

compliance point is in line with current EA guidelines and degradation rates are taken from approved literature sources.

Hydraulic conductivity showed variation across the literature values consulted and across site derived values, however to ensure a site specific assessment was undertaken the site derived value was selected.

Values pertaining to the plume length and thickness are identified as low sensitivity values.

Hydraulic gradient was subject to a sensitivity analysis, using the possible ranges in hydraulic gradient. The mean was selected as the most representative for the Site, maintain a level of conservatism.

Table 5: Sensitivity Analysis

Contaminant	Min Hydraulic gradient	Max hydraulic gradient	Mean hydraulic gradient	Median hydraulic gradient
	0.0032	0.014	0.0069	0.0051
Aromatic >C5-C6 (Benzene)	1.85E+19	1.80E+7	8.06E+11	2.92E+14
Xylene	1.02E+30	3.91E+12	2.24E+19	1.15E+23

1.2.8 Groundwater RTM Results

The results of the RTM model are included in **6**.

Table 6: RTM model results

Contaminant	Initial Concentration (mg/l)	Target Concentration (mg/l)	RTV at Compliance Point (mg/l)	Groundwater Exceedances
Fluoranthene	2.8x10 ⁻⁴	6.3x10 ⁻⁶	3.18x10 ⁷	None
Benzo(b)fluoranthene	1x10 ⁻⁵	1.7x10 ⁻⁷	5.78x10 ³	None
Benzo(k)fluoranthene	1x10 ⁻⁵	1.7x10 ⁻⁷	1.38x10 ⁻²	None
Aromatic >C05-C06 (Benzene)	1x10 ⁻⁵	0.01	8.06x10 ¹¹	None
Aromatic >C08-C10 (Xylenes)	1x10 ⁻⁵	0.03	2.24x10 ¹⁹	None
Aromatic >C10-C12	1x10 ⁻³	0.09*	1.99x10 ²⁷	None
Aromatic >C12-C16	1x10 ⁻³	0.09*	2.19x10 ¹¹	None
Aromatic >EC16-EC21 (anthracene)	1x10 ⁻⁵	1.0x10 ⁻⁴	2.43x10 ⁸	None
Aromatic >EC16-EC21	0.01	0.09*	1.20x10 ⁴	None

Aromatic >EC21- EC35 (benzo[a]pyrene)	1x10 ⁻⁵	1.7x10 ⁻⁷	4.49x10 ⁴	None
Aromatic >EC21- EC35	0.01	0.09*	1.20x10 ⁴	None
Aliphatic >C5-C6	1x10 ⁻³	15*	9.19x10 ³	None
Aliphatic >C12-C16	1.3	0.3 *	1.84x10 ²	None
Aliphatic >C16-C21	38	0.3 *	1.84x10 ²	None
Aliphatic >C21-C35	120	0.3 *	1.84x10 ²	None
Aliphatic >C35-C44	0.37	0.3 *	1.84x10 ²	None
* World Health Organization (WHO) guide values for TPHCWG fractions in drinking water				

II. Parameter Calculations – Cannon Factory

Infiltration			
Average mm/year	Cannon Factory		
	0.05	0.05	m/day
631.9348	31.59674	1.579837	4.33E-06

	exceeding Tier 1	Target value	Source	concentration (mg/l)		Hydrocarbon CoPC indicators	High mobility?
				Socotec	Waterman		
waterman (2023)	Anthracene	0.0001	EQS				N
	Fluoranthene	0.0000063	EQS	0.00002			Y
	Benzo(a)pyrene	0.00000017	EQS				N
	Benzo (b)fluorant	0.00000017	EQS				N
	Benzo (k)fluorant	0.00000017	EQS				N
	Aliphatic >C5-C	15000	WHO				Y
	Aliphatic >C12-C	300	WHO				N - very low mobility
	Aliphatic >C16-C	-	WHO				N - very low mobility
	Aliphatic >C21-C	-	WHO				N - very low mobility
	Aliphatic >C35-C	-	WHO				N - very low mobility
	Aromatic >EC10	0.09	WHO				Y
	Aromatic >EC12	0.09	WHO				Y
	Aromatic >EC16	0.09	WHO			Anthracene	N - low mobility
Socotec (2019)	m & p Xylene	0.03	EQS				Y
	Arom >C05-C06	0.01	EQS			Benzene	Y
	Arom >C08-C10	0.03	EQS			Xylenes	Y
	Arom >C21 - C3	0.09	WHO			benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene	

BH01
BH02

	Borehole ID	Sample depth (m)	Strata	TOC (% w/w)	Fraction (%)
Socotec	BH2	2.5		0.57	0.0057
	BH2	3.5		0.096	0.00096
Waterman	WWS01				
	WWS02	2.8	SAND		0.022
		3.5	SAND		0.001
		4.5	SAND		0.001
	WWS03				
	WWS10	2.2	SAND		0.021
		3.8	SAND		0.013
	WWS11	3	GRAVEL		0.036
	WTP01				
	WTP02	2.5	SAND		0.001
	WTP03	2.5	GRAVEL		0.014
	WTP10				
	WTP11				
				Average	0.011566
				Median	0.00935

				02/05/2023	16/05/2023
Borehole ID	mAOD	Water Strike (mbgl)	depth London Clay is encountered	Depth to water (mbgl)	Depth to water (mbgl)
BH01	8.86	no strike recorded	5.4	2.67	2.32
BH02	8.75	no strike recorded	6.7	2.43	2.41
PH3		R			
PH3A		R			
PH3B		R			
PH3C		3			
WWS01	9.01	Dry			
WWS02	9.05	2.8		2.64	2.62
WWS03	9.04	3		2.8	dry
WWS10	-	3		2.55	
WWS11	9.05	3		dry	2.87
PH1	-	no strike recorded			
PH2	-	R			
PH3	-	no strike recorded			
PH4	-	R			
PH5	-	no strike recorded			
PH6	-	R			
		Average water strike	2.95		
		Average depth to londfon clay	6.05		
		thickness	3.1		

Hydraulic Gradient Calculations - Cannon Factory				
Borehole ID	Borehole ID	Head (dh)	distance (m) (dl)	dh/dl
WWS11	BH01	WWS11 - dry during the first round		
WWS10	BH01	0.31	53.47	0.0057976
WWS10	BH02	0.18	12.65	0.0142292
WWS02	BH01	0.22	49.87	0.004411
BH02	BH01	0.13	40.4	0.003218

Average	0.006914
Standard deviation	0.004989
Median	0.005105

E	N	Borehole ID	Groundwater Depths				
			mAOD	02/05/2023		16/05/2023	
				mbgl	mAOD	mbgl	mAOD
534424.67	189757.1	BH01	8.86	2.67	6.19	2.32	6.54
534464.6	189758.5	BH02	8.75	2.43	6.32	2.41	6.34
534472.41	189746	WWS02	9.05	2.64	6.41	2.62	6.43
534454.49	189773.9	WWS03	9.04	2.8	6.24	dry	-
534476.25	189778.6	WWS11	9.05	dry	-	2.87	6.18
534477	189761	WWS10	9.05*	2.55	6.5		

*assumed level as the borehole positioned inside the building, therefore assumed to be at the same level as WWS

0.26245109 0.000262451
2.00E+04

III. Remedial Target Worksheets – Cannon Factory



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	22-May-23		
Contaminant	Aromatic >C10-C12		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C10-C12	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	2.80E-04	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	2.04E+02	days Howard et al 1991
Calculated decay rate	λ	3.40E-03	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	3.10E+00	m assumed plume thickness
Saturated aquifer thickness	da	3.10E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	6.90E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.01E-02	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	3.01E+01	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	1.79E+02	fraction
Decay rate used	λ	1.90E-05	d ⁻¹
Rate of contaminant flow due to retardation	u	1.95E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.27E-32	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	2.21E+28	

Remedial Targets

Remedial Target	1.99E+27	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	1.27E-32	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

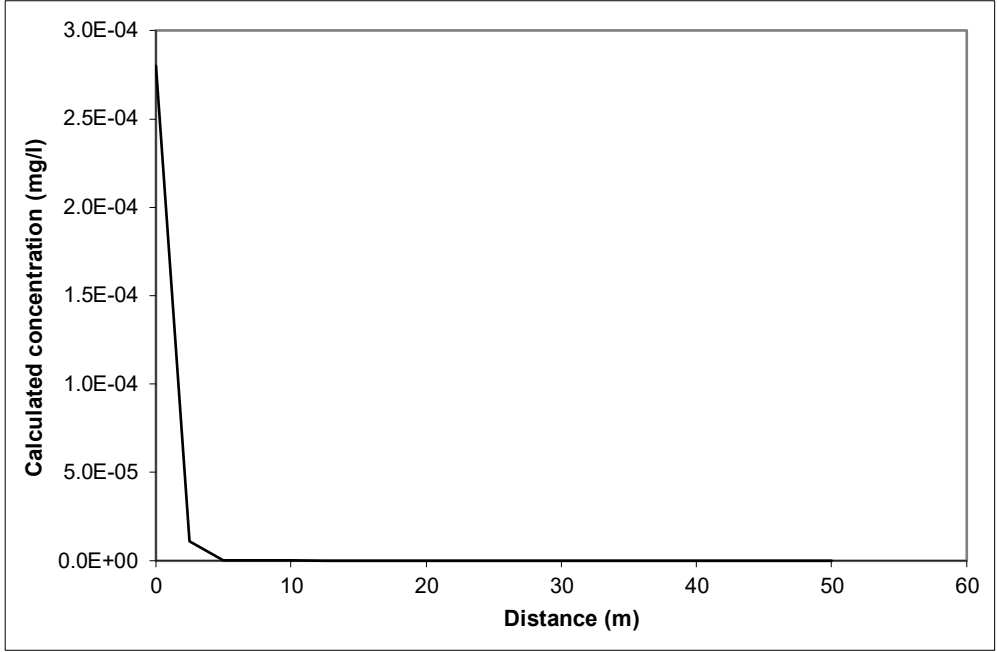
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.20E-02	fraction
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.01E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 5.00E+00	2.98E+00	m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02	
Note values of dispersivity must be > 0					
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x					
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{2.414} ; az = ax/10, ay = ax/100 are assumed					



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

	mg/l
0	2.8E-04
2.5	1.09E-05
5.0	4.21E-07
7.5	1.63E-08
10.0	6.31E-10
12.5	2.44E-11
15.0	9.38E-13
17.5	3.60E-14
20.0	1.38E-15
22.5	5.27E-17
25.0	2.01E-18
27.5	7.67E-20
30.0	2.92E-21
32.5	1.11E-22
35.0	4.22E-24
37.5	1.60E-25
40.0	6.09E-27
42.5	2.31E-28
45.0	8.78E-30
47.5	3.33E-31
50.0	1.27E-32

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: Cannon Factory, London
Completed by: Ugne Ankenaitė
Date: #####
Version: 1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

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Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	22-May-23	Version:	1
Contaminant	Aromatic >C12-C16		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C12-C16	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-05	mg/l
Half life for degradation of contaminant in water	t _{1/2}	9.20E+02	days
Calculated decay rate	λ	7.53E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m
Plume thickness at source	Sy	3.10E+00	m
Saturated aquifer thickness	da	3.10E+00	m
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³
Effective porosity of aquifer	n	2.00E-01	fraction
Hydraulic gradient	i	6.90E-03	fraction
Hydraulic conductivity of aquifer	K	1.01E-02	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	6.01E+01	l/kg
Longitudinal dispersivity	ax	5.00E+00	m
Transverse dispersivity	az	5.00E-01	m
Vertical dispersivity	ay	5.00E-02	m

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	3.56E+02	fraction
Decay rate used	λ	2.12E-06	d ⁻¹
Rate of contaminant flow due to retardation	u	9.80E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	4.11E-18	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	2.43E+12	

Remedial Targets

Remedial Target	2.19E+11	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	4.11E-18	mg/l
		1.0E+100	days
Ogata Banks			

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

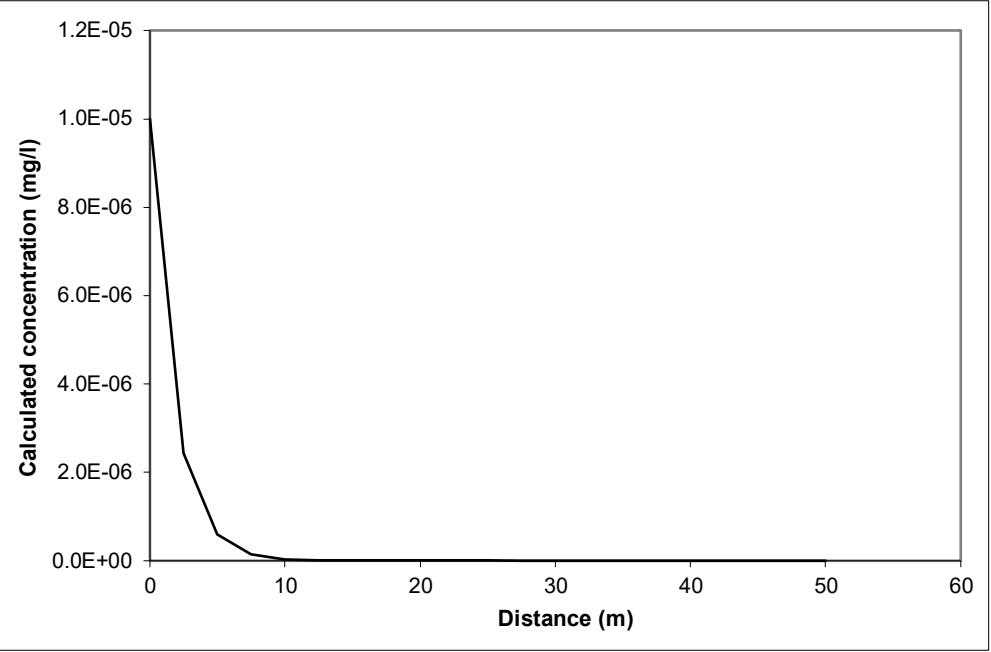
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.20E-02 fraction
Organic carbon partition coefficient	Koc	5.01E+03 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	6.01E+01 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein	m
Transverse dispersivity	az	0.00E+00	5.00E+00	2.98E+00 m
Vertical dispersivity	ay	0.00E+00	5.00E-01	2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02 m
Note values of dispersivity must be > 0				
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x				
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed				



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0	1.0E-05
2.5	2.43E-06
5.0	5.93E-07
7.5	1.44E-07
10.0	3.50E-08
12.5	8.50E-09
15.0	2.05E-09
17.5	4.95E-10
20.0	1.19E-10
22.5	2.86E-11
25.0	6.86E-12
27.5	1.64E-12
30.0	3.92E-13
32.5	9.36E-14
35.0	2.24E-14
37.5	5.33E-15
40.0	1.27E-15
42.5	3.03E-16
45.0	7.23E-17
47.5	1.72E-17
50.0	4.11E-18



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	22-May-23	Version:	1
Contaminant	Aromatic >EC16-EC21 (anthracene)		
Target Concentration (C_T)	0.0001	mg/l	Origin of C_T: EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >EC16-EC21 (anthracene)	from Level 1
Target Concentration	C _T	1.00E-04	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-05	mg/l
Half life for degradation of contaminant in water	t _{1/2}	9.20E+02	days
Calculated decay rate	λ	7.53E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m
Plume thickness at source	Sy	3.10E+00	m
Saturated aquifer thickness	da	3.10E+00	m
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³
Effective porosity of aquifer	n	2.00E-01	fraction
Hydraulic gradient	i	6.90E-03	fraction
Hydraulic conductivity of aquifer	K	1.01E-02	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days
Parameters values determined from options			
Partition coefficient	Kd	6.74E+01	l/kg
Longitudinal dispersivity	ax	5.00E+00	m
Transverse dispersivity	az	5.00E-01	m
Vertical dispersivity	ay	5.00E-02	m

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	3.99E+02	fraction
Decay rate used	λ	1.89E-06	d ⁻¹
Rate of contaminant flow due to retardation	u	8.74E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	4.11E-18	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	2.43E+12	

Remedial Targets

Remedial Target	2.43E+08	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	4.11E-18	mg/l
		1.0E+100	days
			Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

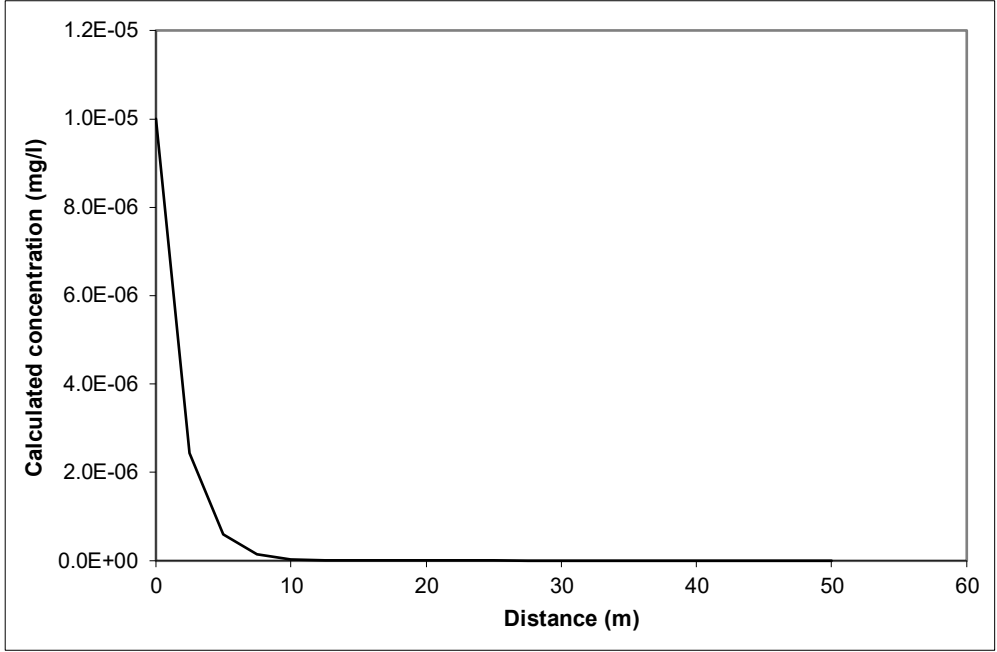
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.20E-02	fraction
Organic carbon partition coefficient	Koc	5.62E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	6.74E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00
Transverse dispersivity	az	0.00E+00	5.00E-01
Vertical dispersivity	ay	0.00E+00	5.00E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{2.414} ; az = ax/10, ay = ax/100 are assumed			



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0	1.0E-05
2.5	2.43E-06
5.0	5.93E-07
7.5	1.44E-07
10.0	3.50E-08
12.5	8.50E-09
15.0	2.05E-09
17.5	4.95E-10
20.0	1.19E-10
22.5	2.86E-11
25.0	6.86E-12
27.5	1.64E-12
30.0	3.92E-13
32.5	9.36E-14
35.0	2.24E-14
37.5	5.33E-15
40.0	1.27E-15
42.5	3.03E-16
45.0	7.23E-17
47.5	1.72E-17
50.0	4.11E-18

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	22-May-23	Version:	1
Contaminant	Aromatic >EC21-EC35 (benzo[a]pyrene)		
Target Concentration (C_T)	0.00000017	mg/l	Origin of C_T: EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

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Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >EC21-EC35 (benz	from Level 1
Target Concentration	C _T	1.70E-07	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-05	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.06E+03	days
Calculated decay rate	λ	6.54E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m
Plume thickness at source	Sy	3.10E+00	m
Saturated aquifer thickness	da	3.10E+00	m
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³
Effective porosity of aquifer	n	2.00E-01	fraction
Hydraulic gradient	i	6.90E-03	fraction
Hydraulic conductivity of aquifer	K	1.01E-02	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days
Parameters values determined from options			
Partition coefficient	Kd	1.55E+03	l/kg
Longitudinal dispersivity	ax	5.00E+00	m
Transverse dispersivity	az	5.00E-01	m
Vertical dispersivity	ay	5.00E-02	m

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	9.13E+03	fraction
Decay rate used	λ	7.16E-08	d ⁻¹
Rate of contaminant flow due to retardation	u	3.81E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	3.79E-17	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	2.64E+11	

Remedial Targets

Remedial Target	4.49E+04	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	3.79E-17	mg/l
		1.0E+100	days
			Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

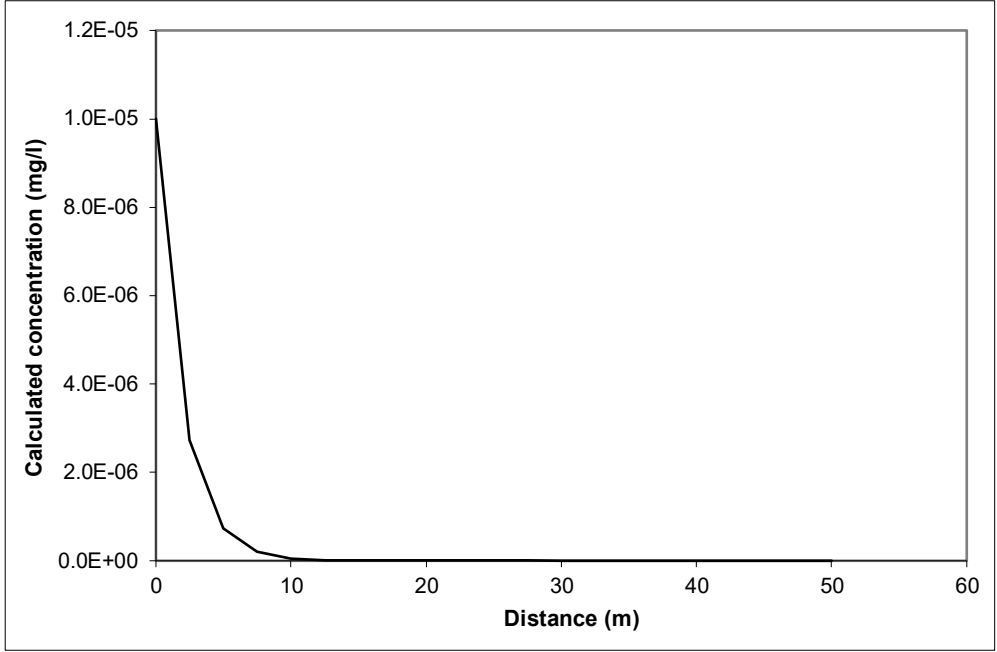
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.20E-02	fraction
Organic carbon partition coefficient	Koc	1.29E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.55E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00
Transverse dispersivity	az	0.00E+00	5.00E-01
Vertical dispersivity	ay	0.00E+00	5.00E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed			



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0	1.0E-05
2.5	2.72E-06
5.0	7.40E-07
7.5	2.01E-07
10.0	5.46E-08
12.5	1.48E-08
15.0	4.00E-09
17.5	1.08E-09
20.0	2.90E-10
22.5	7.77E-11
25.0	2.08E-11
27.5	5.56E-12
30.0	1.49E-12
32.5	3.97E-13
35.0	1.06E-13
37.5	2.82E-14
40.0	7.52E-15
42.5	2.00E-15
45.0	5.34E-16
47.5	1.42E-16
50.0	3.79E-17

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: Cannon Factory, London
Completed by: Ugne Ankenaitė
Date: #####
Version: 1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment

Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	22-May-23		
Contaminant	Aliphatic >C5-C6		
Target Concentration (C_T)	15	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C5-C6	from Level 1
Target Concentration	C _T	1.50E+01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-03	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m
Plume thickness at source	Sy	3.10E+00	m
Saturated aquifer thickness	da	3.10E+00	m
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³
Effective porosity of aquifer	n	2.00E-01	fraction
Hydraulic gradient	i	6.90E-03	fraction
Hydraulic conductivity of aquifer	K	1.01E-02	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	9.53E-01	l/kg
Longitudinal dispersivity	ax	5.00E+00	m
Transverse dispersivity	az	5.00E-01	m
Vertical dispersivity	ay	5.00E-02	m

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	6.62E+00	fraction
Decay rate used	λ	1.05E-05	d ⁻¹
Rate of contaminant flow due to retardation	u	5.26E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.63E-06	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	6.13E+02	

