. ISSN 2047-6450

De Brouwere K, Smolders E, Merckx R, December 2003. Soil properties affecting solid-liquid distribution of As(V) in soils, European Journal of Soil Science, Vol 55, 2004, pp 165-173

Environment Agency 2002. R&D Technical Report P2-228/TR. The Effects of Contaminant Concentration on the Potential for Natural Attenuation

Environment Agency Science Group. March 2004. Science Group report NC/03/12. Attenuation of mecoprop in the subsurface

Environment Agency, June 2007. UK Soil and Herbage Pollutant Survey, Report No 9

Environment Agency, 2008. Science Report - SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values, Environment Agency (Bristol, UK). ISBN: 978-1- 84432-964-9

Environment Agency, January 2024. Landfill operators: environmental permits. What to include in your hydrogeological risk assessment https://www.gov.uk/guidance/landfill-developments-groundwater-risk-assessment-for-leachate

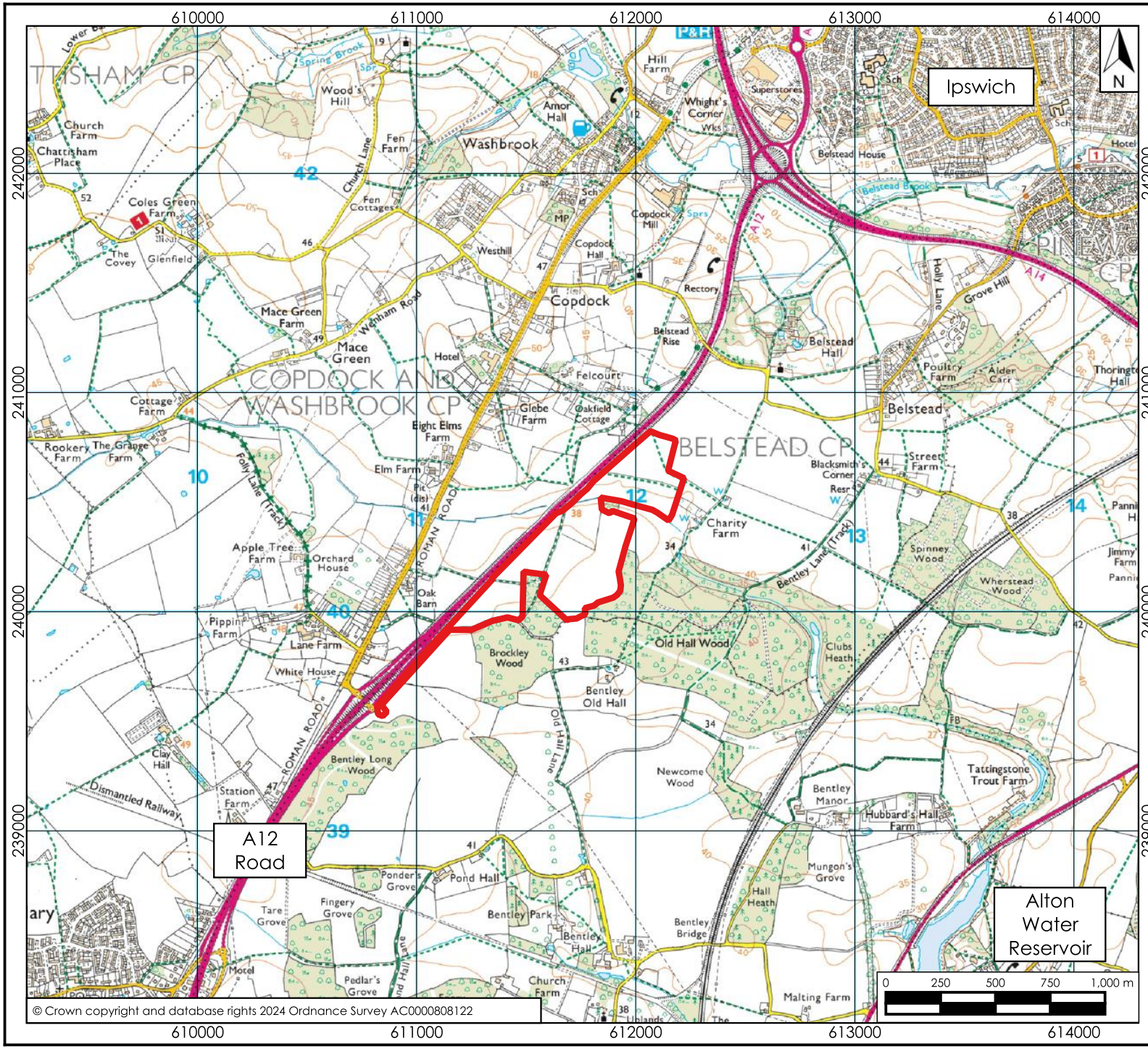
Hill D, 1984. Diffusion coefficients of nitrate, chloride, sulphate and water in cracked and uncracked Chalk. European Journal of Soil Science. Volume 35, Issue 1

Reddy MR and Dunn SJ, 1986. Distribution coefficients for nickel and zinc in soils, Environmental Pollution Series B, Chemical and Physical, Volume 11, Issue 4, 1986

Sato H, Yui M & Yoshikawa H, 1996. Ionic Diffusion Coefficients of Cs^{+}, Pb^{2+}, Sm^{3+}, Ni^{2+}, SeO_4^{2-} and TcO_4^{-} in Free Water Determined from Conductivity Measurements. Journal of Nuclear Science and Technology, 33(12), 950–955

US EPA, Indiana Department of Environmental Management, September 2007. Determining the Fraction of Organic Carbon RISC nondefault option https://semspub.epa.gov/work/05/424375.pdf

DRAWINGS



Key

Site Boundary

Scale correct at A4

Client	Brockley Wood Ventures Ltd
Title	Site Location
Project	Brockley Wood
Drawing	3777/HRA/01
Version	1
Date	Feb 2025
Scale	1:25,000

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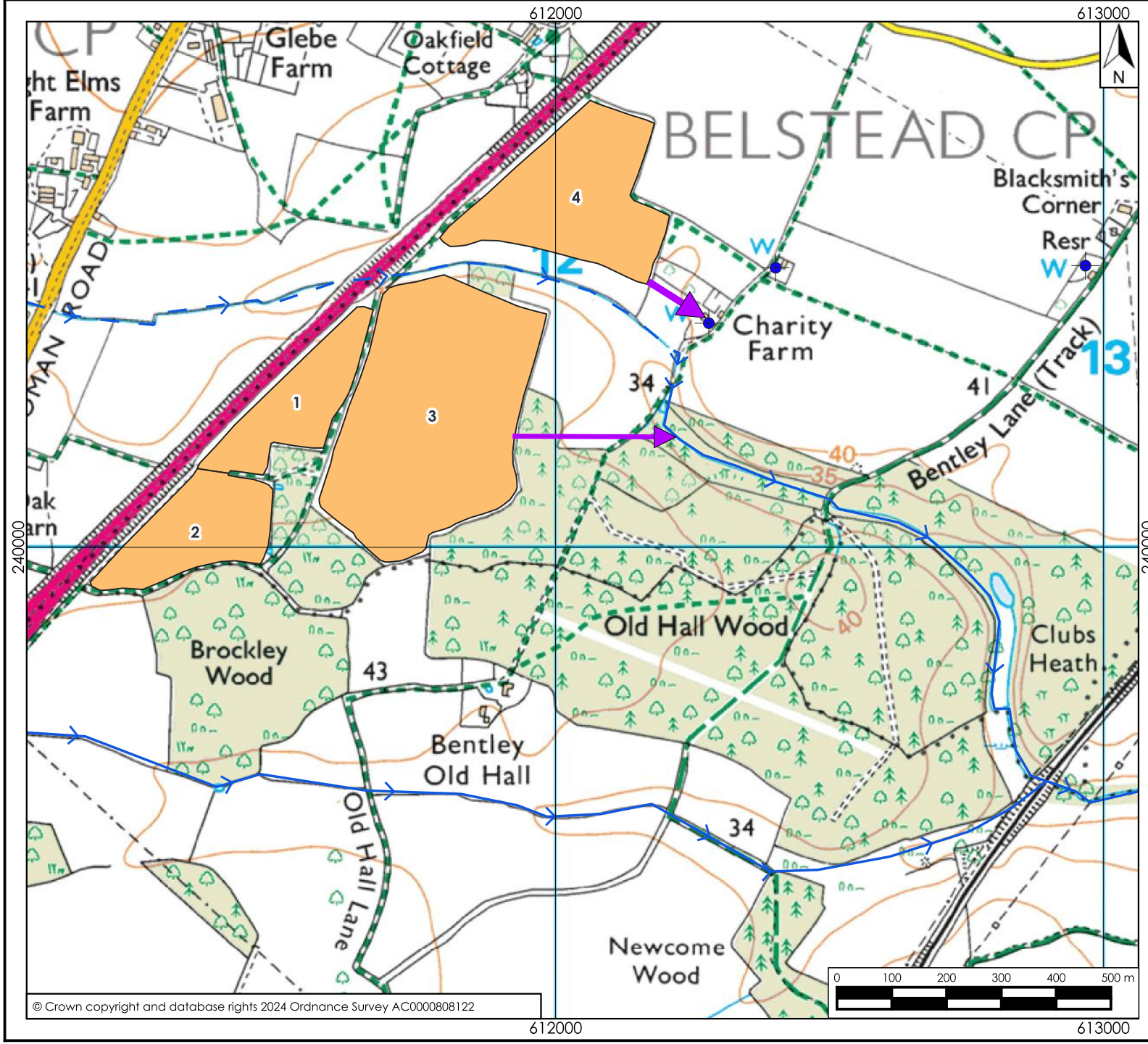

