

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Contaminant	Ammonium	From Level 1
Target Concentration	6.50E-02	mg/l

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

Ogata Banks	Equations in HRA publication
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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

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	7.45E+00	mg/l	95th/5th value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	5.00E+01	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	1.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	6.80E+01	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Partition coefficient	2.00E+00	l/kg	see options
Longitudinal dispersivity	6.80E+00	m	see options
Transverse dispersivity	6.80E-01	m	see options
Vertical dispersivity	6.80E-02	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	2.00E-05	m/d
Retardation factor	2.60E+01	fraction
Decay rate used	2.69E-102	d ⁻¹
Rate of contaminant flow due to retardation	7.69E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	3.61E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	2.06E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	1.34E-01	mg/l	
Distance to compliance point	68	m	
Concentration of contaminant at compliance point after	3.61E+00	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)

User specified value for partition coefficient

Soil water partition coefficient	Kd	2.00E+00	l/kg
Entry for non-polar organic chemicals (option)	loc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)	K _{oc,ion}		l/kg
Sorption coefficient for related species	K _{oc,r}		l/kg
Sorption coefficient for ionised species	pH		fraction
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	loc		fraction
Soil water partition coefficient	Kd	2.00E+00	l/kg

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

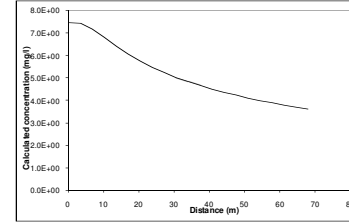
Dispersivities 10%, 1%, 0.1% of pathway length

Enter value	Calc value Xu & Eckstein	m
ax	6.80E+00	6.80E+00
ay	6.80E-01	6.80E-01
ay	6.80E-02	6.80E-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)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration	mg/l
0	7.5E+00	7.5E+00
3.4	7.43E+00	7.43E+00
6.8	7.17E+00	7.17E+00
10.2	6.79E+00	6.79E+00
13.6	6.40E+00	6.40E+00
17.0	6.05E+00	6.05E+00
20.4	5.74E+00	5.74E+00
23.8	5.47E+00	5.47E+00
27.2	5.23E+00	5.23E+00
30.6	5.02E+00	5.02E+00
34.0	4.83E+00	4.83E+00
37.4	4.65E+00	4.65E+00
40.8	4.50E+00	4.50E+00
44.2	4.36E+00	4.36E+00
47.6	4.23E+00	4.23E+00
51.0	4.11E+00	4.11E+00
54.4	3.99E+00	3.99E+00
57.8	3.89E+00	3.89E+00
61.2	3.79E+00	3.79E+00
64.6	3.70E+00	3.70E+00
68.0	3.61E+00	3.61E+00

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:	St. Mary's Park, Limerick
Completed by:	AJS
Date:	#####
Version:	1

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Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Arsenic		from Level 1
Target Concentration	C _T 7.50E-03	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	5.00E+02	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,rel}		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	f _{oc}		fraction
Soil water partition coefficient	Kd	5.00E+02	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 1.43E-02	mg/l	95th/5th value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 5.00E+01	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range CorSim value
Hydraulic gradient	i 1.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 6.80E+01	m	Approx. distance to Abbey River
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 5.00E+02	l/kg	see options
Longitudinal dispersivity	ax 6.80E+00	m	see options
Transverse dispersivity	az 6.80E-01	m	see options
Vertical dispersivity	ay 6.80E-02	m	see options

Calculated Parameters

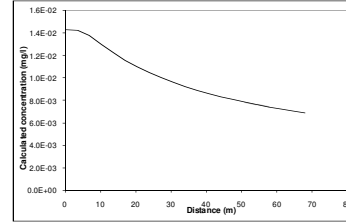
Variable	Value	Unit
Groundwater flow velocity	v 2.00E-05	m/d
Retardation factor	Rf 6.25E+03	fraction
Decay rate used	λ 1.12E-104	d ⁻¹
Rate of contaminant flow due to retardation	u 3.20E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED} 6.93E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	AF 2.06E+00	

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

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	ax 1.00E+00	6.80E+00	m
Transverse dispersivity	az 0.00E+00	6.80E-01	m
Vertical dispersivity	ay 0.00E+00	6.80E-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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration	mg/l
0		1.4E-02
3.4		1.43E-02
6.8		1.38E-02
10.2		1.30E-02
13.6		1.23E-02
17.0		1.16E-02
20.4		1.10E-02
23.8		1.05E-02
27.2		1.00E-02
30.6		9.62E-03
34.0		9.26E-03
37.4		8.93E-03
40.8		8.63E-03
44.2		8.36E-03
47.6		8.11E-03
51.0		7.88E-03
54.4		7.68E-03
57.8		7.46E-03
61.2		7.27E-03
64.6		7.10E-03
68.0		6.93E-03

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

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Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	1.55E-02	mg/l	
Distance to compliance point	68	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₂ 6.93E-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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Chromium (III)		from Level 1
Target Concentration	C _T 3.75E-02	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	4.80E+03	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,rel}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		fraction
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	f _{oc}		fraction
Soil water partition coefficient	Kd	4.80E+03	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 1.00E-01	mg/l	95th/5th value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 5.00E+01	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range CorSim value
Hydraulic gradient	i 1.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 6.80E+01	m	Approx. distance to Abbey River
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 4.80E+03	l/kg	see options
Longitudinal dispersivity	ax 6.80E+00	m	see options
Transverse dispersivity	az 6.80E-01	m	see options
Vertical dispersivity	ay 6.80E-02	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 2.00E-05	m/d
Retardation factor	Rf 6.00E+04	fraction
Decay rate used	λ 1.17E-105	d ⁻¹
Rate of contaminant flow due to retardation	u 3.33E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{EO} 5.14E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	AF 2.06E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	7.74E-02	mg/l	
Distance to compliance point	68	m	
Concentration of contaminant at compliance point after	C _{EO} /C ₂ 5.14E-02	mg/l	Ogata Banks
	1.0E+100	days	

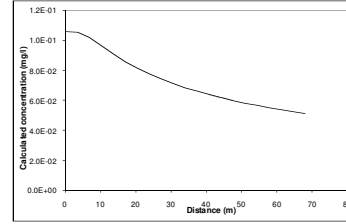
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

