Introduction	***Tool:***	'SeDiChem' (Sediment Disturbance effects on Chemical status)
	Purpose:	SeDiChem has been developed to *assist* in the quantification and assessment of potential effects on water quality from disturbance of contaminated sediments in estuarine and marine waters.
		Note: SeDiChem should be considered to be an aid in the decision making process. The tool does not remove the need for further environmental considerations (e.g. site-specific hydrological considerations) and ecological interpretation of outputs using professional judgement, when coming to a regulatory decision.
Guidance	***Technical:***	The spreadsheet applies the principles and calculation methods that are set out fully in the separate *SeDiChem Technical Report* (SC180002: Impact of sediment disturbance on chemical status', Environment Agency, 2019). The methods and approach are by design and necessity a compromise between 1) a pragmatic and simple method and 2) employment of robust and best available environmental understanding.
	User Guide:	A *SeDiChem Tool User Guide* (Environment Agency, 2019a) outlines the functions of the tool and guides the user through the steps required to make an assessment.
		Note: It is important that you understand the process before using SeDiChem to make an assessment. We recommend that you work through the worked examples in the User Guide.
Use	***Envelope of use:***	Sediment disturbance activities in estuarine and coastal waters.
		The chemicals included within the assessment are restricted to a subset of the Marine Management Organisation suite that are commonly encountered in sediment.
		SeDiChem does not represent a chemical leaching tool e.g. it should not be applied to leachate calculations from spoil heaps or other non-saturated sediments.
		SeDiChem is not designed for the assessment of sediment disposal schemes, it is used to inform assessment of the effects on water quality from disturbance of *in situ* sediments.
		Caution should be applied to the interpretation of all SeDiChem outputs, taking account of the 'spot' nature of outputs, i.e. SeDiChem does not output water quality change effects with distance. Similarly, SeDiChem does not account for temporal variation considerations.
	Before starting:	Make a copy of the spreadsheet.
		Populate Project details tab for audit trail purposes.
		Note that this is a live spreadsheet - therefore the associated assessment is a snap shot at that particular moment in time.
		Familiarise yourself with Guidance, 'Key' tab and data entry requirements (as indicated by yellow cells throughout).

SeDiChem Version & date	
v3.1 Feb2019	Following APEM Ltd. development (using Microsoft Excel 2010); as issued to the Environment Agency.
	DISCLAIMER: SeDiChem is used at your own risk. APEM Ltd cannot be held liable for any (a) decisions made based on its use, or (b) the functionality of any edits made to SeDiChem subseqent to version 3.1

Project details	
File name:	Humber Marine Energy
Project name:	Humber Marine Energy Park and Compensation Scheme
Applicant details:	Able UK Ltd
SeDiChem assessment date:	22/03/2021
Sediment chemistry input data details:	Sampling of sediments in dredge area taken 2011 (full dredge depth), plus resmpling of surface samples in 2017 and 2021
Water quality input data details:	Previous 4 years monthly data (2018-2021) CLEAN SITE - TI02 MONITORING POINT, 1985; HUMBER BUOY 26 0.5 KM O/S HULL MARINA; Humber No.28 Buoy 2.6 Km Ne Hessle Sand; Humber Near Hessle Sand 0.5 Km; R.HUMBER COMMITTEE SITE 7702 Environment Agency monitoring points.
Additional notes:	

Key / Cell reference convention	
🟨	Data input cell
▣	Compulsory data input cell
🟪	Default value provided
⬜	Annual Average (AA) EQS
🟧	As selected from SSC uplift library

>> Enter site specific values in yellow cells. Enter all data available, otherwise leave blank.

>> Compulsory data input cells have bold borders.

General site parameters	Medium	Unit	Value	Default
Background pH	Water	pH units		8
Measured Organic Matter content	Sed	%		8
Measured Fraction of Organic Carbon (Foc)	Sed	n/a		0.05
Fraction of Organic Carbon (calculation)	Sed	*n/a*	*0.05*	
Fraction of Organic Carbon - 'corrected'	Sed	*n/a*	*0.05*	
Back calc of OM	Sed	*%*	*8*	
Measured clay content	Sed	%	50	25
Clay content - 'corrected'	Sed	%	*50*	
Sediment density	Sed	kg/m^3		1250
Volume fraction water in sediment	Sed	%		80
Zinc-ambient background (diss) conc.	Water	µg/l	2.9	1.1
DOC	Water	mg/l		1
Net flow rate	Water	m^3/day	21,000,000	