Key

- Site Boundary
- Extraction Phase
- Well
- Watercourse
- Modelled Pathway

Scale correct at A4

Client	Brockley Wood Ventures Ltd
Title	Conceptual Plan
Project	Brockley Wood
Drawing	3777/HRA/02
Version	2
Date	Jan 2026
Scale	1:10,000

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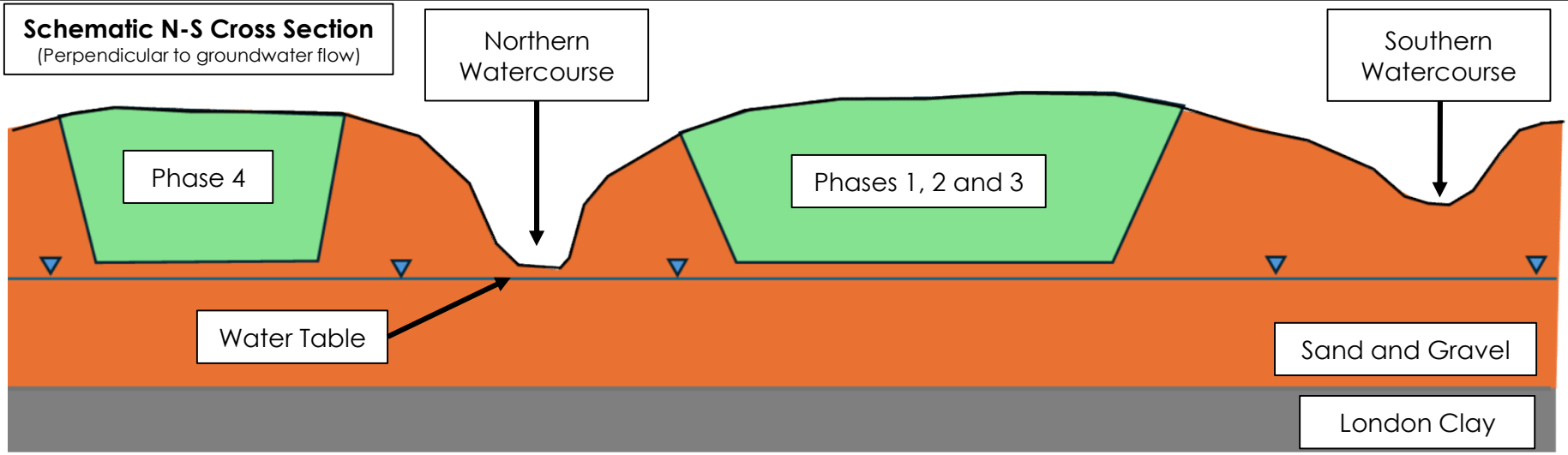
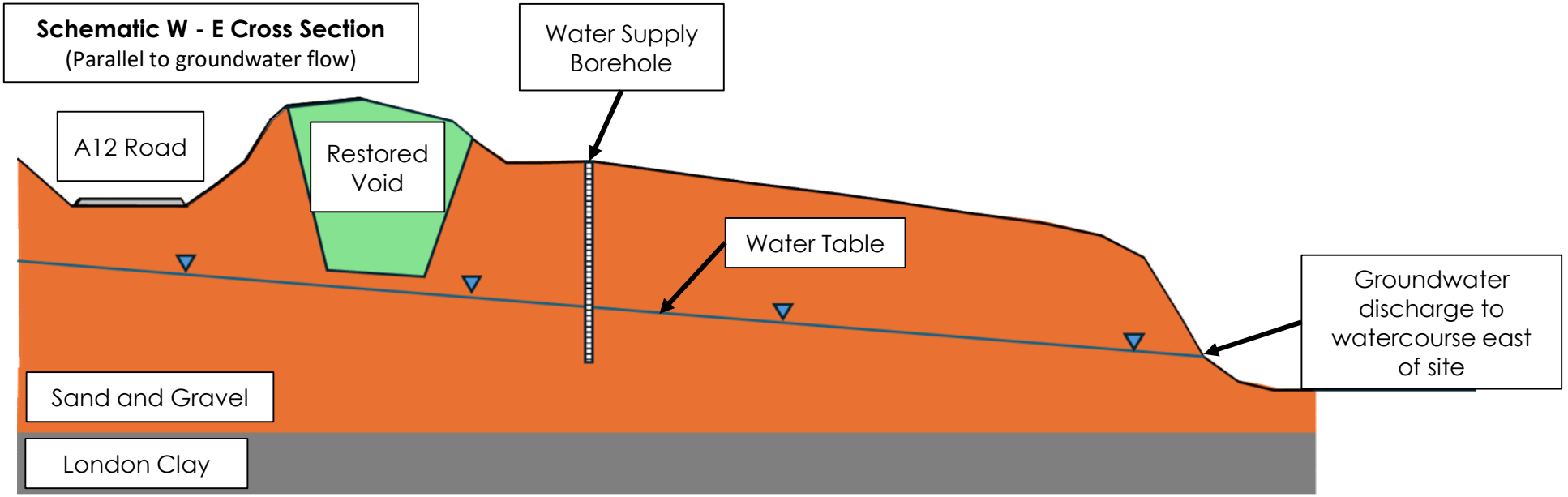
Schematic N-S Cross Section
(Perpendicular to groundwater flow)



Schematic W - E Cross Section
(Parallel to groundwater flow)



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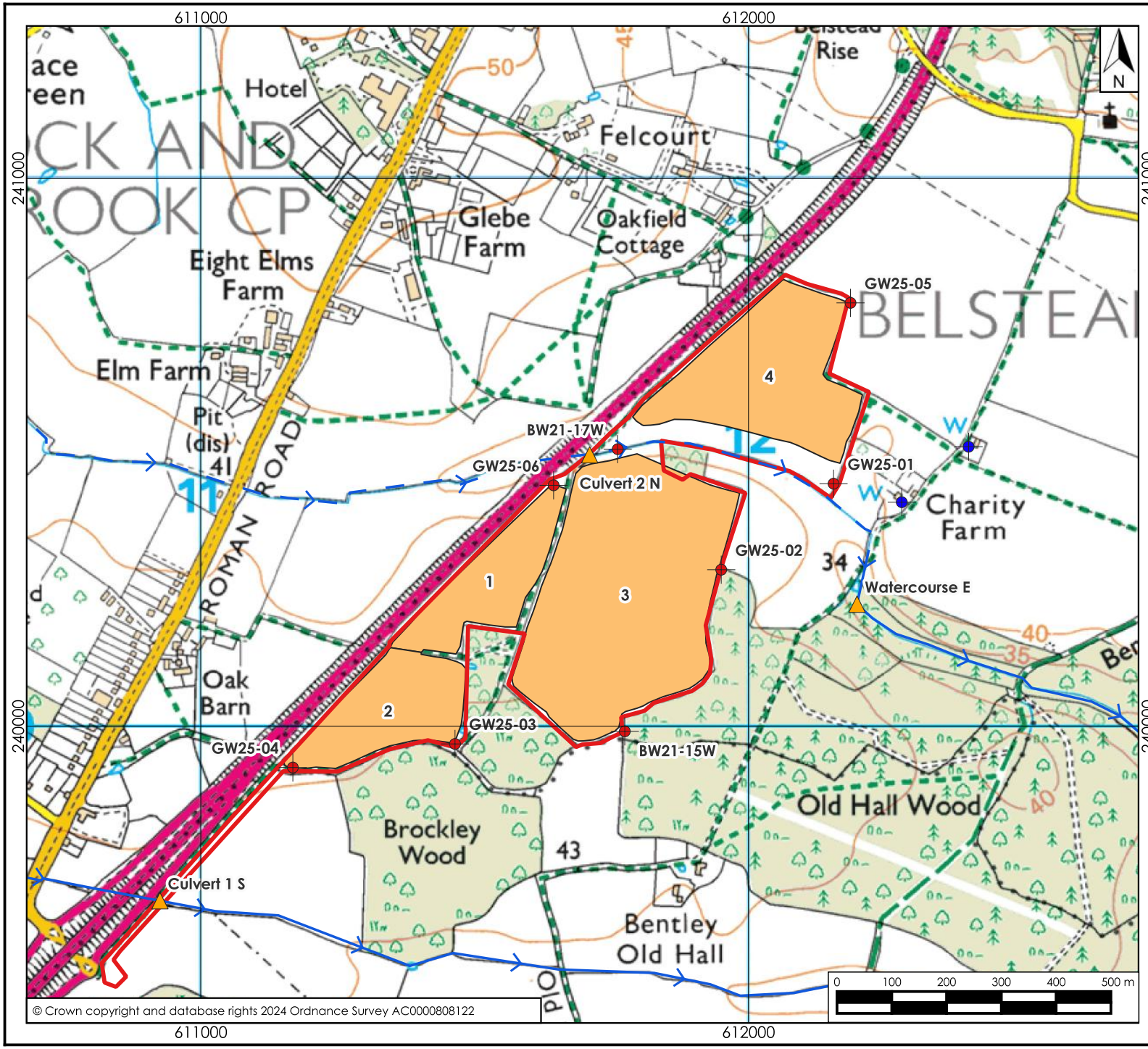
Client	Brockley Wood Ventures Ltd		
Title	Schematic Conceptual Cross Sections		
Project	Brockley Wood		
Drawing	3777/HRA/03	Version	3
Date	Jan 2026	Scale	N/A



