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G.1 INTRODUCTION

In March 2007 URS was commissioned to undertake an investigation of Plot G on the Whitehaven Site and to carry out a controlled waters risk assessment using relevant data gathered from previous investigations and new data from the 2007 investigation. This appendix presents the methodology and results of the Controlled Waters Quantitative Risk Assessment (CWQRA) for Plot G.

The risk assessment is based upon the Mass Balance Model developed in Appendix D of the previous Phase II report (REF: 44319623/R2037, dated 23rd June 2005). The 2005 report recognised that the hydrogeological conditions between the site and the coast were complex, especially in areas underlying the St. Bees Evaporite Formation, which contained enhanced solution features created by acid spills, and as such, recognised that standard risk assessment tools (such as CONSIM) were not suitable for analysis of groundwater flow in this area of the site.

The risk assessment set out in this appendix is considered to be more rigorous and representative of site conditions than the previous risk assessment for the whole of the Whitehaven site as it incorporates additional geological and geochemical data obtained during the Plot G investigation and uses a more sophisticated modelling approach.

The CWQRA is based upon the UK Department of the Environment, Food and Rural Affairs (DEFRA) and Environment Agency (EA) guidance including:

- Environment Agency R&D Publication 20 (1999) Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources (referred to as R&D P-20); and
- Environment Agency R&D Publication CLR11 (2004) Model Procedures for the Management of Land Contamination (referred to as CLR11).

Using CLR 11 methodology, risk assessment is carried out in three stages:

Stage 1 – Preliminary Risk Assessment

Stage 2 - Generic Quantitative Risk Assessment; and

Stage 3 – Detailed Quantitative Risk Assessment.

Stage 1 involves the development of a conceptual understanding of the site and the surrounding environment's geology, hydrogeology, observed contamination (and its distribution), and potential receptors. From this conceptual understanding, potential pollutant linkages (*source-pathway-receptor* relationships) are identified. This stage of the risk assessment is set out in Section 5 of the main body of the report.

Risk assessment at Stages 2 and 3 for Plot G is presented in full in this appendix.

G.2 CONCEPTUAL MODEL SUMMARY

G.2.1 Sources

In Plot G, generally isolated shallow soil, soil leachate, and groundwater contamination was encountered. The maximum value of each Stage 2 exceedance has been considered as individual source terms.

G.2.2 Pathways

The viable pathways applicable to these sources include the leaching and infiltration of soil contamination through the unsaturated zone followed by dilution and lateral migration within the underlying shallow groundwater. Contamination may enter solution-enhanced conduits of the generally low permeability St. Bees Evaporites from vertical migration through the limited thickness of made ground and drift within Plot G. Once within the evaporites, rapid migration towards the coast via complex subsurface pathways (solution enhanced pipes and fissures) before emerging at the surface at the Byerstead Spring.

Tracer testing has provided evidence to suggest that this pathway is rapid, with travel times often less than 10 hours.

Such short travel times suggest that groundwater flow may be via streams at the base of the solution features. Such migration will be characterised by limited dispersion/dilution effects (as compared to more standard groundwater migration within porous media). Therefore, it was considered appropriate to assume that infiltrating contaminated water entering this unit from within Plot G, would remain at this concentration until it reached the site boundary. Beyond this point the only dilution that it was likely to encounter before reaching the sea would be infiltration from overlying geological units (predominantly the St. Bees Sandstone).

G.2.3 Receptors

The compliance point that is deemed protective of the likely receptor (The Irish Sea) has been determined as the point at which groundwater emerges at the coastline immediately before entering the sea.

G.3 STAGE 2 - GENERIC QUANTITATIVE ASSESSMENT

G.3.1 Methodology

The generic screening was undertaken by making a comparison of measured chemical concentrations in soil, soil leachate, and groundwater against conservative screening criteria appropriate for a designated potential receptor. This initial screening is designed to identify Potential Contaminants of Concern (PCoC), which could pose a potential risk to controlled waters. At the generic screening stage, no consideration is given to pathways or potential attenuation factors such as dilution, dispersion or biodegradation.

For this assessment the receptor is considered to be the Byerstead Spring which feeds into the Irish Sea and the screening values that have been used are marine Environmental Quality Standards for soil leachate and shallow groundwater samples. Where published Marine EQS values for certain contaminants were not readily available, reference was made to published Freshwater EQS values. In the absence of Freshwater EQS values, United States Environmental Protection Agency (US EPA) Region 9 Pathway Specific EQS values were used for screening purposes. Where none of these values are available, then reference was made to UK/EU Drinking Water Standards and World Health Authority (WHO) guidelines.

VOC analysis was not carried out on soil leachates as the leaching methodology is unsuitable for VOCs, i.e. it allows VOCs to escape during the leaching process and thus results obtained would be unrealistically low. Thus, for soils samples, concentrations of VOCs have been compared to theoretical soil concentrations that are protective of marine EQS. The theoretical concentrations have been derived using partitioning equations, as outlined in EA R&D-P20 (EA, 1999).

The Stage 2 soils VOC screening values are derived using the following site-specific parameters:

- Total Organic Carbon 0.58%, from site data;
- Soil Type Silty clay, principal soil type at source (made ground)
- Total Porosity 38%
- Water filled Porosity 27%
- Air Filled Porosity 11%
- Dry bulk density 1.64g/cm^3

Details of the sources of all Stage 2 screening criteria are given in Tables G1 (soil VOCs) and G2 (soil leachate and groundwater) at the end of this report.

Where individual concentrations of contaminants exceeded the generic screening criteria, they have been evaluated further as part of the Stage 3 assessment.

In a limited number of cases, the method detection limit was higher than the screening value for the particular analyte. This occurred in the following analytes:

- Azobenzene;
- Benzo(a)anthracene;
- Benzo(a)pyrene;
- Bis(2-chloroethyl)ether;
- 1.2-Dibromo-3-chloropropane;
- 1.2-Dibromoethane;
- Dibenzo(a,h)anthracene;
- 1,3- Dichloropropane;
- Fluoranthene;
- Hexachlorobutadiene;
- N-nitrosodi-n-propylamine;
- 1.1.1.2-Tetrachloroethane;
- 1.1.2.2-Tetrachloroethane;
- 1.2.3-Trichloropropane;
- PCB (total); and
- Vinyl Chloride

Standard practice where the MDL is greater than the Screening Value would be to include the analytes as sources at Stage 3, with concentrations at their MDL. It was considered reasonable to discount the majority of the above analytes as the samples taken within Plot G provided no evidence to suggest that these analytes are present within Plot G.

However, this was not the case for benzo(a)anthracene, benzo(a)pyrene, dibenzo(a,h)anthracene and fluoranthene. These have been measured in shallow groundwater at an isolated hotspots (WS130) in Plot G. These contaminants are discussed in section G.3.5.

G.3.2 Soil Contamination Generic Screening

With the exception of VOC's, generic screening was not performed on soils data. This is because the screening was done using leach test data, which is considered more representative of the potential risks to controlled waters.

A summary of the determinands whose concentrations exceeded the Stage 2 generic screening values is given in Table G3 at the end of this report.

G.3.3 Soil Leachate Generic Screening

G.3.3.1 Metals, Anionic Surfactants, Phosphate

A summary of the determinands whose concentrations exceeded the Stage 2 generic screening values is given in Table G4.

Phosphate was detected in eight of the sixteen samples submitted for analysis, no screening criteria currently exists for phosphate. Anionic surfactant was detected in fifteen of the 24 samples submitted for analysis. Remaining analytes were either present at concentrations below the method detection limit, or less than respective Stage 2 criteria.

G.3.3.2 Total Petroleum Hydrocarbons (TPH)

A summary of the determinands whose concentrations exceeded the Stage 2 generic screening values is given in Table G5.

G.3.3.3 Semi Volatile Organic Compounds (SVOC) and Polycyclic Aromatic Hydrocarbons (PAH)

A summary of the determinands whose concentrations exceeded the Stage 2 generic screening values is given in Table G6.

G.3.4 Groundwater Results Screening

Groundwater has been recorded in monitoring wells across Plot G. Evidence from borehole and trial pit logs indicate that a shallow groundwater body may be present within the Made Ground, perched on top of the natural clay and silt. However, it is unclear whether this groundwater body is continuous across Plot G or the water is ponding in depressions/granular areas within the Made Ground.

The results are presented below.

G.3.4.1 Metals, Anionic Surfactants, Phosphates, and Cyanide

A summary of the determinands whose concentrations exceeded the Stage 2 generic screening values is given in Table G7.

G.3.4.2 Total Petroleum Hydrocarbons (TPH)

A summary of the determinands whose concentrations exceeded the Stage 2 generic screening values is given in Table G8.

G.3.4.3 Semi Volatile Organic Compounds (SVOC), Polycyclic Aromatic Hydrocarbons (PAH) and Volatile Organic Compounds (VOCs) in Groundwater

A summary of the determinands whose concentrations exceeded the Stage 2 generic screening values is given in Table G9.