			Sediment chemistry data			Water quality data (generally Mean)	Local WFD supporting element status	EQS and type			User notes
	Full name	Short name	Maximum mg/kg	Mean mg/kg	User defined mg/kg	µg/l		µg/l	Fraction	Type	(e.g. record source of data, audit information)
Trace metals	Arsenic	**As**	50.00	25.20		2.91		25	Diss	Salt water long-term (mean) (SP)	
	Cadmium	**Cd**	0.50	0.30		0.09		0.2	Diss	Other surface waters' (mean) (PHS)	
	Chromium	**Cr**	112.00	49.70		0.30		32	Diss	MAC (SP)	
	Copper	**Cu**	53.00	28.80		3.08		3.76	Diss	Salt water long-term (mean); DOC dependent (SP)	
	Lead	**Pb**	135.00	60.70		0.40		14	Diss	MAC (PS)	
	Mercury	**Hg**	0.40	0.20		0.01		0.07	Diss	MAC (PHS)	
	Nickel	**Ni**	53.00	31.60		2.42		34	Diss	MAC (PS)	
	Zinc	**Zn**	287.00	55.30		4.94		9.7	Diss	Salt water long-term (mean) (SP)	
Polycyclic Aromatic Hydrocarbons (PAHs)	Benzo[a]pyrene	**Benzo[a]pyrene**	1.18	0.33		0.0818		0.027	Total	MAC; Other surface waters (PHS)	
	Benzo[b]fluoranthene	**Benzo[b]fluoranthene**	0.78	0.35		0.0691		0.017	Total	MAC; Other surface waters (PHS)	
	Benzo[ghi]perylene	**Benzo[ghi]perylene**	0.61	0.32		0.0774		0.00082	Total	MAC; Other surface waters (PHS)	
	Benzo[k]fluoranthene	**Benzo[k]fluoranthene**	0.54	0.17		0.0416		0.017	Total	MAC; Other surface waters (PHS)	
	Fluoranthene	**Fluoranthene**	0.85	0.49		0.0606		0.120	Total	MAC; Other surface waters (PS)	
Organotins	Tributyltin	**TBT**	0.00	0.00		0.00046		0.0015	Total	MAC; other surface waters (PHS)	
Polybrominated diphenyl ethers (PBDE congener no)	Congener: BDE-28	**BDE-28**	0.00	0.00		0.00006		tri	Total		
	Congener: BDE-47	**BDE-47**	0.00	0.00		0.00006		tetra	Total		
	Congener: BDE-99	**BDE-99**	0.00	0.00		0.00006		penta	Total		
	Congener: BDE-100	**BDE-100**	0.00	0.00		0.00006		penta	Total		
	Congener: BDE-153	**BDE-153**	0.00	0.00		0.00006		hexa	Total		
	Congener: BDE-154	**BDE-154**	0.00	0.00		0.00006		hexa	Total		
	Sum of PBDEs	**Sum of PBDEs**						0.014	Total	Sum MAC; Other surface waters (PHS)	
Others	Hexachorobenzene	**HCB**	0.01	0.00				0.05	Total	MAC; other surface waters (PHS)	
	Hexacholorobutadiene	**HCBD**						0.6	Total	MAC; other surface waters (PHS)	
	Hexabromocyclododecane	**HBCDD**						0.05	Total	MAC; other surface waters (PHS)	

Choose sediment chemistry statistic to compare against *in situ* thresholds:

User Input

										WFD Status for info	Comparison 1	Comparison 2	Comparison 3	Comparison 4	Comparison 5
		cAL1	ISQG/TEL	ERL	PEL	cAL2	Max	Mean	User defined	Local WFD supporting element status					
Metals (mg/kg)	**As**	20	7.24	8.2	41.6	100	50.00	25.20	-						
	Cd	0.4	0.676	1.2	4.21	5	0.50	0.30	-						
	Cr	40	52.3	81	160	400	112.00	49.70	-						
	Cu	40	18.7	34	108	400	53.00	28.80	-						
	Pb	50	30.2	46.7	112	500	135.00	60.70	-						
	Hg	0.3	0.13	0.15	0.7	3	0.40	0.20	-						
	Ni	20	15.9	20.9	42.8	200	53.00	31.60	-						
	Zn	130	124	150	271	800	287.00	55.30	-						
PAHs (µg/kg)	**Benzo[a]pyrene**	100	88.8	430.0	763		1,180.00	327.00	-						
	Benzo[b]fluoranthene	100					775.00	351.30	-						
	Benzo[ghi]perylene	100					607.40	315.20	-						
	Benzo[k]fluoranthene	100					539.00	166.40	-						
	Fluoranthene	100	113.0	600.0	1494		850.20	491.70	-						
Organotins (µg/kg)	**TBT**	100				1000	1.00	0.03	-						
PBDEs (µg/kg)	**BDE-28**						0.02	0.02	-						
	BDE-47						0.02	0.02	-						
	BDE-99						0.02	0.02	-						
	BDE-100						0.02	0.02	-						
	BDE-153						0.02	0.02	-						
	BDE-154						0.02	0.02	-						
	Sum of PBDEs						-	-	-						
Others (µg/kg)	**HCB**						8.00	0.55	-						
	HCBD						-	-	-						
	HBCDD						-	-	-						

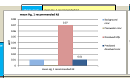
KEY:		**Source reference**
cAL =	chemical Action Level (or 'Cefas Action Level')	MMO (2018)
ISQG =	Interim Sediment Quality Guideline	CCME (1999); Cd & Zn updated using Buchman (2008) & Defra (2017)
TEL =	Threshold Effects Level: Maximum concentration at which no effects are observed	CCME (1999) unless stated otherwise
ERL =	Effects Range Low: 10th percentile values in effects	Buchman (2008) [consistent with Spencer & MacLeod (2002)] with values forming part of the same Screening Quick Reference Tables (SQuiRTs) as the TEL and PEL values. Consistent (where relevant) with OSPAR (2013).
PEL =	Probable Effects Level: Lower limit of the range of concentrations at which adverse effects are always observed	CCME (1999); Zn updated using Buchman (2008) & Defra (2017)

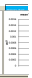
Suspended Sediment Concentration (SSC) increase to assess (mg/l): 500

Library values (see tab 5)

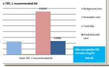
precursor (fo info)		s/s conc. increase (mg/l)	project:
Lower est	<	200	Able Marine Energy Park
Average	<	200	Tilbury2

