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environmental water management

HYDROGEOLOGICAL RISK ASSESSMENT

FOR PROPOSED EXTENSION TO

UPPER LYDE QUARRY

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GENERAL NOTES

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1 INTRODUCTION

1.1 Report context

Upper Lyde Quarry (the site) is operated by Hereford Quarries Ltd for the extraction of sand and gravel with restoration to pre-existing ground levels using inert waste. Planning Permission was granted in August 2023 for an extension of the mineral extraction and restoration. It is now proposed to apply to vary the existing Environmental Permit (reference KB3105LH) to include the extension.

The proposed extension includes three areas: to the southwest of the site, immediately northeast of the site and to the east of Upper Lyde Lane. The permitted restoration back to agriculture, using both overburden and imported inert materials, includes areas of high quality habitat for nature conservation. The Application is for a Deposit for Recovery (DfR) covering all of the three extension areas.

Hafren Water has prepared an Environmental Setting and Site Design (ESSD) report[1], which sets out the background and baseline conditions, in support of the Permit Variation Application. Hafren Water has now been appointed by Hereford Quarries Ltd to prepare a Hydrogeological Risk Assessment (HRA) in support of the Permit Variation Application in response to an Environment Agency request for further information.

The purpose of the HRA is to describe and assess the potential risk posed by the proposed extension to infilling, at Upper Lyde, on the surrounding water environment. This involves assessment of the site-specific data and Conceptual Site Model (CSM) presented in the ESSD, which should be read in conjunction with this HRA. The CSM describes the plausible, potentially significant, pollutant linkages (source-pathway-receptor relationships) between the restored site and extant water environment and receptors in its vicinity.

The HRA is also an opportunity to make recommendations in relation to site management and monitoring that can be included in the Permit, during both the operational and post-restoration phases of the development.

This report has been prepared with regard to guidance issued by the Environment Agency, including "What to include in your hydrogeological risk assessments", updated 14th May 2025, and "Engineering construction proposals for deposit for recovery", updated 20th May 2026.

1 "Environmental Setting and Site Design Report for proposed extension to Upper Lyde Quarry" dated March 2026 Reference 4030/ESSD v F1.1

1.2 Information sources

Hereford Quarries Ltd

- Addendum to the Waste Recovery Plan for Upper Lyde Quarry. Dated 8th September 2025 Report ref 25/004a v3. Westbury Environmental Ltd

Hafren Water

- Environmental Setting and Site Design Report for proposed extension to Upper Lyde Quarry dated March 2026. Reference 4030/ESSD v F1.1

Environment Agency (EA)

- HRA guidance (www.gov.uk/guidance/landfill-operators-environmental-permits/ what-to-include-in-your-hydrogeological-risk-assessment) (updated 14th May 2025)
- Information sourced online.

2 Conceptual hydrogeological site model summary

The conceptual hydrogeological model for the proposed waste operation is described in Sections 3 of the ESSD report and the identified receptors are illustrated on Drawing 4030/ESSD/01.

4030/HRA/T1: Summary of site design		
Topic	**Key Section 3 finding**	**Hydrogeological risk assessment implication**
Source term	The proposed restoration will use imported inert waste, supported by strict waste acceptance procedures. Waste code 19 12 12 will not be accepted and any unsuitable material will be refused or quarantined	The potential contaminant source is limited by the inert nature of the imported material and the proposed controls
Geological pathway	The site is underlain by Glaciofluvial deposits comprising silts, sands and the Lower Gravel, over weak mudstone and sandstone of the Moor Cliffs Formation. The Lower Gravel forms the economic mineral and thins locally, particularly towards the northeast of Phase 3	The principal shallow pathway is through the sand and gravel where present. The Moor Cliffs Formation provides a lower permeability base and limits vertical migration to deeper bedrock groundwater
Aquifer setting	The Glaciofluvial deposits and Moor Cliffs Formation are classified as Secondary A aquifers. A perched water table occurs within the sand and gravel above the Moor Cliffs mudstone, but the superficial aquifer is laterally limited and recharge is restricted by its limited outcrop area	Groundwater within the sand and gravel is the primary receptor for the permit variation. The limited aquifer extent and restricted recharge reduce the scale of the groundwater resource potentially affected
Groundwater flow	Monitoring indicates seasonal groundwater variation of approximately 0.6 m to 0.9 m. Inferred groundwater flow in the sand and gravel is generally towards the northeast, with flow likely to diverge towards the north-northeast and southeast at the edge of the outcrop. The indicative hydraulic gradient is 0.014	Potential migration would be via vertical infiltration through inert fill and unsaturated sand and gravel, followed by lateral migration in shallow groundwater towards the inferred discharge zones
Unsaturated zone and landfill design	Unsaturated zone thickness varies across the site, from the full sand and gravel thickness in the west and southwest to approximately 3.9 m near PZ5 on the southeastern boundary. Mineral extraction is limited to above the water table and dewatering will not be undertaken, so imported waste will be placed above groundwater	Placement of inert waste above groundwater provides an unsaturated pathway and limits direct contact with groundwater

4030/HRA/T1: Summary of site design		
Topic	**Key Section 3 finding**	**Hydrogeological risk assessment implication**
Groundwater abstractions	Licensed groundwater abstractions within 2 km are located outside the sand and gravel deposit and are considered unlikely to be hydraulically linked to the site. Of the private abstractions, the closest, Springfield Cottage spring is no longer used and High Croft is up-gradient of the site	Licensed groundwater abstractions and private supplies are not considered viable down-gradient receptors for the proposed development
Groundwater quality	Monitoring data indicate neutral groundwater with generally low major ion concentrations. Down-gradient groundwater shows moderate natural variation and possible slight upward trends in chloride and sulphate, but concentrations remain relatively low. There is no clear evidence of groundwater contamination from the existing inert waste operation	Baseline quality supports a low-risk conceptual model for inert restoration, subject to continued monitoring and trend review for indicator determinands including chloride, sulphate, ammoniacal nitrogen, conductivity and total organic carbon
Surface water receptors	The site lies within the River Lugg catchment and close to minor tributaries of Moreton Brook. The River Lugg Site of Special Scientific Interest and River Wye Special Area of Conservation are approximately 1.7 km east of the site. The site is in Flood Zone 1	Surface water receptors are sufficiently distant and no direct surface water pathway has been identified. The northern tributary and down-gradient spring remain appropriate secondary compliance considerations for non-hazardous pollutants
Man-made pathways and other sources	A water main crosses the southwest of the site, within an area described as barren of sand and gravel and comprising silty fine sand to clayey silt overburden. Historical and permitted landfills within 2 km are not considered to present significant risk to the proposed development	The water main is not considered to create a significant contaminant migration pathway where the standoff is maintained. External contamination sources do not materially alter the risk assessment for the permit variation
Overall conceptual model	The relevant source–pathway–receptor linkage is imported inert waste, rainfall infiltration through the unsaturated zone, migration within the shallow sand and gravel aquifer, and discharge towards local springs or minor surface watercourses	The hydrogeological risk assessment should assess groundwater in the sand and gravel as the primary receptor, with compliance at the down-gradient site boundary for hazardous substances and at the relevant spring or tributary for non-hazardous pollutants

2.1 Site Design

A summary of the proposed site design, based on information provided in the ESSD report, including references to recommended features described later in this report is provided in *Table 4030/HRA/T2* below.

The site is above the watertable, situated within fluvioglacial sand and gravel deposits. No natural geological barrier therefore exists at the site. Whilst not a requirement for a DfR, an artificial geological barrier (AGB) will be constructed using suitable overburden over the base and sides of the quarry void in accordance with the existing site Permit. This AGB will have a minimum thickness, as determined by this risk assessment, placed to achieve a minimum permeability of 1 x 10^{-7} m/s.

This is a continuation of existing practices at the site.

4030/HRA/T2: Summary of site design	
Aspect	**Description**
Phasing	Site will be infilled in five Phases, in number order. Phase 0 is largely complete and Phases 1a f the extension area, to the east will be filled next with Phases 1b, 2 and 3 completing the site. – see Section 4.2 of the ESSD
Engineering	Artificial Geological Barrier (AGB) constructed against the sand and gravels across the sides and base of the site using clay rich overburden
Cap	None required
Leachate management	None required
Surface water management	Waterbody created on-site with surrounding landscaping to promote run-off Run-off diverted to the drain along the eastern site boundary
Afteruse	Returned back to agriculture

2.2 Summary of pathways and receptors

The plausible receptors and pathways are summarised in *Table 4030/HRA/T3* below.

4030/HRA/T3: Summary of identified 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
Potential primary pathway	Vertical infiltration of rainfall into the imported inert waste, downwards via the AGB into the unsaturated sand and gravel to the watertable Horizontal migration with groundwater in the sand and gravel down-

4030/HRA/T3: Summary of identified receptors and pathways	
	gradient to the discharge zone The presence of Moor Cliff Formation beneath sand and gravel deposits limits any potential pathway to deeper aquifers
Potential primary receptor	Groundwater within the sand and gravel Secondary 'B' Aquifer
Potential secondary receptor	The spring at Springwell Cottage is in hydraulic continuity with the groundwater within the superficial deposit (no longer used as a water supply)
Compliance point	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 spring east of the site and the tributary of Moreton Brook north of the site

2.3 Source

2.3.1 Potential sources of pollution

The three perceived, potential sources of pollution exist within the site are:

- The existing inert waste on site in Phase 0
- the imported infill material (inert waste for recovery), Phases 1a,1b 2 and 3
- chemicals (eg fuel oil) stored on-site

The storage of chemicals within the site will be controlled through the existing site Environmental Management System (EMS), in accordance with best practice for this activity. The risk associated with this was addressed in the Hydrogeological Impact Assessment accompanying the Planning Application and is not specifically assessed in this HRA.

The HRA is therefore primarily concerned with the potential impact of the imported inert infill material on groundwater.

Proposed waste types for the purpose of site restoration and waste acceptance procedures are described in Section 4 of the WRP, although there is no intention in taking waste listed under EU Waste Code 19 12 12.

2.3.2 Timeframe for infilling

Infilling of the extension area will continue consecutively after completion of the existing, Phase 0.

The required 260,000 m^3 (approximately 420,000 tonnes) of inert waste will be imported at a rate of 37,500 m^3 per year over 7 years.

2.3.3 Waste composition

The waste material to be accepted at the site will be limited to inert materials as specified in the Waste Recovery Plan.

The chemical composition of the imported material will be tested to ensure it is in compliance with inert Waste Acceptance Criteria (WAC) as defined in the Environmental Permitting (England and Wales) Regulations 2016, with reference to the EU Council Decisions 2003/33/EC.

Inert waste is defined as material which has a maximum amount of leachable solids for all the specified chemicals as given in *Table 4030/HRA/T4* below. The results as solids (mg/kg) represent the *maximum* leachable amount contained within 10 litres of eluate (water) and therefore the maximum dissolved concentration per litre (mg/l) is taken as one tenth of the solids value.