Remedial Targets

Remedial Target	9.19E+03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	1.63E-06	mg/l Ogata Banks
after		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

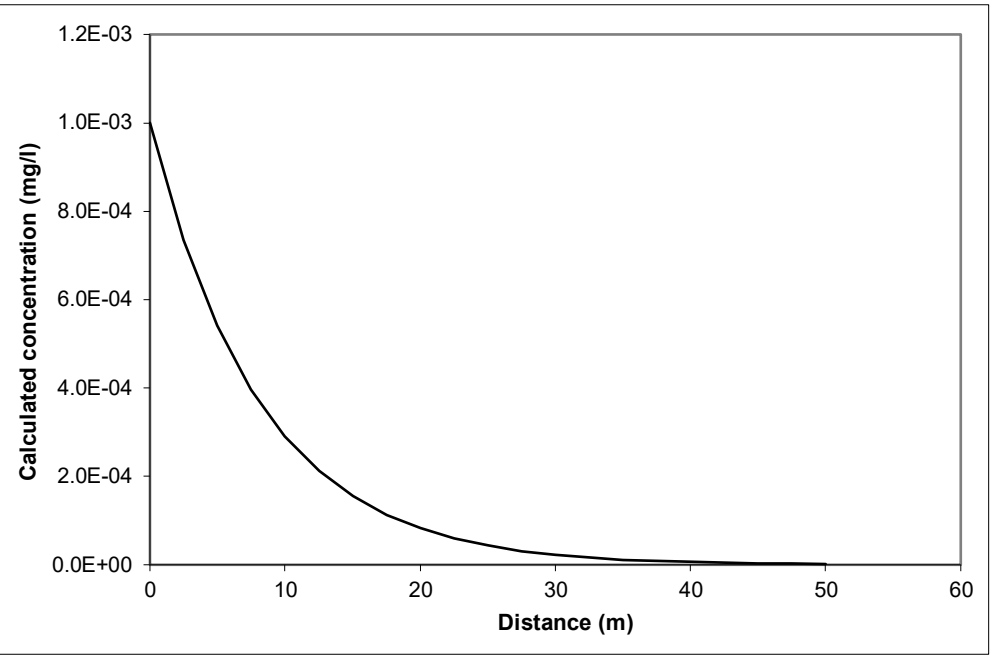
Calculate for non-polar organic chemicals

<i>Entry if specify partition coefficient (option)</i>			
Soil water partition coefficient	Kd		l/kg
<i>Entry for non-polar organic chemicals (option)</i>			
Fraction of organic carbon in aquifer	foc	1.20E-03	fraction
Organic carbon partition coefficient	Koc	7.94E+02	l/kg
<i>Entry for ionic organic chemicals (option)</i>			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	9.53E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00 2.98E+00 m
Transverse dispersivity	az	0.00E+00	5.00E-01 2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02 2.98E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed			



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

Distance	Concentration
	mg/l
0	1.0E-03
2.5	7.35E-04
5.0	5.40E-04
7.5	3.97E-04
10.0	2.91E-04
12.5	2.13E-04
15.0	1.56E-04
17.5	1.13E-04
20.0	8.24E-05
22.5	5.97E-05
25.0	4.32E-05
27.5	3.12E-05
30.0	2.25E-05
32.5	1.62E-05
35.0	1.17E-05
37.5	8.44E-06
40.0	6.08E-06
42.5	4.37E-06
45.0	3.15E-06
47.5	2.27E-06
50.0	1.63E-06

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	22-May-23		
Contaminant	Aliphatic >C12-C16		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C12-C16	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.30E+00	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	3.10E+00	m assumed plume thickness
Saturated aquifer thickness	da	3.10E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	6.90E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.01E-02	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	6.01E+04	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	3.55E+05	fraction
Decay rate used	λ	1.95E-10	d ⁻¹
Rate of contaminant flow due to retardation	u	9.82E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	2.12E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	6.13E+02	

Remedial Targets

Remedial Target	1.84E+02	mg/l	For comparison with measured groundwater concentration.
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Ogata Banks

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	2.12E-03	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.20E-02 fraction

Organic carbon partition coefficient Koc 5.01E+06 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 6.01E+04 l/kg

Define dispersivity (click brown cell and use pull down list)

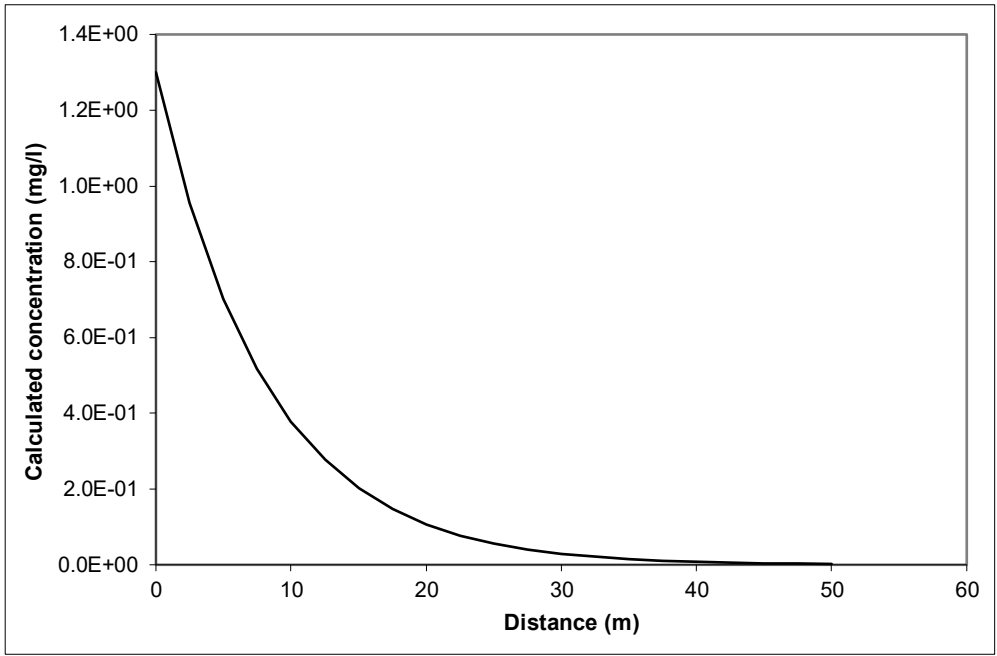
Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity ax	0.00E+00	5.00E+00	2.98E+00 m
Transverse dispersivity az	0.00E+00	5.00E-01	2.98E-01 m
Vertical dispersivity ay	0.00E+00	5.00E-02	2.98E-02

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.414}; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0 1.3E+00

2.5 9.56E-01

5.0 7.02E-01

7.5 5.16E-01

10.0 3.79E-01

12.5 2.77E-01

15.0 2.02E-01

17.5 1.47E-01

20.0 1.07E-01

22.5 7.76E-02

25.0 5.62E-02

27.5 4.06E-02

30.0 2.93E-02

32.5 2.11E-02

35.0 1.52E-02

37.5 1.10E-02

40.0 7.90E-03

42.5 5.69E-03

45.0 4.09E-03

47.5 2.95E-03

50.0 2.12E-03



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	22-May-23		
Contaminant	Aliphatic >C16-C21		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C16-C21	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	3.80E+01	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	3.10E+00	m assumed plume thickness
Saturated aquifer thickness	da	3.10E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	6.90E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.01E-02	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	7.57E+06	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	4.47E+07	fraction
Decay rate used	λ	1.55E-12	d ⁻¹
Rate of contaminant flow due to retardation	u	7.80E-12	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	6.20E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	6.13E+02	

Remedial Targets

Remedial Target	1.84E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	6.20E-02	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

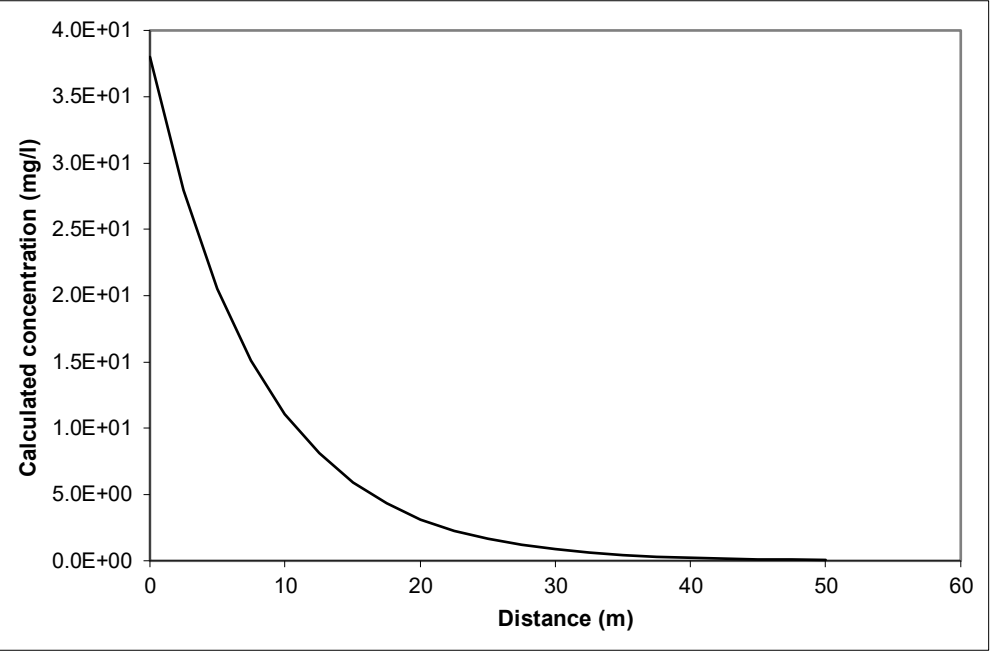
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.20E-02	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	7.57E+06	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 5.00E+00	2.98E+00	m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02	
Note values of dispersivity must be > 0					
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x					
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{2.414} ; az = ax/10, ay = ax/100 are assumed					



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

	mg/l
0	3.8E+01
2.5	2.79E+01
5.0	2.05E+01
7.5	1.51E+01
10.0	1.11E+01
12.5	8.11E+00
15.0	5.92E+00
17.5	4.31E+00
20.0	3.13E+00
22.5	2.27E+00
25.0	1.64E+00
27.5	1.19E+00
30.0	8.56E-01
32.5	6.17E-01
35.0	4.45E-01
37.5	3.21E-01
40.0	2.31E-01
42.5	1.66E-01
45.0	1.20E-01
47.5	8.62E-02
50.0	6.20E-02

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	24-May-23		
Contaminant	Aromatic >EC16-EC21		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO DWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >EC16-EC21	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-05	mg/l	laboratory data
Half life for degradation of contaminant in water	t _{1/2}	4.00E+03	days	Howard et al 1991
Calculated decay rate	λ	1.73E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m	assumed plume width
Plume thickness at source	Sy	3.10E+00	m	assumed plume thickness
Saturated aquifer thickness	da	3.10E+00	m	measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³	EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction	EA Science Report SCO50021/SR3
Hydraulic gradient	i	6.90E-03	fraction	Site specific Value
Hydraulic conductivity of aquifer	K	1.01E-02	m/d	Site specific value
Distance to compliance point	x	5.00E+01	m	EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	1.90E+02	l/kg	see options
Longitudinal dispersivity	ax	5.00E+00	m	see options
Transverse dispersivity	az	5.00E-01	m	see options
Vertical dispersivity	ay	5.00E-02	m	see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	1.12E+03	fraction
Decay rate used	λ	1.55E-07	d ⁻¹
Rate of contaminant flow due to retardation	u	3.11E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	7.47E-11	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	1.34E+05	

Remedial Targets

Remedial Target	1.20E+04	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	7.47E-11	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

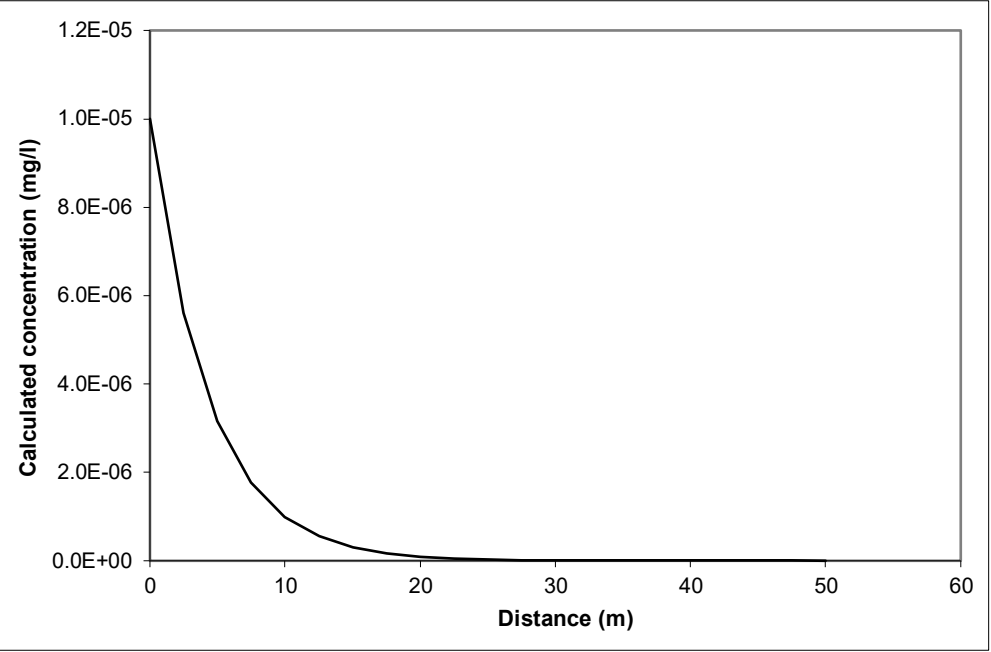
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.20E-02 fraction
Organic carbon partition coefficient	Koc	1.58E+04 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	1.90E+02 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 5.00E+00	2.98E+00 m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02
Note values of dispersivity must be > 0				
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x				
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed				



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0 1.0E-05

2.5 5.62E-06

5.0 3.15E-06

7.5 1.77E-06

10.0 9.92E-07

12.5 5.55E-07

15.0 3.09E-07

17.5 1.72E-07

20.0 9.55E-08

22.5 5.29E-08

25.0 2.92E-08

27.5 1.61E-08

30.0 8.90E-09

32.5 4.90E-09

35.0 2.70E-09

37.5 1.48E-09

40.0 8.17E-10

42.5 4.49E-10

45.0 2.47E-10

47.5 1.36E-10

50.0 7.47E-11



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	24-May-23	Version:	1
Contaminant	Aromatic >EC21-EC35		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO DWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >EC21-EC35	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-02	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	4.00E+03	days Howard et al 1991
Calculated decay rate	λ	1.73E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	3.10E+00	m assumed plume thickness
Saturated aquifer thickness	da	3.10E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	6.90E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.01E-02	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.51E+03	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	8.92E+03	fraction
Decay rate used	λ	1.94E-08	d ⁻¹
Rate of contaminant flow due to retardation	u	3.91E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	7.47E-08	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	1.34E+05	

Remedial Targets

Remedial Target	1.20E+04	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	7.47E-08	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.20E-02 fraction

Organic carbon partition coefficient Koc 1.26E+05 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 1.51E+03 l/kg

Define dispersivity (click brown cell and use pull down list)

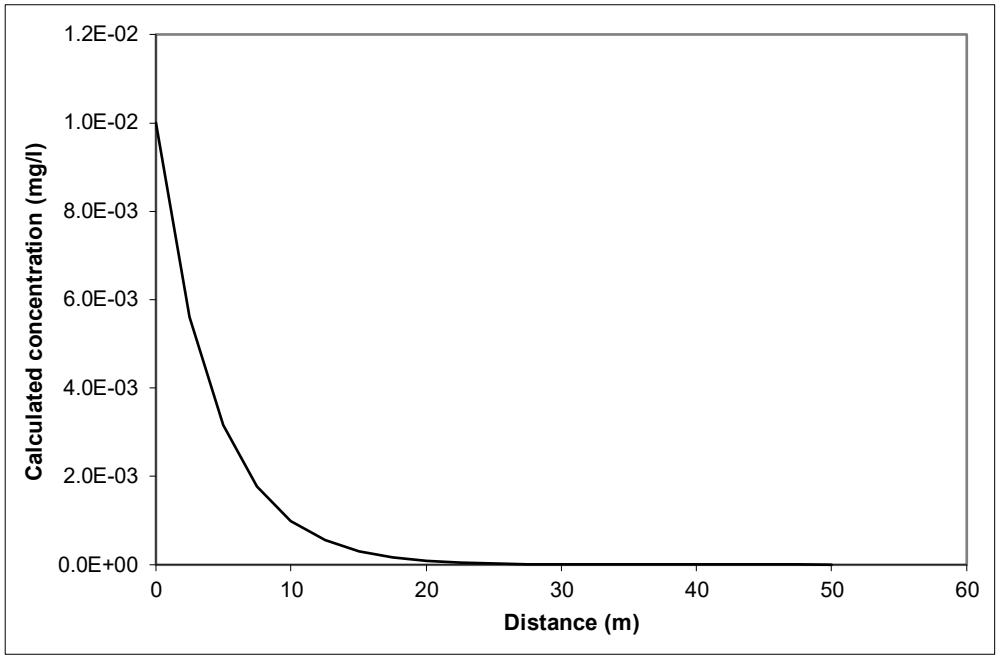
Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.414}; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0 1.0E-02

2.5 5.62E-03

5.0 3.15E-03

7.5 1.77E-03

10.0 9.92E-04

12.5 5.55E-04

15.0 3.09E-04

17.5 1.72E-04

20.0 9.55E-05

22.5 5.29E-05

25.0 2.92E-05

27.5 1.61E-05

30.0 8.90E-06

32.5 4.90E-06

35.0 2.70E-06

37.5 1.48E-06

40.0 8.17E-07

42.5 4.49E-07

45.0 2.47E-07

47.5 1.36E-07

50.0 7.47E-08



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	22-May-23		
Contaminant	Aliphatic >C21-C35		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C21-C35	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	1.20E+02	mg/l	laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days	Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m	assumed plume width
Plume thickness at source	Sy	3.10E+00	m	assumed plume thickness
Saturated aquifer thickness	da	3.10E+00	m	measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³	EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction	EA Science Report SCO50021/SR3
Hydraulic gradient	i	6.90E-03	fraction	Site specific Value
Hydraulic conductivity of aquifer	K	1.01E-02	m/d	Site specific value
Distance to compliance point	x	5.00E+01	m	EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	7.57E+06	l/kg	see options
Longitudinal dispersivity	ax	5.00E+00	m	see options
Transverse dispersivity	az	5.00E-01	m	see options
Vertical dispersivity	ay	5.00E-02	m	see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	4.47E+07	fraction
Decay rate used	λ	1.55E-12	d ⁻¹
Rate of contaminant flow due to retardation	u	7.80E-12	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.96E-01	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	6.13E+02	

Remedial Targets

Remedial Target	1.84E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	1.96E-01	mg/l Ogata Banks
after		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.20E-02 fraction

Organic carbon partition coefficient Koc 6.31E+08 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd 7.57E+06 l/kg

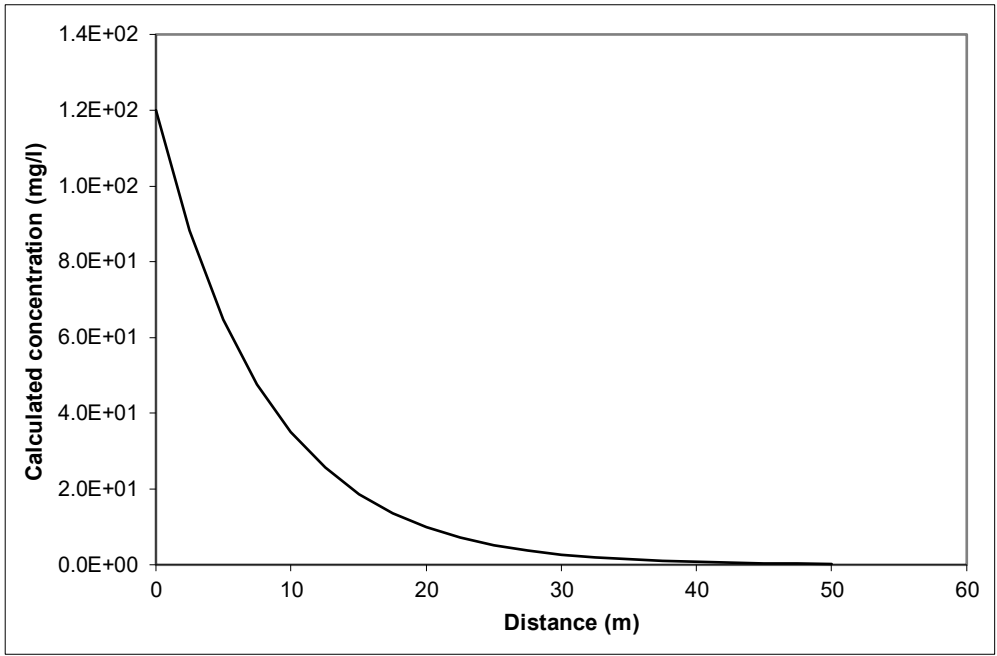
Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0 1.2E+02

2.5 8.82E+01

5.0 6.48E+01

7.5 4.76E+01

10.0 3.50E+01

12.5 2.56E+01

15.0 1.87E+01

17.5 1.36E+01

20.0 9.88E+00

22.5 7.16E+00

25.0 5.18E+00

27.5 3.75E+00

30.0 2.70E+00

32.5 1.95E+00

35.0 1.41E+00

37.5 1.01E+00

40.0 7.29E-01

42.5 5.25E-01

45.0 3.78E-01

47.5 2.72E-01

50.0 1.96E-01

Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: Cannon Factory, London

Completed by: Ugne Ankenaitė

Date: #####

Version: 1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

<u>Details to be completed for each assessment</u>			
Site Name:	Cannon Factory, London		
Site Address:	Cannon Factory, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	24-May-23	Version:	1
Contaminant	Aliphatic >C35-C44		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO DWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C35-C44	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	3.70E-01	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	3.10E+00	m assumed plume thickness
Saturated aquifer thickness	da	3.10E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	6.90E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.01E-02	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	7.57E+06	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	3.48E-04	m/d
Retardation factor	Rf	4.47E+07	fraction
Decay rate used	λ	1.55E-12	d ⁻¹
Rate of contaminant flow due to retardation	u	7.80E-12	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	6.04E-04	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	6.13E+02	

Remedial Targets

Remedial Target	1.84E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	6.04E-04	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.20E-02 fraction

Organic carbon partition coefficient Koc 6.31E+08 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 7.57E+06 l/kg

Define dispersivity (click brown cell and use pull down list)

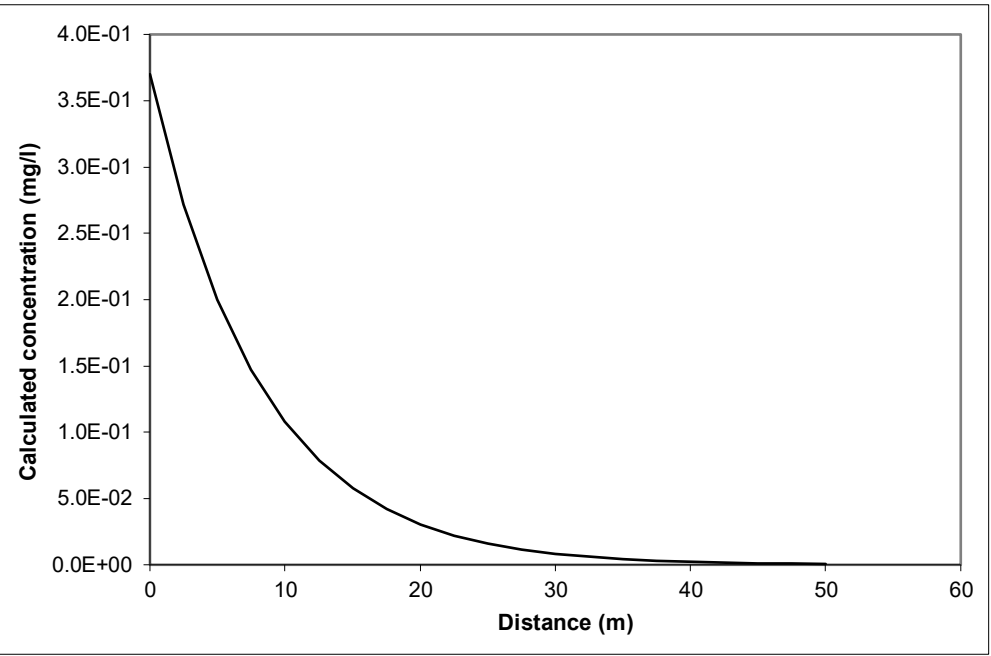
Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity ax	0.00E+00	5.00E+00	2.98E+00 m
Transverse dispersivity az	0.00E+00	5.00E-01	2.98E-01 m
Vertical dispersivity ay	0.00E+00	5.00E-02	2.98E-02

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.414}; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Cannon Factory, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

Distance	Concentration
	mg/l
0	3.7E-01
2.5	2.72E-01
5.0	2.00E-01
7.5	1.47E-01
10.0	1.08E-01
12.5	7.89E-02
15.0	5.76E-02
17.5	4.20E-02
20.0	3.05E-02
22.5	2.21E-02
25.0	1.60E-02
27.5	1.15E-02
30.0	8.34E-03
32.5	6.01E-03
35.0	4.33E-03
37.5	3.12E-03
40.0	2.25E-03
42.5	1.62E-03
45.0	1.17E-03
47.5	8.39E-04
50.0	6.04E-04

IV. Derivation of Site Specific Remediation Target Values – Ashley House

1. Derivation of Site Specific Remediation Target Values – Ashley House

Elevated concentrations of hydrocarbons were recorded in the groundwater at the Site, together with observations of hydrocarbons in the soils in the areas surrounding the tanks/former tanks. The soil sources will be addressed as part of the remediation and redevelopment. However, to confirm the concentrations recorded in the groundwater at the Site pose a low risk to the surrounding controlled waters environment, the following risk assessment has been completed. The following section outlines the methodology used together with justification of the input parameters.