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

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

Dispersivity	ax	ay	Calc. value Xu & Eckstein
Longitudinal dispersivity	ax 1.00E+00	ay 6.80E+00	6.80E+00
Transverse dispersivity	ax 0.00E+00	ay 6.80E-01	6.80E-01
Vertical dispersivity	ax 0.00E+00	ay 6.80E-02	6.80E-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)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.1E-01
3.4	1.06E-01
6.8	1.02E-01
10.2	9.65E-02
13.6	9.10E-02
17.0	8.60E-02
20.4	8.16E-02
23.8	7.79E-02
27.2	7.44E-02
30.6	7.13E-02
34.0	6.86E-02
37.4	6.62E-02
40.8	6.40E-02
44.2	6.20E-02
47.6	6.01E-02
51.0	5.84E-02
54.4	5.68E-02
57.8	5.53E-02
61.2	5.39E-02
64.6	5.26E-02
68.0	5.14E-02

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 9.9E+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

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Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Contaminant	Chromium (VI)	From Level 1
Target Concentration	3.00E-02	mg/l

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

Ogata Banks	Equations in HRA publication
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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

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	4.15E-02	mg/l	95th/5th value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	5.00E+01	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	1.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	6.80E+01	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Partition coefficient	1.80E+03	l/kg	see options
Longitudinal dispersivity	6.80E+00	m	see options
Transverse dispersivity	6.80E-01	m	see options
Vertical dispersivity	6.80E-02	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	2.00E-05	m/d
Retardation factor	2.25E+04	fraction
Decay rate used	3.11E-105	d ⁻¹
Rate of contaminant flow due to retardation	8.89E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	2.01E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	2.06E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Remedial Target	6.19E-02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	68	m	
Concentration of contaminant at compliance point after	2.01E-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)

User specified value for partition coefficient

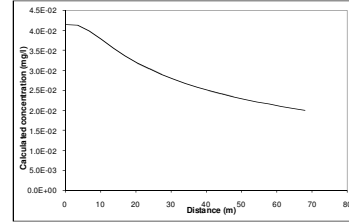
Soil water partition coefficient	Kd	1.80E+03	l/kg
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Sorption coefficient for related species	K _{oc,rel}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		fraction
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.80E+03	l/kg

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

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	6.80E+00	6.80E+00	m
Transverse dispersivity	6.80E-01	6.80E-01	m
Vertical dispersivity	6.80E-02	6.80E-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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration	mg/l
0		4.2E-02
3.4		4.14E-02
6.8		3.99E-02
10.2		3.78E-02
13.6		3.56E-02
17.0		3.37E-02
20.4		3.20E-02
23.8		3.04E-02
27.2		2.91E-02
30.6		2.79E-02
34.0		2.69E-02
37.4		2.59E-02
40.8		2.51E-02
44.2		2.43E-02
47.6		2.35E-02
51.0		2.29E-02
54.4		2.22E-02
57.8		2.17E-02
61.2		2.11E-02
64.6		2.06E-02
68.0		2.01E-02

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

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Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Manganese		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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 2.36E+00	mg/l	95th/5th value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 5.00E+01	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	i 1.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 6.80E+01	m	Approx. distance to Abbey River
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
<i>Parameters values determined from options</i>			
Partition coefficient	Kd 5.00E+06	l/kg	see options
Longitudinal dispersivity	ax 6.80E+00	m	see options
Transverse dispersivity	az 6.80E-01	m	see options
Vertical dispersivity	ay 6.80E-02	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 2.00E-05	m/d
Retardation factor	Rf 6.25E+07	fraction
Decay rate used	λ 1.12E-108	d ⁻¹
Rate of contaminant flow due to retardation	u 3.20E-13	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{EO} 1.14E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	AF 2.06E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	6.19E-01	mg/l	
Distance to compliance point	68	m	
Concentration of contaminant at compliance point after	C _{EO} /C ₂ 1.14E+00	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)

User specified value for partition coefficient

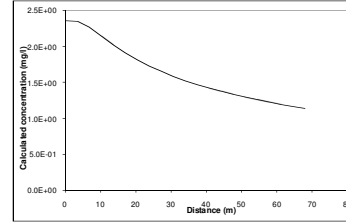
Soil water partition coefficient	Kd	5.00E+06	l/kg
Entry for non-polar organic chemicals (option)	foc		fraction
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)	K _{oc,ion}		l/kg
Sorption coefficient for related species	K _{oc,ion}		l/kg
Sorption coefficient for ionised species	pH		fraction
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	5.00E+06	l/kg

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

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	ax 1.00E+00	6.80E+00	m
Transverse dispersivity	az 0.00E+00	6.80E-01	m
Vertical dispersivity	ay 0.00E+00	6.80E-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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration	mg/l
0		2.4E+00
3.4		2.35E+00
6.8		2.27E+00
10.2		2.15E+00
13.6		2.03E+00
17.0		1.92E+00
20.4		1.82E+00
23.8		1.73E+00
27.2		1.66E+00
30.6		1.59E+00
34.0		1.53E+00
37.4		1.47E+00
40.8		1.42E+00
44.2		1.38E+00
47.6		1.34E+00
51.0		1.30E+00
54.4		1.26E+00
57.8		1.23E+00
61.2		1.20E+00
64.6		1.17E+00
68.0		1.14E+00

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:	St. Mary's Park, Limerick
Completed by:	AJS
Date:	#####
Version:	1

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R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Contaminant	Phosphate	From Level 1
Target Concentration	C _T 3.50E-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
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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

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	C ₀ 1.13E+01	mg/l	95th/5th value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 5.00E+01	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range CorSim value
Hydraulic gradient	i 1.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 6.80E+01	m	Approx. distance to Abbey River
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 0.00E+00	l/kg	see options
Longitudinal dispersivity	ax 6.80E+00	m	see options
Transverse dispersivity	az 6.80E-01	m	see options
Vertical dispersivity	ay 6.80E-02	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 2.00E-05	m/d
Retardation factor	Rf 1.00E+00	fraction
Decay rate used	λ 7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation	u 2.00E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED} 5.47E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	AF 2.06E+00	

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

User specified value for partition coefficient

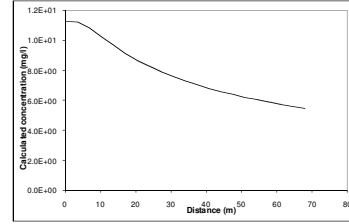
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)	foc		fraction
Entry for ionic organic chemicals (option)	Koc		l/kg
Soil water partition coefficient	K _{oc,w}		l/kg
Sorption coefficient for related species	K _{oc,r}		l/kg
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	0.00E+00	l/kg

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

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	ax 1.00E+00	6.80E+00	m
Transverse dispersivity	az 0.00E+00	6.80E-01	m
Vertical dispersivity	ay 0.00E+00	6.80E-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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration	mg/l
0		1.13E+01
3.4		1.12E+01
6.8		1.03E+01
10.2		1.03E+01
13.6		9.68E+00
17.0		9.15E+00
20.4		8.69E+00
23.8		8.29E+00
27.2		7.91E+00
30.6		7.59E+00
34.0		7.30E+00
37.4		7.04E+00
40.8		6.81E+00
44.2		6.59E+00
47.6		6.40E+00
51.0		6.21E+00
54.4		6.04E+00
57.8		5.89E+00
61.2		5.74E+00
64.6		5.60E+00
68.0		5.47E+00