4030/HRA/T4: Inert Waste Acceptance Criteria		
Chemical	**Inert WAC* mg/kg**	**Maximum potential leachate concentration** 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 SO_4	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		

In reality, any leachate generated within the site is expected to be of significantly better quality, ie much lower concentrations of chemical constituents than shown above, and therefore have a significantly lower pollution potential. Hazardous chemicals such as arsenic, mercury, lead and hydrocarbons can reasonably be expected to not be present in the imported material other than those that can occur naturally, eg metals such as arsenic, at very low concentrations in waste soils.

3 HYDROGEOLOGICAL RISK ASSESSMENT

3.1 Nature of the Hydrogeological Risk Assessment

Environment Agency 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.

An HRA typically includes the following tiers of risk assessment:

- Tier 1 Risk Screening – to identify the baseline potential risk posed by the site, incorporating the degree of dilution in the underlying aquifer, to determine if site engineering (eg construction of an AGB) is required to provide sufficient groundwater protection. If potential risk is determined at Tier 1, more detailed assessment would subsequently be required
- Tier 2 Generic Quantitative Risk Assessment (GQRA) – use of generic input parameters to assess a specific aspect of relevance to the HRA such as the effect of an AGB on the degree of potential risk posed by the site
- Tier 3 Detailed Quantitative Risk Assessment (DQRA) – use of site-specific input parameters to refine the Tier 2 model

3.2 Tier 1- Risk screening

The extension area is located within superficial deposits classified as a Secondary 'A' Aquifer with underlying Raglan Mudstone. The superficial deposits are in hydraulic continuity with local springs and watercourses, the closest being a spring at Springwell Cottage located 60 m to the northeast of the Phase 2 boundary. The proposed site does not fall within a Source Protection Zone (SPZ).

As a result of the proximity of the Secondary A aquifer and the downgradient spring, the site setting is deemed sensitive and therefore a quantitative risk screen has been undertaken.

The Tier 1 level of assessment relates the source term within the site, to the underlying hydrogeological conditions to determine whether there is sufficient dilution within the aquifer to mitigate the worst-case pollution risk posed by the site. The identification of potential risks informs the need for an AGB and the need for a more detailed Teir 2, generic quantitative risk assessment.

3.2.1 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 screen or assessment can be compared.

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 groundwater beneath the site has the potential to be used for potable supply, the UK Drinking Water Standards (DWS) have been selected as the appropriate EAL for non-hazardous substances in the screening assessment.

4030/HRA/T5: Comparison of EALs with groundwater quality

Parameter	Inert WAC	MRV	DWS	EQS	Concentration in upgradient groundwater (PZ02) (see ESSD report)		
					Max	Ave	Min
Unit	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
Arsenic	50	5	10	50		not recorded	
Cadmium	4	0.1	5	0.08	0.01	0.06	1.5
Copper	200		2000	1	6	1.43	0.001
Chromium	50	37.5	50	4.7	1.25	0.45	0.001
Chromium VI		1		3.4		not recorded	
Nickel	40		20	4	1.5	1.15	0.001
Mercury	1	0.01	1	0.07		not recorded	
Lead	50	0.2	10		23	3.1	0.001
Selenium	10		10			not recorded	
Chloride	8.0E+04		250000		110000	25000	6000
Sulphate	1.0E+05		250000		66000	18000	1000
Benzene	600	1	1	10		not recorded	
Benzo-a-pyrene	1.0E+04	5.0E-05	1.0E-02	1.7E-04		not recorded	

Key: Min = minimum Ave = average Max = maximum

Notes: MRV = Minimum Reporting Value (or laboratory detection limit)
EQS = Environmental Quality Standards
Cadmium = all concentrations are below the Limit Of Detection(LOD) at the time of sampling

3.2.2 Conservatism within the risk screening

The risk screening has been undertaken using conservative input values such that the results represent an overestimate of potential baseline risk posed by the site. This means that the actual

risk is considered likely to be significantly lower than as simulated due to the effect of real conditions at the site.

Conservatism is built-in to the risk screening in the following ways:

i) Leachate source – as described in Section 2.3.3 above, the maximum theoretical concentrations of leachable chemicals for inert waste have been used to characterise the leachate source term within the infill material. This represents a considerable overestimation of the expected actual concentrations of dissolved chemicals within leachate contained within the site, thereby increasing the degree of impact on underlying groundwater

ii) Infiltration – the total effective rainfall (310 mm) has been used as the value for infiltration into/through the infill material. This is clearly an overestimation of the vertical flow through the site. The proposed profile of the restored site is such that a large proportion of incident rainfall would be diverted as run-off on untipped ground where infiltration into sand and gravel would occur. The reduction of infiltration into/through the infill will result in a reduced ration of volume of leachate exiting the base of the site to groundwater flowing beneath the site. As a result an increase in the dilution within groundwater will occur, reducing the impact of the site in comparison with the results of the risk screening. In the subsequent risk assessment modelling, the effects of soil type and slope on infiltration, are taken into account

iii) Area of infill – The area of infill is used to estimate the volume of rainfall ingress to the site. The extension infilled area has been estimated as approximately 4.98 hectares. Whereas it will be smaller as the above estimate assumes mineral extraction and filling up to the site boundary and does not take into account site boundary standoffs. It does assume no mineral extraction and infilling will occur to the southwest of the water main. As for infiltration, a reduction of this parameter will cause an increase in the dilution within underlying groundwater, reducing the impact of the site in comparison with the results of the risk screening

iv) Hydraulic conductivity - An estimate for the lower horizons within the sand and gravel aquifer of 5 x 10^{-6} m/s (0.43 m/d) has been made based on grain size analyses indication a well graded deposit with approximately 20% fines

v) Saturated thickness – the saturated thickness to the base of the sand and gravel deposit has been estimated. In the west of the site the deposit is generally dry, however any 'leachate' generated will flow across the top of the mudstone of the Moor Cliffs Formation towards the east. On the downgradient boundary the saturated thickness (based on PZ3) varies between 0.19 m and 2.6 m, with a geometric mean of 1 m and a median of 1.2 m. The geometric mean has been used in the assessment

3.2.3 Results

The WAC concentrations were reduced by the calculated dilution factor of 1.03 and compared wit the EAL (DWS for non-hazardous and MRV for hazardous substances). This has indicated that for some substances listed with inert WAC concentrations, dilution alone would not be sufficient to prevent adverse impacts to water quality and further Tier 2 quantitative risk assessment is needed. The exception to this is non-hazardous substances chloride, sulphate, cadmium, copper and selenium. These substances do not need further investigation. The Tier 1 risk assessment is included at Appendix *4030/HRA/A1*.

3.3 Generic quantitative risk assessment

As the screening assessment identified that dilution alone will not be sufficient to prevent impacts to water quality at Holywell Brook, a generic quantitative risk assessment has been undertaken. This was undertaken to determine the required specification for a geological barrier that would provide attenuation capacity such that pollution of groundwater or other receptors is prevented. The assessment was undertaken using the RAM3 spreadsheet model.

3.3.1 Proposed assessment scenarios

- Lifecycle phases

Environment Agency guidance states that a Hydrogeological Risk Assessment must be carried out for the whole lifecycle of the development, ie from the start of the operational phase until the point at which the site is no longer capable of posing an unacceptable environmental risk.

As the site receives only inert waste and has no leachate management or control and no formal capping, a quantitative Hydrogeological Risk Assessment of the post-closure phase has been undertaken. The nature of the RAM3 model assumes that all waste is deposited instantaneously and so this modelling, which uses a declining source term is deemed conservative and representative of the worse case scenario.

- Failure scenarios

There are no engineering management structures at the site to prevent the ingress of rainwater (other than the sloping topography) or the egress of leachate. This is due to the inert nature of the proposed waste stream. Failure of such systems is, therefore, not possible and failure scenarios will not be considered.

- Accidents

Accidents are considered to be unintentional incidents that could reasonably occur, which are unforeseeable at their time of occurrence. No permanent structures will be located at the site and therefore accidents are unlikely to occur.

However, it would be possible, although highly unlikely, for the acceptance of contaminated material to occur. Due to the proposed waste sources and Waste Acceptance Procedures, it is considered exceedingly unlikely that 'rogue loads' will be accidentally accepted at the site. However, in accordance with accepted practices a rogue load assessment has been undertaken and is provided in Section 3.7 below.

3.3.2 Priority substances

The following substances failed the Tier 1 risk screen:

Hazardous substances:

Arsenic
Chromium
Mercury
Lead
Benzene
Benzo-a-pyrene

Non-hazardous substances:

Nickel

However, as both mercury and lead tend to have low mobility in groundwater and are highly retarded they have not been modelled.

The appropriate EALS are described in Section 3.2.1, as used in the Teir 1 risk assessment. The same EALS will be used in the Generic Quantitative Risk Assessment (GQRA).

3.3.3 Justification for modelling approach and software

The assessment has been undertaken using ESI's (now Stantec) Risk Assessment Model 3 (RAM3) in order to determine the physical requirements of an artificial geological barrier to prevent pollution of the water environment. RAM3 has been selected as it enables modelling of the waste, transport within the unsaturated zone and the saturated zone to the compliance points.

No impact on the water environment has been identified associated with Phase 0, the currently permitted area, therefore the extension areas have been modelled as a single source. Separate pathways have been modelled to the watertable for hazardous substances and to the spring for non-hazardous substances. For simplification, the Phase 3 volume of waste has been included within the single waste source with a pathways to the spring, despite the fact that in reality, flow

beneath Phase 3 would be to the edge of the sand and gravel aquifer to the northeast of Phase 3.

The conceptual model within RAM3 is shown in Appendix 4030/HRA/A2 and the in cross section on *Drawing 4030/HRA/02*.

3.3.4 Modelled parameters

The aquifer/pathway modelled parameters are as per the Tier 1 risk assessment and summarised below.

4030/HRA/T6: Model pathway input parameters		
HYDROGEOLOGICAL UNITS		
Thickness (m):		
Artificial geological barrier	0.3	Calculated from GQRA
Sand &gravel (unsaturated thickness)	1.3	Average sand and gravel thickness left between the winter high and average saturated thickness.
Sand &gravel (saturated thickness)	1	Geometric mean saturated thickness
Hydraulic conductivity (m/s):		
Artificial Geological Barrier	1×10^{-7}	Assumed
Sand & gravel	5×10^{-6}	Estimated based on well sorted deposit with 20% fines
Hydraulic gradient:		
Artificial Geological Barrier	1	Assumed vertical
Sand & gravel	0.014	Measured
Porosity:		
Artificial Geological Barrier	0.4	Generic value for clay
Sand & gravel	0.25	Estimated for well sorted deposit with ~20% fines
Tortuosity	5	Assumed generic value for all hydrogeological layers
Horizontal travel distance (m):		
To spring	163	Average distance from down gradient boundaries of phases 1a, 1b and 2

The source term parameters are provided below.