1.1 Remedial Targets Methodology

Assessment of the potential risk to controlled water receptors from the identified contaminants of concern has been progressed using the EA Remedial Targets Methodology (RTM). The EA RTM model is a one-dimensional fate and transport single porosity model, which assess contaminant and groundwater migration in the intergranular flow pathway. Contaminants are present in the groundwater, the Level 3 groundwater assessment has therefore been used to model contaminant fate and transport on-site.

Conservatism

The RTM model is deterministic model which attempts to replicate ground conditions from Site specific and literature information in order to conclude the possible risks to receptors, and generate criteria at which an impact at the receptor are absent. Due to the complexities of ground conditions and contaminant fate and transport in the environment any model is inevitably a very simplified assessment which may not consider various factors and is likely to provide an overly conservative assessment even with Site specific values. Examples of conservatisms built into the model and the outputs are included below;

- The RTM Model assumes below ground obstructions are absent and a linear groundwater and contaminant flow path comprising a homogenous material is present between the source and receptor. However, the aquifer is not located within a heterogenous material and several below ground obstructions are present in the local area including basements, likely to be distorting groundwater flow. Groundwater and contaminant flow are likely to be less than modelled with increased attenuation of contaminants along the flow path expected.
- An assumption has been made on the plume extending through the whole groundwater body, no allowance has been made for vertical contaminant concentration in the groundwater body. Utilisation of a plume through the entire groundwater body retains conservatism within the model.
- The RTM assessment models the soil transport pathway through predicting the proportion of a contaminant that will enter the dissolved phase within the soil. The dissolved component is then assumed as mixing with and becoming diluted by the underlying groundwater. The dilution is calculated from the ratio of infiltrating rainwater and groundwater flux. The RTM model does not however account for any potential attenuation as the leaching contaminant percolates through the vadose zone.
- The initial concentrations used are set at the maximum recorded groundwater concentrations, the maximum groundwater concentrations are assumed to originate from the closest monitoring well to the Site boundary. The use of the maximum concentration also assumes that concentration is present across the entire Site whereas in reality the maximum concentration is limited in its extent.
- No application of vertical transport retardation in the unsaturated zone including volatilisation of contaminants.

1.2 Physical and Chemical Input Parameters

Table 1 presents the physical and chemical input parameters and associated references used within the RTM worksheets.

Table 1: Controlled Waters Risk Assessment Input Parameters

Parameter	Value	Unit	Information Source
Level 1			
Water Filled Porosity	0.24	Fraction	The water bearing strata at the site is generally described as comprising very gravelly sand to very sandy gravel representing the Kempton Park Gravel Member. A Particle Size Distribution (PSD) test undertaken by Socotec indicated the gravel fraction to range from 63% to 93%. The standard default values for a sandy soil as specified in EA Science Report SCO50021/SR3 are used.
Air Filled Porosity	0.30	Fraction	The water bearing strata at the site is generally described as comprising very gravelly sand to very sandy gravel representing the Kempton Park Gravel Member. A Particle Size Distribution (PSD) test undertaken by Socotec indicated the gravel fraction to range from 63% to 93%. The standard default values for a sandy soil as specified in EA Science Report SCO50021/SR3 are used.
Bulk Density of Soil Zone Material	1.18	g/cm ³	The water bearing strata at the site is generally described as comprising very gravelly sand to very sandy gravel representing the Kempton Park Gravel Member. A Particle Size Distribution (PSD) test undertaken by Socotec indicated the gravel fraction to range from 63% to 93%. The standard default values for a sandy soil as specified in EA Science Report SCO50021/SR3 are used.
Fraction of Organic Carbon in the Soil	0.0021	Fraction	An average value has been selected based on the TOC values recorded within the Sand and Gravel site soils, refer to Appendix E sub-section V.
Level 2			
Infiltration	1.29x10 ⁻⁵	m/day	Based on a total annual rainfall between 2000 and 2022 of 631.9mm/year (Annual Rainfall for Heathrow). Based on the proposed landscaping parameters drawing (ref: 449-102 Rev 02 included in Appendix A) 85% of the site is proposed to be hardstanding, therefore a 15% of the rainfall is assumed to fall on permeable ground. Of the 15% falling on permeable ground the effective rainfall is calculated as 5% of annual rainfall entering the groundwater.
Length of contaminant source in direction of groundwater flow	60.68	m	Elevated concentrations of heavy chained hydrocarbons were recorded only in water sample from WWS06, marginally elevated concentrations of lighter chain hydrocarbons were recorded in a water sample from BH04 (located close to the UST), with no elevated concentrations recorded at the south-eastern, southern and north-western boundaries of the site.

Parameter	Value	Unit	Information Source
			The distance between exploratory hole locations is approximately 60.68m therefore this is taken as a dimension of the hotspot. This is considered to be an overestimation of a potential hotspot, however, to provide a conservative assessment, this value has been adopted.
Saturated aquifer thickness	2.84	m	Thickness of the Secondary A aquifer, comprising the Kempton Park Gravels, is taken from the borehole observations as the depth of strike to the low permeability layer.
Hydraulic gradient of water table	0.0026	-	Calculated as an average hydraulic gradient from on-site groundwater levels from the first monitoring round considered to be most representative of groundwater levels across the monitoring period. Refer to Appendix E sub-section V for calculations.
Hydraulic conductivity of aquifer in which dilution occurs	0.114	m/d	Representative of the Secondary A Aquifer, comprising the Kempton Park Gravels. Based on site specific Falling Head Tests. Refer to Appendix E sub-section V for calculations.
Width of contaminant perpendicular to groundwater flow	25	m	No specific hotspots of contamination were recorded at the Site, however, the distance between exploratory hole locations is approximately 25m therefore this is taken as a dimension of the hotspot.
Level 3 – soil			
Distance to compliance point	50m	m	The default 50 metres compliance point is used in the model for Hazardous Substances.
Bulk Density	1.18	g/cm ²	The Kempton Park Gravels at the site are heterogeneous but are generally described as sand and gravel. The standard default values for a sand as specified in EA Science Report SCO50021/SR3 are used.
Fraction of Organic Carbon in the Aquifer	0.0018	fraction	A median value has been selected based on the TOC values recorded within the superficial site soils (Kempton Park Gravels), refer to Appendix E sub-section V .
Level 3 – Groundwater			
Effective Porosity	0.2	%	Adjusted value given Domenico et al identify a total porosity for sand/gravel between 24% and 53%.
Bulk Density of Aquifer	1.18	g/m ²	The Kempton Park Gravels at the site are heterogeneous but are generally described as sand and gravel. The standard default values for a sand as specified in EA Science Report SCO50021/SR3 are used.
Plume thickness	2.84	m	Entire width of saturated aquifer.
Dispersivity	1 dimension User defined	-	Dispersivity in one direction has been used simulating a source at the top of the groundwater body. Xu and Eckstein has been used with the vertical dispersion altered to a low number to ensure the plume thickness does not exceed the physical limits of the aquifer. This is as advised in the 2006 EA RTM User Manual.

Parameter	Value	Unit	Information Source
	0.03 (Arom >C05-C06 (Benzene))		
	1.35 (Arom >C08-C10 (xylenes))		
	0.12 (Arom >C10-C12)		
	0.02 (Arom >C12-C16)		
	0.02 (Arom >C16-C21(anthracene))		
	0.00035 (Arom >C21-C35 (benzo[a]pyrene))		
	0.13 (Ali >C5-C6)		
	0.078 (Ali >C12 – C16)		
	0.56 (Ali >C16-C21)		
	3.1 (Ali >C21-C35)		
	0.23 (Ali >C35-C44)		

1.2.1 Hydraulic Gradient

Groundwater monitoring on a Site wide basis has been undertaken by Waterman on two occasions on 3rd and 16th of May 2023, within which groundwater levels have generally remained consistent between monitoring rounds. The groundwater levels recorded are presented in **Appendix E sub-section V**, with the first round of groundwater level readings used to calculate the hydraulic gradient.

The hydraulic gradient of the site was calculated based on groundwater levels recorded in the Kempton Park Gravels. Known distances between boreholes and changes in piezometric surface were calculated to derive hydraulic gradients. Analysis of the range of values indicates a small variation across the site.

The range in values was calculated between 0.00115 and 0.00451, which is considered to be indicative of the heterogeneous nature of the Kempton Park Gravels, comprising varying sand and gravel content. To decide on a representative value to be used within this risk assessment, basic statistics were calculated including the mean and median value. The mean was derived as 0.0026, with a standard deviation of 0.0015, alternatively the median was calculated, which was 0.00205. To provide a representative value, 0.0026 has been used within this risk assessment. **Appendix E sub-section V** presents the derived input parameters used in the Controlled Waters Risk Assessment.

The inferred groundwater direction plan (Figure Ref WIE16248-100_GIS_GQRA_7A, Appendix A) indicates the movement of groundwater is generally to the west.

1.2.2 Hydraulic Conductivity

One falling head test was undertaken as part of the Waterman Ground Investigation in 2023. The falling head test was completed in the Kempton Park Gravel (shallow groundwater body) and the results summarised in Table 2.

Table 2: Hydraulic conductivity test results

Borehole ID	Depth of falling head test (m bgl)	Strata	Hydraulic Conductivity (k) m/s
WWS04	2.5-3.5	Made Ground to 1.3mbgl (variable Made Ground consisting of coarse gravel and fine to coarse sand). Silt to 2.1mbgl (soft brown clayey sandy Silt. Sand is fine to medium.) Kempton Park Gravel to 3.5mbgl (brown sandy angular to subrounded fine to coarse GRAVEL of flint and quartzite. Sand is fine to coarse.)	1.32×10^{-06}

Two falling head tests were also completed on the adjacent Cannon Factory. Although this is a different site, it is underlain by the Kempton Park Member, and is located approximately 85m to the northeast of the Ashley House Site. The results of the falling head tests for Cannon Factory are summarised in Table 3 below.

Table 3: Hydraulic conductivity test results (Cannon Factory)

Borehole ID	Depth of falling head test (m bgl)	Strata	Hydraulic Conductivity (k) m/s
WWS03	2.0-3.0	Made Ground to 1.0mbgl (reinforced concrete underlain by granular Mad Ground). Clay to 1.8mbgl (soft orange brown very sandy gravelly Clay. Gravel is angular to subrounded fine to coarse of flint and quartzite.) Kempton Park Gravel to 3.0mbgl (orange, brown clayey gravelly fine to medium SAND. Gravel is angular to subrounded fine to coarse of flint and quartzite.)	1.8×10^{-07}
WWS11	2.5-3.5	Made Ground to 1.3mbgl (reinforced concrete underlain by granular Mad Ground). Silt to 2.3mbgl (Soft orange brown sandy gravelly fine to medium SILT.) Kempton Park Gravel to 3.5mbgl (Brown sandy angular to subrounded fine to coarse GRAVEL of flint and quartzite. Sand is fine to medium)	5.32×10^{-08}

The variability of the values between 1.32×10^{-06} and 5.32×10^{-08} m/s indicates a variable permeability within the Kempton Park Gravel.

The relevance of this value measured can be compared to literature values.

Domenico and Schwartz 1990 provide literature values for gravel between 3×10^{-4} and 3×10^{-2} m/s and for coarse sand between 9×10^{-7} and 6×10^{-3} m/s.

Freeze and Cherry, 1979, provides literature values for gravel between 1×10^{-3} and 1.0 m/s, with a sandy gravel given as between 1×10^{-3} m/s and 1×10^{-2} m/s. The Kempton Park Gravels are generally described as between gravelly sand and a sandy gravel, which would indicate 1×10^{-2} m/s and 1×10^{-3} m/s, might be relevant literature values.

Falling head tests were not previously undertaken for the Site as part of the 2015 RSK and 2019 Socotec ground investigations.

Measured hydraulic conductivity from the ground investigation works indicates the site derived values are much lower than those expected from the literature values. This could be due the compact nature of the

strata and variable sand and gravel content. To ensure the assessment remains site specific the site derived hydraulic conductivity will be applied.

It is therefore considered that the hydraulic conductivity recorded on the Site is representative and will be applied.

1.2.3 Saturated Aquifer Thickness

Two rounds of groundwater monitoring have been completed following the completion of ground investigations. The results of the groundwater monitoring of the shallow aquifer have been tabulated and included in **Appendix E sub-section V**.

The saturated aquifer thickness of 2.84m is utilised in the assessment. The value is extrapolated from the recorded groundwater strikes and depth of low permeability London Clay as an average thickness.

1.2.4 Infiltration

Hard Cover and Soft landscaping

Soft landscaping is proposed as part of the development, bordering western and most of the northern Site boundaries. It is estimated that soft landscaping will cover approximately 15% of the proposed development. As a result the ground cover will remain open and the volume of infiltration through these areas will be much higher than the surrounding Development areas.

Based on this type of land-use and ground conditions across the site (sand and clay matrix in Made Ground, sandy gravelly superficial deposits), the effective infiltration, i.e. the percentage of rainfall that reaches the water table following losses from surface run-off, root zone recharge and plant uptake, should be calculated. This calculation is complex, however it is generally estimated that effective precipitation (i.e. that available to plants etc) is approximately half of total rainfall. Taking into account additional losses to run-off it is estimated that 5.0% of precipitation will end up as deep percolation to the underlying groundwater. It should also be noted that this is likely to be far less in the dry summer months as the ground surface is harder and the soils are drier, leading to a greater loss to surface run off and plant uptake. However, in the winter this is likely to be higher due to saturated soils and softer ground surface.

1.2.5 Contaminant Values

As discussed in the report text, indicative concentrations of key contaminants were tested for as part of the laboratory testing and the ground conditions were considered to be favourable to degradation.

Degradation in the dissolved phase only will be run for the contaminants of concern given the absence of sorption being a primary attenuation factor for them.

Half life values and partition coefficients for the contaminants of concern are included in Table below;

Table 4: Contaminant Values

Contaminant	Half life (days)	Koc (l/kg)	Henry's Law Constant (dimensionless)	Target Concentration mg/l (Source)
Aromatic >C05-C06 (Benzene)	750	68	0.116	0.01 (EQS)
Aromatic >C08-C10 (xylenes)	360	1590	0.112	0.03 (EQS)
Aromatic >EC10-EC12	204	2510	7.22×10^{-2}	0.09 (WHO DWS)

Aromatic >EC12-EC16	920	5010	1.26×10^{-2}	0.09 (WHO DWS)
Aromatic >EC16-EC21 (anthracene)	920	5.62×10^3	1.81×10^{-4}	0.0001 mg/l (EQS)
Aromatic >EC16-EC21	4000	1.58×10^4	6.95×10^{-4}	0.09 (WHO DWS)
Aromatic >EC21-EC35 (benzo[a]pyrene)	1060	1.29×10^5	1.76×10^{-6}	0.00000017 (EQS)
Aromatic >EC21-EC35	4000	1.26×10^5	2.48×10^{-5}	0.09 (WHO DWS)
Aliphatic >C5-C6	10000	794	21	15 (WHO DWS)
Aliphatic >C12-C16	10000	5.01×10^6	171	0.3 (WHO DWS)
Aliphatic >C16-C21	10000	6.31×10^8	1.07×10^3	0.3 (WHO DWS)
Aliphatic >C21-C35*	10000	6.31×10^8	1.07×10^3	0.3 (WHO DWS)
Aliphatic >C35-C44*	10000	6.31×10^8	1.07×10^3	0.3 (WHO DWS)

* There are no contaminant values derived for Aliphatic C21-C35 and C35-C44 bands due to their low mobility, however, for the conservative approach we have applied values for lighter chain Aliphatic band (C16-C21) to derive the RTV.

1.2.6 Distance to Compliance Point

The contaminants of concern are hazardous groundwater contaminants, a default compliance point of 50m will be used in the assessment, consistent with EA guidance.

It should be noted that the key surface water receptor at the Site is the Pymmes Brook, measured as a direct distance from the nearest point along the site boundary to be 360m east of the Site from the eastern site boundary.

Groundwater is currently inferred to the west away from the Pymmes Brook therefore the distance the groundwater will travel to the surface water receptor is likely to be in excess of 360m and the set compliance point of 50m.

The use of 50m as the compliance point builds in substantial conservatism in the assessment.

1.2.7 Sensitivity Analysis

As the model is dependent on a number of assumptions it was considered prudent to run a sensitivity analysis to test whether altering the input values for key parameters would have an effect on the values derived.

A sensitivity analysis was performed during the development of the target values which involved varying one input parameter at a time between reasonable minimum and maximum values and evaluating the effect this had on the target concentrations.

Distance to the compliance point, hydraulic conductivity, hydraulic gradient, degradation rates and time variant have been indicated as values of high sensitivity. However, the value set for distance to compliance point is in line with current EA guidelines and degradation rates are taken from approved literature sources.

Hydraulic conductivity showed variation across the literature values consulted and across site derived values, however to ensure a site specific assessment was undertaken the site derived value was selected.

Values pertaining to the plume length and thickness are identified as low sensitivity values.

Hydraulic gradient was subject to a sensitivity analysis, using the possible ranges in hydraulic gradient. The mean was selected as the most representative for the Site, maintain a level of conservatism.

Table 5: Sensitivity Analysis

Contaminant	Min Hydraulic gradient	Max hydraulic gradient	Mean hydraulic gradient	Median hydraulic gradient
	0.00115	0.00451	0.0026	0.00205
Aromatic >C10-C12	1.36E+19	1.96E+8	6.05E+11	4.16E+13
Aromatic >EC16-EC21	2.30E+2	1.75	7.66	1.74E+1

1.2.8 Groundwater RTM Results

The results of the RTM model are included in 6.

Table 6: RTM model results

Contaminant	Initial Concentration (mg/l)	EQS (mg/l)	RTV at Compliance Point (mg/l)	Groundwater Exceedances
Aromatic >C5-C6 (Benzene)	0.03	0.01	8.57x10 ³	None
Aromatic >C8-C10 (Xylenes)	1.35	0.03	5.25x10 ⁷	None
Aromatic >C10-C12	0.12	0.09*	6.05x10 ¹¹	None
Aromatic >C12-C16	0.02	0.09*	1.49x10 ⁴	None
Aromatic >EC16-EC21 (anthracene)	2.3x10 ⁻⁴	1.0x10 ⁻⁴	16.6	None
Aromatic >EC16-EC21	0.02	0.09*	7.66	None
Aromatic >EC21-EC35 (benzo[a]pyrene)	3.5x10 ⁻⁴	1.7x10 ⁻⁷	9.99x10 ⁻³	None
Aromatic >EC21-EC35	0.01	0.09*	7.66	None
Aliphatic >C5-C6	0.13	15*	1.44x10 ²	None
Aliphatic >C12-C16	0.048	0.3*	2.89	None
Aliphatic >C16-C21	0.56	0.3*	2.89	None
Aliphatic >C21-C35	3.1	0.3*	2.89	1 (WWS106)
Aliphatic >C35-C44	0.23	0.3*	2.89	None

* World Health Organization (WHO) guide values for TPHCWG fractions in drinking water

V. Parameter Calculations – Ashley House

Infiltration			
Average mm/year	Ashley House		
	0.15	0.05	m/day
631.934783	94.79022	4.739511	1.3E-05

	Contam exceeding Tier 1	Target value	Source	Initial Contaminant concentration (mg/l)		Hydrocarbon CoPC indicators	High mobility?
				Socotec	Waterman		
waterman (2023)	Anthracene	0.0001	EQS	0.00017	0.00023		N
	Fluoranthene	0.0000063	EQS	0.00002	0.00111		Y
	Benzo(a)pyrene	0.00000017	EQS	< 0.01	0.00035		N
	Benzo (b)fluoranthene	0.00000017	EQS	< 0.02	0.00051		N
	Benzo (k)fluoranthene	0.00000017	EQS	< 0.03	0.0002		N
	Aliphatic >C5-C6	15000	WHO	0.251	0.13		Y
	Aliphatic >C12-C16	300	WHO	0.078	0.048		N - very low mobility
	Aliphatic >C16-C21	-	WHO		0.56		N - very low mobility
	Aliphatic >C21-C35	-	WHO		3.1		N - very low mobility
	Aliphatic >C35-C44	-	WHO		0.23		N - very low mobility
	Aromatic >EC10-EC12	0.09	WHO	0.59	0.12		Y
	Aromatic >EC12-EC16	0.09	WHO		0.02		Y
	Aromatic >EC16-EC21	0.09	WHO		0.02	Anthracene	N - low mobility
Socotec (2019)	m & p Xylene	0.03	EQS	0.16	0.0082		Y
	Arom >C05-C06 (Benzene)	0.01	EQS	0.03	0.0089	Benzene	Y
	Arom >C08-C10 (xylenes)	0.03	EQS	1.35	0.0082	Xylenes	Y
	Arom >C21 - C35	0.09	WHO	0.168		benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene	

	Borehole ID	Sample depth (m)	Strata	TOC (% w/w)	Fraction (%)
Waterman 2023	WTP04	2.60	Kempton Park Gravel	N/A	0.005
	WWS04	2.20		N/A	< 0.0010
	WWS06	3.5		N/A	< 0.0010
	WWS07	2.10		N/A	< 0.0010
	WWS07	2.60		N/A	< 0.0010
	WWS09	3.00		N/A	0.002
Socotec 2019	PH1A	2.3		0.18	0.0018
	BH3	2.3		0.12	0.00121
RSK 2015	WS103	4		<0.03	0.0003

Average fraction	0.0021
Median	0.0018

				02/05/2023	16/05/2023	
Borehole ID	mAOD	Water Strike (mbgl)	depth London Clay is encountered	Depth to water (mbgl)	Depth to water (mbgl)	
BH03	8.95	no strike recorded	5.3	-		
BH04	9.02	no strike recorded	5.75	2.59		
PH1A		3				
PH2		3				
WWS04		3.4		dry		
WWS05	9.3	R				
WWS06	8.92	2.5		2.56	2.53	
WWS07	9.14	2.8		dry		
WWS08	9.11	2.5		-	2.51	
WWS09	8.94	2.9				
WS101	9.16	2.4		2.78		
WS102		R				
WS103		2.9				
WS104		2.75		-		
WS105		DRY				
WS106		R				
WS107		2.25				
WS108		DRY				
WS109		2.6		2.6		
WS110		R				
BH101		4.9	6.8	2.53		
BH102		5	6.4	2.53		
BH103		4.8	5.8	2.52		
				Average water strike	3.18	
				Average depth to londfon clay	6.01	
				thickness	2.83	