Key

- Site Boundary
- Extraction Phase
- Monitoring Borehole
- Surface water monitoring location
- Well
- Watercourse

Scale correct at A4

Client	Brockley Wood Ventures Ltd
Title	Monitoring locations
Project	Brockley Wood
Drawing	3777/HRA/04
Version	3
Date	Jan 2026
Scale	1:10,000

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APPENDIX 3777/HRA/A1

Tier 1 Quantitative Screening Assessment

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Calc sheet by:	DI	Yellow	Data entry
Version number:	1	Green	Formulae
Date:	22/01/2026	Blue	Select from list

Generic inert Waste Acceptance Criteria (WAC) limits have been compared to appropriate screening values.

A screening exercise has been undertaken using a calculated dilution factor.

Hazardous Substances have been compared against the Minimum Reporting Values (MRV)
Non-Hazardous Substances have been compared againts DWS values
Type of Dilution Aquifer

Screening Values (µg/l)

Parameter	Inert WAC	MRV	DWS	EQS	User Defined
Arsenic (As)+	50	5	10	50	
Cadmium (Cd)	4	0.1	5	0.08	
Copper (Cu)	200		2	1	
Total Chromium (Cr)	50	37.5	50	4.7	
Chromium VI+		1		3.4	
Nickel (Ni)	40		20	4	
Mercury (Hg)	1	0.01	1	0.07	
Lead (Pb)+	50	0.2	10		
Selenium (Se)	10		10		
Chloride (Cl^-)	8.0E+04		250000		
Sulphate (SO_4^{2-})	1.0E+05		250000		
Benzene	600	1	1	10	
Benzo-a-pyrene+	1.0E+04	5.0E-05	1.0E-02	1.7E-04	

Hazardous substance

+ *MRV assumed as Limit of Quantification (LoQ)*

Calculation of Dilution Factor

Site Parameters			Data Source
Rainfall infiltration rate	499.5	mm/yr	EA Chantry Rain Gauge 555 mm/yr
Area of landfill	292443	m^2	Area of Phases
Total infiltration	400.21	m^3/day	

Aquifer Dilution			
Hydraulic Conductivity (k)	20.0000	m/day	Values from Minor Aquifer Manual and Brick
Hydraulic Gradient (i)	0.0027		Groundwater monitoring data
Area	9295	m^2	845m wide with 11m saturated thickness
Flow Rate (Q)	501.93	m^3/day	

Waterbody Dilution		
Waterbody Area		m^2
Waterbody Depth		m
Waterbody Volume	NA	m^3

Watercourse Dilution		
Flow Rate		m^3/sec
Volume	NA	m^3/day

Dilution Factor 2.25

Proposed WAC Concentrations

Parameter	WAC after dilution	Exceeds selected screening value?	Max allowable concentration	
Arsenic (As)+	22	Yes	11	µg/l
Cadmium (Cd)	1.77	No	NA	µg/l
Copper (Cu)	89	Yes	5	µg/l
Total Chromium (Cr)	22.2	No	NA	µg/l
Chromium VI+	No Value	No Value	NA	µg/l
Nickel (Ni)	18	No	NA	µg/l
Mercury (Hg)	0.44	Yes	0.02	µg/l
Lead (Pb)+	22.2	Yes	0.5	µg/l
Selenium (Se)	4.4	No	NA	µg/l
Chloride (Cl^-)	35490	No	NA	µg/l
Sulphate (SO_4^{2-})	44362	No	NA	µg/l
Benzene	266	Yes	2.25	µg/l
Benzo-a-pyrene+	4436	Yes	1.1E-04	µg/l

Hazardous substance

+ *MRV assumed as Limit of Quantification (LoQ)*

Notes

Non-Hazardous substances have been compared againt DWS values due to the presence of a nearby drinking water abstraction.
The EQS value for Cadmium is determined by the water hardness. As the hardness is unknown, the most stringent value has been adopted.
The EQS value for Copper is based on the bioavailable fraction.

Common Assumptions & References

Benzene concentrations are assumed as indicative of BTEX concentrations.
Benzo(a)pyrene concentrations are assumed as indicative of PAH concentrations.
Hazardous substances as defined by List I Substances under Groundwater Directive 2006/118/EC
Assumes 'leachate' density equals that of water and hence 1 mg/kg is equivalent to 1 mg/l

Council Decision Annex 2003/33/EC 19th December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC

The Water Supply (Water Quality) Regulations 2016

UKTAG Technical Report on Groundwater Hazardous Substances 11b(iii) v12, Sep 2016

APPENDIX 3777/HRA/A2

Calculated Background Concentrations

		Plant Site	BW-15		BW-17		GW25-01	GW25-02	GW25-03	GW25-04	GW25-05	GW25-06					
	Units	04/05/2025	04/05/2025	02/10/2025	04/05/2025	02/10/2025	02/10/2025	02/10/2025	02/10/2025	02/10/2025	02/10/2025	02/10/2025	Min	Max	Range	Mean	95%ile
Sulphate (w)	mg/l	43	39	43	23	25	35	59	58	85	63	54	23	85	62	47.91	74
Nickel (dissolved)	µg/l	22	15	10	***1***	***1***	***1***	2	3	9	7	5	1	22	21	6.91	18.5

< LOD ***bold and italic. Assumed half LOD for calculations***

APPENDIX 3777/HRA/A3

RAM input parameters

Source Type

☐ Soil Source ☐ Groundwater Source

Level Number

◉ Advanced

Parameter Values

◉ Deterministic ○ Probabilistic

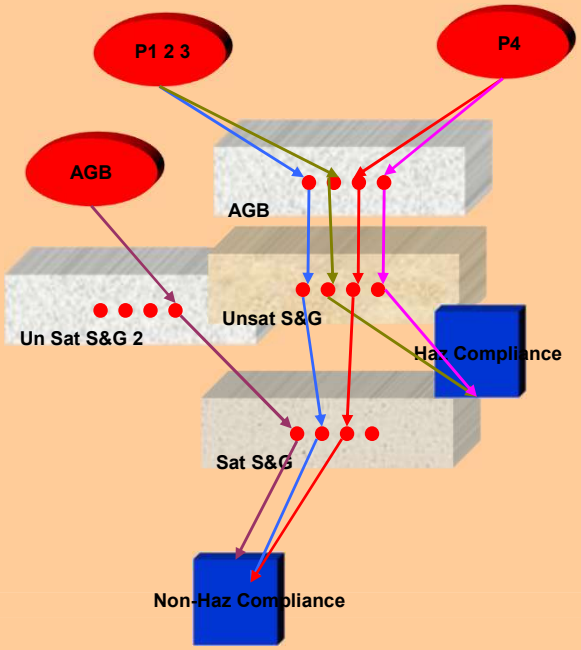
Created: 22/01/2026 19:04:34

by: Dylan Ingman

Version: 3.34.00x Bmb

Site: Brockley Wood V2

Numerical value
Suggested formula
Probabilistic parameters
Data specified elsewhere
Suggested formula edited



SOURCE CONCENTRATIONS: P4

Source Data Options

- (●) Pore water concentrations
- ( ) Leaching test
- ( ) Soil contaminant concentrations

Source Type

- ( ) Constant source
- (●) Declining source

Source Geometry

P4_Source_length	320	m
P4_Source_width	295	m
P4_Source_area	72311	m2
P4_Source_thickness	9	m
P4_Source_volume	650799	m3