G.3.5 Summary of Identified Exceedances of Generic Screening Criteria

From the Stage 2 generic screening process the determinands in soils, soil leachate and shallow groundwater that exceeded the Stage 2 screening criteria are summarised in Table G3.1.

Table G3.1 – Stage 2 Assessment – Summary of Screening Criteria Exceedances

Soil	Soil Leachate	Shallow Groundwater
naphthalene	arsenic	zinc
	chromium	chromium
	copper	TPH C10-C12
	lead	TPH C12-C16
	nickel	TPH C21-C35
	selenium	Anionic Surfactant (MBAS)
	carbazole	benzo(a)anthracene
	napthalene	benzo(a)pyrene
	TPH C12-C16 Aromatic	dibenz(a,h)anthracene
	TPH C16-C21 Aromatic	fluoranthene

Each of the determinands whose concentrations exceeded their respective Stage 2 criterion were then assessed to determine whether the potential risk they posed was realistic. As such, the geochemical profile, geological horizons, water strikes, and field observations of contamination were all considered. For example, consider an exceedance from a sample taken in the made ground. If the underlying geology was several meters of dry low permeability clay, and a deep sample from within or below this clay did not detect this analyte, then this risk may be deemed not significant, given the pathway into the underlying evaporites (which forms part of the pollutant linkage) was not realistic. Therefore this analyte may have been discounted and not taken to Stage 3. Conversely, if contamination was found in granular wet made ground, that sat directly on to bedrock, this will have been considered potentially significant, and taken to Stage 3.

If a pollutant linkage was deemed potentially significant or could not be discounted (due to insufficient geochemical and geological evidence) they were taken forward to Stage 3, the detailed quantitative risk assessment.

The following contaminants that exceeded Stage 2 screening criteria but were not taken forward to the Stage 3a assessment and reasons for this decision are listed below:

SOIL

Naphthalene **-** an exceedance was detected at TP758G – 0.5m (13mg/kg) in a soil sample. It is unlikely that a pathway for the vertical migration of naphthalene exists at this location due to a dry, clay horizon (1.9m thick) underlying the Made Ground. However, due to the magnitude of the exceedance (screening criteria for Naphthalene is 0.04mg/kg) a pore water concentration was calculated for naphthalene in order to estimate leachate concentrations which could potentially emanate from impacted soil at this location. The following equation was used to calculate the pore water concentration,

$$PoreWaterConcentration = \frac{SoilConcentration}{\left(K_d + \frac{\theta_w + \theta_a H}{\rho}\right)}$$

where,

K_d = soil/water partition coefficient (l/Kg)

θ_w = water filled soil porosity (fraction)

θ_a = air filled soil porosity (fraction)

H = Henry's law constant (dimensionless)

ρ = bulk density (g/cm3)

The pore water concentration generated for Naphthalene was 1.7mg/l. The parameters used to calculate the pore water concentration are presented in Table G10.

The source area for naphthalene contamination could not be delineated due to an insufficient number of sample locations, where naphthalene had been analysed for, being present in the vicinity of TP758G. As the concentration of naphthalene at TP758G may be significant it is envisaged that the area surrounding TP758G will be investigated at the same time further works have to be undertaken in Plot G.

LEACHATE

Arsenic **–** an exceedance was detected at TP764G – 1.3m (33μg/l) in a leachate sample. The sample was taken in Made Ground. Underlying this potential source area is 1.45m of clean, stiff, dry clay. This is considered to provide a barrier to vertical migration of arsenic.

Copper **–** exceedances detected across Plot G in leachate samples ranged from 6μg/l to 69μg/l. TP764 displayed highest concentrations (69μg/l at 0.6m and 49μg/l at 1.3m)

however, no pathway is considered to exist at this location (refer to arsenic discussion). The remainder of detections are considered to be background concentrations, for example samples from WS766G – 5.7m (12 μg/l) and WS768 – 3.5m (22μg/l). Both of these samples were taken from natural clay deposits.

Lead **–** an exceedance was detected at TP764G– 1.3m (53μg/l) in a leachate sample. No pathway is considered to exist at this location (see arsenic).

Selenium **-** exceedances were detected from TP764G at 0.6m (11μg/l), TP764G at 1.3m (22μg/l) and TP763G at 0.3m (12μg/l) in leachate samples. As previously stated, no pathway is considered to exist at TP764G (see arsenic). From the borehole logs, horizons of firm and stiff clay are present in TP763G below the Made Ground, which are considered to present a barrier to vertical migration of selenium.

Carbazole **–** an exceedance was detected at TP758G – 0.5m (4μg/l) in a leachate sample. The sample was taken in Made Ground underlain with 1.9m of clay therefore a vertical pathway for the migration of carbazole is not considered to exist at this location. Also, the exceedance was marginally above the screening criteria of 3μg/l.

TPH **–** an exceedance of the TPH fraction C12-C16 (120μg/l) and C16-C21(110μg/l) was recorded at TP758G – 0.5m in a leachate sample. No pathway is considered to exist at this location (see carbazole). Potential risks from TPH will be evaluated once additional samples have been obtained (refer to naphthalene discussion).

GROUNDWATER

TPH **–** exceedances of TPH fractions (C10-C12, C12-C16, C21-C35) were detected in ERMSB15 and an exceedance of the TPH fraction C21-C35 was detected in WS130. Due to the high TPH concentrations detected in groundwater at ERMSB15 and the lack of neighbouring sampling points to delineate the extent of contamination, the area encompassing ERMSB15 and WS130 was selected for further investigation.

MBAS **–** an exceedance of the MBAS screening criteria was recorded in groundwater at WS130. As this monitoring well is already in an area outlined for further investigation (for TPH), it will be possible to investigate MBAS issues in this area concurrently with the TPH investigation.

PAH **–** an exceedance of 4 PAHs (benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene and Fluoranthene) were recorded at WS130. Issues regarding PAH contamination could be investigated at the same time as the TPH investigation in this area.

G.4 STAGE 3A DETAILED QUANTITATIVE RISK ASSESSMENT

Those determinands identified as presenting a potential risk in the Stage 2 assessment have been taken forward to a Stage 3a detailed quantitative risk assessment.

G.4.1 Model Selection and Key Model Assumptions

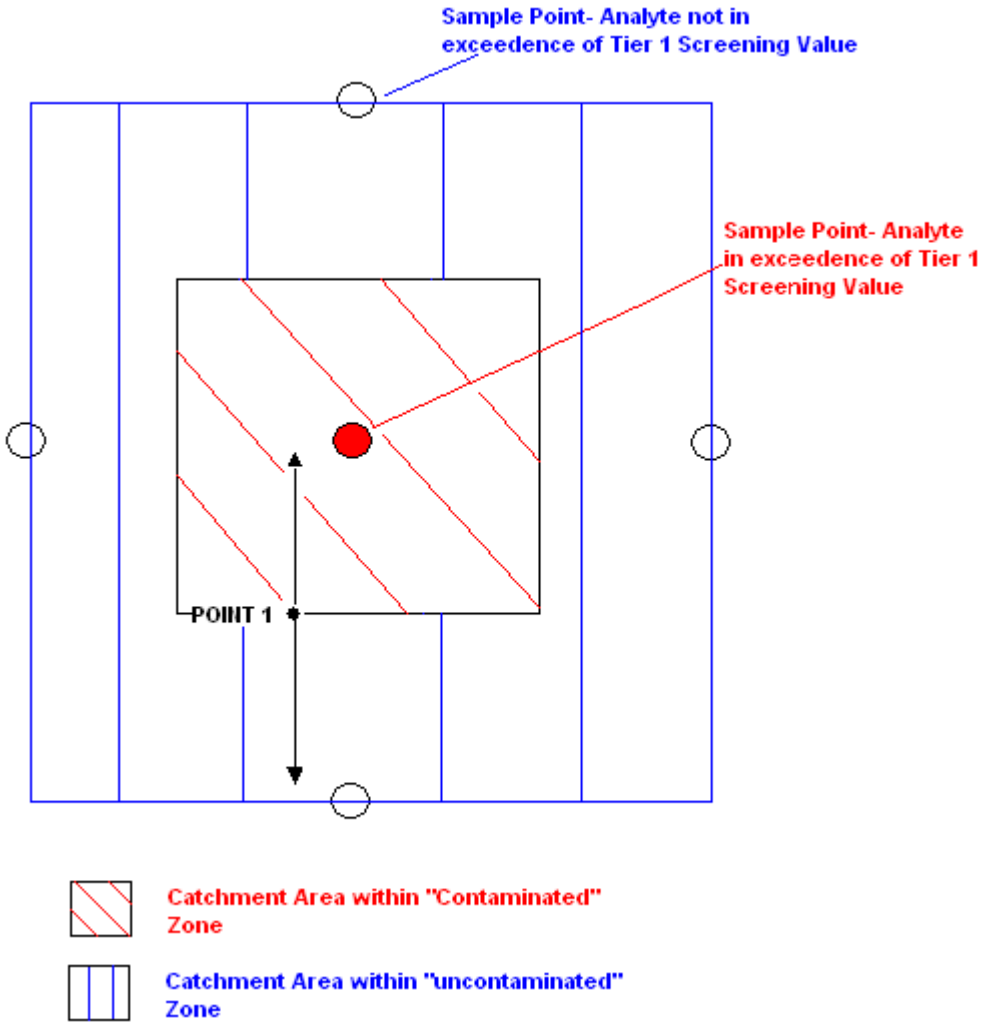
The hydrogeological sequence within Plot G is complex. It has been further compounded by historic site activities, the most prevalent of which has been the deposition of acids into the ground, resulting in voids and channels being created in certain locations, some of which are likely to be in Plot G.