4030/HRA/T7: Model source and substance input parameters		
Parameter	**Value**	**Justification**
SOURCE TERM		
Waste volume (m^3) New phases Waste Area (m^2)	 260,000 49,800	 WRP Approximate, measured
Source porewater concentration (mg/l) Arsenic Chromium Benzene Benzo (a) pyrene Nickel	 0.05 0.05 0.6 10 0.04	 Based on inert WAC
GENERAL CONTAMINANT INFORMATION		
Free water diffusion coefficient (m^2/s): Arsenic Chromium Benzene Benzo (a) pyrene Nickel	 9.05×10^{-10} 1.0×10^{-9} 6.90×10^{-10} 3.67×10^{-10} 1.0×10^{-9}	 Arsenic from Allison & Allison, 2005 Buss et al, 2004, Table 3.1 CLAIRE Research Bulletin RB15 (Sep 2011) Sato H, Yui M & Yoshikawa H (1996)
ATTENUATION PARAMETERS		
Dispersivity	Unit thickness/10	Standard assumption
Mixing depth (m) in: Sand & gravel	 1	 Same as unit thickness.
Bulk density (kg/m^3): Artificial Geological Barrier Unsaturated sand & gravel Unsaturated sand & gravel	 1800 1900 1900	 Generic value used
Fraction of organic carbon (foc) Artificial Geological Barrier Sand & gravel saturated and unsaturated	 0.05 0.0002	 US EPA default concentration for foc of subsurface soils and assumption clays have typically 5 times higher organic content US EPA default concentration for foc of subsurface soils

4030/HRA/T7: Model source and substance input parameters		
Parameter	**Value**	**Justification**
Arsenic		
Partition coefficient (k_d) (L/kg)	2000	Sheppard 2009. Table 5-16.
Chromium		
Partition coefficient (k_d) (L/kg)	631	Allison & Allison, 2005
Benzene		
Koc	190	EA 2002.
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
Benzo (a) Pyrene		
Koc	1.17×10^6	USEPA 1996 Part 5: Chemical Specific Parameters
Partition coefficient (k_d) (L/kg)	Calculated	
Half life in groundwater (days)	830	UK Soil and Herbage Pollutant Survey, Report No 9. June 2007. Middle of range
Nickel		
Partition coefficient (k_d) (L/kg)	20	Value from ConSim
WATER BALANCE		
Vertical pathway		
Average yearly rainfall (1993 to 2025) (mm/yr)	654	Bromyhill rain gauge
Monthly evaporation (mm/yr)	504	MAFF evapotranspiration data
Effective rainfall (mm/yr)	310	Calculated
Horizontal pathways		
Width of waste body	222	Measured
Flow	Calculated	Darcy equation used to calculate flow through saturated thickness of waste using values above.

3.3.5 Results

The results of the GQRA are provided in in *Appendix 4030/HRA/A3* and summarised in *Table 4030/HRA/T8* below. The results indicate that no chemical was simulated to exceed its respective EAL in groundwater at the receptor. Therefore the simulated AGB with a 0.3 m thickness, is considered sufficient to mitigate potential risk posed by the site to groundwater.

4030/HRA/T8: Results of the GQRA		
Determinand	**EAL at the compliance point**	**Peak concentration at the compliance point (time to peak in years)**
Non-hazardous: Nickel	 4 x 10^{-3} mg/l	 1.29 x 10^{-8} (2000 years)
Hazardous: Arsenic Chromium Benzene Benzo(a)pyrene	 5 x 10^{-3} mg/l 3.75 x 10^{-2} mg/l 1 x 10^{-3} mg/l 5 x 10^{-8} mg/l	 8.52 x 10^{-8} (200 years) 4.05 x 10^{-7} (100 years) 7.76 x 10^{-5} (1 years) Not detected up to 3000 years

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 Review of technical precautions

Due to the inert nature of the waste it is considered that the proposed 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
iii) Provision of a 0.3 m thick geological barrier constructed from overburden with a maximum permeability of 1 x 10^{-7} m/s
iv) Progressive restoration to a profile to encourage surface water run-off and minimise water ingress
v) Monitoring of down-gradient water quality

Leachate monitoring and management is not required due to the inert nature of the waste.

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

3.5 Emissions to groundwater

One of the main purposes of the HRA is to establish whether the predicted discharge from the landfill complies with the requirements of the Environmental Permitting (England and Wales) Regulations (EPR 2016) Schedule 22 Groundwater activities.

3.5.1 Hazardous substances

The HRA has demonstrated that the proposed technical precautions will prevent Hazardous substances from entering groundwater at discernible concentrations at the compliance point at the watertable prior to any dilution occurring.

Given the strictly inert nature of the waste and the presence of a geological barrier, and the other technical precautions in place, it is concluded that during normal operation and through to long-term post-closure there will be no discernible discharge of Hazardous substances into the groundwater.

3.5.2 Non-hazardous pollutants

The HRA has demonstrated that technical precautions will limit the introduction of Non-hazardous pollutants into groundwater so as to avoid pollution at the downgradient groundwater compliance point following dilution.

Given the inert nature of the waste, the presence of a geological barrier, and the other technical precautions in place, it is concluded that during normal operation and through to long-term post-closure concentrations of Non-hazardous pollutants would be sufficiently low as to avoid pollution of the groundwater.

3.6 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 if necessary to direct surface water run-off away from the active working area during its operational and post-operational phase. However, as the surrounding sand and gravel is permeable, this is not considered likely to be required.

3.7 Rogue load assessment

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 4030/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. As waste codes to be accepted at the site are those that are considered truly inert and do not require testing, in accordance with the Landfill Directive. Two additional waste codes are proposed for the site; 02 04 01 which includes soils generated from washing beet and is to be used within the restoration soils only and very small volumes of 10 13 14 which comprises concrete from the "manufacture of cement, lime and plaster and products made from them". High concentrations of sulphate above inert WAC levels are not considered likely.

It is therefore 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. The Waste Acceptance Criteria and Procedures applied at the site make the deposition of rogue loads unlikely and the potential risk to groundwater minimal.

3.8 Sensitivity analyses

Sensitivity analyses has been undertaken for parameters that vary across the site.

3.8.1 Saturated thickness

The saturated thickness impacts on the available dilution of non-hazardous substances in groundwater below the site and to the compliance point. The average measured saturated thickness varies from 0.22 m to 1.22 m based on groundwater level monitoring within the existing monitoring boreholes (PZ2, PZ3 and PZ5). With increased saturated thickness the groundwater velocity in the saturated sand and gravel increases from 3.4 x 10-6 m^3/s (for 0.22 m thick saturated zone) to 1.86 x 10-5 m^3/s (for a 1.22 m thick saturated zone). This increase in velocity reduced the peak nickel concentration at the down gradient compliance point fractionally from 1.2962 x 10^{-8} mg/l to 1.2961 x 10^{-8} mg/l.

The sensitivity analyses indicates that the modelling is not sensitive to changes of saturated thickness within the bounds recorded on site.

3.8.2 Unsaturated zone thickness

The unsaturated zone lies above the watertable and below or adjacent to the site. Changes in the unsaturated zone thickness affects available attenuation of substance before they reach the groundwater table. Hence will impact concentrations of hazardous and non hazardous substances at their respective compliance point.

The measured unsaturated zone within the boreholes at site varies due to the geometry of the sand and gravel deposit. It is intended to only extract sand and gravel from above the winter high watertable. The difference between the winter high and average saturated thickness has been used to determine the saturated thickness in the GQRA above. The range in unsaturated zone for borehole PZ2, PZ3 and PZ5 is 1.2 m to 1.43 m. If the minimum groundwater level was used to estimate change in saturated thickness between winter and summer conditions, a larger unsaturated zone would result. As the range above is close to the value used in the GQRA (0.5 m and 2.5 m), rather than realistic site values have been used.

With increased unsaturated zone thickness (0.1, 0.5 to 2.5 m) results in the peak nickel concentration at the down gradient compliance point decreasing fractionally from 1.29615×10^{-8} mg/l to 1.29605×10^{-8} mg/l. For the hazardous substance chromium, concentrations decrease from 4.176×10^{-7} mg/l to 4.101×10^{-7} mg/l.

The sensitivity analyses indicates that the modelling is not sensitive to changes of unsaturated thickness within the bounds plausible at site.

The results of the sensitivity analyses are provided in *Appendix 4030/HRA/A5.*

4 REQUISITE SURVEILLANCE

4.1 Risk-based monitoring scheme

As the site will be operated as a DfR site, there is no automatic requirement for monitoring. However, groundwater monitoring is undertaken at the site and it is proposed that, as the site is considered to be in a sensitive location this continues.

Assessment levels and compliance limits form the basis for assessing groundwater monitoring data at landfill sites.

Control levels are specific assessment criteria relating to groundwater, or other relevant parameters, which are used to determine whether a landfill is performing as designed. They act primarily as an early warning system to enable appropriate investigative or control measures to be implemented.

Compliance limits are specific compliance concentrations (or regulatory standards) and are specified in an Environmental Permit. If the defined compliance limits are exceeded significant adverse environmental effects and/or breaches of regulatory standards will have occurred. Such effects are deemed consistent with groundwater having been polluted.

4.1.1 Leachate monitoring

There is no requirement for collection and management of leachate, hence leachate monitoring is not proposed.

4.1.2 Surface water monitoring

Surface water is absent in close proximity to the site hence monitoring will not be necessary.

4.1.3 Groundwater monitoring

It is proposed that groundwater quality and level continue to be monitored at the site. Details of the proposed monitoring scheme are given in Section 5.2 of the ESSD report and the piezometer locations are shown on Drawing 3994/ESSD/04.

4.1.4 Compliance limits and control levels

The following are proposed groundwater assessment levels and compliance limits.

4030/HRA/T1: Surface water and groundwater control levels and compliance limits			
Compliance point	**Parameter**	**Derived control level**	**Derived compliance limit**
Groundwater down-gradient monitoring boreholes PZ3 and PZ5 *	Chromium (Hazardous) Benzene (Hazardous) Nickel (Non-hazardous)	None set None set 1.25 µg/l[2]	0.1 µg/l[1] 1 µg/l[1] 2.18 µg/l[3]
PZ1 is up gradient of the landfill area and PZ2 is likely to be influenced by groundwater flow from the adjacent agricultural field rather than the landfill. PZ4 monitors groundwater in the Ragland Mudstone which is isolated from that in the sand and gravel. 1 Based on EAL 2 Most common lower limit of detection 3 Mean plus 2 x SD for downgradient borehole PZ5.			

Assessment levels for Non-hazardous substances will be deemed to have been breached if the three point rolling average demonstrates a rising trend. Monitoring data will be compared against the Assessment and Compliance Limits each time they are collected.

If a breach is observed the actions listed on *Table 4030/HRA/T9* will be taken.

4030/HRA/T2: Contingency actions following breach in control levels or compliance		
Contingency action	**Following breach in**	
	Control level	**Compliance limit**
Advise site management	√	√
Advise manager of landfill operating company	√	√
Advise Environment Agency	√	√
Confirm by repeat sampling and analysis	√	√
Review existing monitoring information	√	√
Review site management and operation and implement actions to prevent future failure	√	
Determine degree of risk presented by breach	√	√
Review HRA control levels and compliance limits	√	√
Agree any corrective/remedial action with Environment Agency		√

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 inert 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).