General Source Properties

P4_Source_field_capacity	[-]	0.25

Source Contaminant Information

Source determinand names		Arsenic	Nickel	Sulphate	Benzene	BaP
P4_Pore_water_concentration	mg/L	0.05	0.04	100	0.6	10
P4_Initial_inventory	kg	8.134988	6.50799	16269.98	97.61985	1626.998
P4_Input_concentration	mg/L	0.05	0.04	100	0.6	10

SOURCE CONCENTRATIONS: P1 2 3

Source Data Options

- (●) Pore water concentrations
- ( ) Leaching test
- ( ) Soil contaminant concentrations

Source Type

- ( ) Constant source
- (●) Declining source

Source Geometry

P1_2_3_Source_length	445	m
P1_2_3_Source_width	619	m
P1_2_3_Source_area	292443	m2
P1_2_3_Source_thickness	9	m
P1_2_3_Source_volume	2631987	m3

General Source Properties

P1_2_3_Source_field_capacity	[-]	0.25

Source Contaminant Information

Source determinand names		Arsenic	Nickel	Sulphate	Benzene	BaP
P1_2_3_Pore_water_concentration	mg/L	0.05	0.04	100	0.6	10
P1_2_3_Initial_inventory	kg	32.89984	26.31987	65799.68	394.7981	6579.968
P1_2_3_Input_concentration	mg/L	0.05	0.04	100	0.6	10

SOURCE CONCENTRATIONS: AGB

Source Data Options

- (●) Pore water concentrations
- ( ) Leaching test
- ( ) Soil contaminant concentrations

Source Type

- ( ) Constant source
- (●) Declining source

Source Geometry

AGB_Source_length		m
AGB_Source_width		m
AGB_Source_area	0	m2
AGB_Source_thickness		m
AGB_Source_volume	333249	m3

General Source Properties

AGB_Source_field_capacity	[-]	0.25

Source Contaminant Information

Source determinand names		Arsenic	Nickel	Sulphate	Benzene	BaP
AGB_Pore_water_concentration	mg/L	1	1	1	1	1
AGB_Initial_inventory	kg	83.31225	83.31225	83.31225	83.31225	83.31225
AGB_Input_concentration	mg/L	1	1	1	1	1

CONTAMINANT INFORMATION

		Species1	Species2	Species3	Species4	Species5
Source determinand names	5	Arsenic	Nickel	Sulphate	Benzene	BaP

Receptor Target Concentrations

	Name	Values in mg/L				
Quality Standard 1	P1 2 3	0.005	0.004	74	0.001	5.00E-08
Quality Standard 2	P4	0.005	0.0185	74	0.001	5E-08
Quality Standard 3						
Quality Standard 4						

Generic Contaminant Properties

Contaminants_Organic_Carbon_Water_Partition_Coefficient_Koc	**L/kg**				67.6	1.17E+06
Contaminants_Free_Water_Diffusion_Coefficient	**m2/s**	9.05E-10	1.00E-09	2.80E-11	6.90E-10	3.67E-10

HYDROGEOLOGICAL UNITS

Hydrogeological Units		AGB	Unsat SG	Sat SG	Un Sat SG 2
Hydrogeology_Unit_Thickness	m	1	0.5	11	11
Hydrogeology_Log_Hydraulic_Conductivity	log(m/s)				
Hydrogeology_Hydraulic_Conductivity	m/s	1.00E-08	1.20E-04	4.50E-04	4.50E-04
Hydrogeology_Head	m				
Hydrogeology_Hydraulic_Gradient	[-]	1	1	0.0027	0.0027
Hydrogeology_Porosity	[-]	0.4	0.2	0.2	0.2
Hydrogeology_Velocity	m/s	2.5E-08	0.0006	6.08E-06	0.000006075
Hydrogeology_Tortuosity	[-]	5	5	5	5

ATTENUATION PARAMETERS

Hydrogeological Units		AGB	Unsat SG	Sat SG	Un Sat SG 2
General properties					
Attenuation_Dry_bulk_density	kg/m3	1600	1800	1800	1800
Attenuation_Fraction_organic_carbon	[-]	0.05	0.002	0.002	0.002
Contaminant specific parameters					
Arsenic					
Attenuation_Partition_Coefficient_Kd_Species_1	L/kg	2222	2222	2222	2222
Attenuation_Retardation_Species_1	[-]	8889	19999	19999	19999
Attenuation_Half_Life_Species_1	days	No Decay	No Decay	No Decay	No Decay
Attenuation_Decay_Coefficient_Species_1	1/s	0	0	0	0
Nickel					
Attenuation_Partition_Coefficient_Kd_Species_2	L/kg	270	270	270	270
Attenuation_Retardation_Species_2	[-]	1081	2431	2431	2431
Attenuation_Half_Life_Species_2	days	No Decay	No Decay	No Decay	No Decay
Attenuation_Decay_Coefficient_Species_2	1/s	0	0	0	0
Sulphate					
Attenuation_Partition_Coefficient_Kd_Species_3	L/kg	0	0	0	0
Attenuation_Retardation_Species_3	[-]	1	1	1	1
Attenuation_Half_Life_Species_3	days	No Decay	No Decay	No Decay	No Decay
Attenuation_Decay_Coefficient_Species_3	1/s	0	0	0	0

Benzene

Attenuation_Partition_Coefficient_Kd_Species_4	**L/kg**	3.38	0.1352	0.1352	0.1352
Attenuation_Retardation_Species_4	**[-]**	14.52	2.2168	2.2168	2.2168
Attenuation_Half_Life_Species_4	**days**	300	300	300	300
Attenuation_Decay_Coefficient_Species_4	**1/s**	2.67E-08	2.67E-08	2.67E-08	2.67418E-08

BaP

Attenuation_Partition_Coefficient_Kd_Species_5	**L/kg**	58500	2340	2340	2340
Attenuation_Retardation_Species_5	**[-]**	234001	21061	21061	21061
Attenuation_Half_Life_Species_5	**days**	830	830	830	830
Attenuation_Decay_Coefficient_Species_5	**1/s**	9.67E-09	9.67E-09	9.67E-09	9.66571E-09

WATER BALANCE

User defined

Enter your own calculations for the water balance
Carry fluxes and velocities over onto the Pathway sheet

Average yearly rainfall (2010 - 2022) (mm/yr)	555	Chantry Rain Gauge
	222	Estimated infiltration (60% runoff)

Q_Path P4	0.00050869	m3/s
Q_Path P123	0.002057265	m3/s
Q_Path AGB	0.002565955	m3/s

PATHWAY SUMMARY

Path 1	Section 1		Section 2		Section 3		Section 4		Section 5	
Path 1 Type	Source		Unit		Unit		Unit		Receptor	
Path 1 Name	**P1 2 3**		**AGB: Node 1**		**Unsat S&G: Node 1**		**Sat S&G: Node 2**		**Non-Haz Compliance**	
Path 1 Process	Declining source		ADRD (1D) + Dilution		ADRD (1D) + Dilution		ADRD (1D) + Dilution		Monitoring Borehole	
Path 1 Standards									Target Standard	P1 2 3
Path 1 Parameter1	**Q_managed [m3/s]**	0.000E+00	**Velocity [m/s]**	2.500E-08	**Velocity [m/s]**	6.000E-04	**Velocity [m/s]**	6.075E-06		
Path 1 Parameter2	**Managed time [years]**	0.000E+00	**Dispersivity [m]**	0.1	**Dispersivity [m]**	0.1	**Dispersivity [m]**	27.0		
Path 1 Parameter3	**Q_path [m3/s]**	2.057E-03	**Travel Distance [m]**	1.0	**Travel Distance [m]**	0.5	**Travel Distance [m]**	270.0		
Path 1 Parameter4	**Q_decline [m3/s]**	2.057E-03	**Mixing Depth [m]**		**Mixing Depth [m]**		**Mixing Depth [m]**	11.0		
Path 1 Parameter5			**Mixing Width [m]**		**Mixing Width [m]**		**Mixing Width [m]**	619.0		
Path 1 Parameter6			**Q_Dilute [m3/s]**	0.000E+00	**Q_Dilute [m3/s]**	0.000E+00	**Q_Dilute [m3/s]**	8.273E-03	**Q_dilute [m3/s]**	0.000E+00

Path 2	Section 1		Section 2		Section 3		Section 4	
Path 2 Type	Source		Unit		Unit		Receptor	
Path 2 Name	**P1 2 3**		**AGB: Node 2**		**Unsat S&G: Node 2**		**Haz Compliance**	
Path 2 Process	Declining source		ADRD (1D) + Dilution		ADRD (1D) + Dilution		Monitoring Borehole	
Path 2 Standards							Target Standard	P1 2 3
Path 2 Parameter1	**Q_managed [m3/s]**	0.000E+00	**Velocity [m/s]**	2.500E-08	**Velocity [m/s]**	6.000E-04		
Path 2 Parameter2	**Managed time [years]**	0.000E+00	**Dispersivity [m]**	0.1	**Dispersivity [m]**	0.1		
Path 2 Parameter3	**Q_path [m3/s]**	2.057E-03	**Travel Distance [m]**	1.0	**Travel Distance [m]**	0.5		
Path 2 Parameter4	**Q_decline [m3/s]**	2.057E-03	**Mixing Depth [m]**		**Mixing Depth [m]**			
Path 2 Parameter5			**Mixing Width [m]**		**Mixing Width [m]**			
Path 2 Parameter6			**Q_Dilute [m3/s]**	0.000E+00	**Q_Dilute [m3/s]**	0.000E+00	**Q_dilute [m3/s]**	0.000E+00