Given the complexity of the geology in Plot G, and the rapid travel times for migration sourced from Plot G, no standard model (e.g. CONSIM, which was used in Plots B and C) was considered to be appropriate. Instead, a mass balance approach was adopted in order to assess potential risks. The principal of the model requires an understanding of the following parameters:

1. Area of inferred “Contaminated” Zone
2. Area of inferred “Uncontaminated “ Zone
3. Concentration identified within the source zone

The process for modelling is described below, using arsenic as an example and the conceptual understanding of the model is presented as Figure 7bof the main report.

Arsenic was measured at a concentration of 33μg/L from soil leachate analysis in TP764G, which exceeds the Marine EQS Screening Value of 25μg/l. In surrounding sample locations, measured concentrations of arsenic were less than the Marine EQS.



The likely contaminated and uncontaminated zones surrounding this sample point have been defined as follows:

- The likely extent of contamination is assumed to extend to the half way distance between the central point (which contains contamination in exceedance of the screening criteria) and the peripheral points (which have been deemed "uncontaminated", based on the screening of the current data set). The halfway distance is defined as "Point 1" on the above diagram. The area contained within the halfway points is assumed to represent the source area (diagonally hatched area).

- The *uncontaminated zone* is defined as the remaining area between the half way distance and the sample points where no exceedances have been measured (vertically hatched area).

The combined catchment areas (i.e. contaminated catchment zone + uncontaminated catchment zone) are then referred to as the "total catchment" for that source.

Precipitation falling on this area is assumed to be uniform, before infiltrating downwards through the Made Ground and Drift. Such infiltration is then assumed to be connected to a solution fissure within the evaporate sequence (thought to be only 3-4m below ground level in Plot G). The solution features and fissures effectively act as drains, collecting all water (contaminated and uncontaminated) within the "total catchment". Given that subsequent transport within the fissure system is rapid with limited dispersion, dilution or degradation, it has conservatively been assumed that an analyte concentration entering the St. Bees Evaporite Formation, directly underneath Plot G, could potentially represent the same concentration that emerges at the coastline. Thus, the calculated concentrations entering the fissures would be compared to the Marine EQS Screening Value.

The calculated concentration entering the fissure network has been estimated by diluting the leachable concentrations from identified contaminated areas by the volume of relatively clean water available from the uncontaminated zone of the catchment. For example, for arsenic:

- Percentage of Contaminated Catchment Infiltrating total catchment = 25%;
- Assumed concentration of arsenic in source zone = 33μg/L.
- Therefore, concentration of arsenic as it enters the fracture = 25% x33μg/L = **8.25μg/L.**

The calculated concentrations at the compliance point (opening to the fissure system) were compared directly against the Stage 2 screening criteria, in this instance, the simulated arsenic concentration was below the Screening Value (25μg/L), and therefore no longer considered to represent a potential risk.

G.4.2 Summary of Identified Exceedances (Stage 3a)

The results of the Stage 3a assessment are presented at the end of this report in Table G11 and summarised in Table G4.1 below.

TABLE G4.1 – STAGE 3 A EXCEEDANCES- SUMMARY

Soil	Soil Leachate	Shallow Groundwater
	nickel	chromium
		zinc

Analytes which continued to pose a risk at Stage 3a were taken onto Stage 3b modelling.

The modelling table is presented in Appendix H.

G.5 STAGE 3B QUANTITATIVE ASSESSMENT- OFFSITE DILUTION MODELLING

G.5.1 Review of Previous Modelling

In the Phase II Investigation conducted in 2005 (REF: 44319623: Phase II Investigations and Environmental Assessments at the Former Albright & Wilson Works, Whitehaven, 23 June 2005), a mass balance approach was adopted to model the contributions of various potential sources to the Byerstead Spring. URS considered that the most appropriate method to characterise the migration of contamination was to adopt a simple mass balance approach. Each contaminant and water mass flux term was characterised and the overall mass/water balance used to establish the likely range of contaminant concentrations in water discharged via the Byerstead fault.

The mass balance approach had been adopted for a number of reasons, including:

- contaminant migration velocities between the site and the fault are known to be extremely fast, as a result of tracer experiments conducted by URS and, therefore, the majority of contaminant migration from the site drainage system will be through "conduits" within the sub-surface, where the primary attenuation mechanisms will be dilution with other waters within the conduits;
- a key question that the Environment Agency and URS has with regards to mass balance is that the sum of the known sources does not add up to the observed water discharging via the Byerstead Fault to the beach. Accounting for these uncertainties will form an integral part of this revised risk assessment; and
- the development of a mass balance approach is relatively simple and easily understood.

G.5.2 Stage 3b Methodology

The current model builds upon the previous modelling. Specifically, it recognises the potential for infiltration of clean water through the St. Bees Sandstone, and subsequent movement into the underlying units, including the St. Bees Evaporites, where the conduits containing the site derived waters are thought to exist.

As such, the model takes the Stage 3a assessment to the next step (through generating a second dilution), by considering rainfall, surface area of infiltration to the St. Bees Sandstone, likely infiltration rates through the Evaporites, and combines this with a mass of contamination (a concentration).

A conceptualisation of the Stage 3a and 3b model is presented in Figures G1 and G2.

At Stage 3a, it is assumed that the concentration generated in the source area (following the dilution from the surrounding clean soil) enters the evaporites at Point 1 (on the

diagram in section G.4.1), and remains at this concentration as it passes towards the site boundary at Point 2.

Stage 3b then considers the dilution of this concentration once offsite, as the concentration reduces through dilution from Point 2 to Point 3 (the Byerstead Spring).

This dilution occurs due to a volume of clean water entering the voids/conduits in the evaporite sequence sourced from infiltrating groundwater from the St. Bees Sandstone.

Potential Concentrations at the Byerstead Spring using the above discussion can be estimated as follows:

Concentration at Byerstead Spring = Concentration leaving site A x Df

Where: $Df = \frac{\text{Volume of water leaving site A}}{\text{Volume of water infiltrating St Bees Sandstone}}$

G.5.3 Stage 3b Model Parameters

The generic parameters used for the model are presented below.

TABLE G5.1 – STAGE 3 B MODEL PARAMETERS

Source Characterisation			
Source No.	**Source**	**Assessment Method**	**Plausible Distribution**
1	Infiltration through defined source zone on the site	Discharge (Q): Rainfall rate multiplied by an infiltration factor, Q=ARI Area (A): Total source catchment (defined source area and surrounding clean area). A source area of 1000m^2 for the worked example. Mean annual rainfall (R): 1070mm/annum or 0.00293 m/day (Meteorological Office) Infiltration Rate (I), Rainfall percolation into site catchment for individual analyte, maintained at the greenfield runoff rate, I = 7.5 – 22.5%, balancing potential additional losses at the drainage system with the reduced infiltration at buildings and roads. Likely to vary considerably with the impact of the drainage system and the large areas of concrete cover. The final infiltration rate will be dependent upon the state of the land cover once the site has	Potential Distribution Min I=7.5% Most likely I=15% Max I=22.5% Range above accounts for potential variations in contributing area and infiltration rate. The most likely value of 15% has been used.

Source Characterisation			
Source No.	**Source**	**Assessment Method**	**Plausible Distribution**
		been decommissioned. In the worked example, a volume of 440L was calculated to be flowing in the evaporites away from the source area towards the site boundary.	
2	*Infiltration recharge through non-contaminated areas (St. Bees Sandstone)*	Rainfall rate multiplied by an infiltration factor, Q=ARI Area (A): Width of the total onsite catchment (onsite source area and clean area) multiplied by an approximate length of clean source area extending from the western site boundary to the cliff line at the coast (approximately 300m). This results in a thin rectangular strip of clean catchment. This is a conservative assumption. In reality the clean catchment area is likely to be substantially wider. For the worked example the area of St. Bees Catchment was 9486 (300m long x 31.62m wide). Furthermore, the ground between the source area and the site boundary was not included in the model, as it was conservatively assumed to be contaminated, and therefore unable to contribute clean water. Mean annual rainfall (R): 1070mm/annum or 0.00293 m/day (Meteorological Office) Infiltration Rate (I): Rainfall percolation into St. Bees Sandstone: 7.5 – 22.5%, depending upon surface deposits. Lowest over areas containing boulder clay, highest where rockhead (St Bees Sandstone) is at the surface. The volume of groundwater percolating vertically through the St. Bees Sandstone into the underlying St. Bees Shales will be reduced, as a proportion will migrate laterally at the boundary with the less permeable underlying St. Bees Shale, towards the cliffline at the coast, where it will emerge as springs. Once in the shales, the majority of the groundwater will migrate vertically into the underlying sequence that contains the conduits carrying site derived water. There may be some lateral migration, which will generate more springs on the cliff line. In the worked example, a volume of 2086L was	Potential Distribution Min I=7.5% Most likely I=15% Max I=22.5% Range above accounts for potential variations in contributing area and infiltration rate. Given the potential for water loss through coastline springs in the St. Bees Sandstone/St. Bees Shale boundary, the lowest value of 7.5% has been used.