							(a) Pore water derivation	(b) Pore water dilution factor		(c) Release from sediment cloud										(d) Pore water direct emission											(e) All increases to dissolved chemical								(f) Total chemical										
Filter by: Sediment conc. statistic	Filter by: Kd variation	Filter by: Chemical	Sediment conc.	Sediment conc. adjusted for sediment type	SSC increase	Log (Kd)	Partition coefficient (Kd)	Pore Water Conc based on sed conc.	Pore water dilution required	Estimated actual dilution rate	Increase in SSC	Increase in sorbed load	Increase in dissolved load	Background mean diss aq conc (e.g. EA data)	Predicted aq conc (dis) with increase	% of EQS (background only)	% of EQS including sediment contribution	Aq diss conc. increase as a % of background	Aq diss conc. increase as a % of EQS 'headroom' (i.e. boundary of Good)	Note current WFD status	Mass sediment disturbed	Vol sediment disturbed	Pore water vol disturbed	Pore water loading	Background mean diss aq conc (e.g. EA data)	Predicted aq conc (dis) with increase	% of EQS (background only)	% of EQS including sediment contribution	Aq conc. increase as a % of background	Aq diss conc. increase as a % of EQS 'headroom' (i.e. boundary of Good)	Note current WFD status	Total dissolved increase (c+d)	Background mean diss aq conc (e.g. EA data)	Predicted aq conc (dis) with increase	% of EQS (background only)	% of EQS including sediment contribution	Aq conc. increase as a % of background	Aq conc. increase as a % of EQS 'headroom' (i.e. boundary of Good)	Note current WFD status	Background total concentration	Concentration addition due to disturbed solids	Predicted total conc.	Percentage background compared to total concentration	% of EQS (background only)	% of EQS including sediment contribution	Aq conc. increase as a % of background	Aq conc. increase as a % of EQS 'headroom' (i.e. boundary of Good)	Maximum acceptable suspended sediment uplift	EQS, µg/l	EQS type
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]





mean TBT, 1 recommended Kd



Max acceptable SSC increase (mg/l):
500.00

Organic Chart	Porewater conc	Background conc	Predicted total conc	Total EQS	Max acceptable SSC increase (mg/l)
mean TBT, 1 recommended Kd	[illegible]	[illegible]	0.0005	0.0015	500.00

Metals Chart	Porewater conc	Background conc	Predicted dissolved conc	Dissolved EQS
mean Hg, 1 recommended Kd	[illegible]	[illegible]	[illegible]	[illegible]

	Enter ref no (Col A) from table below:		s/s conc. increase (mg/l):	precursor (for info):	project:
Maximum suspended sediment concentration increase:	6	Lower est	200	<	Able Marine Energy Park
Average suspended sediment concentration increase (if applicable):	1	Average	200	<	Tilbury2