Path 3	Section 1		Section 2		Section 3		Section 4		Section 5	
Path 3 Type	Source		Unit		Unit		Unit		Receptor	
Path 3 Name	**P4**		**AGB: Node 3**		**Unsat S&G: Node 3**		**Sat S&G: Node 3**		**Non-Haz Compliance**	
Path 3 Process	Declining source		ADRD (1D) + Dilution		ADRD (1D) + Dilution		ADRD (1D) + Dilution		Monitoring Borehole	
Path 3 Standards									Target Standard	P4
Path 3 Parameter1	**Q_managed [m3/s]**	0.000E+00	**Velocity [m/s]**	2.500E-08	**Velocity [m/s]**	6.000E-04	**Velocity [m/s]**	6.075E-06		
Path 3 Parameter2	**Managed time [years]**	0.000E+00	**Dispersivity [m]**	0.1	**Dispersivity [m]**	0.1	**Dispersivity [m]**	13.3		
Path 3 Parameter3	**Q_path [m3/s]**	5.087E-04	**Travel Distance [m]**	1.0	**Travel Distance [m]**	0.5	**Travel Distance [m]**	133.0		
Path 3 Parameter4	**Q_decline [m3/s]**	5.087E-04	**Mixing Depth [m]**		**Mixing Depth [m]**		**Mixing Depth [m]**	11.0		
Path 3 Parameter5			**Mixing Width [m]**		**Mixing Width [m]**		**Mixing Width [m]**	295.0		
Path 3 Parameter6			**Q_Dilute [m3/s]**	0.000E+00	**Q_Dilute [m3/s]**	0.000E+00	**Q_Dilute [m3/s]**	3.943E-03	**Q_dilute [m3/s]**	0.000E+00

Path 4	Section 1		Section 2		Section 3		Section 4	
Path 4 Type		Source		Unit		Unit		Receptor
Path 4 Name		**P4**		**AGB: Node 4**		**Unsat S&G: Node 4**		**Haz Compliance**
Path 4 Process		Declining source		ADRD (1D) + Dilution		ADRD (1D) + Dilution		Monitoring Borehole
Path 4 Standards							Target Standard	P4
Path 4 Parameter1	**Q_managed [m3/s]**	0.000E+00	**Velocity [m/s]**	2.500E-08	**Velocity [m/s]**	6.000E-04		
Path 4 Parameter2	**Managed time [years]**	0.000E+00	**Dispersivity [m]**	0.1	**Dispersivity [m]**	0.1		
Path 4 Parameter3	**Q_path [m3/s]**	5.087E-04	**Travel Distance [m]**	1.0	**Travel Distance [m]**	0.5		
Path 4 Parameter4	**Q_decline [m3/s]**	5.087E-04	**Mixing Depth [m]**		**Mixing Depth [m]**			
Path 4 Parameter5			**Mixing Width [m]**		**Mixing Width [m]**			
Path 4 Parameter6			**Q_Dilute [m3/s]**	0.000E+00	**Q_Dilute [m3/s]**	0.000E+00	**Q_dilute [m3/s]**	0.000E+00

Path 5	Section 1		Section 2		Section 3		Section 4	
Path 5 Type		Source		Unit		Unit		Receptor
Path 5 Name		**AGB**		**Un Sat S&G 2: Node 4**		**Sat S&G: Node 1**		**Non-Haz Compliance**
Path 5 Process		Declining source		ADRD (1D) + Dilution		ADRD (1D) + Dilution		Monitoring Borehole
Path 5 Standards							Target Standard	P1 2 3
Path 5 Parameter1	**Q_managed [m3/s]**	0.000E+00	**Velocity [m/s]**	6.075E-06	**Velocity [m/s]**	6.075E-06		
Path 5 Parameter2	**Managed time [years]**	0.000E+00	**Dispersivity [m]**	0.1	**Dispersivity [m]**	13.3		
Path 5 Parameter3	**Q_path [m3/s]**	2.566E-03	**Travel Distance [m]**	0.5	**Travel Distance [m]**	133.0		
Path 5 Parameter4	**Q_decline [m3/s]**	2.566E-03	**Mixing Depth [m]**		**Mixing Depth [m]**	11.0		
Path 5 Parameter5			**Mixing Width [m]**		**Mixing Width [m]**	845.0		
Path 5 Parameter6			**Q_Dilute [m3/s]**	0.000E+00	**Q_Dilute [m3/s]**	1.129E-02	**Q_dilute [m3/s]**	0.000E+00

SIMULATION PARAMETERS

Monte Carlo Analysis with Crystal Ball

Reported Percentile	95
Number of simulations	10000

☐ Stop on calculation error

☐ Use same sequence of random numbers

Minimise while running:

○ Nothing

○ All Spreadsheets (faster)

◉ Microsoft Excel (fastest)

Named Constants

s_per_year	31557600
s_per_day	86400

Laplace Transform Solution Parameters

sigma	0
nu	1
nsum	16
omega	11

Reporting Options

☑ Include Remedial Targets and Attenuation Factors on the results sheets in Advanced level

☐ Use the array form of the RAM function

☑ Include a set of timeslices for each contaminant in each pathway

Number of timeslices for breakthrough curves: 15

The timeslices specified on the results sheets are saved below.

Path1 timeslices in years

TS_Path1_Spec1	TS_Path1_Spec2	TS_Path1_Spec3	TS_Path1_Spec4	TS_Path1_Spec5
0.1	0.1	0.1	0.1	0.1
0.2	0.2	0.2	0.2	0.2
0.5	0.5	0.5	0.5	0.5
0.75	0.75	0.75	0.75	0.75
1	1	1	1	1
2	2	2	2	2
5	5	5	5	5
10	10	10	10	10
50	50	50	50	50
100	100	100	100	100
250	250	250	250	250
500	500	500	500	500
1000	1000	1000	1000	1000
2000	2000	2000	2000	2000
3000	3000	3000	3000	3000

Path2 timeslices in years

TS_Path2_Spec1	TS_Path2_Spec2	TS_Path2_Spec3	TS_Path2_Spec4	TS_Path2_Spec5
0.1	0.1	0.1	0.1	0.1
0.2	0.2	0.2	0.2	0.2
0.5	0.5	0.5	0.5	0.5
0.75	0.75	0.75	0.75	0.75
1	1	1	1	1
2	2	2	2	2
5	5	5	5	5
10	10	10	10	10
50	50	50	50	50
100	100	100	100	100
250	250	250	250	250
500	500	500	500	500
1000	1000	1000	1000	1000
2000	2000	2000	2000	2000
3000	3000	3000	3000	3000

Path3 timeslices in years

TS_Path3_Spec1	TS_Path3_Spec2	TS_Path3_Spec3	TS_Path3_Spec4	TS_Path3_Spec5
0.1	0.1	0.1	0.1	0.1
0.2	0.2	0.2	0.2	0.2
0.5	0.5	0.5	0.5	0.5
0.75	0.75	0.75	0.75	0.75
1	1	1	1	1
2	2	2	2	2
5	5	5	5	5
10	10	10	10	10
50	50	50	50	50
100	100	100	100	100
250	250	250	250	250
500	500	500	500	500
1000	1000	1000	1000	1000
2000	2000	2000	2000	2000
3000	3000	3000	3000	3000

Path4 timeslices in years

TS_Path4_Spec1	TS_Path4_Spec2	TS_Path4_Spec3	TS_Path4_Spec4	TS_Path4_Spec5
0.1	0.1	0.1	0.1	0.1
0.2	0.2	0.2	0.2	0.2
0.5	0.5	0.5	0.5	0.5
0.75	0.75	0.75	0.75	0.75
1	1	1	1	1
2	2	2	2	2
5	5	5	5	5
10	10	10	10	10
50	50	50	50	50
100	100	100	100	100
250	250	250	250	250
500	500	500	500	500
1000	1000	1000	1000	1000
2000	2000	2000	2000	2000
3000	3000	3000	3000	3000

Path5 timeslices in years

TS_Path5_Spec1	TS_Path5_Spec2	TS_Path5_Spec3	TS_Path5_Spec4	TS_Path5_Spec5
0.1	0.1	0.1	0.1	0.1
0.2	0.2	0.2	0.2	0.2
0.5	0.5	0.5	0.5	0.5
0.75	0.75	0.75	0.75	0.75
1	1	1	1	1
2	2	2	2	2
5	5	5	5	5
10	10	10	10	10
50	50	50	50	50
100	100	100	100	100
250	250	250	250	250
500	500	500	500	500
1000	1000	1000	1000	1000
2000	2000	2000	2000	2000
3000	3000	3000	3000	3000

APPENDIX 3777/HRA/A4

EA Note: Suggested leachate quality for rogue loads

‘Advice on potential source term monitoring for inert landfills in relation to Rogue Loads.