Source Characterisation			
Source No.	Source	Assessment Method	Plausible Distribution
		calculated to be flowing in the evaporites away from the source area towards the site boundary.	

Worked Example

The arsenic example above has been continued through to the 3b level to demonstrate the calculations required to generate the concentrations generated at the Byerstead Spring.

From the 3a model, it was determined that the concentration of arsenic as it enters the fracture/conduit was **11.6µg/L**. Once in this conduit, the contamination will move westwards towards the site boundary at the same concentration.

Beyond the site boundary, a volume of clean water that has infiltrated through the overlying St. Bees Sandstone will dilute this concentration, resulting in a reduced concentration as the water reaches the Byerstead Spring, as follows:

Predicted Concentration at Byerstead Spring = Concentration leaving site (e.g. 11.6µg/l) x Df

Where: Df = $\frac{\text{Volume of water leaving site A (e.g. 440L)}}{\text{Volume of water infiltrating St Bees Sandstone (e.g. 2086L)}}$

Predicted Concentration at Byerstead Spring= 11.6µg/l x 0.2107= **2.45 µg/l**

G.5.4 Summary of Identified Exceedances (Stage 3b)

For simulated contaminant concentrations at the adopted compliance point (in this case, the point at which the groundwater rises as a spring on the beach, the Byerstead Spring) to pose a potentially significant risk to controlled waters, they must be in excess of defined screening criteria. The results of the Stage 3b assessment are presented in Table G12 and are summarised in Table G5.2.

TABLE G5.2 – STAGE 3 B EXCEEDANCES- SUMMARY

Soil	Soil Leachate	Shallow Groundwater
		zinc

G.5.5 Limitations and key model assumptions

Key model assumptions include;

- Given that site operations have ceased, it is assumed that the concentration of the individual analytes will not worsen, as no fresh contamination inputs to ground will occur in the future. As such, contamination present in soils or groundwater represents residual contamination of a finite mass.

- No attenuation or biodegradation processes have been simulated to occur within the unsaturated zone.

- A component of the historical spillages and leachate infiltration of contaminants through the subsurface will be stored in the aquifers, mines and mine shafts and adits, and slowly released to the coast through seepage along the coast as well as the Byerstead fault, similar to the effect of baseflow on river flow. Similarly there will be some components of retardation and biological/chemical reactions within the pathway, although this may be limited to the to the component of contaminant mass stored within the subsurface, rather than the rapid movement from the site through the solution features, fractured geology and adits to the Byerstead fault.

- Overall, given the above assumptions and input parameters selected, the Stage 3 assessment is considered to be conservative in nature

G.6 UNCERTAINTIES

It is acknowledged that there are uncertainties inherent in all risk assessment methodologies, particularly in relation to the assignment of assumed values for difficult to measure site specific variables, such as infiltration rate. However, a reasonable body of research exists such that these variables can be estimated with reasonable accuracy, and in a manner that is known to be conservative. It is therefore likely that risks are, if anything, overestimated, as a result of these assumptions (constant source terms, use of maximum concentrations), and so the results of the controlled waters risk assessment should be viewed in this context.

The assessment can only be undertaken on the data set available from site investigations, thus it is possible that higher concentrations of ground contaminants than observed during the recent site assessment works may exist. This uncertainty has been reduced as far as is reasonably practical with use of a relatively high sampling density and several phases of site investigation. It is also balanced by the inherent conservatism of the modelling process.

G.7 SUMMARY OF RISKS TO CONTROLLED WATERS

The results of the modelling have indicated that a potentially significant risk may be present with regard to controlled waters. The concentration of zinc after the Stage 3b

assessment (43μg/l) marginally exceeded the screening criteria (40μg/l). However, taking into account this borderline exceedance and the conservatism within the model, in reality it is unlikely that this exceedance signifies a requirement for further investigation.

One area of the site, focused on the area encompassing ERMSB15 and WS130 will require further invesitgation and assessment to determine whether or not remedial action may be required. There are a number of potential analyte exceedances in this area; considerable exceedances of TPH have been measured in groundwater at ERMSB15 and WS130; PAH exceedances have been measured at WS130 and an MBAS exceedance has also been measured in WS130. These exceedances were not included in the risk assessment as there were insufficient data points (due to inaccesible areas) to delineate an area of contaminated groundwater. A similar situation exists for naphthalene contamination detected in soil at TP758G.

The following outline scope of works is recommended for further investigation in Plot G.

ETO Area – The area in the vicinity of ERMSB15, WS130 and TP758G

It is proposed that up to 8 trial pits and up to 4 boreholes are advanced to 5mbgl (or bedrock, if shallower) in order to delineate the PAH and TPH contamination. Soil samples would be taken at 0.5m interval for headspace screening and water samples from trial pits (grab samples) and boreholes would be taken for laboratory analysis. Also, concurrently with this investigation it is proposed that an investigation into naphthalene contamination in soil is undertaken in the area around TP758G.

G.8 REFERENCES

1) CLR-7 (2002) Assessment of Risks to Human Health from Land Contamination: An overview of the Development of Soil Guideline Values and Related Research. Department for the Environment, Food and Rural Affairs (DEFRA) and Environment Agency (EA), Appendix A.

2) CLR-11 (2004) Model Procedures for the Management of Land Contamination" (Environment Agency, 2004).

3) Environment Agency (1999) Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources. Authors Marsland, P.A. and Carey, M.A. Environment Agency R&D Publication 20, 89pp.

TABLES

TABLE G1 – STAGE 2 SCREENING CRITERIA – VOCS IN SOILS

Determinand	Controlled Waters Stage 2 Soil Screening Criteria (mg/kg)	Source
Benzene	2.82E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
1-Butanol	6.74E-01	USEPA Region 9 (pathway specific)
2-Butanone (MEK = methyl ethyl ketone)	Missing Physchem	USEPA Region 9 (pathway specific)
Butyl benzyl phthalate (BBP)	2.39E+03	USEPA Region 9 (pathway specific)
n-Butylbenzene	1.59E+00	USEPA Region 9 (pathway specific)
sec-Butylbenzene	No Criterion	No Criterion
tert-Butylbenzene	4.78E+00	USEPA Region 9 (pathway specific)
Carbon Disulphide (Carbon Bisulphide)	4.92E-01	USEPA Region 9 (pathway specific)
Carbon Tetrachloride (tetrachloromethane)	2.41E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 86/280/EEC
1-Chlorobutane	2.49E+00	USEPA Region 9 (pathway specific)
Chloroethane (ethyl chloride)	9.90E-04	USEPA Region 9 (pathway specific)
Chloroform (trichloromethane)	4.81E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/347/EEC
Chloromethane (methyl chloride)	3.17E-02	USEPA Region 9 (pathway specific)
2-Chloronaphthalene	1.76E+01	USEPA Region 9 (pathway specific)
2-Chlorophenol (o-chlorophenol)	1.19E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
1,2-Dichlorobenzene	3.68E+00	WHO DWG
1,3-Dichlorobenzene	2.09E+00	USEPA Region 9 (pathway specific)
1,4-Dichlorobenzene	1.11E+00	WHO DWG
Dichlorodifluoromethane	1.73E+00	USEPA Region 9 (pathway specific)
1,1-Dichloroethane (EDC)	2.92E-01	USEPA Region 9 (pathway specific)
1,2-Dichloroethane(EDC)	5.21E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1992 No 337 (Water Resources, England & Wales)
1,1-Dichloroethene	1.72E-02	WHO DWG
1,2-Dichloroethene (cis + trans) total	1.89E-02	WHO DWG
1,2-Dichloroethene (cis)	2.30E-02	USEPA Region 9 (pathway specific)
1,2-Dichloroethene (trans)	5.95E-02	USEPA Region 9 (pathway specific)
Dichloromethane (see methylene chloride)	6.21E-03	WHO DWG
1,2-Dichloropropane (1,2-DCP)	4.40E-05	UK DWS (2000)
1,3-Dichloropropane	Missing Physchem	UK DWS (2000)
2,2-Dichloropropane	No Criterion	No Criterion
1,3-Dichloropropene	7.34E-03	WHO DWG
2,4-Dinitrophenol	1.20E-02	USEPA Region 9 (pathway specific)
2,4-Dinitrotoluene	3.19E-02	USEPA Region 9 (pathway specific)
2,6-Dinitrotoluene	4.85E-02	USEPA Region 9 (pathway specific)
Hexachlorobenzene	9.41E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources,

