

Generic Inputs

Parameter	Value	Justification
Fraction of organic carbon in aquifer	0.00303 (fraction)	Average of all groundwater results for the site, LoD (<2 µg/L) rounded up to 2 µg/L.
Select analytical solution (DDM)	EAs preferred solution is Ogata-Banks , See p22 of User Manual	RTM Documentation
Width of plume in aquifer at source (perpendicular to flow)	10 (m)	Assumed plume source is at borehole location and allowed 5m either side for dispersivity
Plume thickness at source	9 (m)	Has to be less than total aquifer thickness; always assumed less than saturated aquifer thickness
Bulk density of aquifer materials	1.21 (g/cm ³)	Value given within SR3 for sandy silty loam (characterised from assessing PSDs from within the alluvium as sampled on-site)
Effective porosity of aquifer	0.028 (fraction)	Average of on-site data; average value.
Hydraulic conductivity of aquifer	0.00356 (m/d)	Value given within SR3 for sandy silty loam (characterised from assessing PSDs from within the alluvium as sampled on-site)

BH Specific Inputs

Borehole BH101		
Initial contaminant concentration in groundwater at plume source	Copper (22) Lead (52.4) Manganese (226.1) Chromium (5.4) Zinc (148.5) Iron (1,677) Free Cyanide (25) Total Cyanide (130) BaP (0.04) BbF (0.08) BghiP (0.03) BkF (0.03) Fluoranth (0.179) I123cdP (0.03) BaA (0.05) Chrys (0.1)	Highest concentration detected within the borehole being assessed
Plume thickness at source	18.5 (m)	Has to be less than total aquifer thickness; always assumed less than saturated aquifer thickness
Saturated aquifer thickness	19.07 (m)	Calculated from on-site data
Hydraulic gradient	0.0092 (fraction)	385m from BH to receptor, water level at Taff is 26.35 mAOD. Minimum recorded height of GW in BH101 is 29.89, giving a hydraulic gradient of 0.0092. Calculated from on-site monitoring results. $29.89 - 26.35 = 3.54$ $3.54 / 385 = 0.0092$
Distance to compliance point	385 (m)	Calculated from MasterMap of the site and surrounding area. Rounded down from 385.42

Borehole RBBH205		
Initial contaminant concentration in groundwater at plume source	Copper (11) Lead (4.1) Manganese (225.1) Chromium (11.1) Zinc (29.9) Fluoranthene (0.016) Chloroform (3)	Highest concentration detected within the borehole being assessed
Width of plume in aquifer at source (perpendicular to flow)	10 (m)	Assumed plume source is at CPBH212 and allowed 5m either side for dispersivity
Plume thickness at source	9 (m)	Has to be less than total aquifer thickness; always assumed less than saturated aquifer thickness. Originally attempted at 9.6 but reduced to 9 to remove dispersed plume thickness exceeds aquifer thickness error.
Saturated aquifer thickness	9.67 (m)	Calculated from on-site data
Hydraulic gradient	0.0061 (fraction)	161m from BH to receptor, water level at Taff is 26.03 mAOD. Minimum recorded height of GW in RBBH205 is 27.01, giving a hydraulic gradient of 0.0061. Calculated from on-site monitoring results. $27.01 - 26.03 = 0.98$ $0.98 / 161 = 0.0061$
Distance to compliance point	161 (m)	Calculated from MasterMap of the site and surrounding area. Rounded down from 161.48

Borehole RBBH206	Value (µg/L)	Comments
Initial contaminant concentration in groundwater at plume source	Copper (12) Lead (5.3) Manganese (134.2) Chromium (13.2) Zinc (49.1) Aliphatics >EC10-EC12 (438) Aliphatics >EC16-EC35 (2,400) BbF (0.06) BkF (0.01) Fluoranth (0.035) Chloroform (and Dichloromethane) (19) BaA (0.019) Chrys (0.1)	Highest concentration detected within the borehole being assessed
Plume thickness at source	12 (m)	Has to be less than total aquifer thickness; always assumed less than saturated aquifer thickness. but reduced to 12 to remove dispersed plume thickness exceeds aquifer thickness error.
Saturated aquifer thickness	12.51 (m)	Calculated from on-site data
Hydraulic gradient	0.0043 (fraction)	272m from BH to receptor, water level at Taff is 26.37 mAOD. Minimum recorded height of GW in RBBH206 is 27.55, giving a hydraulic gradient of 0.0043. Calculated from on-site monitoring results. $27.55 - 26.37 = 1.18$ $1.18 / 272 = 0.0043$
Hydraulic conductivity of aquifer	0.00356 (m/d)	Value given within SR3 for sandy silty loam (characterised from assessing PSDs from within the alluvium sampled on-site)
Distance to compliance point	272 (m)	Calculated from MasterMap of the site and surrounding area. Rounded down from 272.25