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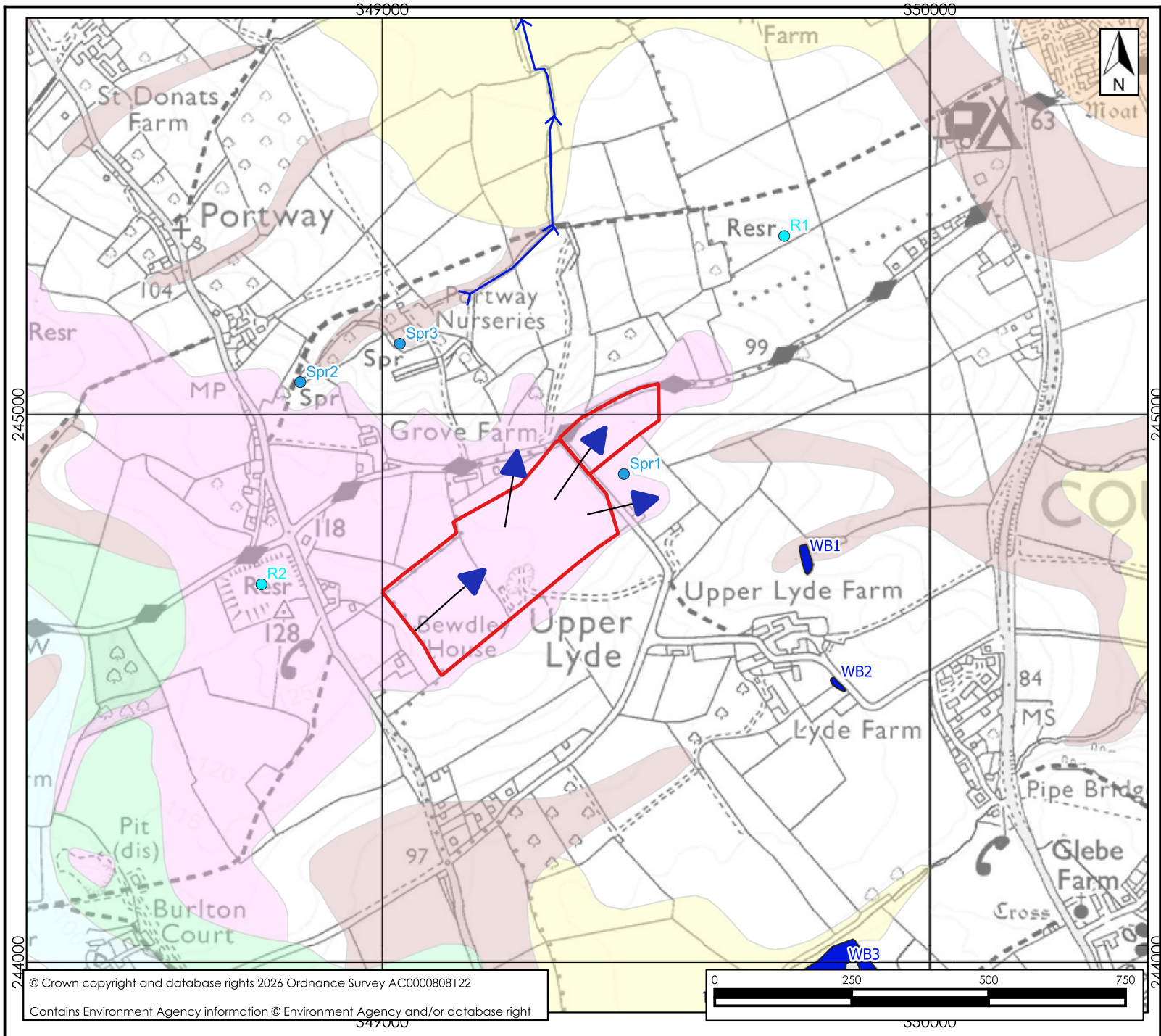
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DRAWINGS



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Key

- Site Boundary
- Watercourses
- Waterbodies
- Springs
  Spring 1 -main groundwater receptor
- Covered Reservoir
- Groundwater flow direction

Spring 1 is the only groundwater receptor and the sand and gravel aquifer is limited in latteral extent.

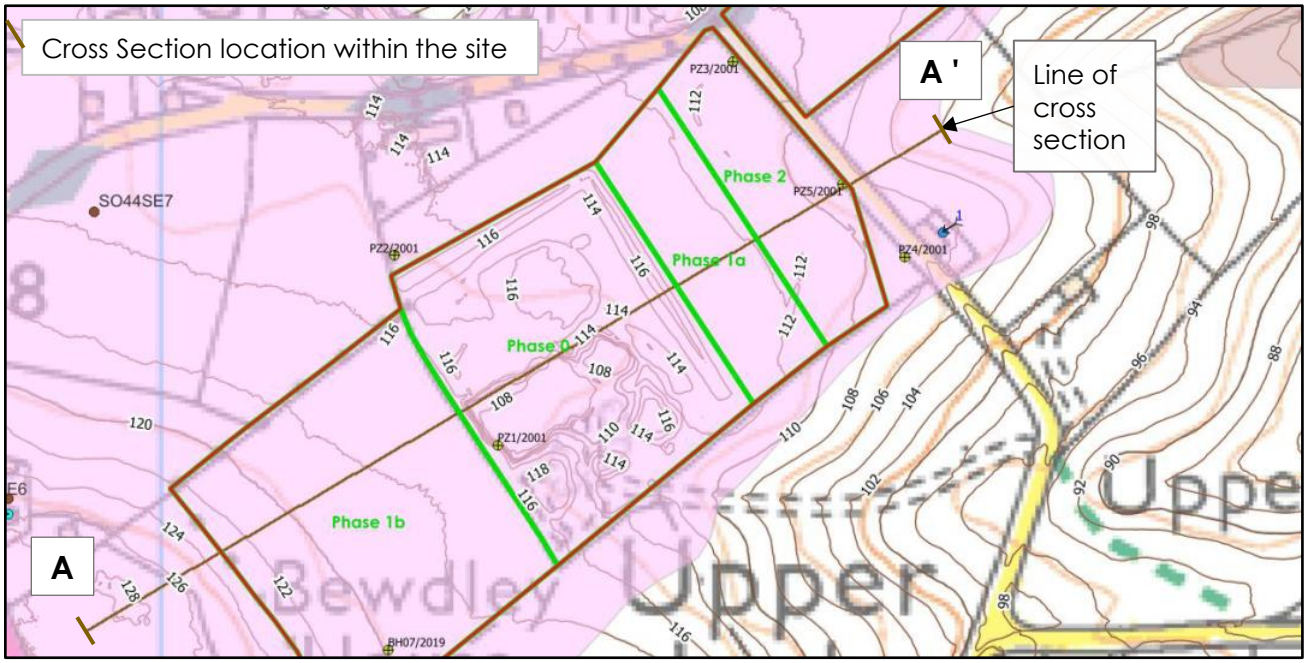
No pathway exists between the site and surface water courses

Scale correct at A4

Client	Hereford Quarries Limited
Title	Conceptual site model
Project	Upper Lyde
Drawing	4030/HRA/01
Version	1, HM
Date	Jun 2026
Scale	1:10,000

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environmental water management
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Key

- Current topography
- Glaciofluvial deposits, Mid Pleistocene
- Moor Cliffs Formation
- Watertable in sand and gravel
- Groundwater direction of flow
- Extension area Phase 1a and 2

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Client	Hereford Quarries		
Title	Conceptual Cross Section		
Project	Upper Lyde Quarry		
Drawing	4030/HRA/02	Version	1, KK
Date	Jun 2026	Scale	N/A

APPENDIX 4030/HRA/A1

Teir 1 Risk Screen

hafrenwater
environmental water management

Calc sheet by:	HM	Yellow	Data entry
Version number:	1	Green	Formulae
Date:	24/06/2026	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 User Defined values

Type of Dilution Aquifer

Screening Values (µg/l)

Parameter	Inert WAC	MRV	DWS	EQS	User Defined
Arsenic (As)+	50	5	10	50	5
Cadmium (Cd)	4	0.1	5	0.08/0.45	5
Copper (Cu)	200		2000	1	2000
Total Chromium (Cr)	50	37.5	50	4.7	37.5
Chromium VI+		1		3.4	1
Nickel (Ni)	40		20	2/34*	20
Mercury (Hg)	1	0.01	1	0.07	0.01
Lead (Pb)+	50	0.2	10	1.2/14	0.2
Selenium (Se)	10		10		10
Chloride (Cl^-)	8.0E+04		250000		250000
Sulphate (SO_4^{2-})	1.0E+05		250000		250000
Benzene	600	1	1	10/50*	1
Benzo-a-pyrene+	1.0E+04	5.0E-05	1.0E-02	0.00017/0.27*	1.00E-02

Hazardous substance

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

EQS values and max allowable/annual average

Calculation of Dilution Factor

Site Parameters			**Data Source**
Rainfall infiltration rate	310.0	mm/yr	Effective rainfall
Area of landfill	49800	m^2	proposed fill area
Total infiltration	42.30	m^3/day	
Aquifer Dilution			
Hydraulic Conductivity (k)	0.4300	m/day	Well graded s&g with 20% fines
Hydraulic Gradient (i)	0.0140		Measured from gwl data
Area	222	m^2	222 m width * 1 m geomean sat thickness
Flow Rate (Q)	1.34	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	1.03		

Proposed WAC Concentrations

Parameter	WAC after dilution	Exceeds selected screening value?	Max allowable concentration	
Arsenic (As)[+]	48	Yes	5	µg/l
Cadmium (Cd)	3.88	No	NA	µg/l
Copper (Cu)	194	No	NA	µg/l
Total Chromium (Cr)	48.5	Yes	38.7	µg/l
Chromium VI[+]	No Value	No Value	NA	µg/l
Nickel (Ni)	39	Yes	20.63	µg/l
Mercury (Hg)	0.97	Yes	0.01	µg/l
Lead (Pb)[+]	48.5	Yes	0.2	µg/l
Selenium (Se)	9.7	No	NA	µg/l
Chloride (Cl^-)	77550	No	NA	µg/l
Sulphate (SO_4^{2-})	96937	No	NA	µg/l
Benzene	582	Yes	1.03	µg/l
Benzo-a-pyrene[+]	9694	Yes	5.2E-05	µg/l

Hazardous substance

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

Notes

Non-Hazardous substances have been compared againt DWS and EQS values due to the presence of groundwater and surface water receptors.
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 Lead, Nickle, Copper is based on the bioavailable fraction.
The EQS value for Benzene is the Maximum allowable
The EQS for arsenic is UKTAG derived

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 'leachatability' based on standars L/S =10