Determinand	Controlled Waters Stage 2 Soil Screening Criteria (mg/kg)	Source
		England & Wales) 88/347/EEC
Hexachlorobutadiene	3.06E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/347/EEC
Hexachlorocyclopentadiene	2.50E+02	USEPA Region 9 (pathway specific)
Hexachloroethane	4.96E-02	USEPA Region 9 (pathway specific)
Iso-Propylbenzene (cumene)	2.04E+00	USEPA Region 9 (pathway specific)
Lindane (HCH-gamma)	1.25E-04	UK Marine / Estuarine EQS
Methanol	3.06E+00	USEPA Region 9 (pathway specific)
Methyl chloride (Chloromethane)	4.01E-03	WHO DWG
Methyl Isobutyl ketone (4-methyl-2-pentanone) MIBK	5.44E-01	USEPA Region 9 (pathway specific)
Methyl tert butyle ether (MTBE)	2.28E-03	USEPA Region 9 (pathway specific)
Methylene chloride (Dichloromethane)	6.21E-03	WHO DWG
Monochlorobenzene	6.30E-01	WHO DWG
Nitrobenzene	1.53E-03	USEPA Region 9 (pathway specific)
m-Nitrotoluene	3.44E-01	USEPA Region 9 (pathway specific)
o-Nitrotoluene	1.26E-04	USEPA Region 9 (pathway specific)
p-Nitrotoluene	8.88E-04	USEPA Region 9 (pathway specific)
Pentachlorobenzene	6.57E+01	USEPA Region 9 (pathway specific)
Pentachlorophenol (PCP)	7.08E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales)
1,2,4,5-Tetrachlorobenzene	4.22E+00	USEPA Region 9 (pathway specific)
1,1,1,2-Tetrachloroethane	3.59E-04	USEPA Region 9 (pathway specific)
1,1,2,2-Tetrachloroethane (PCA)	6.66E-05	USEPA Region 9 (pathway specific)
Tetrachloroethene (Tetrachloroethylene) (PCE)	1.47E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1992 No 337 (Water Resources, England & Wales)
Tetrachloroethene and Trichloroethene (sum of PCE and TCE)	1.12E-02	UK DWS (2000)
Tetrachloromethane (carbon tetrachloride)	2.41E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Toluene (Methyl benzene)	3.92E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	2.05E+02	USEPA Region 9 (pathway specific)
1,2,3-Trichlorobenzene	No Criterion	No Criterion
1,2,4-Trichlorobenzene	7.38E-02	USEPA Region 9 (pathway specific)
1,1,1-Trichloroethane (TCA)	1.35E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
1,1,2-Trichloroethane	1.70E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)

Determinand	Controlled Waters Stage 2 Soil Screening Criteria (mg/kg)	Source
Trichloroethene (Trichloroethylene) (TCE)	1.12E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1992 No 337 (Water Resources, England & Wales)
Trichlorofluoromethane (Freon 11)	1.83E+00	USEPA Region 9 (pathway specific)
Trichloromethane (chloroform)	4.81E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Trihalomethanes (sum of, specified note ix)	4.01E-02	UK DWS (2000)
1,2,4-Trimethylbenzene	9.71E-02	USEPA Region 9 (pathway specific)
1,3,5-Trimethylbenzene	9.71E-02	USEPA Region 9 (pathway specific)
Vinyl Chloride	2.88E-04	UK DWS (2000)
o-Xylene	Sum o-xylene and m,p-xylene and use criteria for "Xylenes"	UK Marine / Estuarine EQS
m-Xylene	Sum o-xylene and m,p-xylene and use criteria for "Xylenes"	UK Marine / Estuarine EQS
p-Xylene	Sum o-xylene and m,p-xylene and use criteria for "Xylenes"	UK Marine / Estuarine EQS
Xylenes	7.78E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC

TABLE G2 – STAGE 2 SCREENING CRITERIA – SOIL LEACHATE AND SHALLOW GROUNDWATER

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
pH	6 - 8.5	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
1,1,1,2-Tetrachloroethane	4.32E-01	USEPA Region 9 (pathway specific)
1,1,1-Trichloroethane (TCA)	1.00E+02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
1,1,2,2-Tetrachloroethane (PCA)	5.53E-02	USEPA Region 9 (pathway specific)
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	5.92E+04	USEPA Region 9 (pathway specific)
1,1,2-Trichloroethane	3.00E+02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
1,1-Biphenyl	2.50E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 389 (Water Resources, England & Wales)
1,1-Dichloroethane (EDC)	8.11E+02	USEPA Region 9 (pathway specific)
1,1-Dichloroethene	3.00E+01	WHO DWG
1,2,3-Trichloropropane	5.60E-03	USEPA Region 9 (pathway specific)
1,2,3-Trichloropropene	2.18E+00	USEPA Region 9 (pathway specific)
1,2,4,5-Tetrachlorobenzene	1.09E+01	USEPA Region 9 (pathway specific)
1,2,4-Trichlorobenzene	7.16E+00	USEPA Region 9 (pathway specific)
1,2,4-Trimethylbenzene	1.23E+01	USEPA Region 9 (pathway specific)
1,2-Dibromo-3-chloropropane	1.00E-01	UK DWS (2000)
1,2-Dibromoethane	1.00E-01	UK DWS (2000)
1,2-Dichlorobenzene	1.00E+03	WHO DWG
1,2-Dichloroethane(EDC)	1.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1992 No 337 (Water Resources, England & Wales)
1,2-Dichloroethene (cis + trans) total	5.00E+01	WHO DWG
1,2-Dichloroethene (cis)	6.08E+01	USEPA Region 9 (pathway specific)
1,2-Dichloroethene (trans)	1.22E+02	USEPA Region 9 (pathway specific)
1,2-Dichloropropane (1,2-DCP)	1.00E-01	UK DWS (2000)
1,3,5-Trichlorobenzene	0.00E+00	UK Freshwater EQS
1,3,5-Trimethylbenzene	1.23E+01	USEPA Region 9 (pathway specific)
1,3-Dichlorobenzene	1.83E+02	USEPA Region 9 (pathway specific)
1,3-Dichloropropane	1.00E-01	UK DWS (2000)
1,3-Dichloropropene	2.00E+01	WHO DWG
1,4-Dichlorobenzene	3.00E+02	WHO DWG
1-Butanol	3.65E+03	USEPA Region 9 (pathway specific)

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
1-Chlorobutane	2.43E+03	USEPA Region 9 (pathway specific)
2,3,4,6-Tetrachlorophenol	1.09E+03	USEPA Region 9 (pathway specific)
2,3,7,8-TCDD (Tetrachlorodibenzodioxin)	4.48E-07	USEPA Region 9 (pathway specific)
2,3-Dichlorophenol	0.00E+00	UK Freshwater EQS
2,4,5-Trichlorophenol	9.00E+00	WHO DWG
2,4,6-Trichlorophenol	2.00E+02	WHO DWG
2,4-D (Dichlorophenoxyacetic acid)	1.00E-01	UK DWS (2000)
2,4-D (ester) (Dichlorophenoxyacetic acid)	1.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
2,4-D (non-ester) (Dichlorophenoxyacetic acid)	4.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
2,4-DB	1.00E-01	UK DWS (2000)
2,4-Dichlorophenol	2.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
2,4-Dimethylphenol (DMP)	7.30E+02	USEPA Region 9 (pathway specific)
2,4-Dinitrophenol	7.30E+01	USEPA Region 9 (pathway specific)
2,4-Dinitrotoluene	7.30E+01	USEPA Region 9 (pathway specific)
2,6-Dimethylphenol (DMP)	2.19E+01	USEPA Region 9 (pathway specific)
2,6-Dinitrotoluene	3.65E+01	USEPA Region 9 (pathway specific)
2-Butanone (MEK = methyl ethyl ketone)	6.97E+03	USEPA Region 9 (pathway specific)
2-Chloronaphthalene	4.87E+02	USEPA Region 9 (pathway specific)
2-Chlorophenol (o-chlorophenol)	5.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
2-Chlorotoluene	1.22E+02	USEPA Region 9 (pathway specific)
2-Nitroaniline	1.09E+02	USEPA Region 9 (pathway specific)
3,3`-Dichlorobenzidine	1.49E-01	USEPA Region 9 (pathway specific)
3,4-Dimethylphenol (DMP)	3.65E+01	USEPA Region 9 (pathway specific)
3-Nitroaniline	3.20E+00	USEPA Region 9 (pathway specific)
4,4`DDD (1,1-dichloro-2,2-bis(4-chlorophenyl)ethane)	1.00E-01	UK DWS (2000)
4,4`DDE (1,1-dichloro-2,2-bis(4-chlorophenyl)ethylene)	1.00E-01	UK DWS (2000)
4,6-Dinitro-2-methylphenol	3.65E+00	USEPA Region 9 (pathway specific)
4-Chloro-3-methylphenol	4.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
4-Chloroaniline	1.46E+02	USEPA Region 9 (pathway specific)
4-Methylphenol	1.82E+02	USEPA Region 9 (pathway specific)
4-Nitroaniline	3.20E+00	USEPA Region 9 (pathway specific)