Hydraulic Gradient Calculations - Ashley House

Borehole ID	Borehole ID	Head (dh)	distance (m) (dl)	dh/dl
BH04	WWS06	0.07	60.68	0.00115
WS109	WWS06	0.26	68.17	0.00381
BH101	WS101	0.17	37.71	0.00451
WS109	BH102	0.11	73.78	0.00149
BH103	WS101	0.17	82.79	0.00205

Max	0.00451	Average	0.00260
min	0.00115	Median	0.00205

0.001478

E	N	Borehole ID	Groundwater Depths				
				02/05/2023		16/05/2023	
			mAOD	mbgl	mAOD	mbgl	mAOD
534292.6	189667	BH03	8.95	-	-	-	-
534352.7	189649.2	BH04	9.02	2.59	6.43	-	-
534354.4	189678.2	WWS04	9.25	dry		-	-
534291.6	189665.8	WWS06	8.92	2.56	6.36	2.53	6.39
534348.3	189660.8	WWS07	9.14	dry	-	dry	-
534356.9	189643.6	WWS08	9.11	-	-	2.51	6.6
534277.9	189642	WS101	9.16	2.78	6.38	-	-
534355.1	189661.2	WS109	9.22	2.6	6.62	-	-
534311.6	189629.4	BH101	9.08	2.53	6.55	-	-
534298.9	189699.3	BH102	9.04	2.53	6.51	-	-
534362.3	189625.8	BH103	9.07	2.52	6.55	-	-

VI. Remedial Target Worksheets – Ashley House



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	19-May-23	Version:	1
Contaminant	Aromatic >C10-C12		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C10-C12	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.20E-01	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	2.04E+02	days Howard et al 1991
Calculated decay rate	λ	3.40E-03	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.83E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	5.27E+00	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	3.21E+01	fraction
Decay rate used	λ	1.06E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	4.62E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.79E-14	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	6.72E+12	

Remedial Targets

Remedial Target	6.05E+11	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	1.79E-14	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

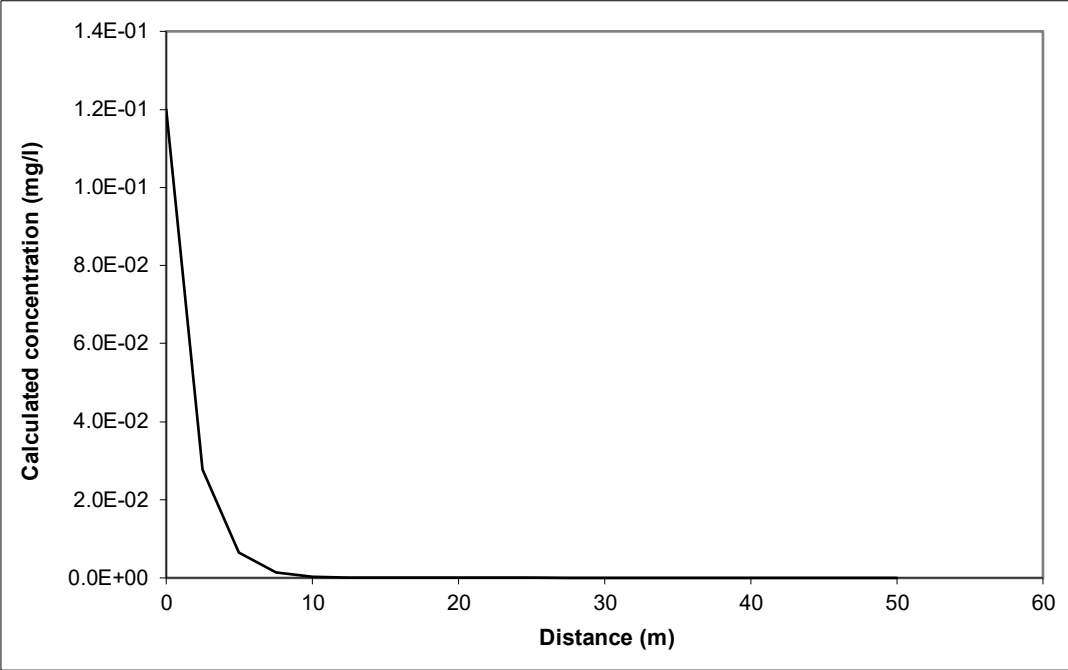
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.10E-03	fraction
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	5.27E+00	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00 2.98E+00 m
Transverse dispersivity	az	0.00E+00	5.00E-01 2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02 2.98E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed			



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Concentration
	mg/l
0	1.2E-01
2.5	2.78E-02
5.0	6.46E-03
7.5	1.50E-03
10.0	3.46E-04
12.5	7.96E-05
15.0	1.83E-05
17.5	4.18E-06
20.0	9.54E-07
22.5	2.17E-07
25.0	4.95E-08
27.5	1.12E-08
30.0	2.55E-09
32.5	5.79E-10
35.0	1.31E-10
37.5	2.98E-11
40.0	6.75E-12
42.5	1.53E-12
45.0	3.47E-13
47.5	7.87E-14
50.0	1.79E-14



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	18-May-23	Version:	1
Contaminant	Aromatic >C12-C16		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C12-C16	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	2.00E-02	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	9.20E+02	days Howard et al 1991
Calculated decay rate	λ	7.53E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.84E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	9.02E+00	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	5.42E+01	fraction
Decay rate used	λ	1.39E-05	d ⁻¹
Rate of contaminant flow due to retardation	u	2.73E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.21E-07	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	1.66E+05	

Remedial Targets

Remedial Target	1.49E+04	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	1.21E-07	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

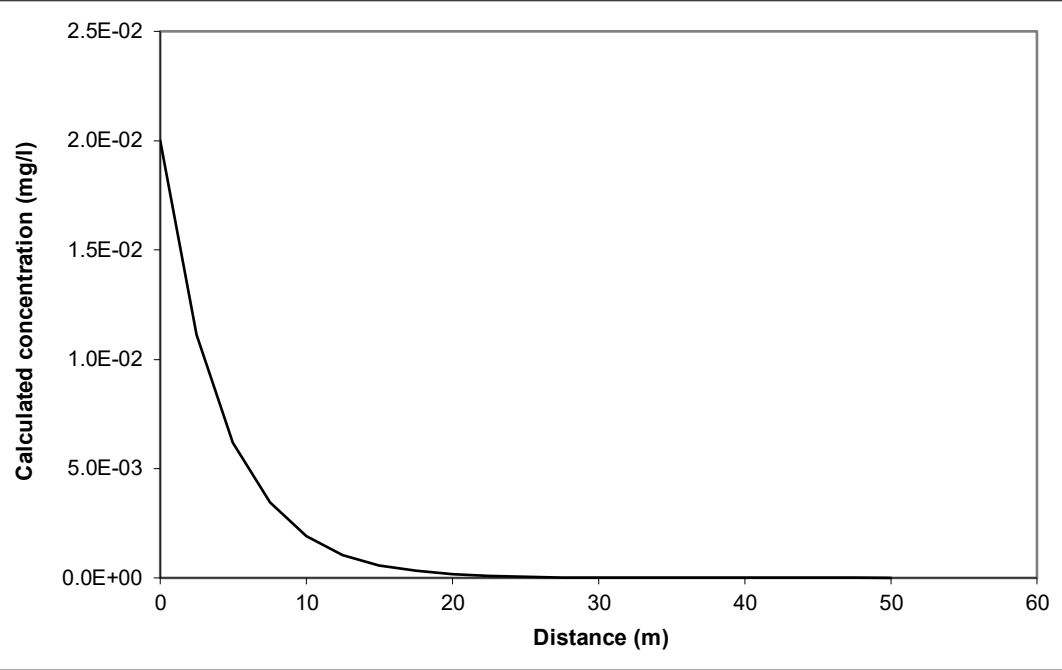
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.80E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	9.02E+00	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00 2.98E+00 m
Transverse dispersivity	az	0.00E+00	5.00E-01 2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02 2.98E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed			



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

Distance	Concentration
	mg/l
0	2.0E-02
2.5	1.11E-02
5.0	6.20E-03
7.5	3.45E-03
10.0	1.91E-03
12.5	1.06E-03
15.0	5.83E-04
17.5	3.21E-04
20.0	1.76E-04
22.5	9.61E-05
25.0	5.25E-05
27.5	2.87E-05
30.0	1.56E-05
32.5	8.51E-06
35.0	4.64E-06
37.5	2.52E-06
40.0	1.37E-06
42.5	7.48E-07
45.0	4.07E-07
47.5	2.22E-07
50.0	1.21E-07



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	19-May-23	Version:	1
Contaminant	Aromatic >C16-C21 (Anthracene)		
Target Concentration (C_T)	0.0001	mg/l	Origin of C_T: EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C16-C21 (Anthracene)	from Level 1
Target Concentration	C _T	1.00E-04	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	2.30E-04	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	9.20E+02	days Howard et al 1991
Calculated decay rate	λ	7.53E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.84E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.01E+01	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	6.07E+01	fraction
Decay rate used	λ	1.24E-05	d ⁻¹
Rate of contaminant flow due to retardation	u	2.44E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.39E-09	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	1.66E+05	

Remedial Targets

Remedial Target	1.66E+01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	1.39E-09	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

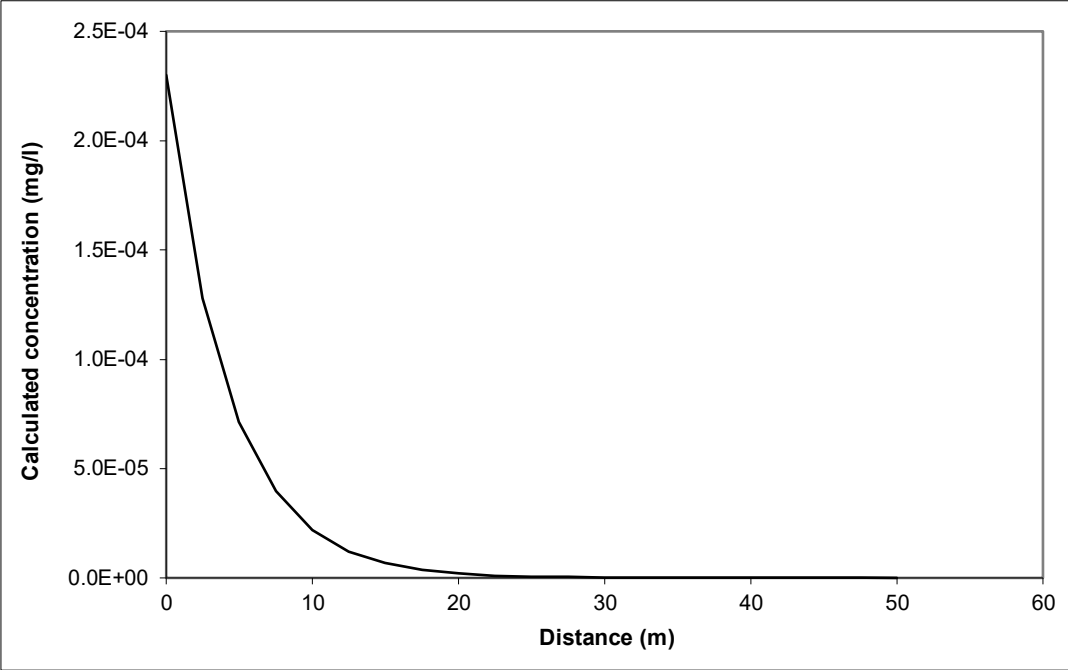
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.80E-03	fraction
Organic carbon partition coefficient	Koc	5.62E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.01E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00 2.98E+00 m
Transverse dispersivity	az	0.00E+00	5.00E-01 2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02 2.98E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed			



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0	2.3E-04
2.5	1.28E-04
5.0	7.13E-05
7.5	3.97E-05
10.0	2.20E-05
12.5	1.22E-05
15.0	6.71E-06
17.5	3.69E-06
20.0	2.02E-06
22.5	1.11E-06
25.0	6.04E-07
27.5	3.30E-07
30.0	1.80E-07
32.5	9.79E-08
35.0	5.33E-08
37.5	2.90E-08
40.0	1.58E-08
42.5	8.60E-09
45.0	4.68E-09
47.5	2.55E-09
50.0	1.39E-09



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	19-May-23	Version:	1
Contaminant	Aromatic >C21-C35 (benzo(a)pyrene)		
Target Concentration (C_T)	0.00000017	mg/l	Origin of C_T: EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C21-C35 (benzo(a))	from Level 1
Target Concentration	C _T	1.70E-07	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	3.50E-04	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.06E+03	days
Calculated decay rate	λ	6.54E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m
Plume thickness at source	Sy	2.84E+00	m
Saturated aquifer thickness	da	2.84E+00	m
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³
Effective porosity of aquifer	n	2.00E-01	fraction
Hydraulic gradient	i	2.60E-03	fraction
Hydraulic conductivity of aquifer	K	1.14E-01	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days
Parameters values determined from options			
Partition coefficient	Kd	2.32E+02	l/kg
Longitudinal dispersivity	ax	5.00E+00	m
Transverse dispersivity	az	5.00E-01	m
Vertical dispersivity	ay	5.00E-02	m

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	1.37E+03	fraction
Decay rate used	λ	4.77E-07	d ⁻¹
Rate of contaminant flow due to retardation	u	1.08E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	5.96E-09	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	5.87E+04	

Remedial Targets

Remedial Target	9.99E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	5.96E-09	mg/l
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

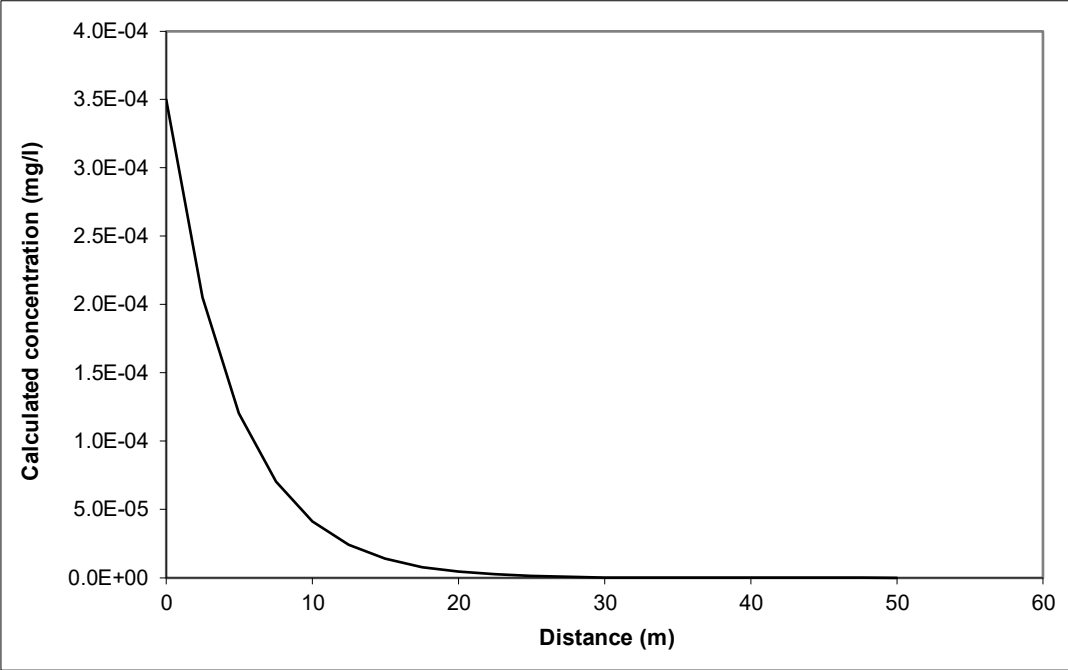
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.80E-03	fraction
Organic carbon partition coefficient	Koc	1.29E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	2.32E+02	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02	
Note values of dispersivity must be > 0					
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x					
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed					



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

	mg/l
0	3.5E-04
2.5	2.05E-04
5.0	1.20E-04
7.5	7.05E-05
10.0	4.12E-05
12.5	2.40E-05
15.0	1.39E-05
17.5	8.06E-06
20.0	4.66E-06
22.5	2.68E-06
25.0	1.54E-06
27.5	8.87E-07
30.0	5.09E-07
32.5	2.92E-07
35.0	1.68E-07
37.5	9.61E-08
40.0	5.51E-08
42.5	3.16E-08
45.0	1.81E-08
47.5	1.04E-08
50.0	5.96E-09



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment

Site Name:	Ashley House, London
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London
Completed by:	Ugne Ankenaite
Date:	18-May-23
	Version: 1
Contaminant	Aliphatic >C5-C6
Target Concentration (C_T)	15 mg/l
	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C5-C6	from Level 1
Target Concentration	C _T	1.50E+01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	1.30E-01	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.84E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.43E+00	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	9.43E+00	fraction
Decay rate used	λ	7.35E-06	d ⁻¹
Rate of contaminant flow due to retardation	u	1.57E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.35E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	9.63E+00	

Remedial Targets

Remedial Target	1.44E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	1.35E-02	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

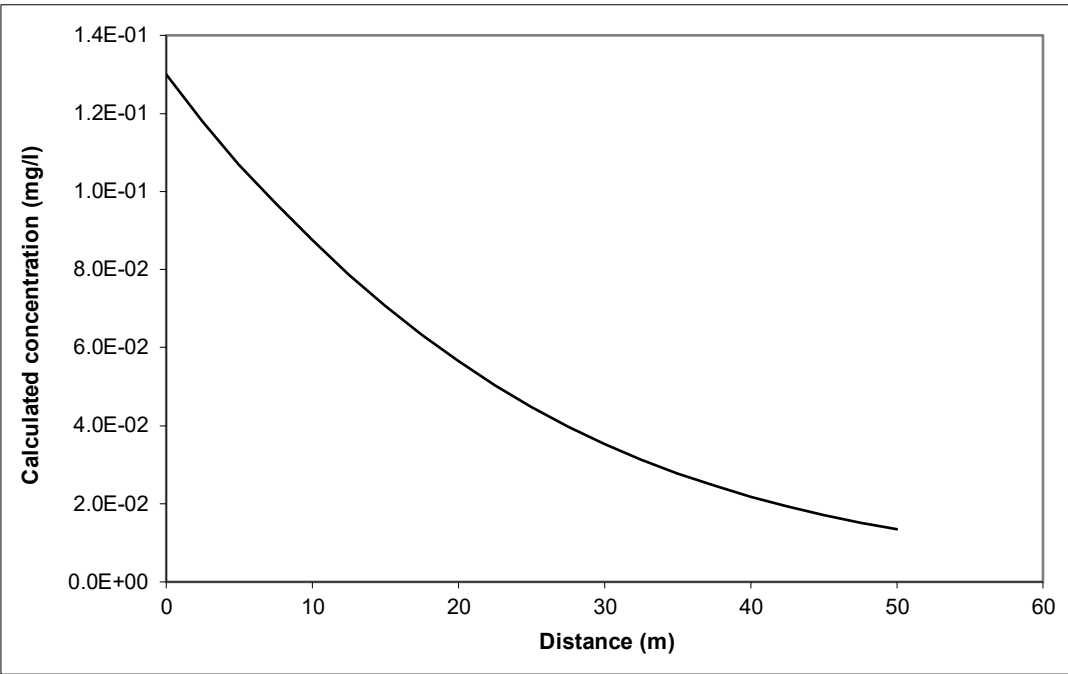
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.80E-03 fraction
Organic carbon partition coefficient	Koc	7.94E+02 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	1.43E+00 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00 2.98E+00 m
Transverse dispersivity	az	0.00E+00	5.00E-01 2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02 2.98E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed			



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0	1.3E-01
2.5	1.18E-01
5.0	1.07E-01
7.5	9.68E-02
10.0	8.75E-02
12.5	7.88E-02
15.0	7.07E-02
17.5	6.33E-02
20.0	5.65E-02
22.5	5.03E-02
25.0	4.48E-02
27.5	3.98E-02
30.0	3.53E-02
32.5	3.13E-02
35.0	2.78E-02
37.5	2.46E-02
40.0	2.19E-02
42.5	1.94E-02
45.0	1.72E-02
47.5	1.52E-02
50.0	1.35E-02



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	18-May-23	Version:	1
Contaminant	Aliphatic >C12-C16		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C12-C16	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	4.80E-02	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.84E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	9.02E+03	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	5.32E+04	fraction
Decay rate used	λ	1.30E-09	d ⁻¹
Rate of contaminant flow due to retardation	u	2.79E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	4.99E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	9.63E+00	

Remedial Targets

Remedial Target	2.89E+00	mg/l	For comparison with measured groundwater concentration.
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Ogata Banks

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	4.99E-03	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

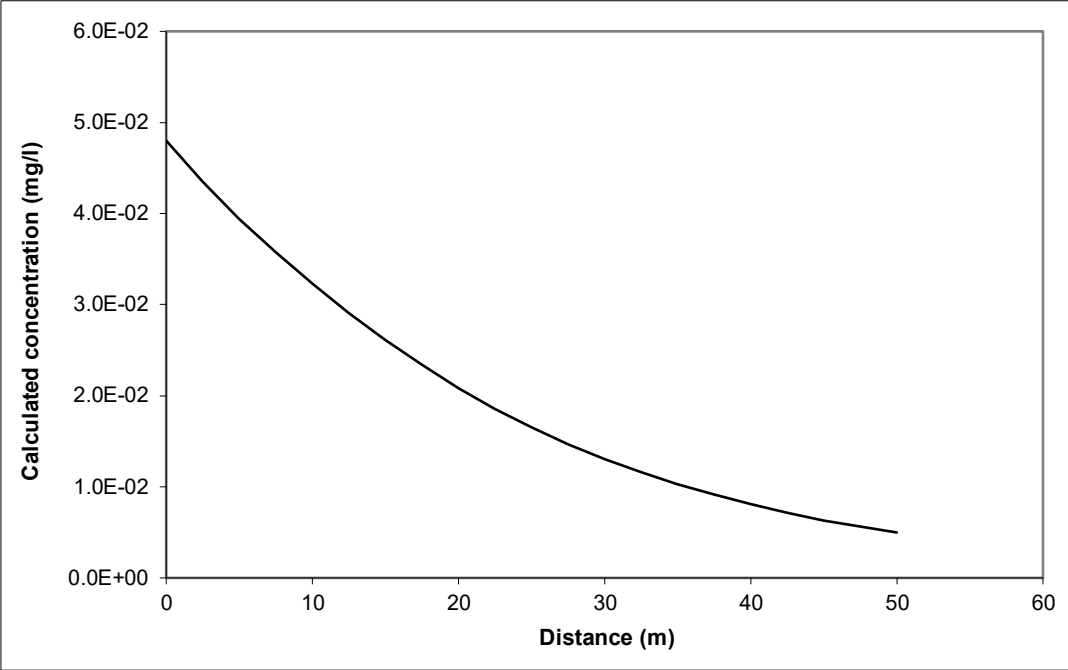
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.80E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+06	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	9.02E+03	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	5.00E+00 2.98E+00 m
Transverse dispersivity	az	0.00E+00	5.00E-01 2.98E-01 m
Vertical dispersivity	ay	0.00E+00	5.00E-02 2.98E-02
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{2.414} ; az = ax/10, ay = ax/100 are assumed			



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0	4.8E-02
2.5	4.35E-02
5.0	3.95E-02
7.5	3.58E-02
10.0	3.23E-02
12.5	2.91E-02
15.0	2.61E-02
17.5	2.34E-02
20.0	2.09E-02
22.5	1.86E-02
25.0	1.65E-02
27.5	1.47E-02
30.0	1.30E-02
32.5	1.16E-02
35.0	1.03E-02
37.5	9.10E-03
40.0	8.07E-03
42.5	7.15E-03
45.0	6.34E-03
47.5	5.62E-03
50.0	4.99E-03