Collated in 2023 in relation to review of limited monitoring available of leachate in inert soils type landfills.

While the starting point for any inert site is that the residual leachate quality would be that of the inert WAC criteria permitted, a consistent approach to rogue load modelling (to assess risk of accidents) is also expected to enable risk assessment of the more soluble and mobile contaminants that could arise from the deposition of more variable soils wastes.

Any quantitative modelling of these sites should consider the fate of a possible range of contaminants within the source term. This should be determined by undertaking a risk screen against appropriate water quality standards or natural baseline quality.

From Environment Agency observation of the fate of soils leachates, the three most mobile contaminants that could leach from deposited soils are: sulphate, ammoniacal nitrogen and nickel (all non-hazardous substances). While likely to be present only at trace concentrations in leachate, selection of one of either arsenic or lead should be used to assess the fate of a nominal hazardous substance in leachate at each site.

From our observations from a limited data set of sites, the following ranges of leachate quality are considered appropriate to represent concentrations likely from the outcome of accidental rogue load acceptance:

Possible Range of Leachate Quality for assessing accidental rogue load acceptance

	Minimum	*Most Likely*	*Maximum*
Arsenic	0.001	0.007	0.06
Lead	0.002	0.007	0.15
Ammoniacal Nitrogen	0.3	8	25
Chloride	100	300	800
Sulphate	200	1200	1800
Nickel	0.002	0.02	0.12

Units: mg/l

We note that the above advice is developing / emerging work for both industry and the Agency and is limited to date by current guidance stating that leachate quality monitoring is not required at inert landfills. Should the operator wish to install or undertake any programme of leachate monitoring (particularly at the higher risk sites on Principal aquifers over short or longer term timescales), the Environment Agency would be likely to support such an initiative.

APPENDIX 3777/HRA/A5

Water monitoring results

Plant Site

	Units	Limit of Detection	04/05/2025
pH (w)	pH	0.01	6.59
Electrical conductivity @ 20degC (w)	µs/cm	10	455
Dissolved Oxygen	mg/l	0.5	8.6
COD (total) DEFAULT	mg/l	5	7
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	45
Ammoniacal nitrogen as N (w)	mg/l	0.05	<0.05
Chloride (w)	mg/l	1	23
Nitrate (w)	mg/l	0.1	120
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	27.1
Sulphate (w)	mg/l	1	43
DOC - Dissolved Organic Carbon (w)	mg/l	2	4.6
Antimony (dissolved)	µg/l	1	<1
Cadmium (dissolved)	µg/l	0.2	<0.2
Calcium (dissolved)	mg/l	1	50.4
Copper (dissolved)	µg/l	4	<4
Chromium (total)	µg/l	1	4
Iron (dissolved)	µg/l	10	<10
Lead (dissolved)	µg/l	0.1	<1
Manganese (dissolved)	µg/l	1	76
Magnesium (dissolved)	mg/l	1	14
Nickel (dissolved)	µg/l	2	22
Potassium (dissolved)	mg/l	1.2	<1.2
Sodium (dissolved)	mg/l	1	12.6
Zinc (dissolved)	µg/l	2	26
Ionic Balance (w)	% difference		-1.8
PAH 16MS (w)			
Acenaphthene (w)	µg/l	0.01	<0.01
Acenaphthylene (w)	µg/l	0.01	<0.01
Anthracene (w)	µg/l	0.01	<0.01
Benzo(a)anthracene (w)	µg/l	0.01	<0.01
Benzo(a)pyrene (w)	µg/l	0.01	<0.01
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01
Chrysene (w)	µg/l	0.01	<0.01
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01
Fluoranthene (w)	µg/l	0.01	<0.01
Fluorene (w)	µg/l	0.01	<0.01
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01
Naphthalene (w)	µg/l	0.01	<0.01
Phenanthrene (w)	µg/l	0.01	<0.01
Pyrene (w)	µg/l	0.01	<0.01
Total PAH 16MS (w)	µg/l	0.01	<0.01

BW-15W

	Units	Limit of Detection	04/05/2025	02/10/2025	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	6.16	6.31	8.1	7.9	8.2	8.3	7.6	7.6	8
Electrical conductivity @ 20degC (w)	µs/cm	10	461	506	1300	1500	710	700	940	1000	980
Dissolved Oxygen	mg/l	0.5	9	8.8							
COD (total) DEFAULT	mg/l	5	220	27							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	24	44							
Ammoniacal nitrogen as N (w)	mg/l	0.05	<0.05	0.11	0.4	0.6	1	1.2	0.64	0.15	< 0.050
Chloride (w)	mg/l	1	29	43	270	320	68	69	100	88	74
Nitrate (w)	mg/l	0.1	138	140							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	31.3	31.6							
Sulphate (w)	mg/l	1	39	43							
DOC - Dissolved Organic Carbon (w)	mg/l	2	4.9	<2.0							
Antimony (dissolved)	µg/l	1	<1	<1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cadmium (dissolved)	µg/l	0.2	<0.2	<0.2	< 0.08	0.11	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08
Calcium (dissolved)	mg/l	1	51.5	61.5							
Copper (dissolved)	µg/l	4	<4	<4							
Chromium (total)	µg/l	1	133	133							
Iron (dissolved)	µg/l	10	<10	<10							
Lead (dissolved)	µg/l	0.1	<1	<0.1							
Manganese (dissolved)	µg/l	1	11	7							
Magnesium (dissolved)	mg/l	1	14.9	14.3							
Nickel (dissolved)	µg/l	2	15	10							
Potassium (dissolved)	mg/l	1.2	1.8	2.4							
Sodium (dissolved)	mg/l	1	17.7	21.7							
Zinc (dissolved)	µg/l	2	13	8							
Ionic Balance (w)	% difference		3	0.2							
PAH 16MS (w)											
Acenaphthene (w)	µg/l	0.01	<0.01	<0.01							
Acenaphthylene (w)	µg/l	0.01	<0.01	<0.01							
Anthracene (w)	µg/l	0.01	<0.01	<0.01							
Benzo(a)anthracene (w)	µg/l	0.01	<0.01	<0.01							
Benzo(a)pyrene (w)	µg/l	0.01	<0.01	<0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01	<0.01							
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01	<0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01	<0.01							
Chrysene (w)	µg/l	0.01	<0.01	<0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01	<0.01							
Fluoranthene (w)	µg/l	0.01	<0.01	<0.01							
Fluorene (w)	µg/l	0.01	<0.01	<0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01	<0.01							
Naphthalene (w)	µg/l	0.01	<0.01	0.02							
Phenanthrene (w)	µg/l	0.01	<0.01	<0.01							
Pyrene (w)	µg/l	0.01	<0.01	<0.01							
Total PAH 16MS (w)	µg/l	0.01	<0.01	0.02							

BW-17W

	Units	Limit of Detection	04/05/2025	02/10/2025
pH (w)	pH	0.01	6.93	6.85
Electrical conductivity @ 20degC (w)	µs/cm	10	532	526
Dissolved Oxygen	mg/l	0.5	7.8	8.2
COD (total) DEFAULT	mg/l	5	388	11
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	163	173
Ammoniacal nitrogen as N (w)	mg/l	0.05	<0.05	<0.05
Chloride (w)	mg/l	1	54	57
Nitrate (w)	mg/l	0.1	24.1	25
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	5.4	5.6
Sulphate (w)	mg/l	1	23	25
DOC - Dissolved Organic Carbon (w)	mg/l	2	15.8	3.4
Antimony (dissolved)	µg/l	1	<1	<1
Cadmium (dissolved)	µg/l	0.2	<0.2	<0.2
Calcium (dissolved)	mg/l	1	74.3	68.9
Copper (dissolved)	µg/l	4	<4	<4
Chromium (total)	µg/l	1	144	114
Iron (dissolved)	µg/l	10	<10	<10
Lead (dissolved)	µg/l	0.1	<1	<0.1
Manganese (dissolved)	µg/l	1	<1	<1
Magnesium (dissolved)	mg/l	1	2.8	2.6
Nickel (dissolved)	µg/l	2	<2	<2
Potassium (dissolved)	mg/l	1.2	3	2.7
Sodium (dissolved)	mg/l	1	55.2	54.4
Zinc (dissolved)	µg/l	2	<2	<2
Ionic Balance (w)	% difference		6.4	0.9
PAH 16MS (w)				
Acenaphthene (w)	µg/l	0.01	<0.01	<0.01
Acenaphthylene (w)	µg/l	0.01	<0.01	<0.01
Anthracene (w)	µg/l	0.01	<0.01	<0.01
Benzo(a)anthracene (w)	µg/l	0.01	<0.01	<0.01
Benzo(a)pyrene (w)	µg/l	0.01	<0.01	<0.01
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01	<0.01
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01	<0.01
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01	<0.01
Chrysene (w)	µg/l	0.01	<0.01	<0.01
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01	<0.01
Fluoranthene (w)	µg/l	0.01	<0.01	<0.01
Fluorene (w)	µg/l	0.01	<0.01	<0.01
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01	<0.01
Naphthalene (w)	µg/l	0.01	<0.01	<0.01
Phenanthrene (w)	µg/l	0.01	<0.01	<0.01
Pyrene (w)	µg/l	0.01	<0.01	<0.01
Total PAH 16MS (w)	µg/l	0.01	<0.01	<0.01