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Acenaphthene	3.65E+02	USEPA Region 9 (pathway specific)
Acenaphthylene	1.00E+01	UK DWS (2000)
Acephate	1.00E-01	UK DWS (2000)
Acetaldehyde	1.75E+00	USEPA Region 9 (pathway specific)
Acetochlor	1.00E-01	UK DWS (2000)
Acetone	5.48E+03	USEPA Region 9 (pathway specific)
Acetonitrile	1.03E+02	USEPA Region 9 (pathway specific)
Acrolein	4.16E-02	USEPA Region 9 (pathway specific)
Acrylamide	1.00E-01	UK DWS (2000)
Acrylic Acid	1.82E+04	USEPA Region 9 (pathway specific)
Acrylonitryle	3.89E-02	USEPA Region 9 (pathway specific)
Alachlor	1.00E-01	UK DWS (2000)
Aldicarb	1.00E-01	UK DWS (2000)
Aldrin	1.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/34/EEC
Aldrin+Dieldrin	3.00E-02	WHO DWG
Aldrin+Dieldrin+Endrin+Isodrin	3.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Aluminium	2.00E+02	UK DWS (2000)
Ammonia (undissociate NH3 only)	2.10E+01	UK Marine / Estuarine EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC
Ammonium NH4 (total)	1.00E+03	UK Freshwater EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC
Aniline	1.18E+01	USEPA Region 9 (pathway specific)
Anthracene	1.83E+03	USEPA Region 9 (pathway specific)
Antimony	5.00E+00	UK DWS (2000)
Arsenic	2.50E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Atrazine	2.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Azinphos-methyl (Guthion)	1.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Azobenzene	6.11E-01	USEPA Region 9 (pathway specific)
Barium	7.00E+02	WHO DWG

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Bentazon	5.00E+02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 389 (Water Resources, England & Wales)
Benz[a]anthracene	9.21E-02	USEPA Region 9 (pathway specific)
Benzaldehyde	3.65E+03	USEPA Region 9 (pathway specific)
Benzene	3.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
Benzo[a]pyrene	1.00E-02	UK DWS (2000)
Benzoic Acid	1.46E+05	USEPA Region 9 (pathway specific)
Benzyl alcohol	1.09E+04	USEPA Region 9 (pathway specific)
Beryllium	7.30E+01	USEPA Region 9 (pathway specific)
bis(2-chloroethyl)ether	1.02E-02	USEPA Region 9 (pathway specific)
bis(2-chloroisopropyl)ether	2.74E-01	USEPA Region 9 (pathway specific)
bis(2-ethylhexyl)phthalate (di(2-ethylhexyl)phthalate)(DEHP)	8.00E+00	WHO DWG
bis(chloromethyl)ether	5.15E-05	USEPA Region 9 (pathway specific)
BOD (cyprinid fisheries)	6.00E+03	UK Freshwater EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC
BOD (salmonid fisheries)	3.00E+03	UK Freshwater EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC
Boron	7.00E+03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Bromate	1.00E+01	UK DWS (2000)
Bromobenzene	2.03E+01	USEPA Region 9 (pathway specific)
Bromomethane (methyl bromide)	8.66E+00	USEPA Region 9 (pathway specific)
Bromoxynil	1.00E+02	UK Marine / Estuarine EQS WRc Report DoE 36271/1 1995
Butyl benzyl phthalate (BBP)	7.30E+03	USEPA Region 9 (pathway specific)
Cadmium	2.50E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Calcium	2.50E+05	UK DWS (2000)
Carbazole	3.36E+00	USEPA Region 9 (pathway specific)
Carbofuran	1.00E-01	UK DWS (2000)
Carbon Disulphide (Carbon Bisulphide)	1.04E+03	USEPA Region 9 (pathway specific)
Carbon Tetrachloride (tetrachloromethane)	1.20E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 86/280/EEC

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Chlofenvinphos	1.00E-02	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996 [NRA R&D Note 216(1993)]
Chlorate	7.00E+02	WHO DWG
Chlordane	1.00E-01	UK DWS (2000)
Chloride	2.50E+05	UK Freshwater EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Chlorine	1.00E+01	UK Marine / Estuarine EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC
Chlorite	7.00E+02	WHO DWG
Chloroethane (ethly chloride)	4.64E+00	USEPA Region 9 (pathway specific)
Chloroform (trichloromethane)	1.20E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/347/EEC
Chloromethane (methyl chloride)	1.58E+02	USEPA Region 9 (pathway specific)
Chloronitrotoluenes (CNT)	1.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Chlorotoluron	2.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Chlorphenylid	5.00E-02	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996
Chromium	1.50E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Chromium III	5.47E+04	USEPA Region 9 (pathway specific)
Chromium VI	1.09E+02	USEPA Region 9 (pathway specific)
Chrysene	9.21E+00	USEPA Region 9 (pathway specific)
Cobalt	7.30E+02	USEPA Region 9 (pathway specific)
Copper	5.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Coumaphos	4.00E-02	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996 [NRA R&D) Note 216 (1993)]
Cyanazine	1.00E-01	UK DWS (2000)
Cyanide (free)	5.00E+01	UK DWS (2000)

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Cyfluthrin	1.00E-03	UK Marine / Estuarine EQS Department of the Environment (now DETR) Circular 7/89, Environment Agency Research & Development(R&D) Report 12 1996
DDT (1,1,1-trichloro-2,2-bis(4chlorophenyl)ethane)	1.00E-01	UK DWS (2000)
DDT(all isomers) (1,1,1-trichloro-2,2-bis(4chlorophenyl)ethane)	2.50E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 86/280/EEC
DDT/DDE/DDD (sum)	1.00E-01	UK DWS (2000)
Demetons (total)	5.00E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 389 (Water Resources, England & Wales)
Di(2-ethylhexyl)adipate	8.00E+01	WHO DWG
Diazinon	1.50E-02	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996 [NRA R&D) Note 216 (1993)]
Dibenzo[a,h]anthracene	9.21E-03	USEPA Region 9 (pathway specific)
Dibenzofuran	1.22E+01	USEPA Region 9 (pathway specific)
Dibromoacetonitrile	7.00E+01	WHO DWG
Dibromomethane	6.08E+01	USEPA Region 9 (pathway specific)
Dibutyl phthalate (DBP)	3.65E+03	USEPA Region 9 (pathway specific)
Dichloroacetate	5.00E+01	WHO DWG
Dichloroacetonitrile	2.00E+01	WHO DWG
Dichlorobiphenyls	1.00E-01	UK DWS (2000)
Dichlorodifluoromethane	3.95E+02	USEPA Region 9 (pathway specific)
Dichloromethane (see methylene chloride)	2.00E+01	WHO DWG
Dichlorprop	1.00E-01	UK DWS (2000)
Dichlorvos	4.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Dieldrin	1.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/34/EEC
Diethylphthalate (DEP)	2.92E+04	USEPA Region 9 (pathway specific)
Dimethoate	1.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 389 (Water Resources, England & Wales)
Dimethylphthalate	3.65E+05	USEPA Region 9 (pathway specific)
Di-n-octylphthalate	1.46E+03	USEPA Region 9 (pathway specific)
Diuron	1.00E-01	UK DWS (2000)
DO2 (cyprinid fisheries)	5.00E+03	UK Freshwater EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
DO2 (salmonid fisheries)	7.00E+03	UK Freshwater EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC
Edetic acid (EDTA)	6.00E+02	WHO DWG
Endosulfan	3.00E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Endrin	5.00E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/347/EEC
Epichlorohydrin	1.00E-01	UK DWS (2000)
Ethyl chloride (chloroethane)	4.64E+00	USEPA Region 9 (pathway specific)
Ethylbenzene	3.00E+02	WHO DWG
Fenchlorphos	1.00E-02	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996
Fenitrothion	1.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Fenoprop	1.00E-01	UK DWS (2000)
Flucofuron	1.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Fluoranthene	2.00E-01	UK DWS (2000)
Fluorene	2.43E+02	USEPA Region 9 (pathway specific)
Fluoride	1.50E+03	UK DWS (2000)
Formaldehyde	5.00E+00	UK Freshwater EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
HCH-alpha	1.00E-01	UK DWS (2000)
HCH-beta	1.00E-01	UK DWS (2000)
HCH-gamma (Lindane)	1.00E-01	UK DWS (2000)
Heptachlor	3.00E-02	UK DWS (2000)
Heptachlor and heptachlor epoxide	3.00E-02	UK DWS (2000)
Heptachlor epoxide	1.00E-01	UK DWS (2000)
Heptachlorobiphenyls	1.00E-01	UK DWS (2000)
Hexachlorobenzene	3.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/347/EEC
Hexachlorobiphenyls	1.00E-01	UK DWS (2000)
Hexachlorobutadiene	1.00E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 88/347/EEC