Council Decision Annex 2003/33/EC

The Water Supply (Water Quality) Regulations 2016

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

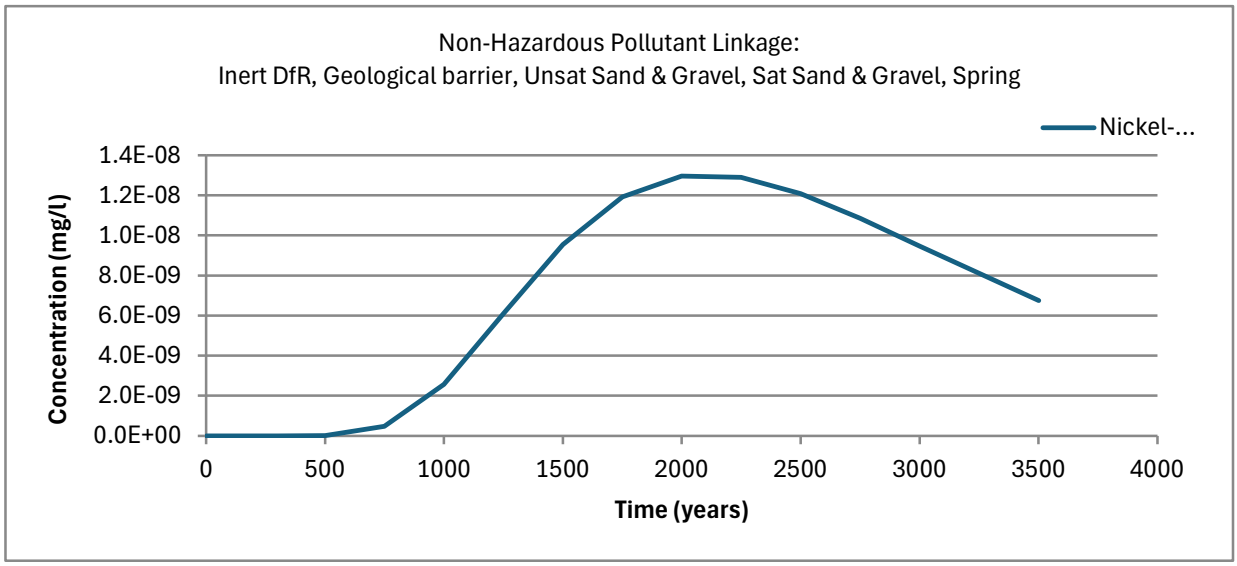
APPENDIX 4030/HRA/A2

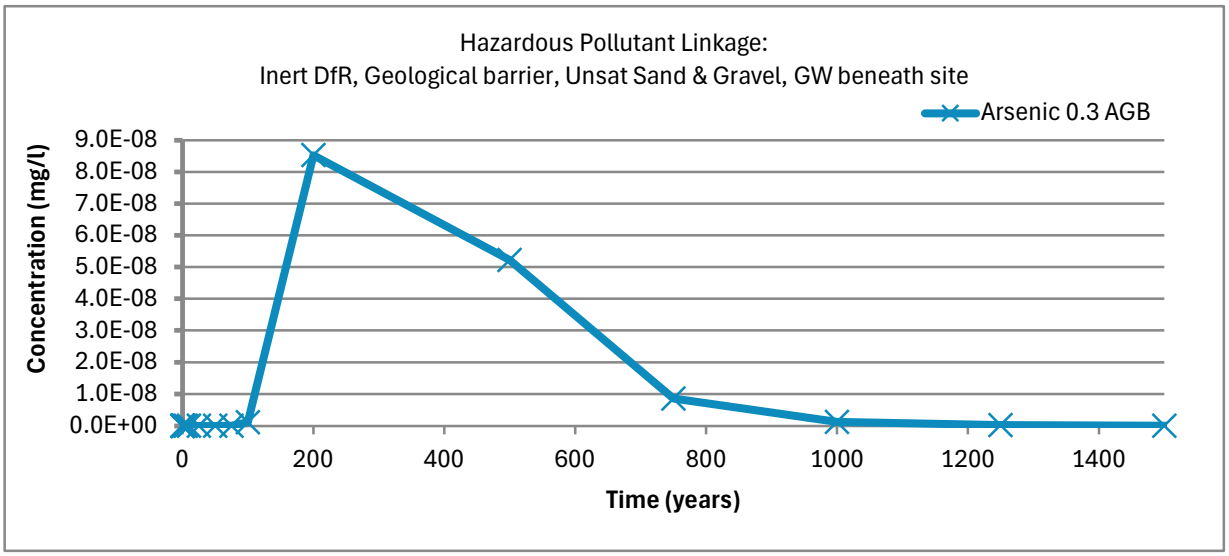
RAM model

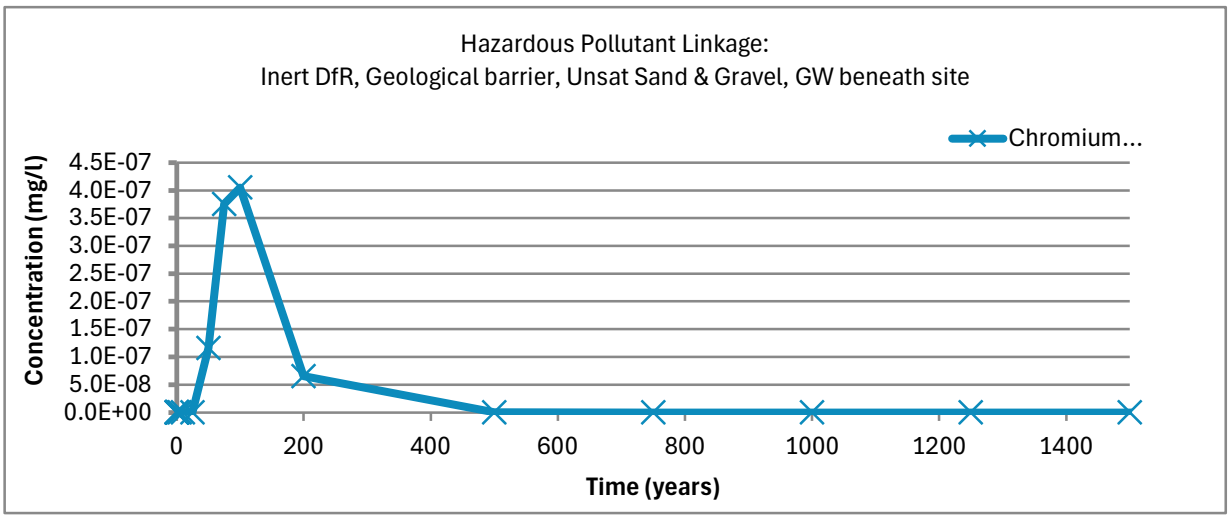
APPENDIX 4030/HRA/A3

Results of Generic Quantitative Risk Assessment (GQRA)

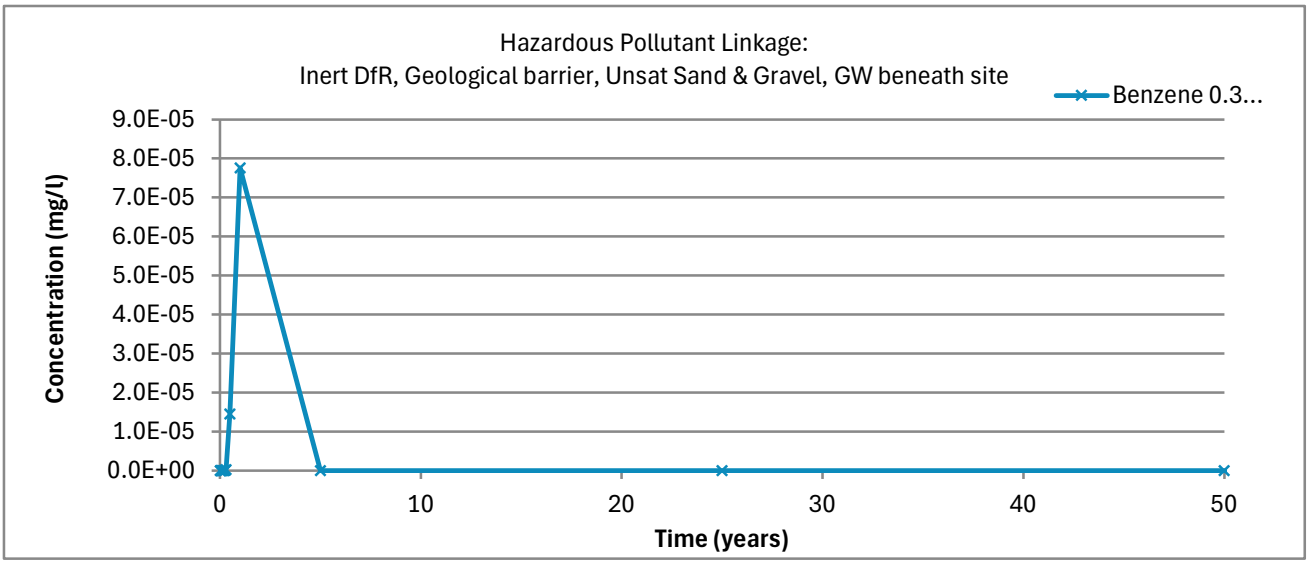
Breakthrough Curves

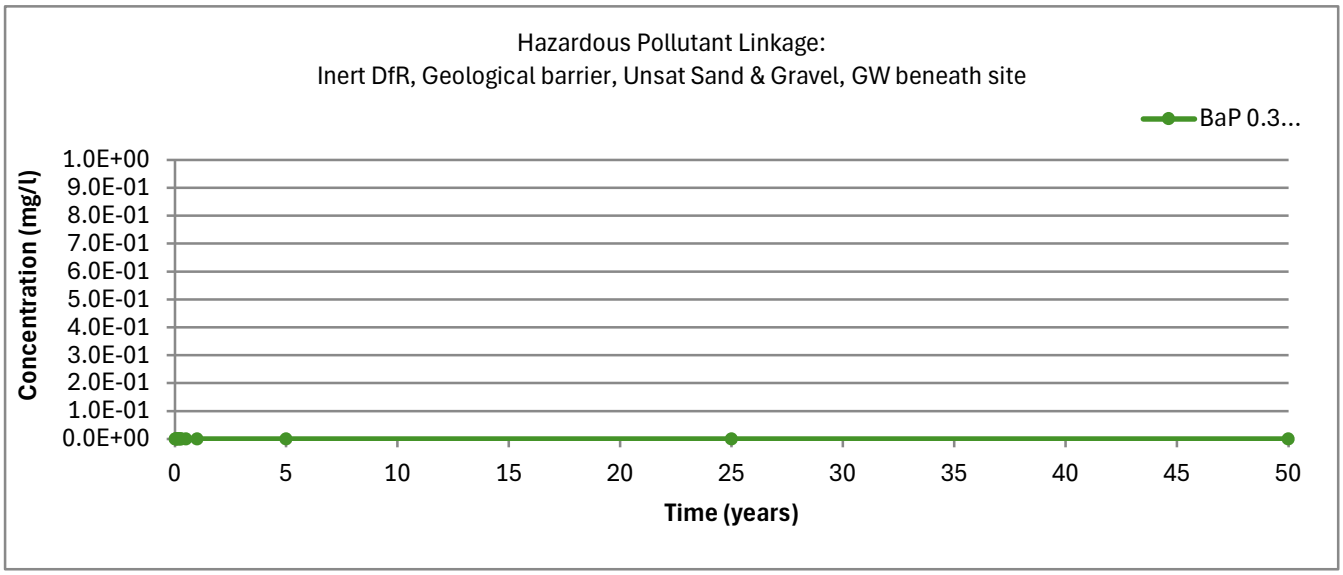






Breakthrough Curves





BREAKTHROUGH RESULTS

0.3 m AGB

Site Name: "Upper Lyde extension"