Ref. no	Sediment disturbance type	Equipment detail	Activity detail	Project	Data precursor	Concentration increase (mg/l)	Value detail	Position in water column	Predominant sediment type	Location	Environment type	Average Background sediment concentration (mg/l)	Model or field study	Other commentary	Document	Weblink	Date accessed
24	Drilling	-	Foundation installation	East Anglia ONE Offshore Windfarm	<	`	Average	Depth average max	Medium sand	43km from the Suffolk	Marine	0-40	Model	Model over 15 day period, value for outside immediate vicinity of drilling	Environmental Statement Chapter 6 - Marine Geology, Oceanography and Physical Processes	https://infrastructure.planningins	03/10/2018
28	Drilling	Drilling monopiles and jackets using 3 or 4 pin piles	Foundation installation	East Anglia THREE Offshore Wind	<	10	Average	Depth average max	Medium sand	Approximately 70km e	Marine	6 -10	Model	Away from immediate vicinity of activity, plume shortlived	Environmental Statement Chapter 7 Marine Geology, Oceanography and Physical Processes	https://infrastructure.planningins	03/10/2018
29	Drilling	-	Foundation installation	Galloper Offshore Wind Farm	<	2	Average	Depth average max	Fine sediment	Approximately 27km c	Marine	20	Model	Modelled over 14 days, max. footrpint <15km. Modelled for 50. 96 and 187 um.	Environment Statement – Chapter 9: Ph	https://infrastructure.planningins	03/10/2018
32	Drilling	Drilling monopiles	Foundation installation	Hornsea Offshore Wind Farm (Zone 4) - Project One	<	10	Average	Depth average max	Silt and clay	East coast offshore Ho	Marine	0-30	Model	Plume confined to area close around wondfarm <24 hours	Environmental Statement Volume 2 – O	https://infrastructure.planningins	03/10/2018
46	Drilling	Drilling monopiles	Foundation installation	Rampion Offshore Windfarm	>	20	Lower est	Depth average max	Not specified	Approximately 13 - 23	Marine	5-15	Model	20mg/l plume within 1km, 50mg/l plume within 200m. Plume very short duration.	Document 6.1.6. ES Section 6 – Physical	https://infrastructure.planningins	05/10/2018
47	Drilling	Drilling monopiles	Foundation installation	Rampion Offshore Windfarm	<	50	Upper est	Depth average max	Not specified	Approximately 13 - 23	Marine	5-15	Model	20mg/l plume within 1km, 50mg/l plume within 200m. Plume very short duration.	Document 6.1.6. ES Section 6 – Physical	https://infrastructure.planningins	05/10/2018
48	Drilling	Drilling monopiles	Foundation installation	Hornsea Offshore Wind Farm (Zone 4) - Project Two	>	94	Lower est	Depth average max	Silt, clay and fine sand	Approximately 13 - 23	Marine	30	Model	Max 161 mg/l close vicinty to dredging, 10mg/l 2.5km - 8km. Plume duration <17 hours	Environmental Statement Volume 2 – O	https://infrastructure.planningins	05/10/2018
49	Drilling	Drilling monopiles	Foundation installation	Hornsea Offshore Wind Farm (Zone 4) - Project Two	<	161	Upper est	Depth average max	Silt, clay and fine sand	Approximately 13 - 23	Marine	30	Model	Max 161 mg/l close vicinty to dredging, 10mg/l 2.5km - 8km. Plume duration <17 hours	Environmental Statement Volume 2 – O	https://infrastructure.planningins	05/10/2018
57	Drilling	Drilling 11.1m concrete monopile	Foundation installation	Triton Knoll Offshore Wind Farm	~	20	Average	Depth average max	Sand, clay, chalk	Greater Wash	Marine	2-50	Model	Plume 10 - 20mg/l for up to 60 days (tidal axis acting to concentrate material)	Environmental Statement Volume 2: Ch	https://infrastructure.planningins	05/10/2018
64	Drilling	Single drill rig	Foundation installation	Navitus Bay Wind Park	<	30	Average	Depth average max	Chalk	South West of Isle of	Marine	0 - 30	Model	Using single drill rig.Value for outside immediate vicinity of release location. Value . 5mg/l at 20km plume extent	Environmental Statement 6.1.2.5 Volum	https://infrastructure.planningins	15/10/2018
65	Drilling	Single drill rig	Foundation installation	Navitus Bay Wind Park	<	20	Average	Depth average max	Fine sediment	South West of Isle of	Marine	0 - 30	Model	Plume duration hours to days	Environmental Statement 6.1.2.5 Volum	https://infrastructure.planningins	15/10/2018
69	Drilling	-	Foundation installation	Norfolk Vangaurd	<	10	Average	Depth average max	Fine sediment	The centre of Norfolk	Marine	1-35	Model	Plume extent <1km. Plume <5mg/l up to 10km extent. Plume duration a few days.	Environmental Statement Chapter 8 - M	https://infrastructure.planningins	15/10/2018
75	Drilling	-	Foundation installation	Thanet Extension Offshore Wind Farm	>	10	Lower est	Not specified	Fine sediment	approximately 8km of	Marine	10-80	Model	Narrow plume (0s to 000s m wide) with length of tidal cycle (7 - 13km). Plume duration <24 hours.	6.4.2.1 Annex 2-1 - Marine Geology, Oc	https://infrastructure.planningins	15/10/2018
76	Drilling	-	Foundation installation	Thanet Extension Offshore Wind Farm	<	30	Upper est	Not specified	Fine sediment	approximately 8km of	Marine	10-80	Model	Narrow plume (0s to 000s m wide) with length of tidal cycle (7 - 13km). Plume duration <24 hours.	6.4.2.1 Annex 2-1 - Marine Geology, Oc	https://infrastructure.planningins	15/10/2018

Sediment Type Correction (e.g. ESDAT,2000)

Substance	A (constant)	B (clay related coefficient)	C (organic matter related coefficient)
As	15	0.4	0.40
Cd	0.4	0.007	0.02
Cr	50	2	0.00
Cu	15	0.6	0.60
Pb	50	1	1.00
Hg	0.2	0.0034	0.00
Ni	10	1	0.00
Zn	50	3	1.50

$$Sed\ con_{adj} = Sed\ con_{measured} \times \left(\frac{A + B \times 25 + C \times 10}{A + B \times clay\% + C \times OM\%} \right)$$