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Hexachlorocyclohexane	2.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 84/491/EEC
Hexachlorocyclopentadiene	2.19E+02	USEPA Region 9 (pathway specific)
Hexachloroethane	4.80E+00	USEPA Region 9 (pathway specific)
Hydrogen sulphide	1.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Ioxynil	1.00E+01	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996
Iron	1.00E+03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Isodrin	5.00E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales)
Isophorone	7.08E+01	USEPA Region 9 (pathway specific)
Iso-Propylbenzene (cumene)	6.58E+02	USEPA Region 9 (pathway specific)
Isoproturon	2-20	UK Freshwater EQS Environment Agency Research & Development (R&D) Technical Summary 173(xi) 1999
Kjeldahl nitrogen/Total Organic Nitrogen (N)	1.00E+03	UK DWS (2000)
Lead	2.50E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Lead (tetraethyl)	3.65E-03	USEPA Region 9 (pathway specific)
Lindane (HCH-gamma)	2.00E-02	UK Marine / Estuarine EQS
Linuron	2.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
Lithium	7.30E+02	USEPA Region 9 (pathway specific)
m or 3-Cresol (3-methylphenol)	1.82E+03	USEPA Region 9 (pathway specific)
Magnesium	5.00E+04	UK DWS (2000)
Malachite Green	5.00E-01	UK Freshwater EQS Environment Agency Research & Development (R&D) Report P12 1996
Malathion	2.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Manganese	5.00E+01	UK DWS (2000)
MCPA (2-methyl-4-chlorophenoxy acetic acid)	2.00E+00	UK Marine / Estuarine EQS DETR (1997) National EQSs for Dangerous Substances in Water; Draft Regulations and Compliance Cost

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
		Assessment
Mecoprop	2.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
Mercury (elemental)	1.00E+00	UK DWS (2000)
Mercury (inorganic compounds)	3.00E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Mercury (methyl)	3.65E+00	USEPA Region 9 (pathway specific)
Mercury and compounds	3.00E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Methanol	1.82E+04	USEPA Region 9 (pathway specific)
Methoxychlor	1.00E-01	UK DWS (2000)
Methyl chloride (Chloromethane)	2.00E+01	WHO DWG
Methyl ethyl ketone (MEK) (2-Butanone)	6.97E+03	USEPA Region 9 (pathway specific)
Methyl Isobutyl ketone (4-methyl-2-pentanone) MIBK	1.99E+03	USEPA Region 9 (pathway specific)
Methyl tert butyle ether (MTBE)	1.10E+01	USEPA Region 9 (pathway specific)
Methylcyclohexane	5.22E+03	USEPA Region 9 (pathway specific)
Methylene chloride (Dichloromethane)	2.00E+01	WHO DWG
Metolachlor	1.00E-01	UK DWS (2000)
Mevinphos	2.00E-02	UK Freshwater EQS UK EQS
m-Nitrotoluene	1.22E+02	USEPA Region 9 (pathway specific)
Molinate	1.00E-01	UK DWS (2000)
Molybdenum	7.00E+01	WHO DWG
Monochloramine	3.00E+03	WHO DWG
Monochloroacetate	2.00E+01	WHO DWG
Monochlorobenzene	3.00E+02	WHO DWG
Monochlorobiphenyls	1.00E-01	UK DWS (2000)
Naphthalene	5.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
n-Butylbenzene	2.43E+02	USEPA Region 9 (pathway specific)
Nickel	3.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Nitrate (NO3)	5.00E+04	UK DWS (2000)
Nitrilotriacetic acid	2.00E+02	WHO DWG
Nitrite - consumers taps (NO2)	0.01 - 0.03	UK Freshwater EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales)

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
		78/659/EEC
Nitrite - ex works (NO2)	0.01 - 0.03	UK Freshwater EQS Surface Waters (Fishlife) (Classification) Regulations 1997 No 1331 (Water Resources, England & Wales) 78/659/EEC
Nitrobenzene	3.40E+00	USEPA Region 9 (pathway specific)
n-Nitroso-di-n-propylamine	9.60E-03	USEPA Region 9 (pathway specific)
n-Nitrosodiphenylamine	1.37E+01	USEPA Region 9 (pathway specific)
Nonachlorobiphenyls	1.00E-01	UK DWS (2000)
n-Propylbenzene	2.43E+02	USEPA Region 9 (pathway specific)
o or 2-Cresol (2-methylphenol)	1.82E+03	USEPA Region 9 (pathway specific)
Octachlorobiphenyls	1.00E-01	UK DWS (2000)
Omethoate	1.00E-02	UK Freshwater EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
o-Nitrotoluene	4.87E-02	USEPA Region 9 (pathway specific)
Oxidizability (permanganate value) (O2)	5.00E+03	UK DWS (2000)
p or 4-Cresol (4-methylphenol)	1.82E+02	USEPA Region 9 (pathway specific)
p`p`-DDT (1,1,1-trichloro-2,2-bis(4chlorophenyl)ethane)	1.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 86/280/EEC
PAHs (sum of 4, specified note (vii))	1.00E-01	UK DWS (2000)
PCB (total)	5.00E-01	UK DWS (2000)
PCB 101	1.00E-01	UK DWS (2000)
PCB 105	1.00E-01	UK DWS (2000)
PCB 114	1.00E-01	UK DWS (2000)
PCB 118	1.00E-01	UK DWS (2000)
PCB 123	1.00E-01	UK DWS (2000)
PCB 126	1.00E-01	UK DWS (2000)
PCB 138	1.00E-01	UK DWS (2000)
PCB 153	1.00E-01	UK DWS (2000)
PCB 156	1.00E-01	UK DWS (2000)
PCB 157	1.00E-01	UK DWS (2000)
PCB 167	1.00E-01	UK DWS (2000)
PCB 169	1.00E-01	UK DWS (2000)
PCB 180	1.00E-01	UK DWS (2000)
PCB 189	1.00E-01	UK DWS (2000)
PCB 28	1.00E-01	UK DWS (2000)
PCB 52	1.00E-01	UK DWS (2000)
PCB 77	1.00E-01	UK DWS (2000)
PCB 81	1.00E-01	UK DWS (2000)
PCB Aroclor-1016 (42% Cl)	1.00E-01	UK DWS (2000)
PCB Aroclor-1221	1.00E-01	UK DWS (2000)
PCB Aroclor-1232	1.00E-01	UK DWS (2000)
PCB Aroclor-1242	1.00E-01	UK DWS (2000)
PCB Aroclor-1248	1.00E-01	UK DWS (2000)

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
PCB Aroclor-1254	1.00E-01	UK DWS (2000)
PCB Aroclor-1260	1.00E-01	UK DWS (2000)
PCBs (sum of 7 - see comment)	1.00E-01	UK DWS (2000)
PCSDs	5.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Pendimethalin	1.00E-01	UK DWS (2000)
Pentachlorobenzene	2.92E+01	USEPA Region 9 (pathway specific)
Pentachlorophenol (PCP)	2.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales)
Perchlorethylene (refer to PCE)	1.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Permethrin	1.00E-02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Pesticides: Total substances (sum)	5.00E-01	UK DWS (2000)
Phenanthrene	1.00E+01	UK DWS (2000)
Phenol	3.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Phenols (phenol index)	2.20E+03	UK DWS (2000)
Phosphorus	2.20E+03	UK DWS (2000)
Phosphorus (white)	7.30E-01	USEPA Region 9 (pathway specific)
p-Nitrotoluene	6.59E-01	USEPA Region 9 (pathway specific)
Potassium	1.20E+04	UK DWS (2000)
Propazine	1.00E-01	UK DWS (2000)
Propetamphos	1.00E-02	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996
Pyrene	1.83E+02	USEPA Region 9 (pathway specific)
Pyridine	3.65E+01	USEPA Region 9 (pathway specific)
Selenium	1.00E+01	UK DWS (2000)
Silver	5.00E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Simazine	2.00E+00	UK Marine / Estuarine EQS UK EQS
Sodium	0.00E+00	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Styrene	5.00E+01	UK Marine / Estuarine EQS UK EQS