GW25-01

	Units	Limit of Detection	02/10/2025	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	7.13	8.1	7.8	8.5	8.5	8.3	7.9	7.8
Electrical conductivity @ 20degC (w)	µs/cm	10	561	1300	1500	530	580	770	680	690
Dissolved Oxygen	mg/l	0.5	7.1							
COD (total) DEFAULT	mg/l	5	376							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	231							
Ammoniacal nitrogen as N (w)	mg/l	0.05	0.24	0.39	0.6	0.93	1	1.1	0.16	< 0.050
Chloride (w)	mg/l	1	22	280	290	36	36	41	34	33
Nitrate (w)	mg/l	0.1	41.2							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	9.5							
Sulphate (w)	mg/l	1	35							
DOC - Dissolved Organic Carbon (w)	mg/l	2	8.6							
Antimony (dissolved)	µg/l	1	<1	< 0.50	< 0.50	< 0.50	< 0.50	1.3	< 0.50	< 0.50
Cadmium (dissolved)	µg/l	0.2	<0.2	< 0.08	0.1	< 0.08	< 0.08	0.13	< 0.08	0.09
Calcium (dissolved)	mg/l	1	105.9							
Copper (dissolved)	µg/l	4	<4							
Chromium (total)	µg/l	1	182							
Iron (dissolved)	µg/l	10	<10							
Lead (dissolved)	µg/l	0.1	<0.1							
Manganese (dissolved)	µg/l	1	31							
Magnesium (dissolved)	mg/l	1	4.9							
Nickel (dissolved)	µg/l	2	<2							
Potassium (dissolved)	mg/l	1.2	6.9							
Sodium (dissolved)	mg/l	1	15.7							
Zinc (dissolved)	µg/l	2	<2							
Ionic Balance (w)	% difference		-0.6							
PAH 16MS (w)										
Acenaphthene (w)	µg/l	0.01	<0.01							
Acenaphthylene (w)	µg/l	0.01	<0.01							
Anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)pyrene (w)	µg/l	0.01	<0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01							
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01							
Chrysene (w)	µg/l	0.01	<0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01							
Fluoranthene (w)	µg/l	0.01	<0.01							
Fluorene (w)	µg/l	0.01	<0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01							
Naphthalene (w)	µg/l	0.01	<0.01							
Phenanthrene (w)	µg/l	0.01	<0.01							
Pyrene (w)	µg/l	0.01	<0.01							
Total PAH 16MS (w)	µg/l	0.01	<0.01							

GW25-02

	Units	Limit of Detection	02/10/2025	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	7.14	8.2	7.8	8.3	8.4	7.9	7.6	8
Electrical conductivity @ 20degC (w)	µs/cm	10	928	1300	87	1000	1000	970	950	950
Dissolved Oxygen	mg/l	0.5	6.8							
COD (total) DEFAULT	mg/l	5	39							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	284							
Ammoniacal nitrogen as N (w)	mg/l	0.05	0.51	0.37	0.59	0.78	0.74	0.45	0.16	< 0.050
Chloride (w)	mg/l	1	96	280	290	110	110	110	88	75
Nitrate (w)	mg/l	0.1	94.6							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	21.6							
Sulphate (w)	mg/l	1	59							
DOC - Dissolved Organic Carbon (w)	mg/l	2	4							
Antimony (dissolved)	µg/l	1	<1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cadmium (dissolved)	µg/l	0.2	<0.2	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08
Calcium (dissolved)	mg/l	1	115.4							
Copper (dissolved)	µg/l	4	<4							
Chromium (total)	µg/l	1	203							
Iron (dissolved)	µg/l	10	<10							
Lead (dissolved)	µg/l	0.1	<0.1							
Manganese (dissolved)	µg/l	1	158							
Magnesium (dissolved)	mg/l	1	28.2							
Nickel (dissolved)	µg/l	2	2							
Potassium (dissolved)	mg/l	1.2	4.6							
Sodium (dissolved)	mg/l	1	38.4							
Zinc (dissolved)	µg/l	2	<2							
Ionic Balance (w)	% difference		-5.9							
PAH 16MS (w)										
Acenaphthene (w)	µg/l	0.01	<0.01							
Acenaphthylene (w)	µg/l	0.01	<0.01							
Anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)pyrene (w)	µg/l	0.01	<0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01							
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01							
Chrysene (w)	µg/l	0.01	<0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01							
Fluoranthene (w)	µg/l	0.01	<0.01							
Fluorene (w)	µg/l	0.01	<0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01							
Naphthalene (w)	µg/l	0.01	<0.01							
Phenanthrene (w)	µg/l	0.01	<0.01							
Pyrene (w)	µg/l	0.01	<0.01							
Total PAH 16MS (w)	µg/l	0.01	<0.01							

GW25-03

	Units	Limit of Detection	02/10/2025	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	7.15	8.2	7.9	8	8.2	7.5	7.2	7.7
Electrical conductivity @ 20degC (w)	µs/cm	10	760	1300	1300	1000	1100	1400	1500	1500
Dissolved Oxygen	mg/l	0.5	5.8							
COD (total) DEFAULT	mg/l	5	18							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	205							
Ammoniacal nitrogen as N (w)	mg/l	0.05	0.94	0.4	0.55	0.93	0.93	0.63	0.17	< 0.050
Chloride (w)	mg/l	1	97	270	290	170	180	340	280	320
Nitrate (w)	mg/l	0.1	36.9							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	8.8							
Sulphate (w)	mg/l	1	58							
DOC - Dissolved Organic Carbon (w)	mg/l	2	2.7							
Antimony (dissolved)	µg/l	1	<1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cadmium (dissolved)	µg/l	0.2	<0.2	< 0.08	0.09	< 0.08	< 0.08	< 0.08	0.09	0.09
Calcium (dissolved)	mg/l	1	109.4							
Copper (dissolved)	µg/l	4	<4							
Chromium (total)	µg/l	1	224							
Iron (dissolved)	µg/l	10	13							
Lead (dissolved)	µg/l	0.1	0.1							
Manganese (dissolved)	µg/l	1	146							
Magnesium (dissolved)	mg/l	1	7.9							
Nickel (dissolved)	µg/l	2	3							
Potassium (dissolved)	mg/l	1.2	3.3							
Sodium (dissolved)	mg/l	1	48.9							
Zinc (dissolved)	µg/l	2	3							
Ionic Balance (w)	% difference		-1.6							
PAH 16MS (w)										
Acenaphthene (w)	µg/l	0.01	<0.01							
Acenaphthylene (w)	µg/l	0.01	<0.01							
Anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)pyrene (w)	µg/l	0.01	<0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01							
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01							
Chrysene (w)	µg/l	0.01	<0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01							
Fluoranthene (w)	µg/l	0.01	<0.01							
Fluorene (w)	µg/l	0.01	<0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01							
Naphthalene (w)	µg/l	0.01	<0.01							
Phenanthrene (w)	µg/l	0.01	<0.01							
Pyrene (w)	µg/l	0.01	<0.01							
Total PAH 16MS (w)	µg/l	0.01	<0.01							