	Kd reference name	General remarks	Selected Log Kd	Kd cm3/g	EPA (2005) log Kd range (median) [n] {estimated mean} *SD*	Kd notes
Metal						
As	**0 high Kd**	Arsenic adsorption is dependent on pH, the arsenic oxidation state and temperature. In acidic and neutral waters, As(V) is extensively adsorbed, while As(III) is relatively weakly adsorbed (EA, 2007). In waters with a high pH, Kp values are considerably lower for both oxidation states.	**3.82**	6,607	n/a	-Principal ref: EA (2007), consistent with Verbruggen et al (2001) i.e. used in Netherlands assessments. - Note for info. EA (2007) particulate matter/water has Kd of 4. - Note for info. value used in SGV is 2.7 (EA, 2009); sand, loam & clay.
As	**1 recommended Kd**		**2.40**	251	1.6-4.3 (2.2) {2.4} *0.7*	- Principal ref: EPA (2005) lit review of sediment/porewater. - Good confidence in mean estimate, assumes log-normal data distribution. Assume representative of all As oxidation states. Assumes includes freshwater data (which would generally make precautionary).
As	**3 worst case Kd**		**1.60**	40	1.6-4.3 (2.2) {2.4} *0.7*	-Principal ref: EPA (2005) lit review. - Worst case/most precautionary from EPA sediment/porewater lit review.Assumes minimum value from literature review (within 2x SD from mean). No details of environmental conditions. - Assume representative of both As oxidation states. Largely freshwater. - In pH regimes of 9 and above, negatively charged arsenic(V) species should dominate. This negative charge, in conjunction with the increased negative charge on clay, should increase the mobility of the arsenic (V) species (Strenge & Peterson, 2004). Strenge & Peterson (2004) reduce Kd by an order of magnitude relative to pH5-9; for info a log Kd value of 2.0 is consistent with Strenge & Peterson-Cell 8.
Cd	**0 high Kd**	Cd Kd exhibits strong relationship with salinity. Where an assessment site is known to exhibit predominantly low salinities, the SeDiChem user is encouraged to use the highest cadmium Kd value ('0 high Kd') in assessments.	**4.93**	85,114	n/a	- Verbruggen et al (2001) i.e. used in Dutch assessments (4.93) focussed on pore water. - For info EQS dossier only contains only SPM Kd (130,000).
Cd	**1 recommended Kd**	Cd Kd exhibits strong relationship with salinity. Where site salinity change is large (most estuarine locations), noting that SeDiChem is a spot assessment with no temporal resolution change, the '1 recommended Kd' value remains most appropriate Kd selection.	**3.70**	5,012	0.5-7.3 (3.7) {3.3} *1.8*	- Principal ref: EPA (2005) sediment/pore water lit review. - Excellent confidence in mean estimate, assumes log-normal data distribution. Based on Cd(II) data. - Selected above Verbruggen et al (2001) given more precautionary and review of multiple sources.
Cd	**3 worst case Kd**	Cd Kd exhibits strong relationship with salinity. Where an assessment site is marine salinity dominated (approximating 35 ppt) the SeDiChem user is encouraged to use the lowest cadmium Kd value ('3 worst case Kd') in assessments.	**2.00**	100	n/a	-Principal ref: EA (2009b); presented as a worst case for information. Not directly relevant to a sediments study, because a soil-water partition value, taken from the SGV framework, itself taken from Thorne et al (2005. Likely to be overly precautionary and results should be treated with caution. - Minimum value from EPA (2005) rejected as likely to be an outlier and not representative.
Cr	**0 high Kd**	Note, Cr(III) is the dominant chromium species in the estuarine environment. Cr(VI) is reduced to Cr(III) in seconds and is effectively permanent.	**5.28**	190,546	n/a	- Verbruggen et al (2001) i.e. used in Dutch assessments (5.28) focussed on pore water.
Cr	**1 recommended Kd**		**4.57**	37,000	1.9-5.9 {4.9} *1.5*	- SKB (2009) marine benthic sediment-water Kd 37,000. -SKB (2009) lit review 30,000 [log Kd=4.5] (1.0 GSD), based on Turner (1996) only. - EPA (2005) values provided here. Selected SKB (2009) value as slightly more precautionary than mean EPA (2005) value, which itself is <Verbruggen et al (2001).
Cr	**3 worst case Kd**		**1.90**	79	1.9-5.9 {4.9} *1.5*	- EPA (2005) sediment/pore water. Assumes log-normal data distribution. Based on Cr(III) data. 2x SD from mean, which also equals minimum from lit review. - Very conservative relative to all other sources.
Cu	**1 recommended Kd**	When pH is low, copper adsorption is insignificant due to hydrogen ion competition for adsorption sites. In the case of high pH values (above 9), copper adsorption decreases because of the formation of soluble metal carbonate and hydroxides or metal organic complexes [adsorption is high at pH 8~marine waters and is salinity independent]. The copper adsorption can strongly be correlated to the content of adsorbed organic carbon. An increase of adsorbed organic carbon enhances the copper uptake and vice-versa. Copper partitioning is maximal at the neutral pH region [which includes pH8] and decreases at both low and high pH values. The fate of copper in natural waters depends on such partitioning characteristics in the solid-	**4.53**	33,884	n/a	- Verbruggen et al (2001), as used in Dutch assessments. - Median value of 10 European studies reported in ECI (2009) was 4.66 i.e. less conservative than this recommended value.