Borehole RBBH209	Value	Comments
Select nature of decay rate (DDM)	EAs recommend Dissolved Phase only, but need to be careful. Check EA R&D Publication 95 for more information on assessing degradation rates from field data.	RTM Documentation
Initial contaminant concentration in groundwater at plume source	Copper (21) Lead (4.4) Manganese (1,411) Chromium (15) Zinc (35.1) Iron (2,120) Nickel (9.5)	Highest concentration detected within the borehole being assessed
Plume thickness at source	10.9 (m)	Has to be less than total aquifer thickness; always assumed less than saturated aquifer thickness but reduced to 10.9 to remove dispersed plume thickness exceeds aquifer thickness error.
Saturated aquifer thickness	11.1 (m)	As BH specific data is not available (BH did not reach bedrock), the average calculated value from on-site data was used. Base of RTDs was not encountered within the BH
Hydraulic gradient	0.0071 (fraction)	177m from BH to receptor, water level at Taff is 26.78 mAOD. Minimum recorded height of GW in RBBH209 is 28.4, giving a hydraulic gradient of 0.0071. Calculated from on-site monitoring results. $28.04 - 26.78 = 1.26$ $1.26 / 177 = 0.0071$
Distance to compliance point	177 (m)	Calculated from MasterMap of the site and surrounding area. Rounded up from 176.69

Borehole RBBH210		
Initial contaminant concentration in groundwater at plume source	Copper (6) Lead (3.9) Manganese (3,942) Chromium (7.5) Zinc (25) Iron (1,124) Phenol (14)	Highest concentration detected within the borehole being assessed
Plume thickness at source	10.9 (m)	Has to be less than total aquifer thickness; always assumed less than saturated aquifer thickness.
Saturated aquifer thickness	11.1 (m)	As BH specific data is not available (BH did not reach bedrock), the average calculated value from on-site data was used. RTD is at least 11.45m thick.
Hydraulic gradient	0.0103 (fraction)	185m from BH to receptor, water level at Taff is 27.22 mAOD. Minimum recorded height of GW in RBBH210 is 29.13, giving a hydraulic gradient of 0.0103. Calculated from on-site monitoring results. $29.13 - 27.22 = 1.91$ $1.91 / 185 = 0.0103$
Hydraulic conductivity of aquifer	0.00356 (m/d)	Value given within SR3 for sandy silty loam (characterised from assessing PSDs from within the alluvium sampled on-site)
Distance to compliance point	185 (m)	Calculated from MasterMap of the site and surrounding area. Rounded down from 185.41

Contaminant Specific Parameters

Contaminant	Target	Target Source	Half Life (days)		Kd (L/kg)	Koc (L/kg)	foc
			Run 1	Run 2			
Copper	1ug/L	Freshwater EQS	9E+99		100		
Lead	1.2 ug/L	Freshwater EQS	9E+99		900		
Manganese	123 ug/L	Freshwater EQS	9E+99		65		
Chromium	4.7 ug/L	Freshwater EQS	9E+99		4800		
Zinc	10.9 ug/L	Freshwater EQS	9E+99		38		
Iron	1000 ug/L	Freshwater EQS	9E+99		25		
Nickel	4 ug/L	Freshwater EQS	9E+99		500		
Nitrate	4,000 ug/L	DWS	9E+99		0.5		
Phenol	7.7 ug/L	Freshwater EQS	9E+99			1.48	0.00303
Free Cyanide	1 ug/L	Freshwater EQS	9E+99	15		1.4	
Aliphatics >EC10-EC12	300 ug/L	WHO DWS	9E+99			5.4	
Aliphatics >EC16-EC35	300 ug/L	WHO DWS Surrogate	9E+99			6.7	
BaP	0.00017 ug/L	Inland Surface Water EQS	9E+99	1059		5.11	
BbF	0.00017 ug/L	BaP Surrogate	9E+99	1219.1		5.02	
BghiP	0.00017 ug/L	BaP Surrogate	9E+99	1314		6.81	
BkF	0.00017 ug/L	BaP Surrogate	9E+99	4270.5		5.17	
Fluoranth	0.0063 ug/L	Inland Surface Water EQS	9E+99	879.65		4.26	
I123cdP	0.00017 ug/L	BaP Surrogate	9E+99	1460		7.94	
Chloroform	2.5 ug/L	PWS(E)R 2016	9E+99			1.7	
Dichloromethane	2ug/L	PWS(E)R 2016	9E+99			1.2	