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	19-May-23	Version:	1
Contaminant	Aliphatic >C16-C21		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C16-C21	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	5.60E-01	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.84E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.14E+06	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	6.70E+06	fraction
Decay rate used	λ	1.03E-11	d ⁻¹
Rate of contaminant flow due to retardation	u	2.21E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	5.82E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	9.63E+00	

Remedial Targets

Remedial Target	2.89E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point 50 m

Concentration of contaminant at compliance point after C_{ED}/C₀ 5.82E-02 mg/l Ogata Banks
1.0E+100 days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.80E-03 fraction

Organic carbon partition coefficient Koc 6.31E+08 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 1.14E+06 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity

ax 0.00E+00 5.00E+00 2.98E+00 m

Transverse dispersivity

az 0.00E+00 5.00E-01 2.98E-01 m

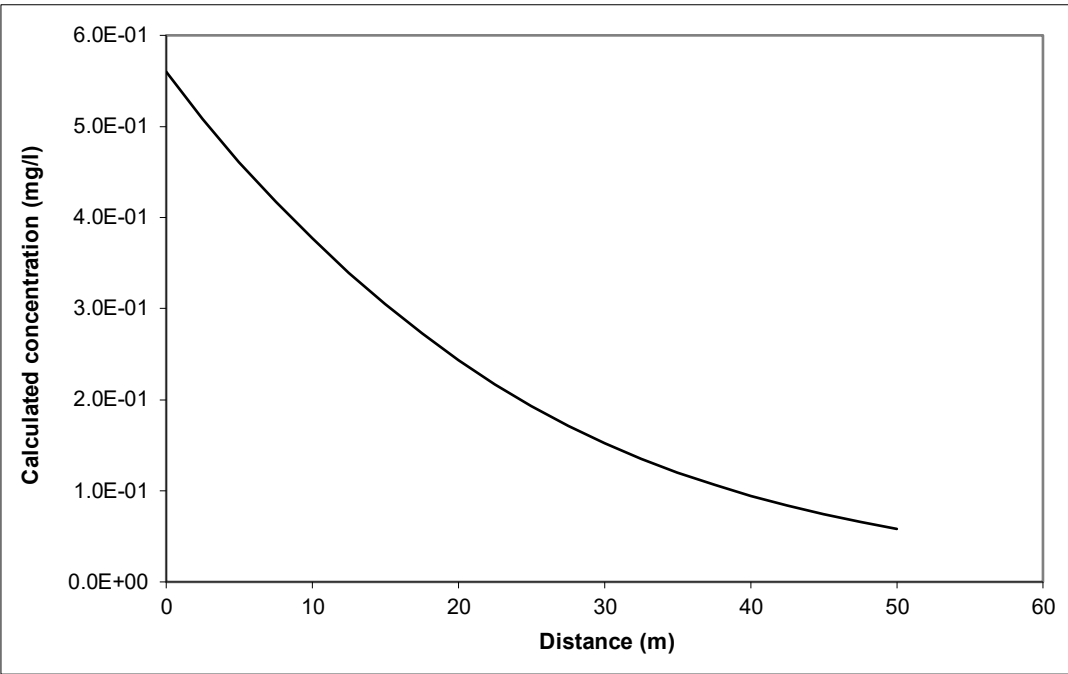
Vertical dispersivity

ay 0.00E+00 5.00E-02 2.98E-02

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0 5.6E-01

2.5 5.08E-01

5.0 4.60E-01

7.5 4.17E-01

10.0 3.77E-01

12.5 3.39E-01

15.0 3.05E-01

17.5 2.73E-01

20.0 2.43E-01

22.5 2.17E-01

25.0 1.93E-01

27.5 1.71E-01

30.0 1.52E-01

32.5 1.35E-01

35.0 1.20E-01

37.5 1.06E-01

40.0 9.41E-02

42.5 8.34E-02

45.0 7.40E-02

47.5 6.56E-02

50.0 5.82E-02



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	24-May-23		
Contaminant	Aliphatic >C21-C35		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO DWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C21-C35	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	3.10E+00	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m
Plume thickness at source	Sy	2.84E+00	m
Saturated aquifer thickness	da	2.84E+00	m
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³
Effective porosity of aquifer	n	2.00E-01	fraction
Hydraulic gradient	i	2.60E-03	fraction
Hydraulic conductivity of aquifer	K	1.14E-01	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days
Parameters values determined from options			
Partition coefficient	Kd	1.14E+06	l/kg
Longitudinal dispersivity	ax	5.00E+00	m
Transverse dispersivity	az	5.00E-01	m
Vertical dispersivity	ay	5.00E-02	m

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	6.70E+06	fraction
Decay rate used	λ	1.03E-11	d ⁻¹
Rate of contaminant flow due to retardation	u	2.21E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	3.22E-01	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	9.63E+00	

Remedial Targets

Remedial Target	2.89E+00	mg/l	For comparison with measured groundwater concentration.
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Ogata Banks

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	3.22E-01	mg/l
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

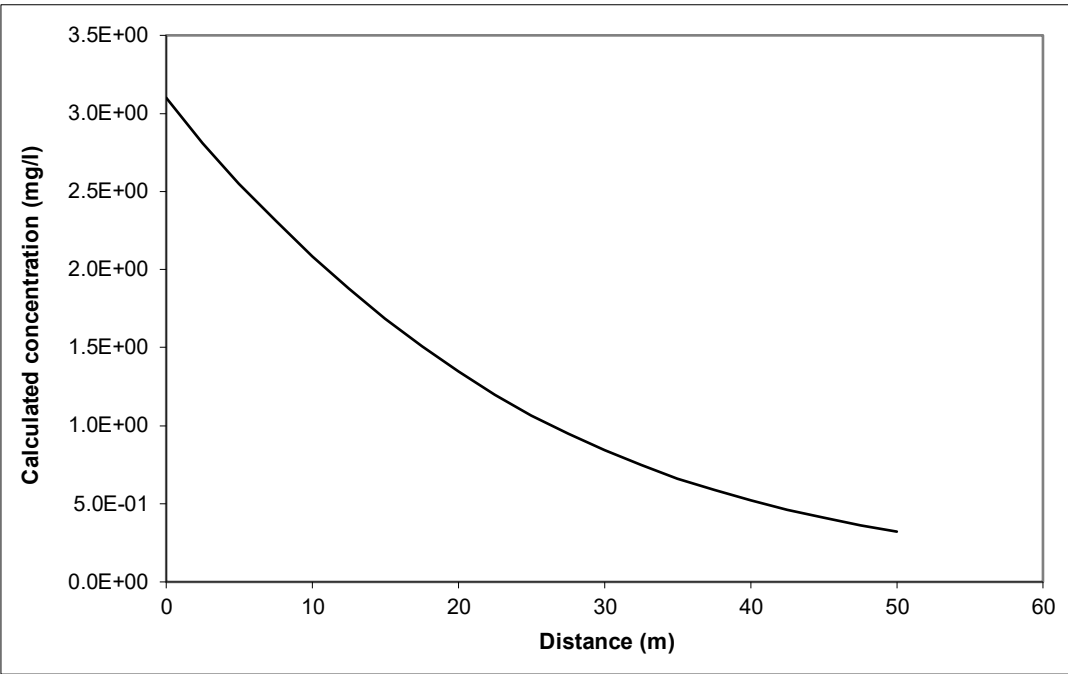
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.80E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.14E+06	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02	
Note values of dispersivity must be > 0					
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x					
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{2.414} ; az = ax/10, ay = ax/100 are assumed					



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

	mg/l
0	3.1E+00
2.5	2.81E+00
5.0	2.55E+00
7.5	2.31E+00
10.0	2.09E+00
12.5	1.88E+00
15.0	1.69E+00
17.5	1.51E+00
20.0	1.35E+00
22.5	1.20E+00
25.0	1.07E+00
27.5	9.49E-01
30.0	8.42E-01
32.5	7.47E-01
35.0	6.63E-01
37.5	5.88E-01
40.0	5.21E-01
42.5	4.62E-01
45.0	4.10E-01
47.5	3.63E-01
50.0	3.22E-01



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	24-May-23	Version:	1
Contaminant	Aliphatic >C21-C35		
Target Concentration (C_T)	0.3	mg/l	Origin of C_T: WHO DWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aliphatic >C21-C35	from Level 1
Target Concentration	C _T	3.00E-01	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	2.30E-01	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	1.00E+04	days Howard et al 1991
Calculated decay rate	λ	6.93E-05	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.84E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.14E+06	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	6.70E+06	fraction
Decay rate used	λ	1.03E-11	d ⁻¹
Rate of contaminant flow due to retardation	u	2.21E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	2.39E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	9.63E+00	

Remedial Targets

Remedial Target	2.89E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	2.39E-02	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.80E-03 fraction

Organic carbon partition coefficient Koc 6.31E+08 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

acid dissociation constant pKa

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 1.14E+06 l/kg

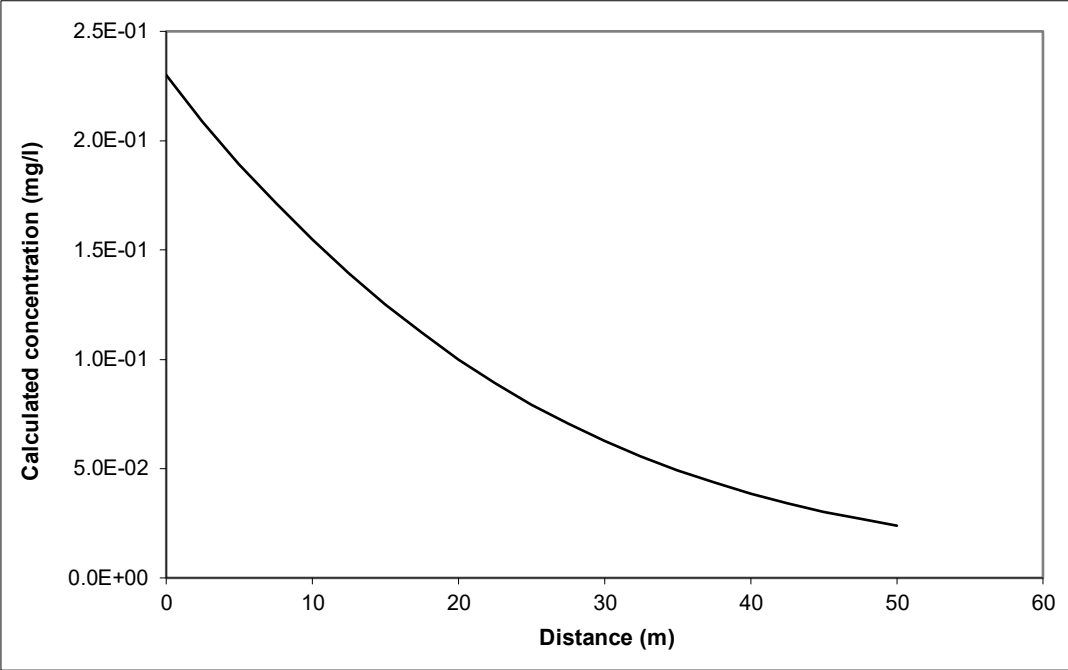
Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity ax	0.00E+00	5.00E+00	2.98E+00 m
Transverse dispersivity az	0.00E+00	5.00E-01	2.98E-01 m
Vertical dispersivity ay	0.00E+00	5.00E-02	2.98E-02

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

0 2.3E-01

2.5 2.09E-01

5.0 1.89E-01

7.5 1.71E-01

10.0 1.55E-01

12.5 1.39E-01

15.0 1.25E-01

17.5 1.12E-01

20.0 1.00E-01

22.5 8.91E-02

25.0 7.92E-02

27.5 7.04E-02

30.0 6.25E-02

32.5 5.55E-02

35.0 4.92E-02

37.5 4.36E-02

40.0 3.87E-02

42.5 3.43E-02

45.0 3.04E-02

47.5 2.69E-02

50.0 2.39E-02



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite		
Date:	24-May-23	Version:	1
Contaminant	Aromatic >C16-C21		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO DWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

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Data carried forward from an earlier worksheet are identified by a light green background

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The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C16-C21	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	2.00E-02	mg/l laboratory data
Half life for degradation of contaminant in water	t _{1/2}	4.00E+03	days Howard et al 1991
Calculated decay rate	λ	1.73E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m assumed plume width
Plume thickness at source	Sy	2.84E+00	m assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³ EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d Site specific value
Distance to compliance point	x	5.00E+01	m EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	1.00E+100	days time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.84E+01	l/kg see options
Longitudinal dispersivity	ax	5.00E+00	m see options
Transverse dispersivity	az	5.00E-01	m see options
Vertical dispersivity	ay	5.00E-02	m see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	1.69E+02	fraction
Decay rate used	λ	1.03E-06	d ⁻¹
Rate of contaminant flow due to retardation	u	8.78E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	2.35E-04	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	8.52E+01	

Remedial Targets

Remedial Target	7.66E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	2.35E-04	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

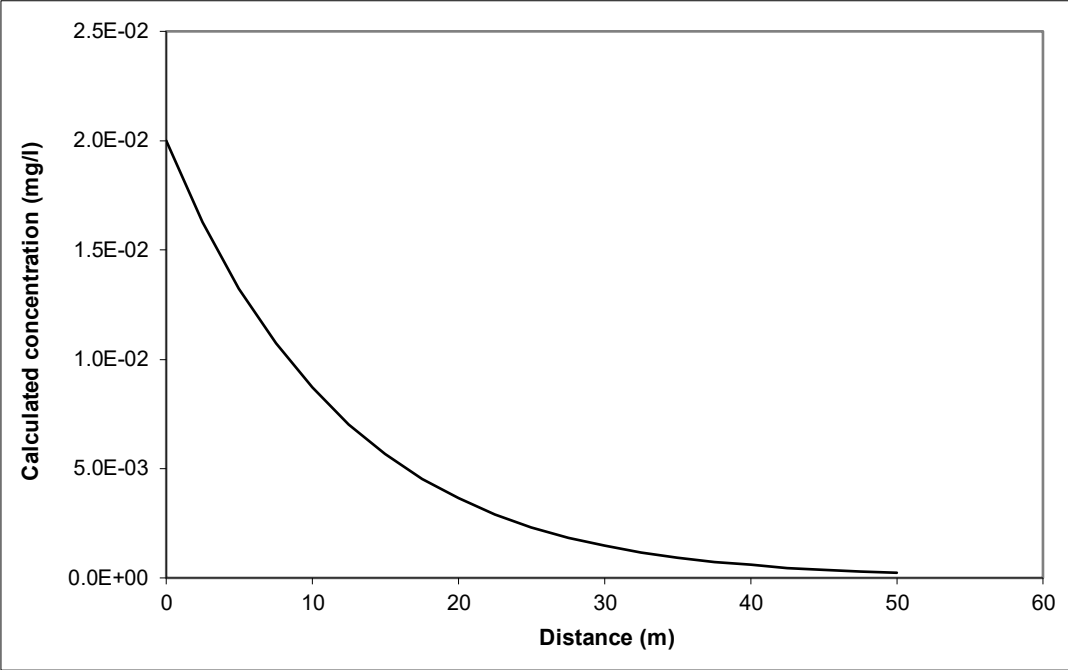
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.80E-03	fraction
Organic carbon partition coefficient	Koc	1.58E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	2.84E+01	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 5.00E+00	2.98E+00	m
Transverse dispersivity	az	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	0.00E+00	5.00E-02	2.98E-02	
Note values of dispersivity must be > 0					
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x					
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{0.414} ; az = ax/10, ay = ax/100 are assumed					



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

	mg/l
0	2.0E-02
2.5	1.63E-02
5.0	1.32E-02
7.5	1.07E-02
10.0	8.71E-03
12.5	7.03E-03
15.0	5.66E-03
17.5	4.54E-03
20.0	3.63E-03
22.5	2.90E-03
25.0	2.32E-03
27.5	1.85E-03
30.0	1.47E-03
32.5	1.17E-03
35.0	9.30E-04
37.5	7.39E-04
40.0	5.88E-04
42.5	4.67E-04
45.0	3.71E-04
47.5	2.95E-04
50.0	2.35E-04



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

© Environment Agency, 2006. (Produced by the Environment Agency's Science Group)

The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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Liability: The Environment Agency does not promise that the worksheet will provide any particular facilities or functions. You must ensure that the worksheet meets your needs and you remain solely responsible for the competent use of the worksheet. You are entirely responsible for the consequences of any use of the worksheet and the Agency provides no warranty about the fitness for purpose or performance of any part of the worksheet. We do not promise that the media will always be free from defects, computer viruses, software locks or other similar code or that the operation of the worksheet will be uninterrupted or error free. You should carry out all necessary virus checks prior to installing on your computing system.

IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions)

Details to be completed for each assessment			
Site Name:	Ashley House, London		
Site Address:	Ashley House, Ashley Road, London, N17 9LZ, London		
Completed by:	Ugne Ankenaite	Version:	1
Date:	24-May-23		
Contaminant	Aromatic >C21-C35		
Target Concentration (C_T)	0.09	mg/l	Origin of C_T: WHO DWS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Aromatic >C21-C35	from Level 1
Target Concentration	C _T	9.00E-02	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	4.00E+03	days	laboratory data
Calculated decay rate	λ	1.73E-04	days ⁻¹	Howard et al 1991
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.50E+01	m	assumed plume width
Plume thickness at source	Sy	2.84E+00	m	assumed plume thickness
Saturated aquifer thickness	da	2.84E+00	m	measured from site data
Bulk density of aquifer materials	ρ	1.18E+00	g/cm ³	EA Science Report SCO50021/SR3
Effective porosity of aquifer	n	2.00E-01	fraction	EA Science Report SCO50021/SR3
Hydraulic gradient	i	2.60E-03	fraction	Site specific Value
Hydraulic conductivity of aquifer	K	1.14E-01	m/d	Site specific value
Distance to compliance point	x	5.00E+01	m	EA (2020) LCRM
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	2.27E+02	l/kg	see options
Longitudinal dispersivity	ax	5.00E+00	m	see options
Transverse dispersivity	az	5.00E-01	m	see options
Vertical dispersivity	ay	5.00E-02	m	see options

Dispersed plume thickness exceeds aquifer thickness! Reduce vertical dispersivity

Calculated Parameters

Groundwater flow velocity	v	1.48E-03	m/d
Retardation factor	Rf	1.34E+03	fraction
Decay rate used	λ	1.29E-07	d ⁻¹
Rate of contaminant flow due to retardation	u	1.11E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	1.17E-04	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	8.52E+01	

Remedial Targets

Remedial Target	7.66E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point	50	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	1.17E-04	mg/l Ogata Banks
		1.0E+100	days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

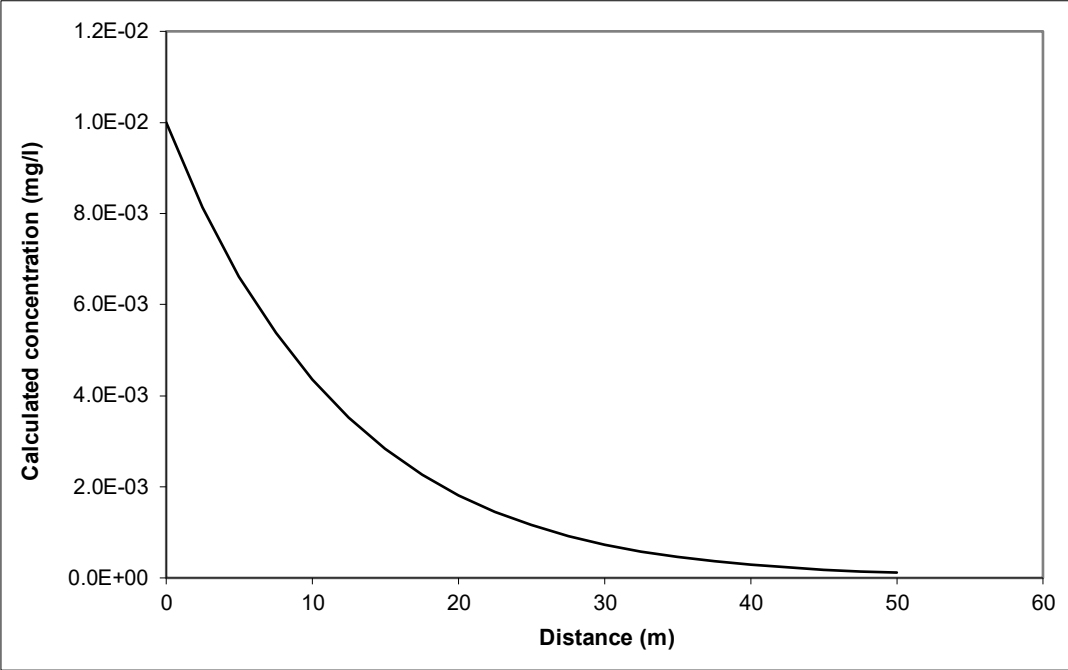
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.80E-03 fraction
Organic carbon partition coefficient	Koc	1.26E+05 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	2.27E+02 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value	Calc value	Xu & Eckstein	m
Transverse dispersivity	az	0.00E+00	5.00E+00	2.98E+00	m
Vertical dispersivity	ay	0.00E+00	5.00E-01	2.98E-01	m
		0.00E+00	5.00E-02	2.98E-02	
Note values of dispersivity must be > 0					
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x					
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{2.414} ; az = ax/10, ay = ax/100 are assumed					



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	Ashley House, London
Completed by:	Ugne Ankenaitė
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	1.0E-02
2.5	8.13E-03
5.0	6.61E-03
7.5	5.37E-03
10.0	4.35E-03
12.5	3.52E-03
15.0	2.83E-03
17.5	2.27E-03
20.0	1.82E-03
22.5	1.45E-03
25.0	1.16E-03
27.5	9.23E-04
30.0	7.35E-04
32.5	5.85E-04
35.0	4.65E-04
37.5	3.70E-04
40.0	2.94E-04
42.5	2.34E-04
45.0	1.86E-04
47.5	1.48E-04
50.0	1.17E-04

Detailed Ground Gas Assessment

Introduction

Calford Seaden on behalf of Notting Hill Genesis (client) instructed Waterman Infrastructure & Environment Limited (Waterman) to prepare a Detailed Ground Gas Risk Assessment for the Ashley House & Cannon Factory, Ashley Road South, Tottenham Hale, London (Site).

Previous ground investigations have identified the ground gas regime on the Ashley House as being Characteristic Situation 2 (CS2) in which ground gas protection measures are required in built structures. The purpose of this assessment is to undertake a critical review of the ground gas regime on the Ashley House site based on a detailed examination of the Site's environmental setting, ground conditions, surrounding land uses, and previous ground investigation results.

The report will conclude with an assessment of the Site's ground gas regime consistent with the approach detailed in CIRIA C665, and where required determination of the ground gas protection measures required to mitigate the risk to human health receptors.

The ground gas regime on the Cannon Factory has been identified as Characteristic Situation 1 (CS1) in which ground gas protection measures would not be required.

Proposed Development

Proposed buildings on the Ashley House site will comprise;

- A four storey building (Building 2) comprising 15 residential units above commercial units on the ground floor.
- A four to seven storey building (Building 2A) comprising residential units at ground floor alongside commercial units, and residential units on the floors above the ground floor.

Basements are not proposed.

A significant cut and fill is not proposed with finished levels generally remaining as existing.

Soft and hard landscaping will surround the buildings. Private soft landscaping is not proposed.

History

Historically the Ashley House site was a farm between 1850 – 1898 prior to becoming occupied by a multiple factories in 1913 (braid and bootlace factory, woollen factory and a pencil factory). In 1936 the Ashley House site was occupied by a printing ink and varnish factory which included various tanks chimneys and a water cooling tower. From 1972 to present the Site has remained as it currently exists.

Previous Site uses in which extensive fill would have likely occurred have not been identified.

Site Surroundings

Land uses historically in the surrounding area include recreational grounds, school, residential buildings, and works.

Landfills historical or current are absent in the surrounding area, with the closest landfill (historical/current) located 500m north east (Tottenham Marshes 1955 – 1962 – inert and industrial waste).

Ground Conditions

Geology generally encountered on-site is included in Table B1.