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:	St. Mary's Park, Limerick
Completed by:	AJS
Date:	#####
Version:	1

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Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	7.22E-02	mg/l	
Distance to compliance point	68	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₂ 5.47E+00	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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Sulphate		from Level 1
Target Concentration	$1.88E+02$	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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	$1.77E+02$	mg/l	95th/5thile value
Half life for degradation of contaminant in water	$9.90E+99$	days	No degradation assumed
Calculated decay rate	$7.00E-101$	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	$5.00E+01$	m	Width of site perpendicular to flow
Plume thickness at source	$2.00E+00$	m	Max. thickness of Made Ground
Saturated aquifer thickness	$6.00E+00$	m	Assume 6m
Bulk density of aquifer materials	$2.50E+00$	g/cm ³	Average value
Effective porosity of aquifer	$2.00E-01$	fraction	Mid range ConSim value
Hydraulic gradient	$1.00E-02$	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	$4.00E-04$	m/d	Mid range literature value for clay
Distance to compliance point	$6.80E+01$	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	$1.00E+100$	days	time variant options only
Partition coefficient	$0.00E+00$	l/kg	see options
Longitudinal dispersivity	$6.80E+00$	m	see options
Transverse dispersivity	$6.80E-01$	m	see options
Vertical dispersivity	$6.80E-02$	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	$2.00E-05$	m/d
Retardation factor	$1.00E+00$	fraction
Decay rate used	$7.00E-101$	d ⁻¹
Rate of contaminant flow due to retardation	$2.00E-05$	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$8.57E+01$	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	$2.06E+00$	

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

User specified value for partition coefficient

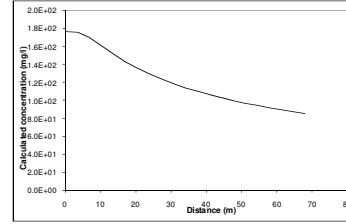
Soil water partition coefficient	Kd	$0.00E+00$	l/kg
Entry for non-polar organic chemicals (option)	foc		fraction
Entry for ionic organic chemicals (option)	Koc		l/kg
Soil water partition coefficient	K _{oc,w}		l/kg
Sorption coefficient for related species	K _{oc,r}		l/kg
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	$0.00E+00$	l/kg

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

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

Variable	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity	$1.00E+00$	$6.80E+00$	m
Transverse dispersivity	$0.00E+00$	$6.80E-01$	m
Vertical dispersivity	$0.00E+00$	$6.80E-02$	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 $ax = 0.83(\log_{10}x)^{+1.1}$; $az = ax/10$, $ay = ax/100$ 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration	mg/l
0		$1.88E+02$
3.4		$1.76E+02$
6.8		$1.70E+02$
10.2		$1.61E+02$
13.6		$1.52E+02$
17.0		$1.43E+02$
20.4		$1.36E+02$
23.8		$1.30E+02$
27.2		$1.24E+02$
30.6		$1.19E+02$
34.0		$1.14E+02$
37.4		$1.10E+02$
40.8		$1.07E+02$
44.2		$1.03E+02$
47.6		$1.00E+02$
51.0		$9.74E+01$
54.4		$9.47E+01$
57.8		$9.22E+01$
61.2		$8.99E+01$
64.6		$8.77E+01$
68.0		$8.57E+01$

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:	St. Mary's Park, Limerick
Completed by:	AJS
Date:	#####
Version:	1

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Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	$3.87E+02$	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	68	m	
Concentration of contaminant at compliance point after	$8.57E+01$	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 $9.9E+99$.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Ammonium		from Level 1
Target Concentration	6.50E-02	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	2.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,m}		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	f _{oc}		fraction
Soil water partition coefficient	Kd	2.00E+00	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	7.45E+00	mg/l	95th/5th value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	7.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	2.20E+02	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Partition coefficient	2.00E+00	l/kg	see options
Longitudinal dispersivity	2.20E+01	m	see options
Transverse dispersivity	2.20E+00	m	see options
Vertical dispersivity	2.20E-01	m	see options

Calculated Parameters

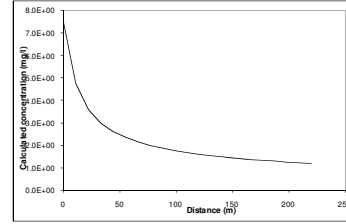
Variable	Value	Unit
Groundwater flow velocity	1.40E-05	m/d
Retardation factor	2.60E+01	fraction
Decay rate used	2.69E-102	d ⁻¹
Rate of contaminant flow due to retardation	5.38E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	1.20E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	6.21E+00	

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

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	ax	2.20E+01	m
Transverse dispersivity	az	2.20E+00	m
Vertical dispersivity	ay	2.20E-01	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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration
0	7.5E+00
11.0	4.75E+00
22.0	3.57E+00
33.0	2.98E+00
44.0	2.61E+00
55.0	2.35E+00
66.0	2.16E+00
77.0	2.00E+00
88.0	1.88E+00
99.0	1.77E+00
110.0	1.69E+00
121.0	1.61E+00
132.0	1.54E+00
143.0	1.48E+00
154.0	1.43E+00
165.0	1.38E+00
176.0	1.34E+00
187.0	1.30E+00
198.0	1.26E+00
209.0	1.23E+00
220.0	1.20E+00

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: St. Mary's Park, Limerick
Completed by: AJS
Date: #####
Version: 1

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	4.04E-01	mg/l	
Distance to compliance point	220	m	
Concentration of contaminant at compliance point after	1.20E+00	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.

