

Support Information

Sorption and desorption of sex hormones in soil- and sediment-water systems: A review

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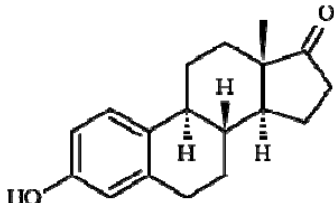
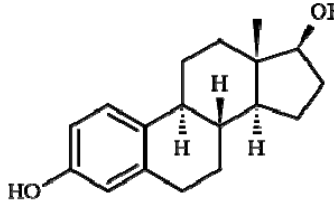
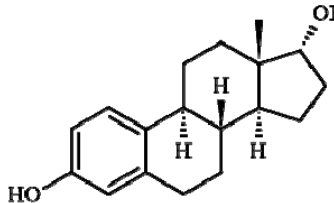
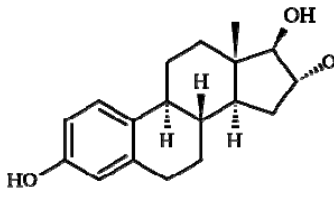
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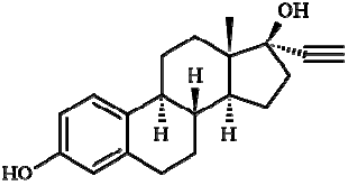
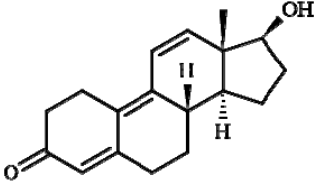
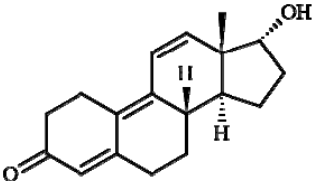
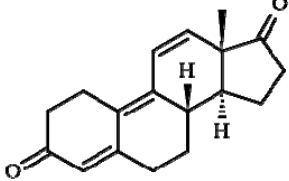
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Table S1 Classification and physicochemical properties of sex hormones.

MF ^a /CAS ^b /MW ^c	Structure	Physiochemical properties
Estrogens		
Estrone (E1)		Log K_{ow} ^d : 3.43 ^e , 3.55 ^f , 2.95 ^g
MF: C ₁₆ H ₂₂ O ₂		S_w ^h (mg/L): 146.8 ^e , 3.94 ⁱ
CAS: 53-16-7		pK_a ^j : 10.33 ⁱ , 10.4 ^k
MW: 270.4		VP ^l (Pa): 0.679 ^e , 3×10^{-5m}
17 β -Estradiol (17 β -E2)		Log K_{ow} : 3.94 ^e , 3.70 ^f , 3.86 ^g
MF: C ₁₈ H ₂₄ O ₂		S_w (mg/L): 81.97 ^e , 21.3 ⁱ
CAS: 50-28-2		pK_a : 10.33 ⁱ , 10.23 ⁿ
MW: 272.4		VP (Pa): 2.65×10^{-7e} , 3×10^{-5m}
17 α -Estradiol (17 α -E2)		Log K_{ow} : 3.94 ^e , 3.73 ^f
MF: C ₁₈ H ₂₄ O ₂		S_w (mg/L): 81.97 ^e
CAS: 57-91-0		pK_a : NA ^o
MW: 272.4		VP (Pa): 2.65×10^{-7e} , 3×10^{-5m}
Estriol (E3)		Log K_{ow} : 2.81 ^e , 2.45 ^g , 2.6 ^p
MF: C ₁₈ H ₂₄ O ₃		S_w (mg/L): 440.8 ^e , 119 ⁱ
CAS: 50-27-1		pK_a : 10.33 ⁱ , 10.05 ⁿ
MW: 288.4		VP (Pa): 1.25×10^{-9e} , 3×10^{-8m}

17 α -Ethinylestradiol (EE2)		Log K_{ow} : 4.16 ^c , 3.67 ^g S_w (mg/L): 116.4 ^e , 6.67 ⁱ pK_a : 10.33 ⁱ , 10.21 ⁿ VP (Pa): 2.65 $\times 10^{-7d}$, 6 $\times 10^{-9i}$
MF: C ₂₀ H ₂₄ O ₂		
CAS: 57-63-6		
MW: 296.4		
MF ^a /CAS ^b /M ^c	Structure	Physiochemical properties
Androgens		
17 β -Trenbolone (17 β -TBOH)		Log K_{ow} : 2.65 ^e , 3.08 ^q S_w (mg/L): 324.1 ^e , 58.6 ⁱ pK_a : 18.4 ⁱ VP (Pa): 2.48 $\times 10^{-6e}$
MF: C ₁₈ H ₂₂ O ₂		
CAS: 10161-33-8		
MW: 270.37		
17 α -Trenbolone (17 α -TBOH)		Log K_{ow} : 2.65 ^e , 2.72 ^q S_w (mg/L): 324.1 ^e pK_a : NA VP (Pa): 2.48 $\times 10^{-6e}$
MF: C ₁₈ H ₂₂ O ₂		
CAS: 80657-17-6		
MW: 270.37		
Trendione (TBO)		Log K_{ow} : 2.13 ^e , 2.63 ^q S_w (mg/L): 277.4 ^c pK_a : NA VP (Pa): 2.28 $\times 10^{-4e}$
MF: C ₁₈ H ₂₀ O ₂		
CAS: 4642-95-9		
MW: 268.37		

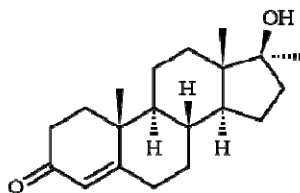
17 α -methyltestosterone

(MT)