Table B1: Site Geology

Stratum	Thickness (m)	Description
Made Ground	0.59 – 2.0	Sub-base underlain by a sandy gravelly clay with fragments of brick, concrete
Enfield Silt Member	1.10 – 1.27	Orangish/yellowish brown slightly sandy gravelly CLAY
Kempton Park Gravel Member	1.14 – 3.50	Orangish brown very gravelly SAND to very sandy GRAVEL.
London Clay Formation	15.0	Grey and dark brown CLAY

Thin granular Made Ground deposits is present on-site consistent with the Site's history in which multiple phases of redevelopment or land raising has not occurred. The Site retains the current layout as observed in the 1972 historical maps when the Site was first developed. The Made Ground on-site is therefore associated with the construction of the existing development and is a minimum of 50 years old. Given the age of the Made Ground all readily degradable material would have degraded.

Ground Gas Regime

As identified in the CL:AIRE 2012 RB17 guidance document and CIRIA C665 ground gases only pose a risk to developments when the following can be satisfied, which is in line with source – pathway – receptor model followed by CLR11.

- An accumulation of a **large volume** of gas in the ground in or near the buildings (source).
- A pathway that allows gas to migrate through and/or out of the ground into a building or other structure sufficiently quickly to allow it to build up inside the building (pathway).
- A confined space within the building or structure where gas can build up to unacceptable levels (receptor).

In order for a risk from ground gases a source – pathway – receptor linkage needs to be present. This requires a sufficient quantity of gas to pose a hazard and one or more pathways by which it may cause significant harm to people. Crucially it is the quantity/volume of gas present within the soil/Made Ground matrix which should be considered a risk and not the gas concentration present in the ground (or monitoring well) which is commonly mistaken as posing a risk to future Site users.

Within this report the source – pathway – receptor linkage will be tested through a detailed site specific review of the Site's environmental setting, ground investigation results and the built structure present on-site. The report will conclude with an assessment into what the Site's ground gas regime is and whether ground gas protection measures consistent with BS8485 2017+2019 are required.

Ground Gas Source

A review of the Site's environmental setting identifies an absence of significant ground gas generating sources. Landfills identified as being representative of a significant ground gas generating source are absent on-site and in the surrounding area, and the Site is not in a coal mining area. Made Ground on-site is a relatively thin deposit (0.59 – 2.0m thick) and generally inert, with fragments of brick and concrete making up the anthropogenic fragments. A qualitative assessment of the Made Ground records it as being unlikely to represent a significant ground gas generating source.

As identified in the 2019 Geoff Card, James Lucas, and Steve Wilson, Technical Paper: Risk and Reliability in Gas Protection Design – 20 years on: Part 1, and the 2018 Ambisense and Environmental Protection Group, Using Ternary Plots for Interpretation of Ground Gas Monitoring Results river terrace gravels (Kempton Park Gravel Member, Enfield Silt Member) may contain small quantities of organic matter, which may degrade locally when exposed to oxygen generated during installation of boreholes. However, the rate of gas generation in these circumstances and the volume produced is extremely small and would not represent a risk to structures. The Kempton Park Gravel Formation or Enfield Silt Member would therefore not represent a significant ground gas generating source.

Off-site ground gas sources should only be considered a risk where a significant ground gas generating source is present. A review of historical maps identifies historical land uses similar to those present on-site or residential uses. The surrounding land uses are therefore likely to have a similar Made Ground composition and unlikely to represent a significant ground gas generating source.

Preferential pathways from an off-site significant ground gas generating source have not been identified.

The proposed Development will incorporate the following elements;

- Stripping of the existing hardstanding and sub-base;
- Excavation of the foundation pads and strip footings

The above actions completed as part of the proposed Developments construction will remove a portion of the Made Ground, decreasing the quantum of Made Ground on-site post development completion. The Site's level will be increased using crushed concrete and would therefore not represent a significant ground gas generating source. New ground gas sources will therefore not be introduced onto Site.

Six ground gas monitoring rounds have been completed on the Ashley House site, 4No as part of the 2019 Socotec ground investigation and 2No. as part of the 2015 RSK ground investigation. The ground gas monitoring results from the 6No monitoring rounds are included in Table B2.

Table B2: Ground gas monitoring results – RSK 2015

Borehole	Round 1			Round 2		
	Flow (l/hr)	Carbon Dioxide (%)	Methane (%)	Flow (l/hr)	Carbon Dioxide (%)	Methane (%)
BH101	0.2	1.7	<0.1	<0.1	0.3	<0.1
BH102	NM	NM	NM	0.1	0.3	<0.1
BH103A	NM	NM	NM	0.1	0.1	<0.1
WS101	0.4	2.1	16.3	<0.1	1.0	3.7
WS104	-0.5	3.6	<0.1	0.1	2.1	<0.1
WS107	-0.4	2.5	<0.1	<0.1	2.4	<0.1
WS108	0.3	0.1	<0.1	-0.1	0.3	<0.1
WS109	0.2	2.7	<0.1	<0.1	0.8	<0.1

Table B3: Ground gas monitoring results – Socotec 2019

Round	BH3			BH4		
	Flow (l/hr)	Carbon Dioxide (%)	Methane (%)	Flow (l/hr)	Carbon Dioxide (%)	Methane (%)
07/04/2019	<0.1	<0.1	<0.1	<0.1	0.7	<0.1
21/04/2019	<0.1	2.3	<0.1	<0.1	1.2	<0.1
24/04/2019	<0.1	2.7	<0.1	<0.1	0.2	<0.1
22/05/2019	<0.1	5.2	<0.1	<0.1	1.9	<0.1

The ground gas monitoring results are consistent with the absence of a significant ground gas source on-site or in the surrounding area. Methane concentrations and the gas flow rate are very low and commonly below the equipment's detection limit, and carbon dioxide is consistent with concentrations from the river terrace gravels (Enfield Silt Member and Kempton Park Gravel Member) in which concentrations up to 21% are not uncommon (EPG 2018 Ternary Plot Guidance, and CIEH 2009, Local Authority Guide to Ground Gas).

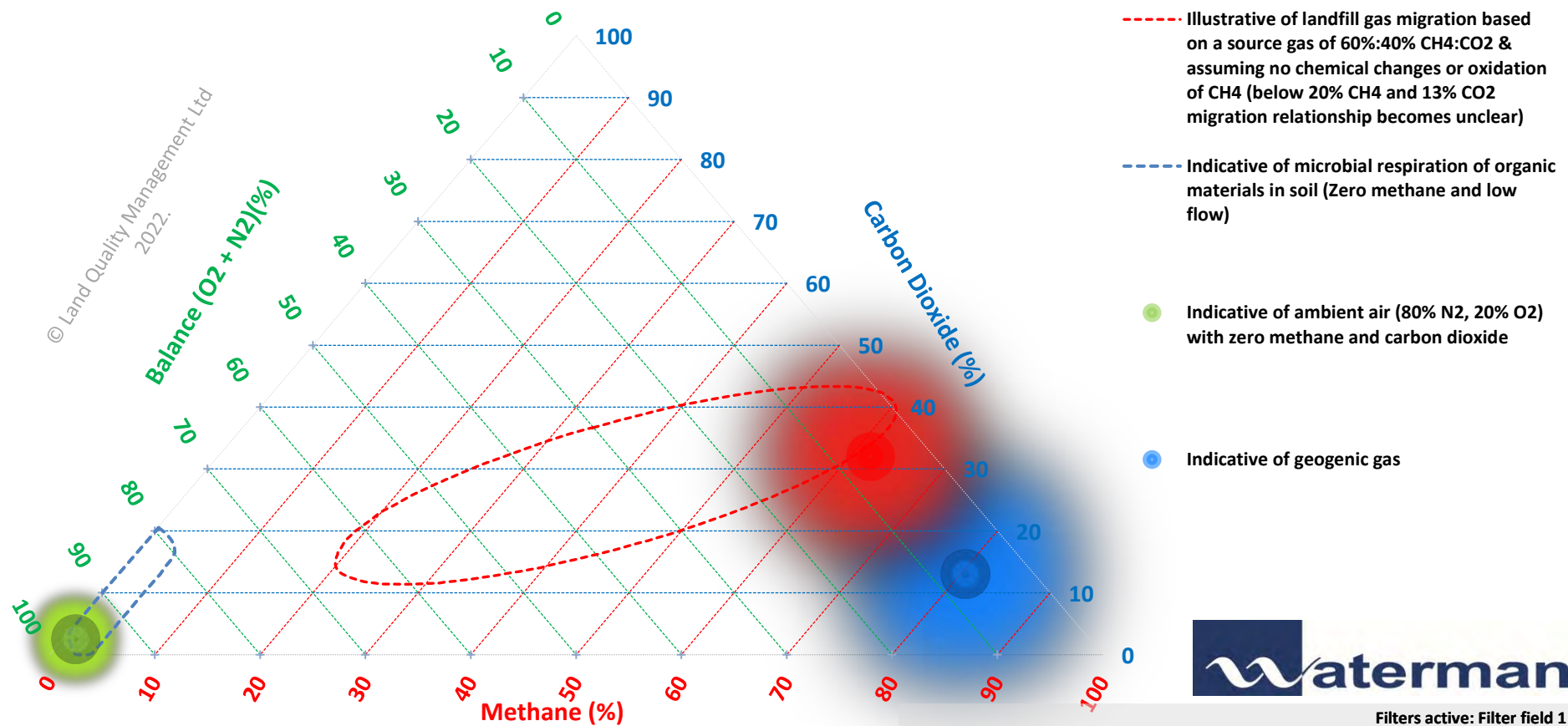
In the Kempton Park Gravel Formation and Made Ground in which low concentrations of readily degradable organic matter is present the carbon dioxide is generated through microbial/geochemical processes at very slow rates such they would not be emitted at the ground surface in sufficient quantities to pose a risk to built structures/future Site users. The installation of a monitoring well also temporarily exaggerates the microbial action through introducing oxygen into the sub-surface immediately surrounding the well, allowing enhanced degradation of the small volumes of organic material present in the Made Ground for a short time period. The presence of very low flow rates further confirms the above process in which carbon dioxide is being generated and emitted at very low rates.

Methane above the limit of detection was recorded solely in WS101. During the first monitoring round methane decreased from 18.7% at the start of the monitoring to 16.3% after 3 minutes. During the second monitoring round a decrease in methane from 20.9% to 3.7% after 10 minutes. The decrease in methane concentrations over the monitoring periods identifies a methane source with a small reservoir of readily degradable material rather than a large methane source as would be present at a landfill for example which would have large reservoir of readily degradable material. A review of the exploratory hole log for WS101 records Made Ground to 1.8m comprising 0.2m of concrete, 0.4m of sub-base, 1.2m of black silty sandy gravelly clay, underlain by the Kempton Park Gravel Member to base of exploratory hole. Between 1.2mbgl and 1.8mbgl black oil is identified in the sandy pockets and is the likely cause behind the high methane concentrations.

Petroleum hydrocarbons degrade and produce methane at very slow rates such hazardous rates of surface emissions are unlikely in the long term, the volume of methane produced is low but sufficient to cause high concentrations in the monitoring well. The absence of high flow rates in WS101 and on-site is further evidence the methane is being produced at a very slow rate. The high methane to low carbon dioxide ratio is consistent with the degradation of methane rather than interference with the meter. The gas from hydrocarbon degradation can become trapped below impermeable layers over time and if below the water table the pockets can become pressurised. There is no significant risk in the long term (because the volumes of gas are typically small). However they can present a short term health and safety hazard during construction if they are penetrated. Typically where a pocket is punctured, the gas pressure will dissipate over a few days. Given the above, the methane recorded in WS101 is unrepresentative of the ground gas regime on-site and is not evidence of a long term of high surface emissions risk, and will not be considered further.

The ground gas results from the monitoring completed have been included in a ternary plot (Figure B1) to further characterise the ground gas source and identify whether a significant ground gas risk is present/absent. The Ternary Plot identifies ground gas consistent with the microbial respiration of organic materials in soil, in which a low flow and low volume of ground gas is present.

Figure B1: Ternary Plot Ground Gas Results



Source Conclusion

A review of the Site's environmental Site setting identifies an absence of a significant ground gas source as being present on-site or off-site in the surrounding area. Made Ground is largely inert with a low organic matter content and has a maximum thickness of 2.0m. Landfills which would be a significant ground gas generating source are absent on-site or in the surrounding area, and the Site is not located in a coal mining area.

Pathway

For a risk to a human health receptor from ground gas risk there must be sufficient flow from the ground gas in the sub-surface environment into an enclosed space. The permeability of soil should therefore be considered when determining the potential for ground gas to reach the surface and migrate into a building. The empirical Gas Screening Values (GSV) included in the BS8485:2015+A1:2019 developed by correlations considered by Peckson (1985) did not account for permeability leading to the GSV used being highly conservative due to the absence of permeability which could have significant attenuation factor on ground gas migration.

Made Ground on-site has been recorded as comprising a predominately cohesive deposit with varying proportions of sand/gravel, in addition to anthropogenic material inclusions. The Made Ground would have a permeability in the region of 2.2×10^{-5} m/s (Environment Agency, SR3 2009), which would restrict the vertical migration of ground gases and would be resistant to pressure driven flows as caused by atmospheric pressure drops.

The proposed Development will incorporate a 250mm thick cast in-situ ground bearing reinforced floor slab with minimal penetrations. The ground floor slab will be tanked with a waterproof membrane with a minimum 200 gauge thickness. The cast in-situ ground bearing floor slab and membrane would restrict ground gas ingress and provide effective restriction of ground gas migration through it.

Receptor

The Development is residential led with buildings up to seven storeys, commercial is predominately located at ground floor with limited residential in Building 2A at ground floor. In areas of commercial use relatively high levels of ventilation will be present limiting the potential for ground gases to accumulate and the risk posed by ground gases to future human health receptors.

Conclusions

A review of the Site's environmental setting, which has been confirmed through completion of ground gas monitoring has not identified significant ground gas generating sources as being present on-site or in the surrounding area.

A review of the possible pathways and receptors identifies a 250mm thick cast in-situ ground bearing floor slab which would restrict the vertical migration of residual ground gas into the building, and a built structure which would inherently restrict the migration of ground gases into the proposed Development.

Following the detailed review of the Site's ground gas regime in-line with the recent guidance the Source – Pathway – Receptor linkage for the Site is broken primarily through removal of a ground gas source. The requirement for ground gas protection measures including ground gas membranes in the proposed Development would not be required.

Recommendations

- Ground gas protection measures would not be required in the completed developments;
- During construction works a watching brief should be maintained during excavations. Should Made Ground which would not be removed be encountered as part of the development construction which differs substantially from that identified in previous ground investigations either in appearance or thickness, works should cease and the environment consultant notified. The environmental consultant should assess the Made Ground encountered and its ground gas generation potential and determine whether there is a requirement for ground gas protection measures. The assessment of the Made Grounds ground gas generation potential, and determination of the requirement for ground gas protection measures should be agreed with the regulatory authority.

Appendix G Risk Rating Matrix

Table G.1: Risk rating for contaminated land qualitative risk assessment

Level of Severity	Likelihood		
	Most Likely	Reasonably Foreseeable	Unlikely
Acute harm or severe chronic harm. Direct pollution of sensitive water receptors or serious pollution of other water bodies.	High	High	Low
Harm from long-term exposure. Slight pollution of sensitive receptors or pollution of other water bodies.	Medium	Medium	Low
No significant harm in either short or long term. No pollution of water that is likely to affect sensitive receptors. No more than slight pollution of other water bodies.	Low	Low	Low

Appendix H Environmental Receptors

The Contaminated Land Statutory Guidance has a four category system that considers harm to human health, controlled waters, flora and fauna, property, livestock and crops. The Categories are broadly defined as follows:

- 1 Contaminated Land – similar to land where it is known that significant harm has been caused or significant harm is being caused
- 2 Contaminated Land – no significant harm being caused but there is a significant possibility for significant harm to be caused in the future
- 3 Not Contaminated Land – there may be harm being caused but no significant possibility for significant harm to be caused in the future
- 4 Not Contaminated Land – no contaminant linkage, normal levels of contaminants and no significant harm being caused and no significant possibility for significant harm to be caused in the future.

Table H.1: Significant pollution to controlled waters

Pollution of controlled waters

Under Section 78A(9) of Part 2A the term “pollution of controlled waters means the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter. The term “controlled waters” in relation to England has the same meaning as in Part 3 of the Water Resources Act 1991, except that “ground waters” does not include water contained in underground strata but above the saturation zones. (Paragraph 4.36)

Given that the Part 2A regime seeks to identify and deal with significant pollution (rather than lesser levels of pollution), the local authority should seek to focus on pollution which: (i) may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems; (ii) which may result in damage to material property; or (iii) which may impair or interfere with amenities and other legitimate uses of the environment. (Paragraph 4.37)

Significant pollution of controlled waters

Paragraph 4.38 states that “The following types of pollution should be considered to constitute significant pollution of controlled waters:

- (a) Pollution equivalent to “environmental damage” to surface water or groundwater as defined by The Environmental Damage (Prevention and Remediation) Regulations 2009, but which cannot be dealt with under those Regulations.
- (b) Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.
- (c) A breach of a statutory surface water Environment Quality Standard, either directly or via a groundwater pathway.
- (d) Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants (as defined in Article 2(3) of the Groundwater Daughter Directive (2006/118/EC)5”.

Paragraph 4.39 states that “In some circumstances, the local authority may consider that the following types of pollution may constitute significant pollution: (a) significant concentrations⁶ of hazardous substances or non-hazardous pollutants in groundwater; or (b) significant concentrations of priority hazardous substances, priority substances or other specific polluting substances in surface water; at an appropriate, risk based compliance point. The local authority should only conclude that pollution is significant if it considers that treating the land as contaminated land would be in accordance with the

broad objectives of the regime as described in Section 1 (of the Contaminated Land Statutory Guidance). This would normally mean that the authority should conclude that less serious forms of pollution are not significant. In such cases the authority should consult the Environment Agency”.

The following types of circumstance should not be considered to be contaminated land on water pollution grounds:

- (a) The fact that substances are merely entering water and none of the conditions for considering that significant pollution is being caused set out in paragraphs 4.38 and 4.39 above are being met.
- (b) The fact that land is causing a discharge that is not discernible at a location immediately downstream or down-gradient of the land (when compared to upstream or up-gradient concentrations).
- (c) Substances entering water in compliance with a discharge authorised under the Environmental Permitting Regulations.

Significant pollution of controlled waters is being caused

In deciding whether significant pollution of controlled waters is being caused, the local authority should consider that this test is only met where it is satisfied that the substances in question are continuing to enter controlled waters; or that they have already entered the waters and are likely to do so again in such a manner that past and likely future entry in effect constitutes ongoing pollution. For these purposes, the local authority should:

- (a) Regard substances as having entered controlled waters where they are dissolved or suspended in those waters, or (if they are immiscible with water) they have direct contact with those waters on or beneath the surface of the water.
- (b) Take the term “continuing to enter” to mean any measurable entry of the substance(s) into controlled waters additional to any which has already occurred.
- (c) Take the term “likely to do so again” to mean more likely than not to occur again.

Land should not be determined as contaminated land on grounds that significant pollution of controlled waters is being caused where: (a) the relevant substance(s) are already present in controlled waters; (b) entry into controlled waters of the substance(s) from land has ceased; and (c) it is not likely that further entry will take place.

Significant Possibility of Significant Pollution of Controlled Waters

In deciding whether or not a significant possibility of significant pollution of controlled waters exists, the local authority should first understand the possibility of significant pollution of controlled waters posed by the land, and the levels of certainty/uncertainty attached to that understanding, before it goes on to decide whether or not that possibility is significant. The term “possibility of significant pollution of controlled waters” means the estimated likelihood that significant pollution of controlled waters might occur. In assessing the possibility of significant pollution of controlled waters from land, the local authority should act in accordance with the advice on risk assessment in Section 3 and the guidance in this sub-section.

In deciding whether the possibility of significant pollution of controlled waters is significant the local authority should bear in mind that Part 2A makes the decision a positive legal test. In other words, for particular land to meet the test the authority needs reasonably to believe that there is a significant possibility of such pollution, rather than to demonstrate that there is not.

Before making its decision on whether a given possibility of significant pollution of controlled waters is significant, the local authority should consider:

- (a) The estimated likelihood that the potential significant pollution of controlled waters would become manifest; the strength of evidence underlying the estimate; and the level of uncertainty underlying the estimate.

- (b) The estimated impact of the potential significant pollution if it did occur. This should include consideration of whether the pollution would be likely to cause a breach of European water legislation, or make a major contribution to such a breach.
- (c) The estimated timescale over which the significant pollution might become manifest.
- (d) The authority's initial estimate of whether remediation is feasible, and if so what it would involve and the extent to which it might provide a solution to the problem; how long it would take; what benefit it would be likely to bring; and whether the benefits would outweigh the costs and any impacts on local society or the environment from taking action

Reproduced from DEFRA (2012) Contaminated Land Statutory Guidance pursuant to section 78YA of the Environmental Protection Act 1990 as amended by Section 57 of the Environment Act 1995.

Table H.2: Significant harm to human health, ecological systems and property

Relevant types of receptor	Significant harm	Significant possibility of significant harm
Human beings	The following health effects should always be considered to constitute significant harm to human health: death; life threatening diseases (eg cancers); other diseases likely to have serious impacts on health; serious injury; birth defects; and impairment of reproductive functions. Other health effects may be considered by the local authority to constitute significant harm. For example, a wide range of conditions may or may not constitute significant harm (alone or in combination) including: physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. In deciding whether or not a particular form of harm is significant harm, the local authority should consider the seriousness of the harm in question: including the impact on the health, and quality of life, of any person suffering the harm; and the scale of the harm. The authority should only conclude that harm is significant if it considers that treating the land as contaminated land would be in accordance with the broad objectives of the regime as described in Section 1 of the Contaminated Land Statutory Guidance.	The risk posed by one or more relevant contaminant linkage(s) relating to the land comprises: (a) The estimated likelihood that significant harm might occur to an identified receptor, taking account of the current use of the land in question. (b) The estimated impact if the significant harm did occur – i.e. the nature of the harm, the seriousness of the harm to any person who might suffer it, and (where relevant) the extent of the harm in terms of how many people might suffer it. In estimating the likelihood that a specific form of significant harm might occur the local authority should, among other things, consider: (a) The estimated probability that the significant harm might occur: (i) if the land continues to be used as it is currently being used; and (ii) where relevant, if the land were to be used in a different way (or ways) in the future having regard to the guidance on "current use" in Section 3 of the Contaminated Land Statutory Guidance. (b) The strength of evidence underlying the risk estimate. It should also consider the key assumptions on which the estimate of likelihood is based, and the level of uncertainty underlying the estimate.

Relevant types of receptor	Significant harm	Significant possibility of significant harm
Any ecological system, or living organism forming part of such a system, within a location which is: • a site of special scientific interest (under section 28 of the Wildlife and Countryside Act (WCA) 1981 (as amended) and Part 4 of the Natural Environment and Rural Communities Act 2006 (as amended)); • a national nature reserve (under Section 35 of the WCA 1981 (as amended)); • a marine nature reserve (under Section 36 of the WCA 1981 (as amended)); • an area of special protection for birds (under Section 3 of the WCA 1981 (as amended)); • a "European site" within the meaning of regulation 8 of the Conservation of Habitats and Species Regulations 2010 (as amended); • any habitat or site afforded policy protection under Section 15 of The National Planning Policy Framework (NPPF) on conserving and enhancing the natural environment (i.e. possible Special Areas of Conservation, potential Special Protection Areas and listed or proposed Ramsar sites); or • any nature reserve established under Section 21 of the National Parks and Access to the Countryside Act 1949.	The following types of harm should be considered to be significant harm: • harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or • harm which significantly affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location. In the case of European sites, harm should also be considered to be significant harm if it endangers the favourable conservation status of natural habitats at such locations or species typically found there. In deciding what constitutes such harm, the local authority should have regard to the advice of Natural England and to the requirements of the Conservation of Habitats and Species Regulations 2010 (as amended).	Conditions would exist for considering that a significant possibility of significant harm exists to a relevant ecological receptor where the local authority considers that: • significant harm of that description is more likely than not to result from the contaminant linkage in question; or • there is a reasonable possibility of significant harm of that description being caused, and if that harm were to occur, it would result in such a degree of damage to features of special interest at the location in question that they would be beyond any practicable possibility of restoration. Any assessment made for these purposes should take into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.
Property in the form of: • crops, including timber • produce grown domestically, or on allotments, for consumption • livestock • other owned or domesticated animals; • wild animals which are the subject of shooting or fishing rights.	For crops, a substantial diminution in yield or other substantial loss in their value resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage. The local authority should regard a substantial loss in value as occurring only when a substantial proportion of the animals or crops are dead or otherwise no longer fit for their intended purpose. Food should be regarded as being no longer fit for purpose when it fails to comply with the provisions of the Food Safety Act 1990. Where a	Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question, taking into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.