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Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Arsenic		from Level 1
Target Concentration	C _T 7.50E-03	mg/l	from Level 1

Select Method for deriving Partition Co-efficient (using pull down menu)
User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	5.00E+02	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,rel}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	f _{oc}		fraction
Soil water partition coefficient	Kd	5.00E+02	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 1.43E-02	mg/l	95th/5th value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	i 5.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 2.20E+02	m	Approx. distance to Abbey River
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 5.00E+02	l/kg	see options
Longitudinal dispersivity	ax 2.20E+01	m	see options
Transverse dispersivity	az 2.20E+00	m	see options
Vertical dispersivity	ay 2.20E-01	m	see options

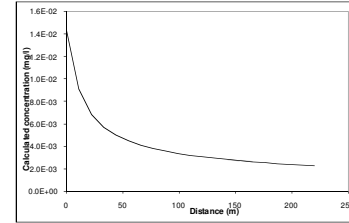
Define dispersivity (click brown cell and use pull down list)

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	ax 1.00E+00	2.20E+01	m
Transverse dispersivity	az 0.00E+00	2.20E+00	m
Vertical dispersivity	ay 0.00E+00	2.20E-01	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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration	mg/l
0		1.4E-02
11.0		9.10E-03
22.0		6.86E-03
33.0		5.72E-03
44.0		5.01E-03
55.0		4.51E-03
66.0		4.14E-03
77.0		3.84E-03
88.0		3.61E-03
99.0		3.41E-03
110.0		3.24E-03
121.0		3.09E-03
132.0		2.96E-03
143.0		2.85E-03
154.0		2.75E-03
165.0		2.65E-03
176.0		2.57E-03
187.0		2.50E-03
198.0		2.43E-03
209.0		2.36E-03
220.0		2.30E-03

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 9.9E+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

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.00E-05	m/d
Retardation factor	Rf 6.25E+03	fraction
Decay rate used	λ 1.12E-104	d ⁻¹
Rate of contaminant flow due to retardation	u 1.60E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED} 2.30E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	AF 6.21E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	4.66E-02	mg/l	
Distance to compliance point	220	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀ 2.30E-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.

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Completed by:	AJS
Date:	#####
Version:	1

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Chromium (III)		From Level 1
Target Concentration	3.75E-02	mg/l	From Level 1

Select Method for deriving Partition Co-efficient (using pull down menu)
User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	4.80E+03	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,rel}		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	f _{oc}		fraction
Soil water partition coefficient	Kd	4.80E+03	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	1.00E-01	mg/l	95th/5th value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range CorSim value
Hydraulic gradient	7.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	2.20E+02	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Partition coefficient	4.80E+03	l/kg	see options
Longitudinal dispersivity	2.20E+01	m	see options
Transverse dispersivity	2.20E+00	m	see options
Vertical dispersivity	2.20E-01	m	see options

Calculated Parameters

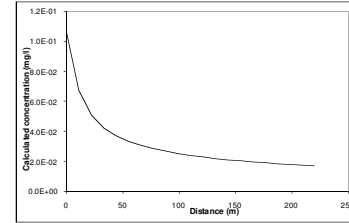
Variable	Value	Unit
Groundwater flow velocity	1.40E-05	m/d
Retardation factor	6.00E+04	fraction
Decay rate used	1.17E-105	d ⁻¹
Rate of contaminant flow due to retardation	2.33E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	1.71E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	6.21E+00	

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

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	ax	2.20E+01	m
Transverse dispersivity	ay	2.20E+00	m
Vertical dispersivity	az	2.20E-01	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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration	mg/l
0		1.1E-01
11.0		6.75E-02
22.0		5.08E-02
33.0		4.24E-02
44.0		3.72E-02
55.0		3.35E-02
66.0		3.07E-02
77.0		2.85E-02
88.0		2.67E-02
99.0		2.52E-02
110.0		2.40E-02
121.0		2.29E-02
132.0		2.19E-02
143.0		2.11E-02
154.0		2.03E-02
165.0		1.97E-02
176.0		1.91E-02
187.0		1.85E-02
198.0		1.80E-02
209.0		1.75E-02
220.0		1.71E-02

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 9.9E+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

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Remedial Targets

Remedial Target	2.33E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	220	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	1.71E-02	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.

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Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	Chromium (VI)	From Level 1
Target Concentration	3.00E-02	mg/l

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

Ogata Banks	Equations in HRA publication
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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

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	4.15E-02	mg/l	95th/5th value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	7.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	2.20E+02	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Partition coefficient	1.80E+03	l/kg	see options
Longitudinal dispersivity	2.20E+01	m	see options
Transverse dispersivity	2.20E+00	m	see options
Vertical dispersivity	2.20E-01	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.40E-05	m/d
Retardation factor	2.25E+04	fraction
Decay rate used	3.11E-105	d ⁻¹
Rate of contaminant flow due to retardation	6.22E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	6.68E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	6.21E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	1.86E-01	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	220	m	
Concentration of contaminant at compliance point after	6.68E-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)

User specified value for partition coefficient

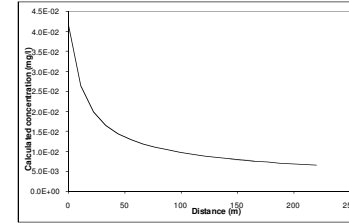
Soil water partition coefficient	Kd	1.80E+03	l/kg
Entry for non-polar organic chemicals (option)	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)	K _{oc,ion}		l/kg
Sorption coefficient for related species	K _{oc,r}		l/kg
Sorption coefficient for ionised species	pH		fraction
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.80E+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
ax	2.20E+01	2.20E+01
ay	2.20E+00	2.20E+00
az	2.20E-01	2.20E-01

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)^{1.17}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration
0	4.2E-02
11.0	2.64E-02
22.0	1.99E-02
33.0	1.66E-02
44.0	1.45E-02
55.0	1.31E-02
66.0	1.20E-02
77.0	1.12E-02
88.0	1.05E-02
99.0	9.88E-03
110.0	9.39E-03
121.0	8.96E-03
132.0	8.59E-03
143.0	8.26E-03
154.0	7.97E-03
165.0	7.70E-03
176.0	7.46E-03
187.0	7.24E-03
198.0	7.04E-03
209.0	6.86E-03
220.0	6.68E-03

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 9.9E+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

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Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Manganese		From Level 1
Target Concentration	3.00E-01	mg/l	From Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.00E+06 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} fraction

Organic carbon partition coefficient K_{oc} l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,m} 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 f_{oc} fraction

Soil water partition coefficient Kd 5.00E+06 l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	2.86E+00	mg/l	95th/5th value
Half life for degradation of contaminant in water t _{1/2}	9.90E+99	days	No degradation assumed
Calculated decay rate λ	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source Sy	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness da	6.00E+00	m	Assume 6m
Bulk density of aquifer materials ρ	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer n	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient i	7.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer K	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point x	2.20E+02	m	Approx. distance to Abbey River
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
Partition coefficient Kd	5.00E+06	l/kg	see options
Longitudinal dispersivity ax	2.20E+01	m	see options
Transverse dispersivity az	2.20E+00	m	see options
Vertical dispersivity ay	2.20E-01	m	see options

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

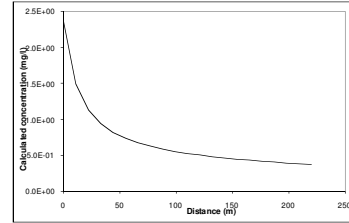
Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	ax	az	ay	Enter value	Calc. value Xu & Eckstein
Longitudinal dispersivity	ax	2.20E+01	2.20E+01	2.20E+01	4.88E-01
Transverse dispersivity	az	2.20E+00	2.20E+00	2.20E+00	5.48E-01
Vertical dispersivity	ay	2.20E-01	2.20E-01	2.20E-01	6.48E-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)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Concentration
0	mg/l
11.0	2.4E+00
22.0	1.50E+00
33.0	1.13E+00
44.0	8.45E-01
55.0	7.45E-01
66.0	6.63E-01
77.0	6.35E-01
88.0	5.95E-01
99.0	5.62E-01
110.0	5.34E-01
121.0	5.10E-01
132.0	4.89E-01
143.0	4.70E-01
154.0	4.53E-01
165.0	4.38E-01
176.0	4.24E-01
187.0	4.12E-01
198.0	4.00E-01
209.0	3.90E-01
220.0	3.80E-01

Note C.