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Sulcofuron (Sulcofuron-sodium)	2.50E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Sulphate	2.50E+05	UK DWS (2000)
Surfactants (as lauryl sulphate)	2.00E+02	UK DWS (2000)
Tecnazene	1.00E+00	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996
Terbuthylazine	1.00E-01	UK DWS (2000)
Terbutryn	1.00E-01	UK DWS (2000)
tert-Butylbenzene	2.43E+02	USEPA Region 9 (pathway specific)
Tetrachlorobiphenyls	1.00E-01	UK DWS (2000)
Tetrachloroethene (Tetrachloroethylene) (PCE)	1.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1992 No 337 (Water Resources, England & Wales)
Tetrachloroethene and Trichloroethene (sum of PCE and TCE)	1.00E+01	UK DWS (2000)
Tetrachloromethane (carbon tetrachloride)	1.20E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Tin	1.00E+01	UK Marine / Estuarine EQS Environment Agency Research & Development (R&D) Report P12 1996
Toluene (Methyl benzene)	4.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
TPH (>EC10-12) aliphatic	1.00E+01	UK DWS (2000)
TPH (>EC10-12) aromatic	1.00E+01	UK DWS (2000)
TPH (>EC12-16) aliphatic	1.00E+01	UK DWS (2000)
TPH (>EC12-16) aromatic	1.00E+01	UK DWS (2000)
TPH (>EC16-21) aliphatic	1.00E+01	UK DWS (2000)
TPH (>EC16-21) aromatic	1.00E+01	UK DWS (2000)
TPH (>EC21-35) aromatic	1.00E+01	UK DWS (2000)
TPH (>EC5-6) aliphatic	1.00E+01	UK DWS (2000)
TPH (>EC5-7) aromatic	1.00E+01	UK DWS (2000)
TPH (>EC6-7) aromatic	1.00E+01	UK DWS (2000)
TPH (>EC6-8) aliphatic	1.00E+01	UK DWS (2000)
TPH (>EC7-8) aliphatic	1.00E+01	UK DWS (2000)
TPH (>EC7-8) aromatic	1.00E+01	UK DWS (2000)
TPH (>EC8-10) aliphatic	1.00E+01	UK DWS (2000)
TPH (>EC8-10) aromatic	1.00E+01	UK DWS (2000)
TPH (EC21-35) aliphatic	1.00E+01	UK DWS (2000)
TPH (Total)	1.00E+01	UK DWS (2000)

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Triazaphos	5.00E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1998 No 389 (Water Resources, England & Wales)
Tributly tin	2.00E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Tributyl tin oxide (TBTO)	2.00E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Trichloroacetaldehyde (Chloral Hydrate)	1.00E+01	WHO DWG
Trichloroacetate	2.00E+02	WHO DWG
Trichlorobenzenes (total)	4.00E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Trichlorobiphenyls	1.00E-01	UK DWS (2000)
Trichloroethene (Trichloroethylene) (TCE)	1.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1992 No 337 (Water Resources, England & Wales)
Trichlorofluoromethane (Freon 11)	1.29E+03	USEPA Region 9 (pathway specific)
Trichloromethane (chloroform)	1.20E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Trifluralin	1.00E-01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Trihalomethanes (sum of, specified note ix)	1.00E+02	UK DWS (2000)
Triphenyl tin	8.00E-03	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1997 No 2560 (Water Resources, England & Wales)
Uranium	1.50E+01	WHO DWG
Vanadium	1.00E+02	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC
Vinyl Chloride	5.00E-01	UK DWS (2000)
Xylenes	3.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC

Determinand	Controlled Waters Generic Screening Criteria UK Marine/Estuarine EQS (µg/l)	Source
Zinc	4.00E+01	UK Marine / Estuarine EQS Surface Waters (Dangerous Substances)(Classification) Regulations 1989 No 2286 (Water Resources, England & Wales) 83/513/EEC

Table G3 – Stage 2 Assessment – VOCs in Soils

Target Compound	Generic Controlled Waters Screening Criteria (mg/kg)	Statistical Analysis					Number of Samples Exceeding Generic Screen
		Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	US95 (mg/kg)	Number Analysed	
Naphthalene	0.0382	13	13	-	-	13	1

Table G4 – Stage 2 Assessment – Leachable Metals & Surfactant

Target Compound	Stage 2 Controlled Waters (µg/L)	Statistical Analysis						Number of Samples Exceeding Stage 2
		Minimum	Maximum	Geomean	Mean	US95	Number Analysed	
ARSENIC	25	nd	33	4.7	7.6	11.9	17	2
CHROMIUM	15	nd	54	5	14.2	311.7	17	2
COPPER	5	nd	69	10.3	15.7	23.1	17	13
LEAD	25	nd	53	3.7	11.3	28.3	17	1
NICKEL	30	nd	170	14.1	31.2	60.5	17	10
SELENIUM	10	nd	22	4.7	7	10.1	17	12
ZINC	40	nd	140	24.9	35.3	57.4	17	10
ANIONIC SURFACTANT	200	nd	21000	471	3455	7255	20	8

Table G5 – Stage 2 Assessment – Leachable TPH

Target Compound	Stage 2 Controlled Waters (µg/L)	Statistical Analysis						Number of Samples Exceeding Stage 2
		Minimum	Maximum	Geomean	Mean	US95	Number Analysed	
TPH C12-C16 AROMATIC	10	nd	120	-	-	-	12	1
TPH C16-C21 AROMATIC	10	nd	110	-	-	-	12	1

Table G6 – Stage 2 Assessment – Leachable SVOC and PAH

Target Compound	Stage 2 Controlled Waters (µg/L)	Statistical Analysis						Number of Samples Exceeding Stage 2
		Minimum	Maximum	Geomean	Mean	US95	Number Analysed	
NAPHTHALENE	5	Nd	87	-	-	-	16	1
CARBAZOLE	3.36	nd	4	-	-	-	16	1

Table G7 – Stage 2 Assessment –Shallow Groundwater Metals & Inorganic Compounds

Target Compound	Stage 2 Controlled Waters (µg/L)	Statistical Analysis						Number of Samples Exceeding Stage 2
		Minimum	Maximum	Geomean	Mean	US95	Number Analysed	
CHROMIUM	15	1	83	-	-	-	6	1
ZINC	40	7	236	37.7	74	164	5	2
ANIONIC SURFACTANT	200	50	1100	-	-	-	3	2

Table G8 – Stage 2 Assessment –Shallow Groundwater TPH

Target Compound	Stage 2 Controlled Waters (ug/L)	Statistical Analysis						Number of Samples Exceeding Stage 2
		Minimum	Maximum	Geomean	Mean	US95	Number Analysed	
C10-C12	10	nd	46600	-	-	-	2	1
C12-C16	10	nd	12200	-	-	-	2	1
C21-C35	10	nd	933	1150	-	-	2	2

Table G9 – Stage 2 Assessment –Shallow Groundwater VOCs and SVOCs

Target Compound	Stage 2 Controlled Waters (ug/L)	Statistical Analysis						Number of Samples Exceeding Stage 2
		Minimum	Maximum	Geomean	Mean	US95	Number Analysed	
BENZO(A)ANTHRACENE	0.092	nd	0.52	-	-	-	2	1
BENZO(A)PYRENE	0.01	nd	0.23	-	-	-	2	1
DIBENZ(A,H)ANTHRACENE	0.01	nd	0.062	-	-	-	2	1
FLUORANTHENE	0.2	nd	0.41	-	-	-	2	1
CHLOROFORM	12	nd	40	-	-	-	4	1

Table G10 – Pore Water Concentration Calculation Parameters

Contaminant	Soil Concentration (mg/Kg)	K_d (l/Kg)	H' (-)	ρ (g/cm^3)	θ_w (-)	θ_a (-)	Calculated Pore Water Concentration (mg/l)
Naphthalene	13	7.48	0.0174	1.64	0.27	0.11	1.7

Table G11 – Stage 3a Assessment – Summary

Analyte	Measured Concentration (mg/L)	Marine EQS Screening Value (mg/L)	Type of contamination	Location	Estimated catchment area of contamination (m^2)	Estimated catchment area of clean water (m^2)	Total catchment (m^2)	Percentage of Contaminated Catchment Infiltrating Total Catchment	Resultant simulated concentration as analyte enters Evaporites (mg/L)	Marine EQS Screening Value Exceeded
Nickel	170	30	Soil leachate hotspot	TP764G	375	1125	1500	25	42.5	**Yes**
Chromium	54	15	Soil leachate hotspot	TP764G	375	1125	1500	25	13.5	**No**
Chromium'	83	15	Groundwater hotspot	WS418	350	0	350	27	83	**Yes**
Zinc'	236	40	Groundwater hotspot	WS418	750	0	750	47	236	**Yes**

'Measured groundwater concentrations therefore concentration is unaffected by infiltration

* Pore water concentration calculated from concentration measured in soil (see Section G.2.5 in Appendix G)

Table G12 – Stage 3b Assessment – Summary

Analyte	Resultant simulated concentration as analyte enters Evaporites (mg/L)	Rainfall (m/day)	Infiltration into Source Zone and Clean Zone around Source (%)	Effective Rainfall (m/day)	Area of Source and Clean Zone Around Source (m2)	Discharge Contribution from onsite source zone and dilution zone (L/day)	Infiltration into St. Bees Sandstone (%)	Effective Rainfall (m/day)	Length of St. Bees Dilution Zone (m)	Width of St. Bees Dilution Zone (m)	Discharge Contribution from St. Bees Dilution Zone (L/day)	Dilution Factor	Concentration after Dilution of Clean St. Bees Water (mg/L)	Marine EQS	Marine EQS Screening Value Exceeded
Nickel	42.5	0.0029	15%	0.0004	1500	660	7.5%	0.0002	300	39	2555	0.258	11.0	30	**No**
Chromium	83	0.0029	15%	0.0004	350	572	7.5%	0.0002	300	36	2378	0.258	10.4	15	**No**
Zinc	236	0.0029	15%	0.0004	750	704	7.5%	0.0002	300	40	2638	0.183	**43**	40	**No**