Relevant types of receptor	Significant harm	Significant possibility of significant harm
	diminution in yield or loss in value is caused by a contaminant linkage, a 20% diminution or loss should be regarded as a benchmark for what constitutes a substantial diminution or loss. In the Guidance states that this description of significant harm is referred to as an "animal or crop effect".	
Property in the form of buildings. For this purpose 'building' means any structure or erection and any part of a building, including any part below ground level, but does not include plant or machinery comprised in a building, or buried services such as sewers, water pipes or electricity cables.	Structural failure, substantial damage or substantial interference with any right of occupation. The local authority should regard substantial damage or substantial interference as occurring when any part of the building ceases to be capable of being used for the purpose for which it is or was intended. In the case of a scheduled Ancient Monument, substantial damage should be regarded as occurring when the damage significantly impairs the historic, architectural, traditional, artistic or archaeological interest by reason of which the monument was scheduled. The Guidance states that this description of significant harm is referred to as a 'building effect'.	Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question during the expected economic life of the building (or in the case of a scheduled Ancient Monument the foreseeable future), taking into account relevant information for that type of contaminant linkage.

Reproduced from DEFRA (2012) Contaminated Land Statutory Guidance pursuant to section 78YA of the Environmental Protection Act 1990 as amended by Section 57 of the Environment Act 1995.

Appendix I Generic Assessment Criteria

Human Health Generic Assessment Criteria

Background

In order to be able to make inference on whether the results obtained during the site investigation (e.g. chemical concentrations in soils, waters and gas) point to the presence of a potential hazard to human health, it is necessary to distinguish between the results, reflecting background and/or insignificantly elevated levels of contamination (i.e. with negligible potential to cause harm or pollution) and the results with significantly elevated concentrations (i.e. with significant potential to cause harm or pollution).

The approach to risk assessment with respect to risks to human health from contaminated land in the UK is set out in the publication Model Procedures for the Management of Land Contamination (CLR11) Environment Agency (2004).

This sets out a tiered approach:

- Preliminary Risk Assessment (e.g. establishing potential contaminant linkages);
- Generic Quantitative Risk Assessment (GQRA) (e.g. comparison of site contaminant concentrations against generic standards and compliance criteria e.g. Soil Guideline Values (SGV) or other Generic Assessment Criteria including an assessment of risk using the source pathway target model); and
- Detailed Quantitative Risk Assessment (DQRA) (e.g. the comparison of contaminant concentrations against site specific assessment criteria).

Preliminary Risk Assessment

This typically encompasses a desk based generation of a conceptual model to establish the potential contaminant linkages associated with the site and any proposed development. Works would typically involve:

- Evaluation of the potential sources of contamination on the site and in the locality and from both a current and historical perspective
- Statutory Consultation;
- Evaluation of a sites geology, hydrology and hydrogeology;
- Site inspection;
- Additional pertinent information as necessary on a site by site basis.

Where works indicate the presence of a potential contaminant linkage further evaluation and potentially site investigation works are necessary to determine the significance of the linkage.

Generic Quantitative Risk Assessment (GQRA)

In August 2008 the Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) announced the withdrawal of the Contaminated Land Reports CLR7 – 10, CLEA UK (beta) and existing SGV reports as they no-longer fully reflected the revised approach to human health risk assessment.

New partial guidance (in particular Science Reports SR2, SR3 and SR7) and new risk assessment tools (CLEA model version v1.04, v1.05 and currently v1.06) were published in 2009 and these allow environmental practitioners to derive generic and site specific Soil Assessment Criteria (GAC and SAC).

Soil Guideline Values (SGVs)

The EA and DEFRA updated the TOX reports and Soil Guideline Values (SGVs) to reflect the guidance documents published in 2009. SGVs for arsenic, cadmium, nickel, mercury, selenium, BTEX compounds

(benzene, toluene, ethylbenzene and xylenes), dioxins, furans and dioxin like PCBs and phenol have been made available.

Since publishing the revised SGVs the CLEA model was updated to version v1.06. The Environment Agency has however confirmed that v1.05 has only a “minor effect on assessment criteria calculated using the CLEA software 1.04” and consequently the GACs derived are considered to remain valid. Environment Agency SGVs generated using v1.04 have also not been updated. Software version v1.06 is identical to v1.05 with some password protection enhancements that in no way affect the GAC values generated.

Owing to the scientific advances since 2009 and in particular toxicological research outputs, less significance is now placed on the SGVs in the hierarchy outlined below.

Category 4 Screening Levels (C4SLs)

Category 4 Screening Levels were generated by Contaminated Land: Applications in Real Environments (CL:AIRE) on behalf of DEFRA and made available to the public in April 2014. Category 4 Screening Levels were derived in response to policy changes outlined in the recently revised Statutory Guidance (SG) for Part 2A of the Environmental Protection Act 1990 (Part 2A). Part 2A was originally introduced to ensure that the risks from land contamination to human health, property and the environment are managed appropriately, with the revised SG being designed to address concerns regarding its real-world application. The revised SG presents a new four category system for classifying land under Part 2A, ranging from Category 4, where the level of risk posed is acceptably low, to Category 1, where the level of risk is clearly unacceptable.

The document SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document (March 2014) states that:

The Impact Assessment that accompanied the revised Part 2A Statutory Guidance identified a potential role for new ‘Category 4 Screening Levels’ in providing a simple test for deciding when land is suitable for use and definitely not contaminated land. It was envisaged that these new screening levels would allow ‘low-risk’ land to be dismissed from the need for further risk assessment more quickly and easily and allow regulators to focus efforts on the highest-risk land. The C4SLs were proposed to be more pragmatic (whilst still strongly precautionary) compared to existing generic screening levels. It is anticipated that, where they exist, C4SLs will be used as generic screening criteria that can be used within a GQRA, albeit describing a higher level of risk than the currently or previously available SGVs.

Suitable For Use Screening Levels (S4USLs)

In January 2015, Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) have published updated screening criteria that were derived in line with UK guidance on risk assessment (SR2 and SR3). The resultant screening criteria reflect the industries greater knowledge of the relevant toxicology and further consideration of exposure scenarios as set out in SP1010.

Waterman’s Generic Assessment Criteria (GACs)

Waterman have used the following hierarchy for the generic assessment of soils to evaluate Human Health.

- Published Category 4 Screening Values (C4SLs) derived by CL:AIRE on behalf of DEFRA; or in their absence;
- Suitable 4 Use Screening Levels (S4USLs) derived by LQM/CIEH; or in their absence;
- Published Soil Guideline Values (SGVs);
- GAC prepared in accordance with the CLEA v1.04 / v1.06 model by authoritative bodies (e.g. Contaminated Land Applications in Real Environments (CL:AIRE) 2009; and
- Waterman in-house GAC prepared in accordance with the CLEA V1.06 model and associated documents.

Tabulated values of the GACs used are presented overleaf. The references of the sources quoted in the table are:-

- Environment Agency, 2009. CLEA Software, version 1.06;
- DEFRA, Environment Agency, 2004. Model Procedures for the Management of Land Contamination, Contaminated Land Report 11;
- DEFRA, 2014, SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document and appendices;
- LQM / CIEH, 2015. The LQM/CIEH S4ULs for Human Health Risk Assessment;
- Environment Agency, 2009. Human health toxicological assessment of contaminants in soil. Report SC050021/SR2;
- Environment Agency, 2009. Updated technical background to the CLEA model. Report SC050021/SR3;
- Environment Agency, 2008. Compilation of chemical data for priority organic pollutants for derivation of Soil Guideline Values. Report SC050021/SR7; and
- EIC / CL:AIRE, 2010. Soil generic assessment criteria for human health risk assessment.

Detailed Quantitative Risk Assessment (DQRA)

Detailed Quantitative Risk Assessments are undertaken on a site specific basis and full details of the alterations to the CLEA model and generic land use scenarios will be described within the specific reports.

Benzo(a)pyrene Surrogate Marker (SM) Approach

The DEFRA Category 4 Screening Level for B(a)P is based on the surrogate marker approach. In order to utilise the GAC or others based on this approach, the sample assessed must exhibit certain properties that comply with underlying assumptions.

SP1010, Appendix E states:

“The SM approach estimates the toxicity of a mixture of PAHs in an environmental matrix by using toxicity data for a PAH mixture for which the composition is known. Exposure to the SM is assumed to represent exposure to all PAHs in that matrix therefore the toxicity of the SM represents the toxicity of the mixture. In most cases, BaP is chosen as the SM due to its ubiquitous nature and the vast amount of data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food (EFSA 2008). However, RIVM considered that ‘it would not be suitable to use BaP as a SM for carcinogenic risk assessment of PAH mixtures in soil due to the wide variety in composition of PAH mixtures in Dutch land contamination sites’, although little data was provided in the report to support this statement (RIVM 2001). Similarly, the Canadian Council of Ministers of the Environment (CCME) also stated that contaminated soil is likely to contain a diverse range of carcinogenic and non-carcinogenic PAH of varying potency (CCME, 2008).

The SM approach relies on a number of assumptions (HPA 2010).

- *The SM (BaP) must be present in all soil samples.*
- *The profile of the different PAH relative to BaP should be similar in all samples.*
- *The PAH profile in the soil samples should be similar to that used in the pivotal toxicity study on which HBGV was based i.e. the Culp study.*

[sic] To assess the PAH profile in the test soil sample [complies with the assumptions above], the ratio of the seven genotoxic PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene,

benzo[g,h,i]perylene, chrysene, dibenz[a,h]anthracene and indeno[1,2,3-c,d]pyrene), relative to BaP, should be calculated to ensure it is similar to the test material used in the Culp study (HPA 2010). To be considered sufficiently similar, the ratio relative to BaP should fit within the upper and lower limits (representing an order of magnitude above and below the mean ratio to BaP of test material used in the Culp study). In such cases BaP is considered an adequate SM and the LLTC for BaP may be used in the risk assessment.

If the site falls outside the order of magnitude limits, it may be appropriate to considering a LLTC for groups of surrogate markers, such as groups of 2, 4 or 8 PAHs, as used by EFSA for the evaluation of PAHs in food (EFSA 2008). Expert judgement should be sought in such situations where there is uncertainty as to whether BaP is sufficiently representative (HPA 2010)."

The ratios of the seven genotoxic PAHs relative to B(a)P can be calculated 'by hand' or using LQM's PAH profiling tool.

Generic Quantitative Risk Assessment Criteria

Table I1: Residential and Allotment end-uses.

Proposed End Use	units	Residential without plant uptake			Source
Soil Organic Matter Content	%	1	2.5	6	
Arsenic	mg/kg	40	40	40	DEFRA C4SLs
Antimony	mg/kg	550	550	550	CL:AIRE 2009
Barium	mg/kg	1300	1300	1300	CL:AIRE 2009
Beryllium	mg/kg	1.7	1.7	1.7	LQM S4ULs 2015
Boron (Water Soluble)	mg/kg	11000	11000	11000	LQM S4ULs 2015
Cadmium	mg/kg	150	150	150	DEFRA C4SLs
Chromium (Total)	mg/kg	910	910	910	LQM S4ULs 2015
Chromium (VI)	mg/kg	21	21	21	DEFRA C4SLs
Copper	mg/kg	7100	7100	7100	LQM S4ULs 2015
Lead	mg/kg	310	310	310	DEFRA C4SLs
Mercury	mg/kg	1.2	1.2	1.2	LQM S4ULs 2015
Molybdenum	mg/kg	670	670	670	CL:AIRE 2009
Nickel	mg/kg	180	180	180	LQM S4ULs 2015
Selenium	mg/kg	430	430	430	LQM S4ULs 2015
Vanadium*	mg/kg	1200	1200	1200	LQM S4ULs 2015
Zinc	mg/kg	40000	40000	40000	LQM S4ULs 2015
Aliphatic EC5 - EC6	mg/kg	42	78	160	LQM S4ULs 2015
Aliphatic EC6 - EC8	mg/kg	100	230	530	LQM S4ULs 2015
Aliphatic EC8-EC10	mg/kg	27	65	150	LQM S4ULs 2015

Proposed End Use	units	Residential without plant uptake			Source
Soil Organic Matter Content	%	1	2.5	6	
Aliphatic EC10-EC12	mg/kg	130	330	770	LQM S4ULs 2015
Aliphatic EC12-EC16	mg/kg	1100	2400	4400	LQM S4ULs 2015
Aliphatic EC16-EC35	mg/kg	65000	92000	110000	LQM S4ULs 2015
Aliphatic EC35-EC44	mg/kg	65000	92000	110000	LQM S4ULs 2015
Aromatic C5-C7	mg/kg	370	690	1400	LQM S4ULs 2015
Aromatic C7-C8	mg/kg	860	1800	3900	LQM S4ULs 2015
Aromatic C8-C10	mg/kg	47	110	270	LQM S4ULs 2015
Aromatic C10-C12	mg/kg	250	590	1200	LQM S4ULs 2015
Aromatic C12-C16	mg/kg	1800	2300	2500	LQM S4ULs 2015
Aromatic C16-C21	mg/kg	1900	1900	1900	LQM S4ULs 2015
Aromatic C21-C35	mg/kg	1900	1900	1900	LQM S4ULs 2015
Aromatic C35-C44	mg/kg	1900	1900	1900	LQM S4ULs 2015
Benzene	mg/kg	0.38	0.7	1.4	LQM S4ULs 2015
Toluene	mg/kg	880	1900	3900	LQM S4ULs 2015
Ethyl Benzene	mg/kg	83	190	440	LQM S4ULs 2015
Xylene - o	mg/kg	88	210	480	LQM S4ULs 2015
Xylene - m	mg/kg	82	190	450	LQM S4ULs 2015
Xylene - p	mg/kg	79	180	430	LQM S4ULs 2015
MTBE (Methyl tert-butyl ether)	mg/kg				CL:AIRE 2009
Naphthalene	mg/kg	2.3	5.6	13	LQM S4ULs 2015

Proposed End Use	units	Residential without plant uptake			Source
Soil Organic Matter Content	%	1	2.5	6	
Acenaphthylene	mg/kg	2900	4600	6000	LQM S4ULs 2015
Acenaphthene	mg/kg	3000	4700	6000	LQM S4ULs 2015
Fluorene	mg/kg	2800	3800	4500	LQM S4ULs 2015
Phenanthrene	mg/kg	1300	1500	1500	LQM S4ULs 2015
Anthracene	mg/kg	31000	35000	37000	LQM S4ULs 2015
Fluoranthene	mg/kg	1500	1600	1600	LQM S4ULs 2015
Pyrene	mg/kg	3700	3800	3800	LQM S4ULs 2015
Benzo(a)anthracene	mg/kg	11	14	15	LQM S4ULs 2015
Chrysene	mg/kg	30	31	32	LQM S4ULs 2015
Benzo(b)fluoranthene	mg/kg	3.9	4	4	LQM S4ULs 2015
Benzo(k)fluoranthene	mg/kg	110	110	110	LQM S4ULs 2015
Benzo(a)pyrene	mg/kg	3.2	3.2	3.2	LQM S4ULs 2015
Indeno(1,2,3-cd)pyrene	mg/kg	45	46	46	LQM S4ULs 2015
Di-benzo(a.h.)anthracene	mg/kg	0.31	0.32	0.32	LQM S4ULs 2015
Benzo(g.h.i.) Perylene	mg/kg	360	360	360	LQM S4ULs 2015
Phenol	mg/kg	750	1300	2300	LQM S4ULs 2015
Pentachlorophenol (PCP)	mg/kg	27	29	31	LQM S4ULs 2015
1,1,2,2 Tetrachloroethane	mg/kg	3.9	8	17	LQM S4ULs 2015
1,1,1,2 Tetrachloroethane	mg/kg	1.5	3.5	8.2	LQM S4ULs 2015
1,1,1 Trichloroethane	mg/kg	9	18	40	LQM S4ULs 2015

Proposed End Use	units	Residential without plant uptake			Source
Soil Organic Matter Content	%	1	2.5	6	
Trichloroethene	mg/kg	0.017	0.036	0.08	LQM S4ULs 2015
Tetrachloromethane (Carbon Tetrachloride)	mg/kg	0.026	0.056	0.13	LQM S4ULs 2015
1,2- Dichloroethane	mg/kg	0.0092	0.013	0.023	LQM S4ULs 2015
Chloroethene (Vinyl chloride)	mg/kg	0.00077	0.001	0.0015	LQM S4ULs 2015
Trichloroethene	mg/kg	0.017	0.036	0.08	LQM S4ULs 2015
Tetrachloroethene	mg/kg	0.18	0.4	0.92	LQM S4ULs 2015
Trichloromethane (Chloroform)	mg/kg	1.2	2.1	4.2	LQM S4ULs 2015
Sum of PCDDs, PCDFs and dioxins like PCBs	ug/kg				CLEA SGVs 2009
Isopropylbenzene	mg/kg	12	28	67	CL:AIRE 2009
Propylbenzene	mg/kg	40	97	230	CL:AIRE 2009
Styrene	mg/kg	35	78	170	CL:AIRE 2009
Bromobenzene	mg/kg	0.91	2.1	4.9	CL:AIRE 2009
1,1,2 Trichloroethane	mg/kg	0.88	1.8	3.9	CL:AIRE 2009
1,1-Dichloroethane	mg/kg	2.5	4.1	7.7	CL:AIRE 2009
1,1-Dichloroethene	mg/kg	0.23	0.41	0.82	CL:AIRE 2009
1,2,4-Trimethylbenzene	mg/kg	0.41	0.99	2.3	CL:AIRE 2009
1,2-Dichloropropane	mg/kg	0.024	0.042	0.085	CL:AIRE 2009
2-Chloronaphthalene	mg/kg	3.8	9.3	22	CL:AIRE 2009

Proposed End Use	units	Residential without plant uptake			Source
Soil Organic Matter Content	%	1	2.5	6	
Bromodichloromethane	mg/kg	0.019	0.034	0.07	CL:AIRE 2009
Bromoform	mg/kg	5.2	11	23	CL:AIRE 2009
Chloroethane	mg/kg	8.4	11	18	CL:AIRE 2009
Chloromethane	mg/kg	0.0085	0.0099	0.013	CL:AIRE 2009
Cis 1,2 Dichloroethene	mg/kg	0.12	0.2	0.39	CL:AIRE 2009
Dichloromethane	mg/kg	2.1	2.8	4.5	CL:AIRE 2009
Hexachloroethane	mg/kg	0.22	0.54	1.3	CL:AIRE 2009
Trans 1,2 Dichloroethene	mg/kg	0.19	0.35	0.71	CL:AIRE 2009
Bis (2-ethylhexyl) phthalate	mg/kg	2700	2800	2800	CL:AIRE 2009
Butyl benzyl phthalate	mg/kg	42000	44000	44000	CL:AIRE 2009
Diethyl Phthalate	mg/kg	1800	3500	6300	CL:AIRE 2009
Di-n-butyl phthalate	mg/kg	450	450	450	CL:AIRE 2009
Di-n-octyl phthalate	mg/kg	3400	3400	3400	CL:AIRE 2009
Biphenyl	mg/kg	220	500	980	CL:AIRE 2009
2,4-Dinitrotoluene	mg/kg	170	170	170	CL:AIRE 2009
2,6-Dinitrotoluene	mg/kg	78	84	87	CL:AIRE 2009
Tributyl tin oxide	mg/kg	1.4	3.1	0.24	CL:AIRE 2009

Soil Contamination – Risk of Harm to Property

Structures and Underground Services

Buried Concrete

BRE Special Digest 1 (2005), 3rd Edition, entitled *Concrete in aggressive ground*, provides guidance on the specification for concrete for installation in natural ground and in brownfield locations. The procedures given for the ground assessment and concrete specification cover the fairly common occurrences of sulfates, sulfides and acids, and the more rarely occurring aggressive carbon dioxide found in some ground and surface waters, which affects concrete foundations and sub-structures. It gives procedures for specification of concrete and applies to both buildings and civil engineering construction.

Water Supply Pipes

Guidance is provided in the UK Water Industry Research (UKWIR) report entitled “*Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites*” Report Ref. No. 10/WM/03/21, 2010.

Guidance is provided in the November 2010 Q&A Update and the Questions and Answers Sheet dated 4 May 2011 included at the back of the UKWIR report. Item 3 has been reproduced here:

Table 12 UKWIR guidance

Item	Question	Answer
3	Following the flow chart in Figure 1.1, would it be acceptable to not undertake a site investigation and specify the use of barrier pipes (these seem to be suitable for all conditions)? Would it be acceptable to adopt the blanket approach of always using barrier pipes at Brownfield sites, negating the need for a desk study or intrusive investigation?	The UKWIR project steering group decided that barrier pipes would provide sufficient protection for the supply of drinking water in all Brownfield site conditions. It is therefore reasonable to expect that water companies will accept the use of barrier pipe in all situations as a blanket approach

Controlled Waters Generic Assessment Criteria

The Screening Values adopted by Waterman for ground and surface water quality have been selected on the basis of the water quality standards that apply at the controlled water receptor considered to be at potential risk of harm.

Surface Waters

The Water Framework Directive (WFD) (2000/60/EC) was originally introduced in 2000, however a raft of Daughter Directives were introduced to address the objectives the WFD originally set out. Over time the WFD and its Daughter Directives have gradually replaced number of the existing Directives including the Dangerous Substances Directive (DSD) and Surface Water Directive (SWD).

The WFD identifies 'Priority' and 'Priority Hazardous Substances', to which Environmental Quality Standards (EQS) have been determined. The WFD EQS do not provide a full complement of applicable values to adopt. In the absence of an EQS, values under the replaced Surface Water Directive have been used as a guide.

Groundwater

The EU Drinking Water Directive (DWD) (98/83/EC) lays out the standards for drinking water EU wide. The UK have followed the EU regulations and translated the Directive into the Water Supply (Water Quality) Regulations England 2000. The UK Drinking Water Standards are the most relevant criteria to use for the assessment of risks to water destined for potable sources.

The WFD, to date, have not set threshold values for groundwater on a river basin basis.

TPH and PAHs

A suitable risk based assessment criteria for risks from TPH in both surface waters and groundwater are not available in the UK. The WHO have produced a health based risk assessment for drinking waters with regard to TPH “Petroleum Products in Drinking Waters, Background document for development of WHO Guidelines for Drinking-water Quality. Ref. WHO/SDE/WSH/05.08/123”.

A complete list of assessment criteria for PAHs is absent from the UK (benzo(a)pyrene is available). However, the risk from PAHs should be considered. The theory presented in the WHO document “Petroleum Products in Drinking Waters, Background document for development of WHO Guidelines for Drinking-water Quality. Ref. WHO/SDE/WSH/05.08/123” has been applied to provide indicative screening values for PAHs with regard to drinking water. Published TDI and ID effects have been amended for the UK standard body weight and behaviour to derive a UK guideline for DWS of PAHs (70kg body weight and 2l of water consumed per day).

The derived TPH and PAH screening values are used as an indication of the risks from TPH and PAHs to human health through drinking water only.

The standards for the substances tested for in this investigation are provided below.