Advanced

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, Sat Sand & Gravel, Spring

Concentrations in mg/L in Spring

Compared with EAL target concentration in mg/L

	5.000E-03		3.750E-02		1.000E-03		5.000E-08		2.000E-02
	Species1		Species2		Species3		Species4		Species5
Time(year	**Arsenic**	Time(years	**Chromium**	Time(years	**Benzene**	Time(years	**BaP**	Time(years	**Nickel**
0.1	0.000E+00	**0.1**	0.000E+00	**0.02**	0.000E+00	**0.02**	0.000E+00	**1**	0.000E+00
0.2	0.000E+00	**0.2**	0.000E+00	**0.04**	0.000E+00	**0.04**	0.000E+00	**5**	0.000E+00
0.5	0.000E+00	**0.5**	0.000E+00	**0.06**	0.000E+00	**0.06**	0.000E+00	**10**	0.000E+00
0.75	0.000E+00	**0.75**	0.000E+00	**0.1**	0.000E+00	**0.1**	0.000E+00	**20**	0.000E+00
1	0.000E+00	**1**	0.000E+00	**0.15**	0.000E+00	**0.15**	0.000E+00	**50**	1.549E-34
2	0.000E+00	**2**	0.000E+00	**0.2**	0.000E+00	**0.2**	0.000E+00	**100**	0.000E+00
5	0.000E+00	**5**	0.000E+00	**0.25**	0.000E+00	**0.25**	0.000E+00	**200**	1.777E-20
10	0.000E+00	**10**	0.000E+00	**0.3**	0.000E+00	**0.3**	0.000E+00	**300**	1.595E-15
25	0.000E+00	**25**	0.000E+00	**0.5**	0.000E+00	**0.5**	0.000E+00	**500**	9.049E-12
50	0.000E+00	**50**	0.000E+00	**1**	2.536E-25	**1**	0.000E+00	**750**	4.605E-10
75	0.000E+00	**75**	0.000E+00	**5**	5.749E-12	**5**	0.000E+00	**1000**	2.566E-09
100	0.000E+00	**100**	0.000E+00	**25**	6.497E-20	**25**	0.000E+00	**1250**	6.085E-09
200	0.000E+00	**200**	0.000E+00	**50**	0.000E+00	**50**	0.000E+00	**1500**	9.546E-09
500	0.000E+00	**500**	0.000E+00	**75**	3.581E-20	**75**	0.000E+00	**1750**	1.192E-08
750	0.000E+00	**750**	0.000E+00	**100**	2.255E-20	**100**	0.000E+00	**2000**	1.296E-08
1000	0.000E+00	**1000**	0.000E+00	**200**	0.000E+00	**200**	0.000E+00	**2250**	1.290E-08
1250	0.000E+00	**1250**	2.911E-40	**500**	0.000E+00	**500**	0.000E+00	**2500**	1.208E-08
1500	0.000E+00	**1500**	2.629E-36	**750**	0.000E+00	**750**	0.000E+00	**2750**	1.085E-08
2000	0.000E+00	**2000**	3.991E-32	**1000**	0.000E+00	**1000**	0.000E+00	**3000**	9.457E-09
2500	0.000E+00	**2500**	5.336E-30	**2000**	5.130E-23	**2000**	0.000E+00	**3500**	6.747E-09

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, GW beneath site

Concentrations in mg/L in GW beneath site

Compared with EAL target concentration in mg/L

	5.000E-03		3.750E-02		1.000E-03		5.000E-08		2.000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.000E+00	**0.1**	0.000E+00	**0.02**	1.087E-36	**0.02**	0.000E+00	**0.1**	0.000E+00
0.2	0.000E+00	**0.2**	0.000E+00	**0.04**	2.024E-26	**0.04**	0.000E+00	**0.2**	2.805E-22
0.5	0.000E+00	**0.5**	0.000E+00	**0.06**	5.006E-22	**0.06**	0.000E+00	**0.5**	3.780E-13
0.75	0.000E+00	**0.75**	0.000E+00	**0.1**	8.612E-19	**0.1**	0.000E+00	**0.75**	1.743E-09
1	0.000E+00	**1**	0.000E+00	**0.15**	7.282E-13	**0.15**	0.000E+00	**1**	8.112E-08
2	0.000E+00	**2**	1.723E-39	**0.2**	4.800E-10	**0.2**	0.000E+00	**2**	6.573E-06
5	0.000E+00	**5**	2.993E-25	**0.25**	1.999E-08	**0.25**	0.000E+00	**5**	4.273E-06
10	0.000E+00	**10**	0.000E+00	**0.3**	2.148E-07	**0.3**	0.000E+00	**10**	1.082E-07
25	0.000E+00	**25**	1.921E-10	**0.5**	1.449E-05	**0.5**	0.000E+00	**25**	1.183E-12
50	6.183E-15	**50**	1.160E-07	**1**	7.758E-05	**1**	0.000E+00	**50**	0.000E+00
75	2.567E-11	**75**	3.756E-07	**5**	2.433E-09	**5**	0.000E+00	**75**	0.000E+00
100	1.136E-09	**100**	4.053E-07	**25**	0.000E+00	**25**	0.000E+00	**100**	0.000E+00
200	8.526E-08	**200**	6.510E-08	**50**	0.000E+00	**50**	0.000E+00	**200**	0.000E+00
500	5.219E-08	**500**	4.243E-11	**75**	0.000E+00	**75**	0.000E+00	**300**	0.000E+00
750	8.613E-09	**750**	9.803E-14	**100**	0.000E+00	**100**	0.000E+00	**400**	0.000E+00
1000	1.250E-09	**1000**	6.735E-16	**200**	0.000E+00	**200**	0.000E+00	**500**	0.000E+00
1250	1.777E-10	**1250**	1.940E-16	**500**	3.008E-15	**500**	0.000E+00	**1000**	7.027E-17
1500	2.538E-11	**1500**	0.000E+00	**750**	3.117E-15	**750**	0.000E+00	**1500**	4.034E-16
2000	5.342E-13	**2000**	0.000E+00	**1000**	2.776E-15	**1000**	0.000E+00	**2000**	4.425E-16
2500	1.182E-14	**2500**	0.000E+00	**2000**	1.716E-15	**2000**	0.000E+00	**3000**	3.902E-16

APPENDIX 4030/HRA/A4

EA guidance on rogue load source term

‘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 4030/HRA/A5

Sensitivity analyses results

0.22 m Saturated thickness	
dilution only affects Non-hazardous pathway	

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Advanced

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, Sat Sand & Gravel, Spring

Concentrations in mg/L in Spring

Compared with EAL target concentration in mg/L

	5.0000E-03		3.7500E-02		1.0000E-03		5.0000E-08		2.0000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.0000E+00	**0.1**	0.0000E+00	**0.02**	0.0000E+00	**0.02**	0.0000E+00	**1**	0.0000E+00
0.2	0.0000E+00	**0.2**	0.0000E+00	**0.04**	0.0000E+00	**0.04**	0.0000E+00	**5**	0.0000E+00
0.5	0.0000E+00	**0.5**	0.0000E+00	**0.06**	0.0000E+00	**0.06**	0.0000E+00	**10**	0.0000E+00
0.75	0.0000E+00	**0.75**	0.0000E+00	**0.1**	0.0000E+00	**0.1**	0.0000E+00	**20**	0.0000E+00
1	0.0000E+00	**1**	0.0000E+00	**0.15**	0.0000E+00	**0.15**	0.0000E+00	**50**	1.5495E-34
2	0.0000E+00	**2**	0.0000E+00	**0.2**	0.0000E+00	**0.2**	0.0000E+00	**100**	0.0000E+00
5	0.0000E+00	**5**	0.0000E+00	**0.25**	0.0000E+00	**0.25**	0.0000E+00	**200**	1.7769E-20
10	0.0000E+00	**10**	0.0000E+00	**0.3**	0.0000E+00	**0.3**	0.0000E+00	**300**	1.5950E-15
25	0.0000E+00	**25**	0.0000E+00	**0.5**	0.0000E+00	**0.5**	0.0000E+00	**500**	9.0497E-12
50	0.0000E+00	**50**	0.0000E+00	**1**	2.5361E-25	**1**	0.0000E+00	**750**	4.6050E-10
75	0.0000E+00	**75**	0.0000E+00	**5**	5.7494E-12	**5**	0.0000E+00	**1000**	2.5661E-09
100	0.0000E+00	**100**	0.0000E+00	**25**	6.4970E-20	**25**	0.0000E+00	**1250**	6.0853E-09
200	0.0000E+00	**200**	0.0000E+00	**50**	0.0000E+00	**50**	0.0000E+00	**1500**	9.5466E-09
500	0.0000E+00	**500**	0.0000E+00	**75**	3.5817E-20	**75**	0.0000E+00	**1750**	1.1919E-08
750	0.0000E+00	**750**	0.0000E+00	**100**	2.2549E-20	**100**	0.0000E+00	**2000**	1.2962E-08
1000	0.0000E+00	**1000**	0.0000E+00	**200**	0.0000E+00	**200**	0.0000E+00	**2250**	1.2896E-08
1250	0.0000E+00	**1250**	2.9113E-40	**500**	0.0000E+00	**500**	0.0000E+00	**2500**	1.2083E-08
1500	0.0000E+00	**1500**	2.6291E-36	**750**	0.0000E+00	**750**	0.0000E+00	**2750**	1.0854E-08
2000	0.0000E+00	**2000**	3.9910E-32	**1000**	0.0000E+00	**1000**	0.0000E+00	**3000**	9.4571E-09
2500	0.0000E+00	**2500**	5.3367E-30	**2000**	5.1295E-23	**2000**	0.0000E+00	**3500**	6.7475E-09