Cu	**2 low/conservative Kd**		**4.39**	24,409		- ECI (2009): Median value of 24,409 L/kg ((Log KD: 4.39) is derived using existing Environmental Concentration Distributions of background and ambient copper in surface water and sediment (indirect calculation from study data - hence difference from the median value quoted above). - Used the ECI (2009) value (even though not a regulatory authority) as slightly more conservative than Verbruggen et al. (2001) [log Kd 4.53]
Cu	**3 worst case Kd**		**3.50**	3,162	0.7-6.2 (4.1) [12] {3.5} 1.7	-EPA (2005) mean sediment-water Kd. - Not used lowest EPA data as outside of all European values found in literature, e.g. ECI (2009) calculated min and max (relevant combinations of sediment and water concentration percentiles) derived as 3.95 and 5.0 respectively, which shows 3.50 as suitably conservative.
Pb	**0 high Kd**		**5.63**	426,580		- Verbruggen et al. (2001), as used in Netherlands assessments.
Pb	**1 recommended Kd**		**5.19**	154,882		- Adopted EC(2011) 50th percentile Ksed - 154882 [5.19] (range 35,481 - 707,946) - Value chosen equivalent to SKB benthic sed-water is 150,000 [log Kd=5.2] - For information, SKB lit review (SPM related) 180,000 [log Kd=5.3] (9.3 GSD) based on 19 studies; - For information, IAEA coastal (SPM related) 100,000 [log Kd=5].
Pb	**3 worst case Kd**		**4.55**	35,481	2.0-7.0 (5.1) [14] {4.6} *1.9*	- Adopted the lower range extreme from EC(2011)i.e. 35,481 - Equivalent to EPA (2005) derived sediment-water mean Kd. Assumes log-normal data distribution, edited data. Based on Pb(II) data. Excellent confidence in value.
Hg	**1 recommended Kd**	Noted that pH will influence Hg Kd, but relationship for marine sediments is not well described. Quantitative relationship in soils is described in EPA (1999b), however not applied here. Higher pH ranges (of the EPA (1999b) data) into which marine waters would fall have higher Kd values. Therefore not deemed necessary to infer pH influence for	**5.05**	112,202	n/a	- Verbruggen et al. (2001) i.e. used in Netherlands assessments. Strictly speaking underlying data refers to anorganic mercury; it is not clear whether or not this value is applicable for methyl-mercury. No contamination studies reviewed separated sediment Hg data.
Hg	**2 low/conservative Kd**		**4.90**	79,433	3.8-6.0 [2] {4.9} 0.6	- Sediment/water (EPA, 2005). Assumes log-normal data distribution. Based on Hg(II) data. Moderate confidence in mean estimate.
Hg	**3 worst case Kd**		**3.80**	6,310	3.8-6.0 [2] {4.9} 0.6	- Minimum value from the EPA (2005) reviews. - Rejected the SGV soil-water Kd (EA, 2009c) for inorganic mercury (500) which is generic from Thorne et al (2005) and inconsistent with other sources.
Ni	**0 high Kd**		**3.90**	7,943	0.3-4.0 {3.9} 1.8	Sediment/water (EPA, 2005). Assumes log-normal data distribution. Based on Ni(II) data. For info (SKB, 2009): -IAEA coastal (SPM) 20,000 [log Kd=4.3]; -SKB lit review (SPM) 17,000 [log Kd=4.2] (11 GSD); -SKB benthic is 12,000 [log Kd=4.1] - EPA (2005) mean value log Kd=3.9 (all greater than this conservative SS value)
Ni	**1 recommended Kd**		**3.85**	7,079	n/a	EC (2011) 50th percentile Ksed is 7079 [log Ksed=3.85]
Ni	**3 worst case Kd**		**2.70**	500	n/a	- Adopted the SGV soil-water Kd (EA, 2009b), which itself is taken from Thorne et al (2005). Likely to be overly precautionary because derived for soils rather than marine sediments, but is within EPA (2005) data range, therefore reasonable and provides a precautionary approach. - EC(2011) lowest quoted of Ksed range is 2,138 [log Ksed=3.33] i.e. greater than the worst case adopted value here.
Zn	**1 recommended Kd**	EA (2012) found no distinct pH/Kd relationship, although the highest Kd values were observed between ~pH values of 7 and 8.	**4.86**	73,000	n/a	EC (2010) - EU Risk Assessment Report, Zn- value for Kpsed. Same data source as Zebruggen et al (2001).
Zn	**2 low/conservative Kd**		**4.57**	37,333		EC (2010) data values based on median data from Venema (1994). Lowest data from this set taken and same relationship between Kpsusp and Kpsed applied, to extract a minimum Kpsed.
Zn	**3 worst case Kd**		**4.10**	12,589	1.5-6.2 (4.8) [13] {4.1} 1.5	EPA (2005) mean sediment/water Kd. Assumes log-normal data distribution, edited data. Excellent confidence in mean. Adopted the mean value as represents a very precuationary value relative to the European data sets. Minimum EPA (2005) value disregarded.