Table I4 Water Quality Standards

	Concentration (µg/l)
Determinand	Surface Water - EQS Freshwater (DEFRA Directions 2015)
Metals	
Arsenic	50
Cadmium	0.25*
Copper	46.80 (bioavailable)
Chromium (total)	4.7
Chromium (VI)	3.4
Chromium (III)	4.7
Iron	1000
Lead	11.80 (partial bioavailable)
Manganese	123 (bioavailable)
Mercury	0.07
Nickel	24.14 (bioavailable)
Zinc	41.82 (bioavailable)
Non-Metals	
BTEX	
Benzene	10
Toluene	74
Xylene (p+m)	30
Petroleum Hydrocarbons	

Aromatic EC6-EC7 (Benzene)	10
Aromatic EC7-EC8 (Toluene)	74
Polycyclic Aromatic Hydrocarbons	
Anthracene	0.1
Benzo(a)pyrene	0.00017
Benzo(b)fluoranthene	0.00017
Benzo(g,h,i.) Perylene	0.00017
Benzo(k)fluoranthene	0.00017
Fluoranthene	0.0063
Indeno(1,2,3-cd)pyrene	0.00017
Naphthalene	2
Volatile Organic Compounds	
1,2-Dichloroethane	10

Bioavailability based Environmental Quality Standards

Under the Water Framework Directive, originally introduced in 2000, and transposed into the UK regulatory framework via the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015, we are now required take account of the bioavailability when assessing the toxicity of heavy metal contamination in the freshwater environment.

What is Bioavailability and Why Account for it?

It is widely accepted that the total concentration of certain metals in freshwater often has limited relevance to potential environmental risk, but it is the 'bioavailable' fraction that is likely to result in toxic effects to aquatic organisms. Effectively, it's the bioavailability of a metal which reflects the actual metal concentration that the organism will be exposed to, and thus is the relevant concentration that we are interested in when assessing risk.

EQS developed under previous legislation (including the Dangerous Substances Directive (76/464/EEC)) were expressed as total concentration relative to hardness bandings to reflect the indications that toxicity to aquatic life was influenced by water hardness. Scientific knowledge and understanding on the impact of metals has since developed, and metal bioavailability in aquatic systems is now understood to be influenced by several site-specific physio-chemical factors including the pH, calcium content and the level of dissolved organic carbon (DOC) present within the water body under consideration.

Taking bioavailability into account as part of the risk assessment process is now considered best practice and will enable more accurate estimation of metal toxicity and the risks posed to the freshwater environment.

How to Account for Metal Bioavailability

The increased understanding of the impact of certain metals on the aquatic environment has enabled EQSs to be published by the UK Secretary of State for a number of metals based on their bioavailable concentration. These are referred to as EQSbioavailable and are listed in the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

It is very difficult to measure the bioavailable concentration of a metal directly. We therefore have to rely on models to predict the bioavailable concentration from dissolved concentrations. In the UK, a simple predictive tool has been developed that can take account of water quality parameters such as pH, and calcium to determine the amount of bioavailable metal present in the freshwater environment.

The tool is called the Metal Bioavailability Assessment Tool (M-BAT) and is acceptable for use under the UK regulatory framework.

Use of Background Concentrations for the Assessment of Zinc.

Metals occur naturally in the aquatic environment due to weathering of surface geology, and under the EQS Directive (2008/105/EEC) background concentrations for metals can be considered when assessing compliance against the respective EQS.

The situation for Zinc is now slightly different, and consideration of background concentration is now an explicit part of the zinc EQS released under the WFD and needs to be taken into account as part of the initial compliance assessment.

Using this approach, a local background concentration should be subtracted from the monitoring data before the bioavailability estimate is performed using M-BAT. Under the WFD, catchment specific background values have been defined for England and Wales to be used in conjunction with the EQSbioavailable. The background values are listed within the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 Schedule 3, Part 2, Table 2, and also reproduced in Appendix A of the M-BAT user guide available [here](#).

Lead

Lead is not included in the M-BAT tool (referred to above) as it is not a full bioavailable EQS. The EQS for lead is an EU standard under WFD. It takes into account the influence of DOC on the toxicity of lead but, unlike the full bioavailable standards for zinc, copper, manganese and nickel which are included in M-BAT, it only considers the influence of DOC, and does not require the consideration of calcium or pH.

Ground Gas and Volatile Organic Compounds Generic Assessment Criteria

Ground Gas

Current UK guidance has been produced by CIRIA, the British Standards Institution (BSI) and CL:AIRE. The following relevant documents have been prepared to date:

- CIRIA C665 – Assessing the risks posed by hazardous ground gases to buildings, 2007;
 - o Aims to consolidate good practice in investigation, facilitate the collection of relevant data, instigate appropriate monitoring programmes, all in a risk based approach to gas contaminated land.
- BS 8576 – Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs), 2013;
 - o Provides guidance on the monitoring and sampling of ground gases, including methane, carbon dioxide, oxygen, and VOCs. Guidance is not provided on the risk evaluation and characterisation of site's, the selection and design of protective measures, verification of protective measures, sampling of atmospheric gases, and the monitoring and sampling of radon.
- CIRIA C735 – Good practice on the testing and verification of protection systems for buildings against hazardous ground gases, 2014; and
 - o Sets out the good practice guidance for the designer, installer, verifier, and regulator on the verification and integrity testing of gas protection systems.
- BS 8485 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, 2015.
 - o Provides guidance on the appropriate ground gas parameters that can be used to identify a range of possible design solutions for protection against methane and carbon dioxide on a development.
- CL:AIRE - Technical Bulletin (TB 17), August 2018
 - o The bulletin provides guidance on assessing ground gas monitoring data to ensure that sufficient data has been collected to cover critical variations in barometric pressure

Both the CIRIA and BSI publications have been prepared to be generally consistent with CLR11, *Model Procedures for the management of land contamination*, (Defra and the Environment Agency, 2004a) and follow a step by step approach summarised below:

1. Desk Study and Site Walkover.
2. Development of a Preliminary Conceptual Model and Risk Assessment.
3. Site Investigation (If deemed necessary from stage 2).
4. Risk Assessment and Site Characterisation.
5. Recommendation and Mitigation.

Where the preliminary conceptual model has deemed further investigation necessary to characterise the ground gas regime, an appropriate site investigation and monitoring regime should be designed and undertaken. In-depth guidance to assist in the design of the investigation is provided within C665 and BS 8576, which describes intrusive investigation techniques and provides guidance on selecting the number and location of monitoring wells based on the site specific conceptual model.

Waterman has generally followed the approach recommended in CIRIA C665, BS 8576, and BS 8485 with respect to characterising a site and determining the levels of gas protection methods required. Where deviations from the methodology detailed within above guidance occurs, the reasoning behind the deviation and implication of the analysis of the results has been included within the report.

Risk Assessment

In accordance with C665, to assess the ground gas regime at a site, the ground gas monitoring data should be assessed by determining the Gas Screening Value (GSV) (l/hr). BS 8485 details further guidance on which GSV can be adopted based on a number of modifiers.

$$\text{GSV} = (\text{Measured Maximum CO}_2 \text{ or CH}_4 \text{ Gas Concentration (\%)} / 100) \times \text{Maximum Measured Gas Flow Rate from boreholes (l/hr)}.$$

Both C665 and BS 8485 dictate where the gas flow has been measured as less than the detection limit of the instrument used (typically <0.1l/hr), the limit of detection of the instrumented should be used as the gas flow rate.

As per the guidance given in BS 8485 where a negative flow has been recorded, and there is an absence of a positive flow, a qualitative assessment has been undertaken into whether under different temporal conditions, a similar positive flow could occur. When the cause for negative flow is reasonably understood, it has been possible to rule out a corresponding credible positive flow and discount the negative flow.

The Gas Screening Value is used to classify the site, subject to the proposed end use of the site.

The Modified Wilson and Card classification system is used to attribute a Characteristic Situation (CS) value to the site/zone depending upon the calculated GSV. When attributing a CS, additional factors including the maximum recorded gas concentration and the maximum recorded gas flow rate should also be taken into account and may result in an increase in the CS value. Table I.2 below, outlines the CS values associated GSV's and additional factors which must be taken into account.

Table I5 Modified Wilson and Card Classification

Characteristic Situation (CIRIA 149)	Risk Classification	Gas screening value (CH ₄ CO ₂) l/hr	Additional Factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1% and / or carbon dioxide ≤5%. Otherwise consider increase to CS 2.	Natural soils with low organic content 'Typical' made ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider increase to CS 3.	Natural soil, high peat/organic content. 'Typical' made ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mineworking – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very High risk	>70		Recent landfill site

Notes:

- 1) Gas screening value: litres of gas / hour is calculated by multiplying the gas concentration (%) by the measured borehole flow rate (l/hr)
- 2) Source of gas and generation potential/performance must be identified.
- 3) If there is no detectable flow use the limit of detection of the instrument.

Following determination of the site's CS, the requirements and scope of gas protection measures can be prescribed based on the guidance given in BS 8485:2015.

BS 8485 details the required ground gas protection measures for a development using a points-based system, whereby a certain number of points must be accumulated through the installation of various protection measures to mitigate the risk to structures or buildings from the accumulation of methane or carbon dioxide. The number of points assigned will be dependent on the building type and the CS.

Table I6 Building types are separated into four distinct scenarios.

Kj,f Modifier	Building Type			
	Type A	Type B	Type C	Type D
Ownership	Private	Private or commercial / public, possible multiple	Commercial / public	Commercial / industrial
Control (change of use, structural alterations, ventilation)	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to large	Large industrial / retail park style

Further details on the description of the building types, along with examples are included in BS 8485.

Following identification of the appropriate Building Type and CS, the minimum gas protection score can be determined through the use of the following table.

Table I7 Gas Protection Score

Characteristic Situation	Minimum Gas Protection Score			
	Type A	Type B	Type C	Type D
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 ^A	5.5 ^A	4.5	3.5
5	N/A ^B	6 ^A	5.5	4.5
6	N/A ^B	N/A ^B	N/A ^B	6

^AResidential buildings should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system e.g. in Institutional and / or fully serviced contractual situations.

^BThe gas hazard is too high for this empirical method to be used to define the gas protection measures.

Post determination of the minimum gas protection score, a combination of two or more of the following three types of protection measures should be used to achieve the score:

- The structural barrier of the floor slab, or of the basement slab and walls if a basement is present;
- Ventilation measures; and
- Gas resistant measures.

Through combining at least two ground gas protection measures, the lack of redundancy in the use of a single protection measure approach is negated. The ground gas protection measures should work independently and collaboratively.

The tables below detail the specific ground gas protection measures and their associated scores.

Structural Barrier

Table I8

Floor and substructure design	Score ^A
Precast suspended segmental subfloor (l.e. beam and block)	0
Cast in-situ ground bearing floor slab (with only nominal mesh reinforcement)	0.5
Cast in-situ monolithic ground bearing raft or reinforced cast in-situ suspended floor slab with minimal penetrations	1 or 1.5 ^B
Basement floor and slab conforming to BS 8102:2009, Grade 2 waterproofing ^C	2
Basement floor and walls conforming to BS 1802:2009, Grade 3 waterproofing ^C	2.5

^AThe scores are conditional on breaches of floor slabs, etc., being effectively sealed.

^BTo achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast.

^CThe score is conditional on the waterproofing not being based on the use of a geosynthetic clay liner waterproofing product.

Ventilation Measures

Table I9

Protection element / system	Score	Comments
Pressure relief pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building.	0.5	Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measure systems. If the layer has a low permeability and / or is not terminated in a venting trench or similar, then the score is zero.
Passive sub floor dispersal layer: Very good performance: Good performance: Media used to provide the dispersal layer are;	2.5 1.5	The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing, and type and thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B of BS 8485 2015. Passive ventilation should be designed to meet at least good performance, see in Annex B of BS 8485 2015.
• Clear void; • Polystyrene void former blanket; • Geocomposite void former blanket • No-fines gravel layer with gas drains; • No-fines gravel layer.		
Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may compromise a clear void or be formed of geocomposite or polystyrene void formers.	1.5 to 2.5	This system relies on continues serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system including pumps and vents. Active ventilation should always be designed to meet at least good performance as described in in Annex B of BS 8485 2015.
Active positive pressurization by the creation of a blanket of external fresh air beneath the floor slabs by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket.	1.5 to 2.5	This system relies on continues serviceability of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient coverage of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least good performance.
Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park).	4	Assumes that the car fumes is vented to deal with exhaust fumes designed to <i>Buildings Regulations 2000, Approved Document F</i> .

It should be noted that for Type A Buildings active ventilation systems are inappropriate.

Membrane

Table I10

Protection element / system	Score	Comments
Gas resistant membrane meeting all of the following criteria; Sufficiently impervious both in the sheet material A and in the sealing of sheets and sealing around sheet penetrations, to prevent any significant passage of methane and / or carbon dioxide through the membrane; Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; Sufficiently strong B to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc.); and to withstand in-service stresses (e.g settlement if placed below a floor slab); Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and Verified in accordance with CIRIA C735.	2	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. If a membrane is installed that does not meet the all the criteria in column 1 then the score is zero..

A gas protection score should only be assigned to a membrane which is formed of a material with suitably low gas permeability and which has been installed so it completely seals the foundation (including effective seals around all penetrations) and does not sustain damage from in-service stresses.

Volatile Organic Compounds (VOCs)

The Building Regulations 2000 Approved Document C (2004 Edition) also refers to volatile organic carbons (VOCs). These are primarily assessed by examination of the VOC content of site soils. Further guidance on VOCs is provided in *"The VOCs Handbook; Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination"*, CIRIA Report C682, 2009.

For former landfill sites the risk from a wider range of trace gases are considered on a site specific basis when appropriate.

VOCs in groundwater

Under the Environmental Protect Act 1990, Building Regulations Approved Document C 2004 and the National Planning Policy Framework there is a requirement to ensure that Volatile Organic Compounds (VOC) are considered on a risk assessment basis.

VOCs are organic compounds that are volatile under normal atmospheric conditions. However, they may be found in the solid, liquid, and the dissolved phase as well as in the gaseous phase. VOCs are typically found in the following contaminants:

- Petroleum (non-halogenated) hydrocarbons (e.g. benzene, toluene, and butylbenzenes);
- Halogenated hydrocarbons (e.g. chlorinated ethenes and ethanes (dry cleaning fluids or degreasers) or chlorofluorocarbons (freons)); and
- Organic compounds containing nitrogen, sulphur, and oxygen (e.g. tetrahydrofuran).

The likely sources of the above contaminants include:

- Spills, leaks, and discharges from industries;
- Landfills;
- Buildings, furnishings, and common household products;
- Vehicle emissions;
- Marshland; and
- Uncontrolled waste disposal.

The risk to receptors from VOC occur from inhalation (acute and chronic), and a flammable / explosive risk when present at high concentrations in confined spaces.

Current UK guidance for VOCs are limited in comparison to ground gas, and is primarily given in the *“The VOCs Handbook; Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination”*, CIRIA Report C682, 2009.

Additional guidance was published in 2017 by the Society of Brownfield Risk Assessments (SoBRA) *‘Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile contaminants in Groundwater’*, February 2017. The 2017 SoBRA document provided a set of Generic Assessment Criteria (GAC) to allow the risk to a residential/commercial premise to be assessed quantitatively using the contamination concentrations recorded in the groundwater. The GAC were generated using the CLEA model, with each GAC being the theoretical concentration in groundwater/perched water beneath a property that is modelled as resulting in estimated average daily exposure (ADE) to the critical receptor that is equal to the Health Criteria Value (HCV).

The GAC were designed to incorporate several precautionary assumptions, these conservatisms include;

- The assumption that the impacted groundwater/perched water is directly beneath the building, when it may instead be offset from the receptor;
- The assumption that there is an infinite source term, when in fact the source may be finite;
- The assumption that there is no biodegradation between the source term and the receptor;
- The assumption that the groundwater source is at a depth of 0.65m bgl;
- The use of sand soil type for both the saturated and unsaturated zone.
- The omission of a capillary zone between the saturated and unsaturated zone.

These GAC are detailed in the Tables below.

Table I11 Petroleum Hydrocarbons

Chemical	CAS	GACgw vap (µg/l) 1,2		Aqueous Solubility (µg/l)
		Residential	Commercial	
1,2,4-Trimethylbenzene	95-63-6	24	2,200	559,000
Benzene 3	71-43-2	210	20,000	1,780,000
Ethylbenzene 3	100-41-4	10,000	960,000 (sol)	180,000
Isopropylbenzene	98-82-8	850	86,000 (sol)	56,000
Propylbenzene	103-65-1	2,700	240,000 (sol)	54,100
Styrene	100-42-5	8,800	810,000 (sol)	290,000
Toluene 3	108-88-3	230,000	21,000,000 (sol)	590,000
TPH Aliphatic EC5-EC6 3		1,900	190,000 (sol)	35,900
TPH Aliphatic >EC6-EC8 3		1,500	150,000 (sol)	5,370
TPH Aliphatic >EC8-EC10 3		57	5,700 (sol)	427
TPH Aliphatic >EC10-EC12 3		37	3,600 (sol)	34
TPH Aromatic >EC5-EC7 2,3		210,000	20,000,000 (sol)	1,780,000
TPH Aromatic >EC7-EC8 3		220,000	21,000,000 (sol)	590,000
TPH Aromatic >EC8-EC10 3		1,900	190,000 (sol)	64,600
TPH Aromatic >EC10-EC 12 3		6,800	660,000 (sol)	24,500
TPH Aromatic >EC12-EC16 3		39,000	3,700,000 (sol)	5,750
meta-Xylene 3,5	108-38-3	9,500	940,000 (sol)	200,000
ortho-Xylene 3,5	95-47-6	12,000	1,100,000 (sol)	173,000
para-Xylene 3,5	106-42-3	9,900	980,000 (sol)	200,000

Table I12 Polycyclic Aromatic Hydrocarbons

Chemical	CAS	GAC gw vap (µg/l) 1,2		Aqueous Solubility (µg/l)
		Residential	Commercial	
Acenaphthene	83-32-9	170,000 (sol)	15,000,000 (sol)	4,110
Acenaphthylene	208-96-8	220,000 (sol)	20,000,000 (sol)	7,950
Fluorene	86-73-7	210,000 (sol)	18,000,000 (sol)	1,860
Naphthalene	91-20-3	220	23,000 (sol)	19,000

Table I13 Pesticides

Chemical	CAS	GACgw vap (µg/l) 1,2		Aqueous Solubility (µg/l)
		Residential	Commercial	
Aldrin	309-00-2	47 (sol)	3,700 (sol)	20
alpha-Endosulfan	959-98-8	7,400 (sol)	590,000 (sol)	530
beta-Endosulfan	33213-65-9	7,500 (sol)	600,000 (sol)	280

Table I14 Halogenated Organics

Chemical	CAS	GACgwwap (µg/l) 1,2		Aqueous Solubility (µg/l)
		Residential	Commercial	
1,1,1,2-Tetrachloroethane	79-34-5	240	22,000	1,110,000
1,1,1-Trichloroethane	71-55-6	3,000	290,000	1,300,000
1,1,2,2-Tetrachloroethane	79-35-4	1,600	150,000	2,930,000
1,1,2-Trichloroethane	79-00-5	520	49,000	4,491,000
1,1-Dichloroethane	75-34-3	2,700	260,000	3,666,000
1,1-Dichloroethene	75-35-4	160	16,000	3,100,000
1,2,3,4-Tetrachlorobenzene	634-66-2	240	31,000 (sol)	7,800
1,2,3,5-Tetrachlorobenzene	634-90-2	7.0	600	3,500
1,2,3-Trichlorobenzene	87-61-7	35	3,100	21,000
1,2,4,5-Tetrachlorobenzene	95-94-3	8.1	700 (sol)	600
1,2,4-Trichlorobenzene	120-82-1	68	7,200	41,400
1,2-Dichlorobenzene	95-50-1	2,000	220,000 (sol)	133,000
1,2-Dichloroethane	107-06-2	8.9	850	8,680,000
1,2-Dichloropropane	78-87-5	22	2,600	2,050,000
1,3,5-Trichlorobenzene	108-70-3	7.4	660	6,000
1,3-Dichlorobenzene	541-73-1	31	2,800	103,000
1,4-Dichlorobenzene	106-46-7	5,000	460,000 (sol)	51,200
Bromobenzene	108-86-1	220	20,000	388,040
Bromodichloromethane	75-27-4	17	1,600	3,000,000
Bromoform (Tribromomethane)	75-25-2	3,100	400,000	3,000,000
Chlorobenzene	108-90-7	98	15,000	387,000
Chloroethane	75-00-3	10,000	1,000,000	5,742,000
Chloroethene (Vinyl Chloride)	75-01-4	0.62	63	2,760,000
Chloromethane	74-87-3	14	1,400	5,350,000
cis-1,2-Dichloroethene	156-59-2	130	13,000	7,550,000
Dichloromethane	75-09-2	3,300	370,000	20,080,000
Hexachlorobenzene	118-74-1	16 (sol)	1,400 (sol)	10
Hexachlorobutadiene	87-68-3	1.7	230	4,800
Hexachloroethane	67-72-1	8.5	740	49,900
Pentachlorobenzene	608-93-5	140	12,000 (sol)	500
Tetrachloroethene	127-18-4	34	4,600	225,000
Tetrachloromethane (Carbon Tetrachloride)	56-23-5	5.3	770	846,000
trans-1,2-Dichloroethene	156-60-5	160	16,000	5,250,000
Trichloroethene	79-01-6	5.7	530	1,370,000
Trichloromethane (Chloroform)	67-66-3	790	85,000	8,950,000

Table I15 Others (Organic and Inorganic)

Chemical	CAS	GAC _{gw} (µg/l) 1,2		Aqueous Solubility (µg/l)
		Residential	Commercial	
2-Chloronaphthalene	91-58-7	160	14,000 (sol)	11,700
Biphenyl (Limonene)	92-52-4	15,000 (sol)	1,300,000 (sol)	4,060
Carbon disulphide	75-15-0	56	5,600	2,100,000
Mercury, elemental	7439-97-6	1.1	95 (sol)	56
Methyl tertiary butyl ether (MTBE)	1634-04-4	83,000	7,800,000	48,000,000

The risks to receptors from vapours will be assessed through assessment of the volatile contaminant concentrations recorded in groundwater samples against the SoBRA derived GAC. Where an exceedance is recorded, a qualitative assessment will be made, given the conservative approach of the SoBRA derived GAC as to whether a significant vapour regime is present on-site and possible risk to receptors exists. The vapour concentration recorded during headspace analysis of soils, SVOC / VOC contaminant concentration within soil samples, and the vapour concentration within installed boreholes will also be considered qualitatively during this assessment.

Where a significant vapour regime is present and a risk to receptors exists, further assessment will be required, this may include, vapour sampling, further intrusive investigations, or a Detailed Quantitative Risk Assessment (DQRA). Dependent on the results of the further assessment, remedial measures will be required to mitigate the risk to receptors.

Appendix J Limitations and Constraints

The assessment was undertaken in accordance with the scope agreed between Waterman and Notting Hill Genesis, and with Waterman's standard Terms of Appointment.

The benefit of this report is made to Notting Hill Genesis.

The information contained in this report is based on the findings of third party reports, observations made on site, exploratory hole records, laboratory test results, and groundwater monitoring.

The ground conditions reported relate only to the point of excavation and do not necessarily guarantee a continuation of the ground conditions throughout the non-inspected area of the site. Whilst such exploratory holes would usually provide a reasonable indication as to the general ground conditions, these cannot be determined with complete certainty.

Waterman has endeavoured to assess all information provided to them during this investigation, but makes no guarantees or warranties as to the accuracy or completeness of this information.

The scope of this site investigation includes an assessment of the presence of asbestos containing materials in the ground at the site but not within buildings or structures or below ground structures (basements, buried service ducts and the like).

The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the site.

Our vision

“Engineering a better environment for people and the planet”

Our mission

“To solve complex problems for the benefit of clients, communities and the climate”

Our values

People orientated

Individually and collectively, people are our business.
We strive to create environments for everyone to flourish and thrive.

Flexible

Pragmatic by nature and dedicated to getting the job done to the highest possible standard.

Professional

Operating at pace with integrity to deliver technical and robust solutions.

Environmentally aware

We understand our responsibility to the environment, it shapes our decision making and informs our practice.

Innovative

Our forensic questioning provides the ability to deliver appropriate innovations at every stage on every project.

Relationship focused

We value individuality and the benefits of working collaboratively to achieve positive outcomes for all.