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

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity V	1.40E-05	m/d
Retardation factor Rf	6.25E+07	fraction
Decay rate used λ	1.12E-108	d ⁻¹
Rate of contaminant flow due to retardation u	2.24E-13	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C _{ED}	3.80E-01	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd) AF	6.21E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	1.86E+00	mg/l	
Distance to compliance point	220	m	
Concentration of contaminant at compliance point after	3.80E-01	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.

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Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Phosphate		From Level 1
Target Concentration	C _T 3.50E-02	mg/l	From Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	0.00E+00	l/kg
----------------------------------	----	----------	------

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species	K _{oc,ion}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		fraction
Fraction of organic carbon in aquifer	f _{oc}		fraction
Soil water partition coefficient	Kd	0.00E+00	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 1.13E+01	mg/l	95th/5thile value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	i 7.00E-02	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 2.20E+02	m	Approx. distance to Abbey River
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
Partition coefficient	Kd 0.00E+00	l/kg	see options
Longitudinal dispersivity	ax 2.20E+01	m	see options
Transverse dispersivity	az 2.20E+00	m	see options
Vertical dispersivity	ay 2.20E-01	m	see options

Calculated Parameters

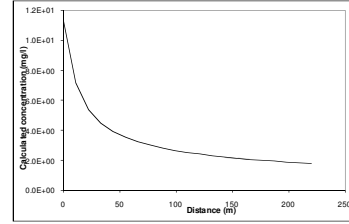
Variable	Value	Unit
Groundwater flow velocity	v 1.40E-05	m/d
Retardation factor	Rf 1.00E+00	fraction
Decay rate used	λ 7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation	u 1.40E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{EO} 1.82E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	AF 6.21E+00	

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

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

Dispersivity	ax	az	ay
Longitudinal dispersivity	ax 1.00E+00	2.20E+01	4.40E+01
Transverse dispersivity	az 0.00E+00	2.20E+00	4.40E-01
Vertical dispersivity	ay 0.00E+00	2.20E-01	4.40E-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)^{1.17}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks

Distance	Concentration
0	1.1E+01
11.0	7.18E+00
22.0	5.41E+00
33.0	4.52E+00
44.0	3.95E+00
55.0	3.56E+00
66.0	3.27E+00
77.0	3.03E+00
88.0	2.84E+00
99.0	2.69E+00
110.0	2.55E+00
121.0	2.44E+00
132.0	2.34E+00
143.0	2.25E+00
154.0	2.17E+00
165.0	2.09E+00
176.0	2.02E+00
187.0	1.97E+00
198.0	1.91E+00
209.0	1.86E+00
220.0	1.82E+00

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:	St. Mary's Park, Limerick
Completed by:	AJS
Date:	#####
Version:	1

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Remedial Targets

Remedial Target	2.17E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	220	m	
Concentration of contaminant at compliance point after	C _{EO} /C ₂ 1.82E+00	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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Sulphate		From Level 1
Target Concentration	$1.88E+02$	mg/l	From Level 1

Select Method for deriving Partition Co-efficient (using pull down menu)
User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	0.00E+00	l/kg
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Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		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
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	0.00E+00	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	$1.77E+02$	mg/l	95th/5th value
Half life for degradation of contaminant in water	$9.90E+99$	days	No degradation assumed
Calculated decay rate	$7.00E-101$	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	$6.00E+02$	m	Width of site perpendicular to flow
Plume thickness at source	$2.00E+00$	m	Max. thickness of Made Ground
Saturated aquifer thickness	$6.00E+00$	m	Assume 6m
Bulk density of aquifer materials	$2.50E+00$	g/cm ³	Average value
Effective porosity of aquifer	$2.00E-01$	fraction	Mid range ConSim value
Hydraulic gradient	$1.00E-02$	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	$4.00E-04$	m/d	Mid range literature value for clay
Distance to compliance point	$2.20E+02$	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	$0.00E+00$	m	
Distance (depth) to compliance point perpendicular to flow direction	$0.00E+00$	m	
Time since pollutant entered groundwater	$1.00E+100$	days	time variant options only
Partition coefficient	$0.00E+00$	l/kg	see options
Longitudinal dispersivity	$2.20E+01$	m	see options
Transverse dispersivity	$2.20E+00$	m	see options
Vertical dispersivity	$2.20E-01$	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	$2.00E-05$	m/d
Retardation factor	$1.00E+00$	fraction
Decay rate used	$7.00E-101$	d ⁻¹
Rate of contaminant flow due to retardation	$2.00E-05$	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$2.85E+01$	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	$6.21E+00$	

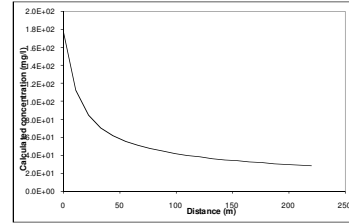
Define dispersivity (click brown cell and use pull down list)

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	$1.00E+00$	$2.20E+01$	m
Transverse dispersivity	$0.00E+00$	$2.20E+00$	m
Vertical dispersivity	$0.00E+00$	$2.20E-01$	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 $ax = 0.83(\log_{10}x)^{+1.1}$; $az = ax/10$, $ay = ax/100$ 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.