Run 1 Results

BH	Contaminant	Target Concentration	Concentration of contaminant at compliance point	Result Pass ✓/Fail ✗
RBBH202	Copper	0.001 mg/L	0.000576 mg/L	✓
RBBH203	Copper	0.001 mg/L	0.00109 mg/L	✗
RBBH205	Copper	0.001 mg/L	0.00151 mg/L	✗
RBBH206	Copper	0.001 mg/L	0.000839 mg/L	✓
RBBH209	Copper	0.001 mg/L	0.00276 mg/L	✗
RBBH210	Copper	0.001 mg/L	0.000739 mg/L	✓
BH101	Copper	0.001 mg/L	0.0018 mg/L	✗
RBBH202	Lead	0.0012 mg/L	0.000403 mg/L	✓
RBBH203	Lead	0.0012 mg/L	0.000665 mg/L	✓
RBBH205	Lead	0.0012 mg/L	0.000562 mg/L	✓
RBBH206	Lead	0.0012 mg/L	0.000371 mg/L	✓
RBBH209	Lead	0.0012 mg/L	0.000553 mg/L	✓
RBBH210	Lead	0.0012 mg/L	0.00048 mg/L	✓
BH101	Lead	0.0012 mg/L	"No significant breakthrough at compliance point"	✓
RBBH202	Manganese	0.123 mg/L	0.0257 mg/L	✓
RBBH203	Manganese	0.123 mg/L	0.0243 mg/L	✓
RBBH205	Manganese	0.123 mg/L	0.0309 mg/L	✓
RBBH206	Manganese	0.123 mg/L	0.00938 mg/L	✓
RBBH209	Manganese	0.123 mg/L	0.186 mg/L	✗
RBBH210	Manganese	0.123 mg/L	0.485 mg/L	✗
BH101	Manganese	0.123 mg/L	0.0119 mg/L	✓
RBBH202	Chromium	0.0047 mg/L	0.00107 mg/L	✓
RBBH203	Chromium	0.0047 mg/L	0.00137 mg/L	✓
RBBH205	Chromium	0.0047 mg/L	0.00152 mg/L	✓
RBBH206	Chromium	0.0047 mg/L	0.000923 mg/L	✓
RBBH209	Chromium	0.0047 mg/L	0.00197 mg/L	✓
RBBH210	Chromium	0.0047 mg/L	0.000923 mg/L	✓
BH101	Chromium	0.0047 mg/L	0.000283 mg/L	✓
CPBH212	Zinc	0.0109 mg/L	0.00233 mg/L	✓
RBBH203	Zinc	0.0109 mg/L	0.000411 mg/L	✓
RBBH205	Zinc	0.0109 mg/L	0.0041 mg/L	✓
RBBH206	Zinc	0.0109 mg/L	0.00343 mg/L	✓
RBBH209	Zinc	0.0109 mg/L	0.00462 mg/L	✓
RBBH210	Zinc	0.0109 mg/L	0.00308 mg/L	✓
BH101	Zinc	0.0109 mg/L	0.00779 mg/L	✓
RBBH202	Iron	1 mg/L	0.161 mg/L	✓
RBBH203	Iron	1 mg/L	0.147 mg/L	✓
RBBH206	Iron	1 mg/L	0.141 mg/L	✓
RBBH209	Iron	1 mg/L	0.279 mg/L	✓
RBBH210	Iron	1 mg/L	0.138 mg/L	✓
BH101	Iron	1 mg/L	0.088 mg/L	✓
RBBH209	Nickel	0.004 mg/L	0.00125 mg/L	✓
RBBH210	Phenol	0.0077 mg/L	0.00172 mg/L	✓
BH101	Free Cyanide	0.001 mg/L	0.00131 mg/L	✗
RBBH206	Aliphatic EC10-EC12	0.3 mg/L	0.0306 mg/L	✓
RBBH206	Aliphatic EC16-EC35	0.3 mg/L	0.168 mg/L	✓
BH101	Benzo(a)pyrene	0.00000017 mg/L	0.000002.1 mg/L	✗
RBBH206	Benzo(b)Flouranthene	0.00000017 mg/L	0.0000042 mg/L	✗
BH101	Benzo(b)Flouranthene	0.00000017 mg/L	0.0000042 mg/L	✗
BH101	Benzo(g,h,i)perylene	0.00000017 mg/L	0.00000157 mg/L	✗
RBBH206	Benzo(k)fluoranthene	0.00000017 mg/L	0.00000699 mg/L	✗
BH101	Benzo(k)fluoranthene	0.00000017 mg/L	0.00000157 mg/L	✗
RBBH205	Fluoranthene	0.0000063 mg/L	0.00000219 mg/L	✓
RBBH206	Fluoranthene	0.0000063 mg/L	0.00000245 mg/L	✓
BH101	Fluoranthene	0.0000063 mg/L	0.0000094 mg/L	✗
BH101	Indeno(1,2,3-c,d)pyrene	0.00000017 mg/L	0.00000157 mg/L	✗
RBBH205	Chloroform	0.0025 mg/L	0.000411 mg/L	✓
RBBH206	Chloroform	0.0025 mg/L	0.00133 mg/L	✓
RBBH205	Dichloromethane		0.000411 mg/L	✓
RBBH206	Dichloromethane		0.00133 mg/L	✓
CPBH212	Nitrate	4 mg/L	67 mg/L	✗