GW25-04

	Units	Limit of Detection	02/10/2025	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	7.23	8.2	8	8.4	8.4	7.2	7.3	7.8
Electrical conductivity @ 20degC (w)	µs/cm	10	1235	1200	1500	1500	1500	1500	1400	1600
Dissolved Oxygen	mg/l	0.5	7.9							
COD (total) DEFAULT	mg/l	5	36							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	245							
Ammoniacal nitrogen as N (w)	mg/l	0.05	0.9	0.37	0.54	0.86	1	0.63	0.26	< 0.050
Chloride (w)	mg/l	1	227	280	290	300	300	340	280	320
Nitrate (w)	mg/l	0.1	36.9							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	8.4							
Sulphate (w)	mg/l	1	85							
DOC - Dissolved Organic Carbon (w)	mg/l	2	2.2							
Antimony (dissolved)	µg/l	1	<1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cadmium (dissolved)	µg/l	0.2	<0.2	< 0.08	< 0.08	0.1	0.1	0.1	0.1	< 0.08
Calcium (dissolved)	mg/l	1	128.9							
Copper (dissolved)	µg/l	4	<4							
Chromium (total)	µg/l	1	<100							
Iron (dissolved)	µg/l	10	<10							
Lead (dissolved)	µg/l	0.1	<0.1							
Manganese (dissolved)	µg/l	1	1320							
Magnesium (dissolved)	mg/l	1	20.5							
Nickel (dissolved)	µg/l	2	9							
Potassium (dissolved)	mg/l	1.2	5.1							
Sodium (dissolved)	mg/l	1	120.2							
Zinc (dissolved)	µg/l	2	6							
Ionic Balance (w)	% difference		-0.3							
PAH 16MS (w)										
Acenaphthene (w)	µg/l	0.01	<0.01							
Acenaphthylene (w)	µg/l	0.01	<0.01							
Anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)pyrene (w)	µg/l	0.01	<0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01							
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01							
Chrysene (w)	µg/l	0.01	<0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01							
Fluoranthene (w)	µg/l	0.01	<0.01							
Fluorene (w)	µg/l	0.01	<0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01							
Naphthalene (w)	µg/l	0.01	<0.01							
Phenanthrene (w)	µg/l	0.01	<0.01							
Pyrene (w)	µg/l	0.01	<0.01							
Total PAH 16MS (w)	µg/l	0.01	<0.01							

GW25-05

	Units	Limit of Detection	02/10/2025	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	6.82	8.1	8	8.2	8.3	7.2	7.1	7.9
Electrical conductivity @ 20degC (w)	µs/cm	10	628	1300	1400	810	700	720	810	770
Dissolved Oxygen	mg/l	0.5	7.5							
COD (total) DEFAULT	mg/l	5	30							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	123							
Ammoniacal nitrogen as N (w)	mg/l	0.05	0.48	0.41	0.86	1.3	1.2	0.56	0.19	< 0.050
Chloride (w)	mg/l	1	41	270	290	38	38	42	35	34
Nitrate (w)	mg/l	0.1	127							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	29.1							
Sulphate (w)	mg/l	1	63							
DOC - Dissolved Organic Carbon (w)	mg/l	2	2.9							
Antimony (dissolved)	µg/l	1	<1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cadmium (dissolved)	µg/l	0.2	<0.2	< 0.08	0.08	0.12	0.14	0.1	0.08	< 0.08
Calcium (dissolved)	mg/l	1	90.5							
Copper (dissolved)	µg/l	4	<4							
Chromium (total)	µg/l	1	129							
Iron (dissolved)	µg/l	10	<10							
Lead (dissolved)	µg/l	0.1	<0.1							
Manganese (dissolved)	µg/l	1	236							
Magnesium (dissolved)	mg/l	1	12.1							
Nickel (dissolved)	µg/l	2	7							
Potassium (dissolved)	mg/l	1.2	1.8							
Sodium (dissolved)	mg/l	1	20.5							
Zinc (dissolved)	µg/l	2	12							
Ionic Balance (w)	% difference		-3.8							
PAH 16MS (w)										
Acenaphthene (w)	µg/l	0.01	<0.01							
Acenaphthylene (w)	µg/l	0.01	<0.01							
Anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)pyrene (w)	µg/l	0.01	<0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01							
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01							
Chrysene (w)	µg/l	0.01	<0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01							
Fluoranthene (w)	µg/l	0.01	<0.01							
Fluorene (w)	µg/l	0.01	<0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01							
Naphthalene (w)	µg/l	0.01	<0.01							
Phenanthrene (w)	µg/l	0.01	<0.01							
Pyrene (w)	µg/l	0.01	<0.01							
Total PAH 16MS (w)	µg/l	0.01	<0.01							

GW25-06

	Units	Limit of Detection	02/10/2025	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	7	8	8.1	8.4	8.4	7.1	7.5	7.7
Electrical conductivity @ 20degC (w)	µs/cm	10	1052	1300	21	1300	1400	1200	1200	1300
Dissolved Oxygen	mg/l	0.5	7.1							
COD (total) DEFAULT	mg/l	5	193							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20	159							
Ammoniacal nitrogen as N (w)	mg/l	0.05	0.62	0.4	1.6	1.2	1.1	0.78	0.16	< 0.050
Chloride (w)	mg/l	1	196	270	310	310	300	310	240	270
Nitrate (w)	mg/l	0.1	67.2							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1	15.5							
Sulphate (w)	mg/l	1	54							
DOC - Dissolved Organic Carbon (w)	mg/l	2	5							
Antimony (dissolved)	µg/l	1	<1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Cadmium (dissolved)	µg/l	0.2	<0.2	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08
Calcium (dissolved)	mg/l	1	57.6							
Copper (dissolved)	µg/l	4	<4							
Chromium (total)	µg/l	1	376							
Iron (dissolved)	µg/l	10	<10							
Lead (dissolved)	µg/l	0.1	0.2							
Manganese (dissolved)	µg/l	1	648							
Magnesium (dissolved)	mg/l	1	3							
Nickel (dissolved)	µg/l	2	5							
Potassium (dissolved)	mg/l	1.2	3.2							
Sodium (dissolved)	mg/l	1	187.4							
Zinc (dissolved)	µg/l	2	<2							
Ionic Balance (w)	% difference		2.2							
PAH 16MS (w)										
Acenaphthene (w)	µg/l	0.01	<0.01							
Acenaphthylene (w)	µg/l	0.01	<0.01							
Anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)anthracene (w)	µg/l	0.01	<0.01							
Benzo(a)pyrene (w)	µg/l	0.01	<0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01	<0.01							
Benzo(ghi)perylene (w)	µg/l	0.01	<0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01	<0.01							
Chrysene (w)	µg/l	0.01	<0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01	<0.01							
Fluoranthene (w)	µg/l	0.01	<0.01							
Fluorene (w)	µg/l	0.01	<0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01	<0.01							
Naphthalene (w)	µg/l	0.01	<0.01							
Phenanthrene (w)	µg/l	0.01	<0.01							
Pyrene (w)	µg/l	0.01	<0.01							
Total PAH 16MS (w)	µg/l	0.01	<0.01							

Culvert 1 - South

	Units	Limit of Detection	20/10/2025	03/11/2025	18/11/2025	18/11/2025	01/12/2025	15/12/2025	05/01/2026
pH (w)	pH	0.01	9.7	8.4	8.3	8.3	7.8	8.1	8
Electrical conductivity @ 20degC (w)	µs/cm	10	2.3	32	1900	1800	2100	2900	6900
Dissolved Oxygen	mg/l	0.5							
COD (total) DEFAULT	mg/l	5							
Alkalinity (total) (w) Colorimetry	mg/l Ca CO3	20							
Ammoniacal nitrogen as N (w)	mg/l	0.05	0.43	1.4	1.7	1.5	0.86	0.58	< 0.050
Chloride (w)	mg/l	1	65	100	520	500	710	760	2200
Nitrate (w)	mg/l	0.1							
Nitrogen, Total Oxidised TOxN (w)	mg/l	0.1							
Sulphate (w)	mg/l	1							
DOC - Dissolved Organic Carbon (w)	mg/l	2							
Antimony (dissolved)	µg/l	1	1.2	9.4	5.8	4.7	3.8	3.1	6.1
Cadmium (dissolved)	µg/l	0.2	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08
Calcium (dissolved)	mg/l	1							
Copper (dissolved)	µg/l	4							
Chromium (total)	µg/l	1							
Iron (dissolved)	µg/l	10							
Lead (dissolved)	µg/l	0.1							
Manganese (dissolved)	µg/l	1							
Magnesium (dissolved)	mg/l	1							
Nickel (dissolved)	µg/l	2							
Potassium (dissolved)	mg/l	1.2							
Sodium (dissolved)	mg/l	1							
Zinc (dissolved)	µg/l	2							
Ionic Balance (w)	% difference								
PAH 16MS (w)									
Acenaphthene (w)	µg/l	0.01							
Acenaphthylene (w)	µg/l	0.01							
Anthracene (w)	µg/l	0.01							
Benzo(a)anthracene (w)	µg/l	0.01							
Benzo(a)pyrene (w)	µg/l	0.01							
Benzo(b)fluoranthene (w)	µg/l	0.01							
Benzo(ghi)perylene (w)	µg/l	0.01							
Benzo(k)fluoranthene (w)	µg/l	0.01							
Chrysene (w)	µg/l	0.01							
Dibenzo(ah)anthracene (w)	µg/l	0.01							
Fluoranthene (w)	µg/l	0.01							
Fluorene (w)	µg/l	0.01							
Indeno(123-cd)pyrene (w)	µg/l	0.01							
Naphthalene (w)	µg/l	0.01							
Phenanthrene (w)	µg/l	0.01							
Pyrene (w)	µg/l	0.01							
Total PAH 16MS (w)	µg/l	0.01							