Calculated concentrations for distance-concentration graph

Ogata Banks

Distance	Concentration	mg/l
0		1.8E+02
11.0		1.13E+02
22.0		8.48E+01
33.0		7.08E+01
44.0		6.20E+01
55.0		5.58E+01
66.0		5.12E+01
77.0		4.75E+01
88.0		4.46E+01
99.0		4.21E+01
110.0		4.00E+01
121.0		3.82E+01
132.0		3.66E+01
143.0		3.52E+01
154.0		3.39E+01
165.0		3.28E+01
176.0		3.18E+01
187.0		3.08E+01
198.0		3.00E+01
209.0		2.92E+01
220.0		2.85E+01

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: St. Mary's Park, Limerick
 Completed by: AJS
 Date: #####
 Version: 1

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Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	$1.16E+03$	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	220	m	
Concentration of contaminant at compliance point after	$2.85E+01$	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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Ammonium		from Level 1
Target Concentration	6.50E-02	mg/l	from Level 1

Select Method for deriving Partition Co-efficient (using pull down menu)
 User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	2.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,rel}		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	f _{oc}		fraction
Soil water partition coefficient	Kd	2.00E+00	l/kg

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

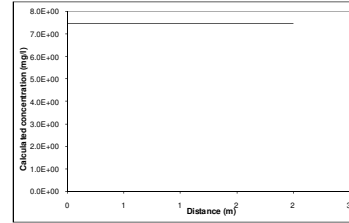
Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	7.45E+00	mg/l	95th ^{ile} value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	7.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	2.00E+00	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.00E+00	l/kg see options
Longitudinal dispersivity	ax	2.00E-01	m see options
Transverse dispersivity	az	2.00E-02	m see options
Vertical dispersivity	ay	2.00E-03	m see options

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

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

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity	ax	2.00E-01	m
Transverse dispersivity	az	2.00E-02	m
Vertical dispersivity	ay	2.00E-03	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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks

Distance	Concentration	mg/l
0	7.45E+00	7.45E+00
0.1	7.45E+00	7.45E+00
0.2	7.45E+00	7.45E+00
0.3	7.45E+00	7.45E+00
0.4	7.45E+00	7.45E+00
0.5	7.45E+00	7.45E+00
0.6	7.45E+00	7.45E+00
0.7	7.45E+00	7.45E+00
0.8	7.45E+00	7.45E+00
0.9	7.45E+00	7.45E+00
1.0	7.45E+00	7.45E+00
1.1	7.45E+00	7.45E+00
1.2	7.45E+00	7.45E+00
1.3	7.45E+00	7.45E+00
1.4	7.45E+00	7.45E+00
1.5	7.45E+00	7.45E+00
1.6	7.45E+00	7.45E+00
1.7	7.45E+00	7.45E+00
1.8	7.45E+00	7.45E+00
1.9	7.45E+00	7.45E+00
2.0	7.45E+00	7.45E+00

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 9.9E+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: St. Mary's Park, Limerick
 Completed by: AJS
 Date: #####
 Version: 1

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Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.40E-05	m/d
Retardation factor	2.60E+01	fraction
Decay rate used	2.69E-102	d ⁻¹
Rate of contaminant flow due to retardation	5.38E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	AF	1.00E+00

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	6.50E-02	mg/l	
Distance to compliance point	2	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	7.45E+00 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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Arsenic		from Level 1
Target Concentration	7.50E-03	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	5.00E+02	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Entry for ionic organic chemicals (option)			
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,rel}		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	f _{oc}		fraction
Soil water partition coefficient	Kd	5.00E+02	l/kg

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

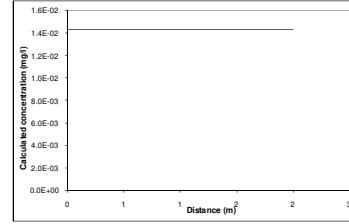
Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	1.43E-02	mg/l	95th/ile value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	5.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	2.00E+00	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	5.00E+02	l/kg see options
Longitudinal dispersivity	ax	2.00E-01	m see options
Transverse dispersivity	az	2.00E-02	m see options
Vertical dispersivity	ay	2.00E-03	m see options

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

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

Dispersivity	ax	az	ay	Enter value	Calc. value Xu & Eckstein
Longitudinal dispersivity	ax			1.00E+00	2.00E-01
Transverse dispersivity	az			0.00E+00	2.00E-02
Vertical dispersivity	ay			0.00E+00	2.00E-03

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)^{0.11}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.43E-02
0.1	1.43E-02
0.2	1.43E-02
0.3	1.43E-02
0.4	1.43E-02
0.5	1.43E-02
0.6	1.43E-02
0.7	1.43E-02
0.8	1.43E-02
0.9	1.43E-02
1.0	1.43E-02
1.1	1.43E-02
1.2	1.43E-02
1.3	1.43E-02
1.4	1.43E-02
1.5	1.43E-02
1.6	1.43E-02
1.7	1.43E-02
1.8	1.43E-02
1.9	1.43E-02
2.0	1.43E-02

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 9.9E+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: St. Mary's Park, Limerick
 Completed by: AJS
 Date: #####
 Version: 1

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.00E-05	m/d
Retardation factor	6.25E+03	fraction
Decay rate used	1.12E-104	d ⁻¹
Rate of contaminant flow due to retardation	1.60E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	1.43E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	1.00E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	7.50E-03	mg/l	
Distance to compliance point	2	m	
Concentration of contaminant at compliance point after	1.43E-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.

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Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Chromium (III)		from Level 1
Target Concentration	C _T 3.75E-02	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	4.80E+03	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,m}		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	f _{oc}		fraction
Soil water partition coefficient	Kd	4.80E+03	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 1.00E-01	mg/l	95th/5th value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range CorSim value
Hydraulic gradient	i 5.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 2.00E+00	m	Approx. distance to Abbey River
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 4.80E+03	l/kg	see options
Longitudinal dispersivity	ax 2.00E-01	m	see options
Transverse dispersivity	az 2.00E-02	m	see options
Vertical dispersivity	ay 2.00E-03	m	see options

Calculated Parameters

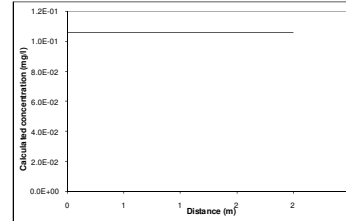
Variable	Value	Unit
Groundwater flow velocity	v 1.00E-05	m/d
Retardation factor	Rf 6.00E+04	fraction
Decay rate used	λ 1.17E-105	d ⁻¹
Rate of contaminant flow due to retardation	u 1.67E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{EO} 1.06E-01	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	AF 1.00E+00	

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

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

Dispersivity	ax	ay	Enter value	Calc. value Xu & Eckstein
Longitudinal dispersivity	ax		1.00E+00	2.00E-01
Transverse dispersivity	az		0.00E+00	2.00E-02
Vertical dispersivity	ay		0.00E+00	2.00E-03

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)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration
0	1.1E-01
0.1	1.06E-01
0.2	1.06E-01
0.3	1.06E-01
0.4	1.06E-01
0.5	1.06E-01
0.6	1.06E-01
0.7	1.06E-01
0.8	1.06E-01
0.9	1.06E-01
1.0	1.06E-01
1.1	1.06E-01
1.2	1.06E-01
1.3	1.06E-01
1.4	1.06E-01
1.5	1.06E-01
1.6	1.06E-01
1.7	1.06E-01
1.8	1.06E-01
1.9	1.06E-01
2.0	1.06E-01

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 9.9E+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: St. Mary's Park, Limerick
Completed by: AJS
Date: #####
Version: 1

Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	3.75E-02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	2	m	
Concentration of contaminant at compliance point after	C _{EO} /C ₂ 1.06E-01	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.