1.22 m Saturated thickness	

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Advanced

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, Sat Sand & Gravel, Spring

Concentrations in mg/L in Spring

Compared with EAL target concentration in mg/L

	5.0000E-03		3.7500E-02		1.0000E-03		5.0000E-08		2.0000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.0000E+00	**0.1**	0.0000E+00	**0.02**	0.0000E+00	**0.02**	0.0000E+00	**1**	0.0000E+00
0.2	0.0000E+00	**0.2**	0.0000E+00	**0.04**	0.0000E+00	**0.04**	0.0000E+00	**5**	0.0000E+00
0.5	0.0000E+00	**0.5**	0.0000E+00	**0.06**	0.0000E+00	**0.06**	0.0000E+00	**10**	0.0000E+00
0.75	0.0000E+00	**0.75**	0.0000E+00	**0.1**	0.0000E+00	**0.1**	0.0000E+00	**20**	0.0000E+00
1	0.0000E+00	**1**	0.0000E+00	**0.15**	0.0000E+00	**0.15**	0.0000E+00	**50**	1.5494E-34
2	0.0000E+00	**2**	0.0000E+00	**0.2**	0.0000E+00	**0.2**	0.0000E+00	**100**	0.0000E+00
5	0.0000E+00	**5**	0.0000E+00	**0.25**	0.0000E+00	**0.25**	0.0000E+00	**200**	1.7768E-20
10	0.0000E+00	**10**	0.0000E+00	**0.3**	0.0000E+00	**0.3**	0.0000E+00	**300**	1.5949E-15
25	0.0000E+00	**25**	0.0000E+00	**0.5**	0.0000E+00	**0.5**	0.0000E+00	**500**	9.0491E-12
50	0.0000E+00	**50**	0.0000E+00	**1**	2.5359E-25	**1**	0.0000E+00	**750**	4.6048E-10
75	0.0000E+00	**75**	0.0000E+00	**5**	5.7491E-12	**5**	0.0000E+00	**1000**	2.5660E-09
100	0.0000E+00	**100**	0.0000E+00	**25**	6.4968E-20	**25**	0.0000E+00	**1250**	6.0849E-09
200	0.0000E+00	**200**	0.0000E+00	**50**	0.0000E+00	**50**	0.0000E+00	**1500**	9.5460E-09
500	0.0000E+00	**500**	0.0000E+00	**75**	3.5809E-20	**75**	0.0000E+00	**1750**	1.1918E-08
750	0.0000E+00	**750**	0.0000E+00	**100**	2.2552E-20	**100**	0.0000E+00	**2000**	1.2961E-08
1000	0.0000E+00	**1000**	0.0000E+00	**200**	0.0000E+00	**200**	0.0000E+00	**2250**	1.2896E-08
1250	0.0000E+00	**1250**	2.9111E-40	**500**	0.0000E+00	**500**	0.0000E+00	**2500**	1.2082E-08
1500	0.0000E+00	**1500**	2.6289E-36	**750**	0.0000E+00	**750**	0.0000E+00	**2750**	1.0853E-08
2000	0.0000E+00	**2000**	3.9908E-32	**1000**	0.0000E+00	**1000**	0.0000E+00	**3000**	9.4565E-09
2500	0.0000E+00	**2500**	5.3364E-30	**2000**	5.1496E-23	**2000**	0.0000E+00	**3500**	6.7471E-09

0.1 m Unsaturated zone thickness
affects both pathways

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Advanced

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, Sat Sand & Gravel, Spring

Concentrations in mg/L in Spring

Compared with EAL target concentration in mg/L

	5.00000E-03		3.75000E-02		1.00000E-03		5.00000E-08		2.00000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.000E+00	**0.1**	0.000E+00	**0.02**	0.000E+00	**0.02**	0.000E+00	**1**	0.00000E+00
0.2	0.000E+00	**0.2**	0.000E+00	**0.04**	0.000E+00	**0.04**	0.000E+00	**5**	0.00000E+00
0.5	0.000E+00	**0.5**	0.000E+00	**0.06**	0.000E+00	**0.06**	0.000E+00	**10**	0.00000E+00
0.75	0.000E+00	**0.75**	0.000E+00	**0.1**	0.000E+00	**0.1**	0.000E+00	**20**	0.00000E+00
1	0.000E+00	**1**	0.000E+00	**0.15**	0.000E+00	**0.15**	0.000E+00	**50**	1.41113E-34
2	0.000E+00	**2**	0.000E+00	**0.2**	0.000E+00	**0.2**	0.000E+00	**100**	0.00000E+00
5	0.000E+00	**5**	0.000E+00	**0.25**	0.000E+00	**0.25**	0.000E+00	**200**	1.86815E-20
10	0.000E+00	**10**	0.000E+00	**0.3**	0.000E+00	**0.3**	0.000E+00	**300**	1.62966E-15
25	0.000E+00	**25**	0.000E+00	**0.5**	0.000E+00	**0.5**	0.000E+00	**500**	9.11455E-12
50	0.000E+00	**50**	0.000E+00	**1**	2.464E-25	**1**	0.000E+00	**750**	4.61792E-10
75	0.000E+00	**75**	0.000E+00	**5**	5.794E-12	**5**	0.000E+00	**1000**	2.56952E-09
100	0.000E+00	**100**	0.000E+00	**25**	6.497E-20	**25**	0.000E+00	**1250**	6.08933E-09
200	0.000E+00	**200**	0.000E+00	**50**	0.000E+00	**50**	0.000E+00	**1500**	9.54965E-09
500	0.000E+00	**500**	0.000E+00	**75**	3.595E-20	**75**	0.000E+00	**1750**	1.19201E-08
750	0.000E+00	**750**	0.000E+00	**100**	2.256E-20	**100**	0.000E+00	**2000**	1.29615E-08
1000	0.000E+00	**1000**	0.000E+00	**200**	0.000E+00	**200**	0.000E+00	**2250**	1.28952E-08
1250	0.000E+00	**1250**	2.992E-40	**500**	0.000E+00	**500**	0.000E+00	**2500**	1.20813E-08
1500	0.000E+00	**1500**	2.711E-36	**750**	0.000E+00	**750**	0.000E+00	**2750**	1.08518E-08
2000	0.000E+00	**2000**	4.075E-32	**1000**	0.000E+00	**1000**	0.000E+00	**3000**	9.45502E-09
2500	0.000E+00	**2500**	5.845E-30	**2000**	5.174E-23	**2000**	0.000E+00	**3500**	6.74575E-09

0.5 m Unsaturated zone thickness
affects both pathways

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Advanced

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, Sat Sand & Gravel, Spring

Concentrations in mg/L in Spring

Compared with EAL target concentration in mg/L

	5.00000E-03		3.75000E-02		1.00000E-03		5.00000E-08		2.00000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.00000E+00	**0.1**	0.00000E+00	**0.02**	0.00000E+00	**0.02**	0.00000E+00	**1**	0.00000E+00
0.2	0.00000E+00	**0.2**	0.00000E+00	**0.04**	0.00000E+00	**0.04**	0.00000E+00	**5**	0.00000E+00
0.5	0.00000E+00	**0.5**	0.00000E+00	**0.06**	0.00000E+00	**0.06**	0.00000E+00	**10**	0.00000E+00
0.75	0.00000E+00	**0.75**	0.00000E+00	**0.1**	0.00000E+00	**0.1**	0.00000E+00	**20**	0.00000E+00
1	0.00000E+00	**1**	0.00000E+00	**0.15**	0.00000E+00	**0.15**	0.00000E+00	**50**	1.45990E-34
2	0.00000E+00	**2**	0.00000E+00	**0.2**	0.00000E+00	**0.2**	0.00000E+00	**100**	0.00000E+00
5	0.00000E+00	**5**	0.00000E+00	**0.25**	0.00000E+00	**0.25**	0.00000E+00	**200**	1.83714E-20
10	0.00000E+00	**10**	0.00000E+00	**0.3**	0.00000E+00	**0.3**	0.00000E+00	**300**	1.61799E-15
25	0.00000E+00	**25**	0.00000E+00	**0.5**	0.00000E+00	**0.5**	0.00000E+00	**500**	9.09274E-12
50	0.00000E+00	**50**	0.00000E+00	**1**	2.48836E-25	**1**	0.00000E+00	**750**	4.61355E-10
75	0.00000E+00	**75**	0.00000E+00	**5**	5.77879E-12	**5**	0.00000E+00	**1000**	2.56835E-09
100	0.00000E+00	**100**	0.00000E+00	**25**	6.49603E-20	**25**	0.00000E+00	**1250**	6.08788E-09
200	0.00000E+00	**200**	0.00000E+00	**50**	0.00000E+00	**50**	0.00000E+00	**1500**	9.54848E-09
500	0.00000E+00	**500**	0.00000E+00	**75**	3.59023E-20	**75**	0.00000E+00	**1750**	1.19194E-08
750	0.00000E+00	**750**	0.00000E+00	**100**	2.25456E-20	**100**	0.00000E+00	**2000**	1.29613E-08
1000	0.00000E+00	**1000**	0.00000E+00	**200**	0.00000E+00	**200**	0.00000E+00	**2250**	1.28954E-08
1250	0.00000E+00	**1250**	2.93994E-40	**500**	0.00000E+00	**500**	0.00000E+00	**2500**	1.20817E-08
1500	0.00000E+00	**1500**	2.68494E-36	**750**	0.00000E+00	**750**	0.00000E+00	**2750**	1.08523E-08
2000	0.00000E+00	**2000**	4.04815E-32	**1000**	0.00000E+00	**1000**	0.00000E+00	**3000**	9.45557E-09
2500	0.00000E+00	**2500**	5.67761E-30	**2000**	4.95521E-23	**2000**	0.00000E+00	**3500**	6.74624E-09

2.5 m Unsaturated zone thickness

affects both pathways

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Advanced

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, Sat Sand & Gravel, Spring

Concentrations in mg/L in Spring

Compared with EAL target concentration in mg/L

	5.00000E-03		3.75000E-02		1.00000E-03		5.00000E-08		2.00000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.00000E+00	**0.1**	0.00000E+00	**0.02**	0.00000E+00	**0.02**	0.00000E+00	**1**	0.00000E+00
0.2	0.00000E+00	**0.2**	0.00000E+00	**0.04**	0.00000E+00	**0.04**	0.00000E+00	**5**	0.00000E+00
0.5	0.00000E+00	**0.5**	0.00000E+00	**0.06**	0.00000E+00	**0.06**	0.00000E+00	**10**	0.00000E+00
0.75	0.00000E+00	**0.75**	0.00000E+00	**0.1**	0.00000E+00	**0.1**	0.00000E+00	**20**	0.00000E+00
1	0.00000E+00	**1**	0.00000E+00	**0.15**	0.00000E+00	**0.15**	0.00000E+00	**50**	1.66422E-34
2	0.00000E+00	**2**	0.00000E+00	**0.2**	0.00000E+00	**0.2**	0.00000E+00	**100**	0.00000E+00
5	0.00000E+00	**5**	0.00000E+00	**0.25**	0.00000E+00	**0.25**	0.00000E+00	**200**	1.69059E-20
10	0.00000E+00	**10**	0.00000E+00	**0.3**	0.00000E+00	**0.3**	0.00000E+00	**300**	1.56094E-15
25	0.00000E+00	**25**	0.00000E+00	**0.5**	0.00000E+00	**0.5**	0.00000E+00	**500**	8.98446E-12
50	0.00000E+00	**50**	0.00000E+00	**1**	2.60343E-25	**1**	0.00000E+00	**750**	4.59175E-10
75	0.00000E+00	**75**	0.00000E+00	**5**	5.70502E-12	**5**	0.00000E+00	**1000**	2.56248E-09
100	0.00000E+00	**100**	0.00000E+00	**25**	6.49815E-20	**25**	0.00000E+00	**1250**	6.08065E-09
200	0.00000E+00	**200**	0.00000E+00	**50**	0.00000E+00	**50**	0.00000E+00	**1500**	9.54263E-09
500	0.00000E+00	**500**	0.00000E+00	**75**	3.56760E-20	**75**	0.00000E+00	**1750**	1.19161E-08
750	0.00000E+00	**750**	0.00000E+00	**100**	2.25242E-20	**100**	0.00000E+00	**2000**	1.29605E-08
1000	0.00000E+00	**1000**	0.00000E+00	**200**	0.00000E+00	**200**	0.00000E+00	**2250**	1.28964E-08
1250	0.00000E+00	**1250**	3.04283E-40	**500**	0.00000E+00	**500**	0.00000E+00	**2500**	1.20838E-08
1500	0.00000E+00	**1500**	2.53707E-36	**750**	0.00000E+00	**750**	0.00000E+00	**2750**	1.08549E-08
2000	0.00000E+00	**2000**	3.89412E-32	**1000**	0.00000E+00	**1000**	0.00000E+00	**3000**	9.45832E-09
2500	0.00000E+00	**2500**	4.81191E-30	**2000**	4.99919E-23	**2000**	0.00000E+00	**3500**	6.74865E-09