red Indicates exceedence of Target Concentration

Indicates the borehole exceedence chosen to be modelled in R2 based on worst case scenario/highest concentration at compliance point

Run 2 Results

BH	Contaminant	Target Concentration	Concentration of contaminant at compliance point (mg/l)	Result Pass ✓/Fail ✗	Comments
RBBH209	Copper	0.001 mg/L	0.000345	✓	Initial concentrations run through M-BAT tool prior to inputting to RTW
RBBH210	Manganese	0.123 mg/L	0.0721	✓	
BH101	Free Cyanide	0.001 mg/L	1.50E-186	✓	Updated half life to 15 days as per WFD-UKTAG free cyanide in groundwater. Sorokin N, Atkinson C, Aldous E, Rule K, Maycock D and Comber S. (2008). Proposed EQS for Water Framework Directive Annex VIII substances: cyanide (For consultation). Water Framework Directive - United Kingdom Technical Advisory Group (WFD-UKTAG).
BH101	Benzo(a)pyrene	0.00000017 mg/L	NO IMPACT	✓	Updated Half Life value to max range after Howard et al (P. H. Howard, R. S. Boethling, W. S. Jarvis, W. M. Meylan and E. M. Michalenko, "Handbook of Environmental Degradation Rates," Lewis, Chelsea, Michigan, 1991.)
BH101	Benzo(b)Flouranthene	0.00000017 mg/L	NO IMPACT	✓	Updated Half Life value to max range after Howard et al (1991)
BH101	Benzo(g,h,i)perylene	0.00000017 mg/L	NO IMPACT	✓	Updated Half Life value to max range after Howard et al (1991)
RBBH206	Benzo(k)fluoranthene	0.00000017 mg/L	3.05458E-17	✓	Updated Half Life value to max range after Howard et al (1991)
BH101	Fluoranthene	0.0000063 mg/L	8.32367E-26	✓	Updated Half Life value to max range after Howard et al (1991)
BH101	Indeno(1,2,3-c,d)pyrene	0.00000017 mg/L	1.15851E-21	✓	Updated Half Life value to max range after Howard et al (1991)
CPBH212	Nitrate	4 mg/L	0.676564994	✓	Corrected initial Concentration (C0) value to correct order of magnitude (10.07mg/l)

Run 2 Results

BH	Contaminant	Target Concentration	Concentration of contaminant at compliance point (mg/l)	Result Pass ✓/Fail ✗	Comments
RBBH209	Copper	0.001 mg/L	0.000345	✓	Initial concentrations run through M-BAT tool prior to inputting to RTW
RBBH210	Manganese	0.123 mg/L	0.0721	✓	
BH101	Free Cyanide	0.001 mg/L	1.50E-186	✓	Updated half life to 15 days as per WFD-UKTAG free cyanide in groundwater. Sorokin N, Atkinson C, Aldous E, Rule K, Maycock D and Comber S. (2008). Proposed EQS for Water Framework Directive Annex VIII substances: cyanide (For consultation). Water Framework Directive - United Kingdom Technical Advisory Group (WFD-UKTAG).
BH101	Benzo(a)pyrene	0.00000017 mg/L	NO IMPACT ON THE RECEPTOR	✓	Updated Half Life value to max range after Howard et al (P. H. Howard, R. S. Boethling, W. S. Jarvis, W. M. Meylan and E. M. Michalenko, "Handbook of Environmental Degradation Rates," Lewis, Chelsea, Michigan, 1991.)
BH101	Benzo(b)Flouranthene	0.00000017 mg/L	NO IMPACT ON THE RECEPTOR	✓	Updated Half Life value to max range after Howard et al (1991)
BH101	Benzo(g,h,i)perylene	0.00000017 mg/L	NO IMPACT ON THE RECEPTOR	✓	Updated Half Life value to max range after Howard et al (1991)
RBBH206	Benzo(k)fluoranthene	0.00000017 mg/L	3.05458E-17	✓	Updated Half Life value to max range after Howard et al (1991)
BH101	Fluoranthene	0.0000063 mg/L	8.32367E-26	✓	Updated Half Life value to max range after Howard et al (1991)
BH101	Indeno(1,2,3-c,d)pyrene	0.00000017 mg/L	1.15851E-21	✓	Updated Half Life value to max range after Howard et al (1991)
CPBH212	Nitrate	4 mg/L	0.676564994	✓	Corrected initial Concentration (C0) value to correct order of magnitude (10.07mg/l)