For inorganics assume Kd=Koc x foc; where Koc is organic carbon partition coefficient and foc is fraction of organic carbon, unitless.

	Kd	Selected Log Kd (derived)	Kd cm3/g	Kd notes	f_{oc}	log Kow	Log Koc	Koc	Principal Ref	Acidity constant p*Ka*	pH correction factor
Organotins											
TBT	1 recommended Kd	**3.164**	1458.97	Regression analysis of data from several studies, reported in Meador (2000). Data supports hypothesis that organic carbon in sediment controls the amount of TBT in water. Because TBT in marine systems occurs predominantly as the hydroxide, the partitioning behaviour of TBT may be similar to that observed for neutral hydrophobic compounds and predictions generated by EqP may be valid (Meador, 2000a). Selected Kd approach is generally consistent with Bangkedphol et al (2009) (e.g. 12.1TOC% gives 3.351logKd using this xls, very close to the 3.34logKd determined by Bangkedphol et al (2009) - Bowling Basin sediments (pH 8.0; 0.2psu). Scale of change associated with salinity and temp (Bangkedphol et al, 2009) for the range that may be naturally expected is not deemed large enough to need accounting for within this assessment, plus natural temporal variations would complicate the assessment. The same could be said for pH but included pH adjustment factor given available data.	0.05		4.5	32,000	Koc - Meador (2000); Meador (2000a). pKa-Meador (2000).	6.25	0.9825279
TBT	2 precautionary Kd	**2.459**	287.67	MIE (2011) i.e. as per Netherlands sediment assessment methods.	0.05		3.8	6,310	MIE (2011).	6.25	0.9825279
TBT	3 worst case Kd	**1.694**	49.42	Koc used in derivation of the MAC (EC 2005)	0.05		3.0	1,084	EC (2005)	6.25	0.9825279
PAHs											
Benzo[a]pyrene	1 recommended Kd	**4.4**	27,258	Approximates Netherlands i.e. MIE (2011) - logKoc of 5.82 More precautionary than the LogKoc of 6.01 presented by EA (2003) - based on older data. Median Log Koc value of 6.7 from Hawthorne et al (2009) and partition coefficients quoted by PubChem (2018) i.e. >4.9, also suggest that this is a precautionary value.	0.046404	6.13	5.7689	587400	MDEQ (2015).	n/a	
Benzo[a]pyrene	2 precautionary Kd	**4.3**	20,795	EC (2011) EQS dossier. Kd is EC (2011) Ksed-water value, i.e. not linked to Koc.	0.046404		5.92	831764	EC (2011).	n/a	
Benzo[a]pyrene	3 worst case Kd	**4.0**	9,120	Eadie (1991) mean 9120 +/-5950 SD	/	/	/	/	Eadie (1991)	n/a	
Benzo[b]fluoranthene	1 recommended Kd	**4.4**	27,814	Approximates Netherlands i.e. MIE (2011) - log Koc of 5.76 Approximates LogKoc of 5.74 presented by EA (2003) - based on older data.	0.046404	5.78	5.8	599400	MDEQ (2015b) - Koc.	n/a	
Benzo[b]fluoranthene	2 precautionary Kd	**4.3**	20,795	EC (2011) EQS dossier. Kd is EC (2011) Ksed-water value, i.e. not linked to Koc.	0.046404		5.9	831764	EC (2011).	n/a	
Benzo[ghi]perylene	1 recommended Kd	**5.0**	90,534	Approximates Netherlands i.e. MIE (2011) - logKoc of 6.47	0.046404	6.63	6.3	1951000	MDEQ (2015).	n/a	
Benzo[ghi]perylene	2 precautionary Kd	**4.4**	25,583	EC (2011) EQS dossier. Kd is EC (2011) Ksed-water value, i.e. not linked to Koc.	0.046404		6.0	1023293	EC (2011)	n/a	
Benzo[ghi]perylene	3 worst case Kd	**4.3**	18,904	Less confidence compared to recommended value above. Value originally taken from SRC database.	0.046404		5.6	407380	EA (2003)	n/a	
Benzo[k]fluoranthene	1 recommended Kd	**4.4**	27,258	Approximates Netherlands i.e. MIE (2011) - log Koc of 5.75. More precautionary than the LogKoc of 6.09 presented by EA (2003) - based on older data. More precautionary than Log Koc range presented by PubChem (2018).	0.046404	6.11	5.8	587400	MDEQ (2015c).	n/a	
Benzo[k]fluoranthene	2 precautionary Kd	**4.3**	19,859	EC (2011) EQS dossier. Kd is EC (2011) Ksed-water value, i.e. not linked to Koc.	0.046404		5.9	794328	EC (2011).	n/a	
Fluoranthene	1 recommended Kd	**3.4**	2,573	Approximates Netherlands i.e. MIE (2011) - logKoc of 4.61. More precautionary than Eadie (1991) - mean Kd of 11396. More precautionary than LogKoc of 5.03 presented by EA (2003). More precautionary than LogKoc of 5.03 presented by EPA (2003). Approximates but is more precautionary than Delle Site (2001) - mean log Koc (sediments) 4.91	0.046404	5.16	4.7	55450	MDEQ (2015a).	n/a	
Fluoranthene	2 precautionary Kd	**3.1**	1,369	Based on worst case of Koc range - Brannon et. al. (1993).	0.046404		4.5	29500	Brannon et. al. (1993)	n/a	
PBDEs											
BDE-28	1 recommended Kd	**4.8**	62,596.89	Wang et al (2011) San Diego Creek data (Log Koc +-0.04 SD) - DOC of 6.49mg/l, sand/silt/clay.	0.046404		6.13	1,348,963	Wang et al (2011)	n/a	
BDE-28	2 precautionary Kd	**3.6**	4,136	Wang et al (2011) Greasy Creek sediment (Log Koc+-0.05 SD) - DOC of 3.39mg/l, sand dominated. More precautionary than Netherlands i.e. MIE (2011) - Log Koc of 5.5 (generic PBDE). Wei-Haas (2015) values (Koc values about an order of magnitude lower) not adopted as focussed entirely on aquatic DOM, rather than soil derived. Given current project focus of sediment disturbance, these values are deemed too low.	0.046404		4.95	89,125	Wang et al (2011)	n/a	