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R&D Publication 20 Remedial Targets Worksheet, Release 3.1



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Chromium (VI)		from Level 1
Target Concentration	3.00E-02	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	1.80E+03	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,ion}		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	f _{oc}		fraction
Soil water partition coefficient	Kd	1.80E+03	l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	4.15E-02	mg/l	95th ^{ile} value
Half life for degradation of contaminant in water	9.90E+99	days	No degradation assumed
Calculated decay rate	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	6.00E+00	m	Assume 6m
Bulk density of aquifer materials	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	5.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	2.00E+00	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.80E+03	l/kg see options
Longitudinal dispersivity	ax	2.00E-01	m see options
Transverse dispersivity	az	2.00E-02	m see options
Vertical dispersivity	ay	2.00E-03	m see options

Calculated Parameters

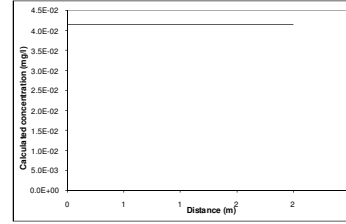
Variable	Value	Unit	
Groundwater flow velocity	1.00E-05	m/d	
Retardation factor	2.25E+04	fraction	
Decay rate used	3.11E-105	d ⁻¹	
Rate of contaminant flow due to retardation	4.44E-10	m/d	
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{EO}	4.15E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	AF	1.00E+00	

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

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

Dispersivity	ax	az	ay
Longitudinal dispersivity	2.00E-01	2.00E-01	2.00E-01
Transverse dispersivity	0.00E+00	2.00E-02	4.58E-03
Vertical dispersivity	0.00E+00	2.00E-03	4.58E-04

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)^{0.417}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
0	4.2E-02
0.1	4.15E-02
0.2	4.15E-02
0.3	4.15E-02
0.4	4.15E-02
0.5	4.15E-02
0.6	4.15E-02
0.7	4.15E-02
0.8	4.15E-02
0.9	4.15E-02
1.0	4.15E-02
1.1	4.15E-02
1.2	4.15E-02
1.3	4.15E-02
1.4	4.15E-02
1.5	4.15E-02
1.6	4.15E-02
1.7	4.15E-02
1.8	4.15E-02
1.9	4.15E-02
2.0	4.15E-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.

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: St. Mary's Park, Limerick
Completed by: AJS
Date: #####
Version: 1

Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	3.00E-02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	2	m	
Concentration of contaminant at compliance point after	C _{EO} /C ₀ 4.15E-02 1.0E+100	mg/l 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.

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R&D Publication 20 Remedial Targets Worksheet, Release 3.1



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Manganese		from Level 1
Target Concentration	C _T 3.00E-01	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.00E+06 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} fraction

Organic carbon partition coefficient K_{oc} l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,m} 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 f_{oc} fraction

Soil water partition coefficient Kd 5.00E+06 l/kg

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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 2.36E+00	mg/l	95th/5th value
Half life for degradation of contaminant in water	t _{1/2} 9.90E+99	days	No degradation assumed
Calculated decay rate	λ 7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source	Sy 2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness	da 6.00E+00	m	Assume 6m
Bulk density of aquifer materials	ρ 2.50E+00	g/cm ³	Average value
Effective porosity of aquifer	n 2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient	i 5.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	K 4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point	x 2.00E+00	m	Approx. distance to Abbey River
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
Partition coefficient	Kd 5.00E+06	l/kg	see options
Longitudinal dispersivity	ax 2.00E-01	m	see options
Transverse dispersivity	az 2.00E-02	m	see options
Vertical dispersivity	ay 2.00E-03	m	see options

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

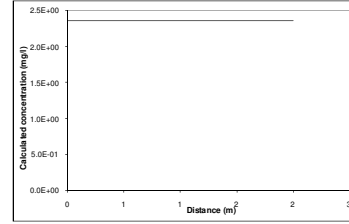
Dispersivities 10%, 1%, 0.1% of pathway length

Dispersivity	ax	az	ay	Enter value	Calc. value Xu & Eckstein
Longitudinal dispersivity	ax	0.10E+00	2.00E-01	2.00E-01	4.58E-02
Transverse dispersivity	az	0.10E+00	2.00E-02	2.00E-02	4.58E-03
Vertical dispersivity	ay	0.10E+00	2.00E-03	2.00E-03	4.58E-04

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)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Concentration	mg/l
0	2.36E+00	2.36E+00
0.1	2.36E+00	2.36E+00
0.2	2.36E+00	2.36E+00
0.3	2.36E+00	2.36E+00
0.4	2.36E+00	2.36E+00
0.5	2.36E+00	2.36E+00
0.6	2.36E+00	2.36E+00
0.7	2.36E+00	2.36E+00
0.8	2.36E+00	2.36E+00
0.9	2.36E+00	2.36E+00
1.0	2.36E+00	2.36E+00
1.1	2.36E+00	2.36E+00
1.2	2.36E+00	2.36E+00
1.3	2.36E+00	2.36E+00
1.4	2.36E+00	2.36E+00
1.5	2.36E+00	2.36E+00
1.6	2.36E+00	2.36E+00
1.7	2.36E+00	2.36E+00
1.8	2.36E+00	2.36E+00
1.9	2.36E+00	2.36E+00
2.0	2.36E+00	2.36E+00

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 9.9E+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:	St. Mary's Park, Limerick
Completed by:	AJS
Date:	#####
Version:	1

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.00E-05	m/d
Retardation factor	Rf 6.25E+07	fraction
Decay rate used	λ 1.12E-108	d ⁻¹
Rate of contaminant flow due to retardation	u 1.60E-13	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED} 2.36E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd)	AF 1.00E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	3.00E-01	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	2	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀ 2.36E+00	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.