0.1 m Unsaturated zone thickness
affects both pathways

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, GW beneath site

Concentrations in mg/L in GW beneath site

Compared with EAL target concentration in mg/L

5.00000E-03		3.75000E-02		1.00000E-03		5.00000E-08		2.00000E-02	
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.000E+00	**0.1**	0.000E+00	**0.02**	0.000E+00	**0.02**	0.000E+00	**0.1**	0.000E+00
0.2	0.000E+00	**0.2**	0.000E+00	**0.04**	0.000E+00	**0.04**	0.000E+00	**0.2**	0.000E+00
0.5	0.000E+00	**0.5**	0.000E+00	**0.06**	8.994E-22	**0.06**	0.000E+00	**0.5**	3.199E-10
0.75	0.000E+00	**0.75**	0.000E+00	**0.1**	2.475E-18	**0.1**	0.000E+00	**0.75**	6.187E-08
1	0.000E+00	**1**	0.000E+00	**0.15**	1.098E-12	**0.15**	0.000E+00	**1**	6.515E-07
2	0.000E+00	**2**	1.148E-32	**0.2**	6.029E-10	**0.2**	0.000E+00	**2**	8.877E-06
5	1.827E-37	**5**	0.000E+00	**0.25**	2.305E-08	**0.25**	0.000E+00	**5**	3.523E-06
10	0.000E+00	**10**	8.474E-16	**0.3**	2.364E-07	**0.3**	0.000E+00	**10**	8.598E-08
25	1.334E-19	**25**	4.656E-09	**0.5**	1.492E-05	**0.5**	0.000E+00	**25**	9.483E-13
50	4.800E-12	**50**	2.248E-07	**1**	7.779E-05	**1**	0.000E+00	**50**	0.000E+00
75	8.645E-10	**75**	4.176E-07	**5**	2.424E-09	**5**	0.000E+00	**75**	0.000E+00
100	8.801E-09	**100**	3.754E-07	**25**	0.000E+00	**25**	0.000E+00	**100**	0.000E+00
200	1.138E-07	**200**	5.237E-08	**50**	0.000E+00	**50**	0.000E+00	**200**	0.000E+00
500	4.292E-08	**500**	3.373E-11	**75**	0.000E+00	**75**	0.000E+00	**300**	0.000E+00
750	6.870E-09	**750**	7.837E-14	**100**	0.000E+00	**100**	0.000E+00	**400**	0.000E+00
1000	9.916E-10	**1000**	4.621E-16	**200**	0.000E+00	**200**	0.000E+00	**500**	0.000E+00
1250	1.410E-10	**1250**	0.000E+00	**500**	3.031E-15	**500**	0.000E+00	**1000**	1.922E-16
1500	2.016E-11	**1500**	0.000E+00	**750**	3.139E-15	**750**	0.000E+00	**1500**	4.615E-16
2000	4.253E-13	**2000**	0.000E+00	**1000**	2.784E-15	**1000**	0.000E+00	**2000**	4.760E-16
2500	9.469E-15	**2500**	0.000E+00	**2000**	1.722E-15	**2000**	0.000E+00	**3000**	4.054E-16

0.5 m Unsaturated zone thickness
affects both pathways

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, GW beneath site

Concentrations in mg/L in GW beneath site

Compared with EAL target concentration in mg/L

	5.00000E-03		3.75000E-02		1.00000E-03		5.00000E-08		2.00000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.00000E+00	**0.1**	0.00000E+00	**0.02**	1.09487E-37	**0.02**	0.00000E+00	**0.1**	3.55000E-27
0.2	0.00000E+00	**0.2**	0.00000E+00	**0.04**	0.00000E+00	**0.04**	0.00000E+00	**0.2**	0.00000E+00
0.5	0.00000E+00	**0.5**	0.00000E+00	**0.06**	8.11045E-22	**0.06**	0.00000E+00	**0.5**	2.41179E-11
0.75	0.00000E+00	**0.75**	0.00000E+00	**0.1**	1.78501E-18	**0.1**	0.00000E+00	**0.75**	1.79990E-08
1	0.00000E+00	**1**	0.00000E+00	**0.15**	9.55534E-13	**0.15**	0.00000E+00	**1**	3.34937E-07
2	0.00000E+00	**2**	3.93055E-36	**0.2**	5.58553E-10	**0.2**	0.00000E+00	**2**	8.20765E-06
5	0.00000E+00	**5**	0.00000E+00	**0.25**	2.19815E-08	**0.25**	0.00000E+00	**5**	3.75843E-06
10	6.97040E-29	**10**	5.41954E-18	**0.3**	2.28972E-07	**0.3**	0.00000E+00	**10**	9.27203E-08
25	0.00000E+00	**25**	1.57662E-09	**0.5**	1.47766E-05	**0.5**	0.00000E+00	**25**	1.01999E-12
50	3.76147E-13	**50**	1.86476E-07	**1**	7.77202E-05	**1**	0.00000E+00	**50**	0.00000E+00
75	2.56881E-10	**75**	4.08671E-07	**5**	2.42682E-09	**5**	0.00000E+00	**75**	0.00000E+00
100	4.58433E-09	**100**	3.87218E-07	**25**	0.00000E+00	**25**	0.00000E+00	**100**	0.00000E+00
200	1.05631E-07	**200**	5.62763E-08	**50**	0.00000E+00	**50**	0.00000E+00	**200**	0.00000E+00
500	4.58198E-08	**500**	3.63637E-11	**75**	0.00000E+00	**75**	0.00000E+00	**300**	0.00000E+00
750	7.40077E-09	**750**	8.43499E-14	**100**	0.00000E+00	**100**	0.00000E+00	**400**	0.00000E+00
1000	1.06982E-09	**1000**	5.51950E-16	**200**	0.00000E+00	**200**	0.00000E+00	**500**	0.00000E+00
1250	1.52117E-10	**1250**	0.00000E+00	**500**	3.01982E-15	**500**	0.00000E+00	**1000**	1.51487E-16
1500	2.17391E-11	**1500**	0.00000E+00	**750**	3.13238E-15	**750**	0.00000E+00	**1500**	4.41730E-16
2000	4.58350E-13	**2000**	0.00000E+00	**1000**	2.77905E-15	**1000**	0.00000E+00	**2000**	4.65077E-16
2500	1.01887E-14	**2500**	0.00000E+00	**2000**	1.71812E-15	**2000**	0.00000E+00	**3000**	4.00524E-16

2.5 m Unsaturated zone thickness
affects both pathways

BREAKTHROUGH RESULTS

Site Name: "Upper Lyde extension"

Advanced

Pollutant Linkage: Inert DfR, Geological barrier, Unsat Sand & Gravel, GW beneath site

Concentrations in mg/L in GW beneath site

Compared with EAL target concentration in mg/L

	5.00000E-03		3.75000E-02		1.00000E-03		5.00000E-08		2.00000E-02
	Species1		Species2		Species3		Species4		Species5
Time(years)	**Arsenic**	Time(years)	**Chromium**	Time(years)	**Benzene**	Time(years)	**BaP**	Time(years)	**Nickel**
0.1	0.00000E+00	**0.1**	0.00000E+00	**0.02**	7.31642E-38	**0.02**	0.00000E+00	**0.1**	1.20743E-32
0.2	0.00000E+00	**0.2**	0.00000E+00	**0.04**	8.71093E-26	**0.04**	0.00000E+00	**0.2**	1.56096E-23
0.5	0.00000E+00	**0.5**	0.00000E+00	**0.06**	0.00000E+00	**0.06**	0.00000E+00	**0.5**	2.44141E-15
0.75	0.00000E+00	**0.75**	0.00000E+00	**0.1**	0.00000E+00	**0.1**	0.00000E+00	**0.75**	7.97147E-11
1	0.00000E+00	**1**	0.00000E+00	**0.15**	4.91410E-13	**0.15**	0.00000E+00	**1**	1.03050E-08
2	0.00000E+00	**2**	0.00000E+00	**0.2**	3.83525E-10	**0.2**	0.00000E+00	**2**	4.06314E-06
5	0.00000E+00	**5**	0.00000E+00	**0.25**	1.73471E-08	**0.25**	0.00000E+00	**5**	5.14961E-06
10	2.53174E-34	**10**	2.10163E-21	**0.3**	1.95080E-07	**0.3**	0.00000E+00	**10**	1.37700E-07
25	2.14877E-23	**25**	1.12778E-11	**0.5**	1.40676E-05	**0.5**	0.00000E+00	**25**	1.49149E-12
50	4.20276E-17	**50**	4.85359E-08	**1**	7.73599E-05	**1**	0.00000E+00	**50**	0.00000E+00
75	1.21372E-12	**75**	2.95065E-07	**5**	2.44287E-09	**5**	0.00000E+00	**75**	0.00000E+00
100	1.47984E-10	**100**	4.10155E-07	**25**	0.00000E+00	**25**	0.00000E+00	**100**	0.00000E+00
200	5.33737E-08	**200**	8.13415E-08	**50**	0.00000E+00	**50**	0.00000E+00	**200**	0.00000E+00
500	6.30936E-08	**500**	5.40204E-11	**75**	0.00000E+00	**75**	0.00000E+00	**300**	0.00000E+00
750	1.08930E-08	**750**	1.24029E-13	**100**	0.00000E+00	**100**	0.00000E+00	**400**	0.00000E+00
1000	1.59340E-09	**1000**	7.41092E-16	**200**	0.00000E+00	**200**	0.00000E+00	**500**	0.00000E+00
1250	2.26775E-10	**1250**	3.78593E-16	**500**	2.98585E-15	**500**	0.00000E+00	**1000**	0.00000E+00
1500	3.23508E-11	**1500**	7.81738E-17	**750**	3.10655E-15	**750**	0.00000E+00	**1500**	3.45043E-16
2000	6.78747E-13	**2000**	0.00000E+00	**1000**	2.76179E-15	**1000**	0.00000E+00	**2000**	4.09106E-16
2500	1.49135E-14	**2500**	0.00000E+00	**2000**	1.70936E-15	**2000**	0.00000E+00	**3000**	3.75420E-16