BDE-47	1 recommended Kd	**4.52**	32,851	Wang et al (2011) San Diego Creek data (Log Koc +-0.03 SD) - DOC of 6.49mg/l, sand/silt/clay.	0.046404		5.85	707,946	Wang et al (2011)	n/a	
BDE-47	2 precautionary Kd	**4.44**	27,325	Wang et al (2011) Greasy Creek sediment (Log Koc+-0.01 SD) - DOC of 3.39mg/l, sand dominated. Approximates the Netherlands generic PBDE value i.e. MIE (2011) - Log Koc of 5.5. For information, average of the literature values gathered by Wei-Haas (2015) produced Log Koc of 5.196. Wei-Haas (2015) values themselves(Koc values about an order of magnitude lower) not adopted as focussed entirely on aquatic DOM, rather than soil derived. Given current project focus of sediment disturbance, these values are deemed too low.	0.046404		5.77	588,844	Wang et al (2011)	n/a	
BDE-47	3 worst case Kd	**4.25**	17,793	EC (2011) EQS dossier. Kd estimated from EC (2011) Koc for consistency with other BDEs.	0.046404		5.58	383,440	EC (2011)	n/a	
BDE-99	1 recommended Kd	**4.92**	82,519	Wang et al (2011) San Diego Creek data (Log Koc +-0.02 SD) - DOC of 6.49mg/l, sand/silt/clay.	0.046404		6.25	1,778,279	Wang et al (2011)	n/a	
BDE-99	2 precautionary Kd	**4.86**	71,871	Wang et al (2011) Greasy Creek sediment (Log Koc+-0.01 SD) - DOC of 3.39mg/l, sand dominated. Less precautionary than Netherlands i.e. MIE (2011) - Log Koc of 5.5 (generic PBDE), however this is generic and confidence in Wang et al (2011) data is good. Wei-Haas (2015) aqautic DOM data not used, as above.	0.046404		6.19	1,548,817	Wang et al (2011)	n/a	
BDE-99	3 worst case Kd	**4.66**	45,631	EC (2011) EQS dossier. Kd taken estimated from Koc (measured) for consistency with other BDEs. Quoted Ksed-water lower range appears very low in any event.	0.046404		5.9927	983,340	EC (2011)	n/a	
BDE-100	1 recommended Kd	**5.0**	99,209	Wang et al (2011) San Diego Creek data (Log Koc +-0.00 SD) - DOC of 6.49mg/l, sand/silt/clay.	0.046404		6.33	2,137,962	Wang et al (2011)	n/a	
BDE-100	2 precautionary Kd	**4.66**	45,631	EC (2011) EQS dossier. Kd taken estimated from Koc (measured) for consistency with other BDEs. Quoted Ksed-water lower range appears very low in any event. Same PentaBDE group as PBE-99 above.	0.046404		5.9927	983,340	EC (2011)	n/a	
BDE-100	3 worst case Kd	**4.4**	27,325	Wang et al (2011) Greasy Creek sediment (Log Koc+-0.12 SD) - DOC of 3.39mg/l, sand dominated. Approximates the Netherlands i.e. MIE (2011) - Log Koc of 5.5 generic PBDE value.	0.046404		5.77	588,844	Wang et al (2011)	n/a	
BDE-153	1 recommended Kd	**5.1**	124,897	Wang et al (2011) San Diego Creek data (Log Koc +-0.01 SD) - DOC of 6.49mg/l, sand/silt/clay.	0.046404		6.43	2,691,535	Wang et al (2011)	n/a	
BDE-153	2 precautionary Kd	**4.9**	71,871	Wang et al (2011) Greasy Creek sediment (Log Koc+-0.02 SD) - DOC of 3.39mg/l, sand dominated. Less precautionary than Netherlands i.e. MIE (2011) - Log Koc of 5.5, however this is generic and confidence in Wang et al (2011) data is good. Wei-Haas (2015) aqautic DOM data not used, as above. Approximates the same as calculated value using EC (2011) Koc of 1740000.	0.046404		6.19	1,548,817	Wang et al (2011)	n/a	
BDE-154	1 recommended Kd	**5.1**	133,830	Wang et al (2011) San Diego Creek data (Log Koc +-0.00 SD) - DOC of 6.49mg/l, sand/silt/clay.	0.046404		6.46	2,884,032	Wang et al (2011)	n/a	
BDE-154	2 precautionary Kd	**5.1**	124,826	Using measured Koc of 2690000 from EC(2011).	0.046404		6.43	2690000	EC (2011)	n/a	
BDE-154	3 worst case Kd	**4.8**	58,419	Wang et al (2011) Greasy Creek sediment (Log Koc+-0.12 SD) - DOC of 3.39mg/l, sand dominated. Less precautionary than Netherlands i.e. MIE (2011) - Log Koc of 5.5, however this is generic and confidence in Wang et al (2011) data is good.	0.046404		6.10	1258925	Wang et al (2011)	n/a	
Others											
Hexachlorobenzene (HCB)	1 recommended Kd	**4.1**	14,014	Average Log Koc sediment value (5.11-5.85)	0.046404		5.48	301995	Delle Site (2001)	n/a	
Hexachlorobenzene (HCB)	2 precautionary Kd	**3.8**	5,978	Minimum value of Log Koc range	0.046404		5.11	128825	Delle Site (2001)	n/a	
Hexachlorobutadiene (HCBD)	0 High literature Kd	**3.6**	3,686	Log Koc provided in Canadian guidelines	0.046404		4.90	79433	CCME (1999)	n/a	
Hexachlorobutadiene (HCBD)	1 recommended Kd	**2.7**	521	More conservative than sediment Kd (1954.05) presented by EuroChlor(2002) and approx equal to calculated Kd value from EuroChlor(2002) Koc of 9371.	0.046404	4.78	4.05	11220	MIE (2011) - log Koc of 4.05	n/a	
Hexabromocyclododecane (HBCDD)	0 High literature Kd	**3.6**	4,223	Koc provided in EPA (2014)	0.046404		4.96	91000	EPA (2014)	n/a	
Hexabromocyclododecane (HBCDD)	1 recommended Kd	**3.3**	2,121	Based on Koc value used for derivation of EU quality standards - dynamic i.e. linked to foc.	0.046404		4.66	45709	EC(2011)	n/a	
Hexabromocyclododecane (HBCDD)	2 precautionary Kd	**3.1**	1143.7	Based on Ksed-water (fixed value) quoted by CIS (2011) / EC(2011)					CIS (2011)	n/a	