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R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Phosphate		from Level 1
Target Concentration	C _T 3.50E-02	mg/l	from Level 1

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 0.00E+00 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} fraction

Organic carbon partition coefficient K_{oc} l/kg

Entry for ionic organic chemicals (option)

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

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

pH value pH

acid dissociation constant pKa fraction

Fraction of organic carbon in aquifer f_{oc} fraction

Soil water partition coefficient Kd 0.00E+00 l/kg

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

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core C ₀	1.13E+01	mg/l	95th/5th value
Half life for degradation of contaminant in water t _{1/2}	9.90E+99	days	No degradation assumed
Calculated decay rate λ	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	6.00E+02	m	Width of site perpendicular to flow
Plume thickness at source Sy	2.00E+00	m	Max. thickness of Made Ground
Saturated aquifer thickness da	6.00E+00	m	Assume 6m
Bulk density of aquifer materials ρ	2.50E+00	g/cm ³	Average value
Effective porosity of aquifer n	2.00E-01	fraction	Mid range ConSim value
Hydraulic gradient i	7.00E-03	fraction	Calculated from site plans
Hydraulic conductivity of aquifer K	4.00E-04	m/d	Mid range literature value for clay
Distance to compliance point x	2.00E+00	m	Approx. distance to Abbey River
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

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

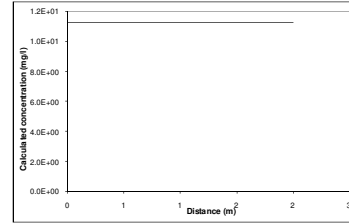
Dispersivities 10%, 1%, 0.1% of pathway length

Variable	Enter value	Calc. value Xu & Eckstein	Unit
Longitudinal dispersivity ax	1.00E+00	2.00E-01	m
Transverse dispersivity ay	0.00E+00	2.00E-02	m
Vertical dispersivity az	0.00E+00	2.00E-03	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(log₁₀x)^{0.417}; 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.

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Concentration	mg/l
0	1.13E+01	1.13E+01
0.1	1.13E+01	1.13E+01
0.2	1.13E+01	1.13E+01
0.3	1.13E+01	1.13E+01
0.4	1.13E+01	1.13E+01
0.5	1.13E+01	1.13E+01
0.6	1.13E+01	1.13E+01
0.7	1.13E+01	1.13E+01
0.8	1.13E+01	1.13E+01
0.9	1.13E+01	1.13E+01
1.0	1.13E+01	1.13E+01
1.1	1.13E+01	1.13E+01
1.2	1.13E+01	1.13E+01
1.4	1.13E+01	1.13E+01
1.5	1.13E+01	1.13E+01
1.6	1.13E+01	1.13E+01
1.7	1.13E+01	1.13E+01
1.8	1.13E+01	1.13E+01
1.9	1.13E+01	1.13E+01
2.0	1.13E+01	1.13E+01

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 9.9E+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: St. Mary's Park, Limerick
 Completed by: AJS
 Date: #####
 Version: 1

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Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity V	1.40E-05	m/d
Retardation factor Rf	1.00E+00	fraction
Decay rate used λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation u	1.40E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C _{ED}	1.13E+01	mg/l
Attenuation factor (one way vertical dispersion, CO/CEd) AF	1.00E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	3.50E-02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	2	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀ 1.13E+01	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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Sulphate		From Level 1
Target Concentration	$1.88E+02$	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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	$1.77E+02$	mg/l	95th/5th value
Half life for degradation of contaminant in water	$9.9E+99$	days	No degradation assumed
Calculated decay rate	$7.00E-101$	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	$6.00E+02$	m	Width of site perpendicular to flow
Plume thickness at source	$2.00E+00$	m	Max. thickness of Made Ground
Saturated aquifer thickness	$6.00E+00$	m	Assume 6m
Bulk density of aquifer materials	$2.50E+00$	g/cm ³	Average value
Effective porosity of aquifer	$2.00E-01$	fraction	Mid range ConSim value
Hydraulic gradient	$1.00E-02$	fraction	Calculated from site plans
Hydraulic conductivity of aquifer	$4.00E-04$	m/d	Mid range literature value for clay
Distance to compliance point	$2.00E+00$	m	Approx. distance to Abbey River
Distance (lateral) to compliance point perpendicular to flow direction	$0.00E+00$	m	
Distance (depth) to compliance point perpendicular to flow direction	$0.00E+00$	m	
Time since pollutant entered groundwater	$1.00E+100$	days	time variant options only
Partition coefficient	$0.00E+00$	l/kg	see options
Longitudinal dispersivity	$2.00E-01$	m	see options
Transverse dispersivity	$2.00E-02$	m	see options
Vertical dispersivity	$2.00E-03$	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	$2.00E-05$	m/d
Retardation factor	$1.00E+00$	fraction
Decay rate used	$7.00E-101$	d ⁻¹
Rate of contaminant flow due to retardation	$2.00E-05$	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$1.77E+02$	mg/l
Attenuation factor (one way vertical dispersion, CO/CE0)	$1.00E+00$	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	$1.88E+02$	mg/l	
Distance to compliance point	2	m	
Concentration of contaminant at compliance point after	$1.77E+02$	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)

User specified value for partition coefficient

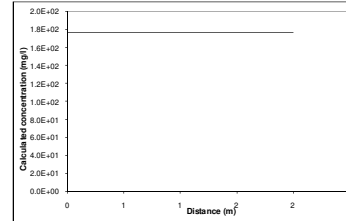
Entry if specify partition coefficient (option)	Value	Unit
Soil water partition coefficient	$0.00E+00$	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer		fraction
Organic carbon partition coefficient		l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species		l/kg
Sorption coefficient for ionised species		l/kg
pH value		fraction
acid dissociation constant		
Fraction of organic carbon in aquifer		fraction
Soil water partition coefficient	$0.00E+00$	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 <td>ay</td> <td>$0.00E+00$</td> <td>$2.00E-01$</td> <td>$4.58E-03$</td>	ay	$0.00E+00$	$2.00E-01$	$4.58E-03$
Vertical dispersivity <td>az</td> <td>$0.00E+00$</td> <td>$2.00E-02$</td> <td>$4.58E-03$</td>	az	$0.00E+00$	$2.00E-02$	$4.58E-03$
		$0.00E+00$	$2.00E-03$	$4.58E-04$

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 $ax = 0.83(\log_{10}x)^{+1.1}$; $az = ax/10$, $ay = ax/100$ 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.

Calculated concentrations for distance-concentration graph

Ogata Banks	Distance	Concentration
	0	$1.8E+02$
	0.1	$1.77E+02$
	0.2	$1.77E+02$
	0.3	$1.77E+02$
	0.4	$1.77E+02$
	0.5	$1.77E+02$
	0.6	$1.77E+02$
	0.7	$1.77E+02$
	0.8	$1.77E+02$
	0.9	$1.77E+02$
	1.0	$1.77E+02$
	1.1	$1.77E+02$
	1.2	$1.77E+02$
	1.3	$1.77E+02$
	1.4	$1.77E+02$
	1.5	$1.77E+02$
	1.6	$1.77E+02$
	1.7	$1.77E+02$
	1.8	$1.77E+02$
	1.9	$1.77E+02$
	2.0	$1.77E+02$

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 $9.9E+99$.

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: St. Mary's Park, Limerick
Completed by: AJS
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Version: 1

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