RTW summary sheet

BH ID	Contaminant	Target Concentration (mg/L)	Concentration of contaminant at compliance point	
			Run 1	Run 2
RBBH202	Copper	0.001	0.000576	
RBBH203	Copper	0.001	0.00109	NM
RBBH205	Copper	0.001	0.00151	NM
RBBH206	Copper	0.001	0.000839	
RBBH209	Copper	0.001	0.00276	3.45E-04
RBBH210	Copper	0.001	0.000739	
BH101	Copper	0.001	0.0018	NM
RBBH202	Lead	0.0012	0.000403	
RBBH203	Lead	0.0012	0.000665	
RBBH205	Lead	0.0012	0.000562	
RBBH206	Lead	0.0012	0.000371	
RBBH209	Lead	0.0012	0.000553	
RBBH210	Lead	0.0012	0.00048	
BH101	Lead	0.0012	No Impact on Receptor	
RBBH202	Manganese	0.123	0.0257	
RBBH203	Manganese	0.123	0.0243	
RBBH205	Manganese	0.123	0.0309	
RBBH206	Manganese	0.123	0.00938	
RBBH209	Manganese	0.123	0.186	NM
RBBH210	Manganese	0.123	0.485	7.21E-02
BH101	Manganese	0.123	0.0119	
RBBH202	Chromium	0.0047	0.00107	
RBBH203	Chromium	0.0047	0.00137	
RBBH205	Chromium	0.0047	0.00152	
RBBH206	Chromium	0.0047	0.000923	
RBBH209	Chromium	0.0047	0.00197	
RBBH210	Chromium	0.0047	0.000923	
BH101	Chromium	0.0047	0.000283	
CPBH212	Zinc	0.0109	0.00266	
RBBH202	Zinc	0.0109	0.000411	
RBBH205	Zinc	0.0109	0.0041	
RBBH206	Zinc	0.0109	0.00343	
RBBH209	Zinc	0.0109	0.00462	
RBBH210	Zinc	0.0109	0.00308	
BH101	Zinc	0.0109	0.00779	
RBBH202	Iron	1	0.161	
RBBH203	Iron	1	0.147	
RBBH206	Iron	1	0.141	
RBBH209	Iron	1	0.279	
RBBH210	Iron	1	0.138	
BH101	Iron	1	0.088	
RBBH209	Nickel	0.004	0.00125	
RBBH210	Phenol	0.0077	0.00172	
BH101	Free Cyanide	0.001	0.00131	1.95E-226
RBBH206	Aliphatic EC10-EC12	0.3	0.0306	

BH ID	Contaminant	Target Concentration (mg/L)	Concentration of contaminant at compliance point	
			Run 1	Run 2
RBBH206	Aliphatic EC16-EC35	0.3	0.168	
BH101	Benzo(a)pyrene	0.00000017	0.0000021	No Impact on Receptor
RBBH206	Benzo(b)Flouranthene	0.00000017	0.0000042	NM
BH101	Benzo(b)Flouranthene	0.00000017	0.00000042	No Impact on Receptor
BH101	Benzo(g,h,i)perylene	0.00000017	0.00000157	No Impact on Receptor
RBBH206	Benzo(k)fluoranthene	0.00000017	0.000000699	3.05E-17
BH101	Benzo(k)fluoranthene	0.00000017	0.00000157	NM
RBBH205	Fluoranthene	0.0000063	0.00000219	
RBBH206	Fluoranthene	0.0000063	0.00000245	
BH101	Fluoranthene	0.0000063	0.0000094	8.32E-26
BH101	Indeno(1,2,3-c,d)pyrene	0.00000017	0.00000157	1.16E-21
RBBH205	Chloroform	0.0025	0.000411	
RBBH206	Chloroform	0.0025	0.00133	
CPBH212	Nitrate	4	6.77E-01	

red Concentration exceeds target concentration
yellow Concentration re-modelled in run 2
NM Not measured
bold RBBH206 concentrations modelled in sensitivity analysis