MF: C₂₀H₃₀O₂

CAS: 58-18-4

MW: 302.45



Log K_{ow} : 3.72^e, 3.36^r

S_w (mg/L): 22.45^e, 13.9ⁱ, 3.4^f

pK_a : 19.09ⁱ

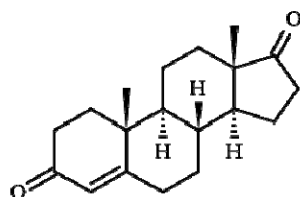
VP (Pa): 1.84 $\times 10^{-6e}$

Androstenedione (AED)

MF: C₂₁H₃₀O₂

CAS: 63-05-8

MW: 286.41



Log K_{ow} : 2.76^e

S_w (mg/L): 65.97^e, 27ⁱ

pK_a : 19.03ⁱ

VP (Pa): 1.77 $\times 10^{-6e}$

MF^a/CAS^b/MW^c

Structure

Physiochemical properties

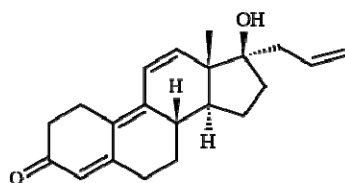
Progestins

Altrenogest (ALT)

MF: C₂₁H₂₆O₂

CAS: 850-52-2

MW: 310.44



Log K_{ow} : 3.71^e, 3.44^s

S_w (mg/L): 23.31^e, 30.1ⁱ

pK_a : 18.4ⁱ

VP (Pa): 1.04 $\times 10^{-6e}$

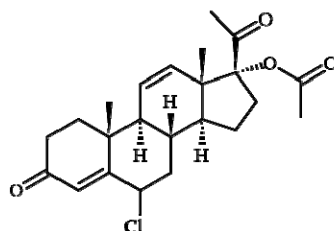
Chlormadinone acetate

(CMA)

MF: C₂₃H₂₉ClO₄

CAS: 302-22-7

MW: 404.93

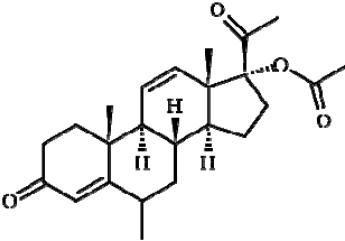
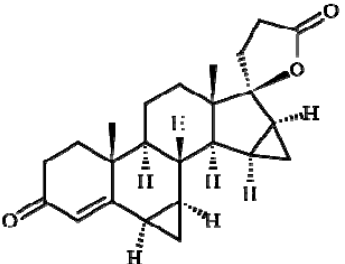
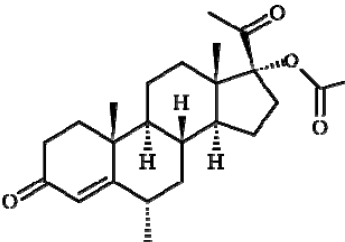
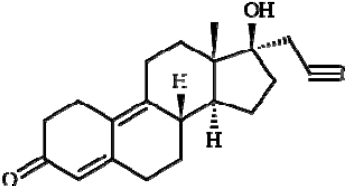


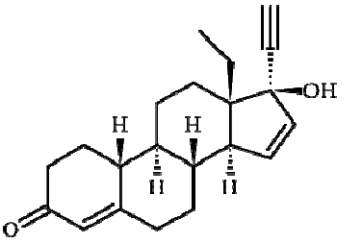
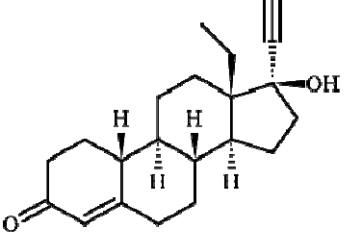
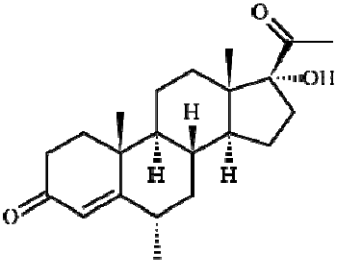
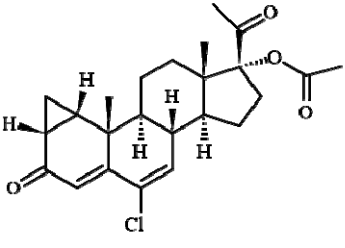
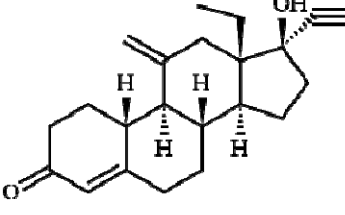
Log K_{ow} : 3.95^e, 3.72^s

S_w (mg/L): 0.324^t

pK_a : NA

VP (Pa): 4.3 $\times 10^{-7e}$

Progestins/MF ^a /CAS ^b /MW ^c	Structure	Physiochemical properties
<p>Megestrol acetate (MGA)</p> <p>MF: C₂₄H₃₂O₄</p> <p>CAS: 595-33-5</p> <p>MW: 384.51</p>		<p>LogK_{ow}: 4.0^e, 3.82^s</p> <p>S_w (mg/L): 1.46^e, 3.36ⁱ, 2.0^t</p> <p>pK_a: 17.83ⁱ</p> <p>VP (Pa): 5.83×10^{-7e}</p>
<p>Drospirenone (DRO)</p> <p>MF: C₂₄H₃₀O₃</p> <p>CAS: 67392-87-4</p> <p>MW: 366.49</p>		<p>LogK_{ow}: 4.02^e, 3.12^s</p> <p>S_w (mg/L): 0.46^e, 2.25ⁱ</p> <p>pK_a: -5ⁱ</p> <p>VP (Pa): 2.98×10^{-7e}</p>
<p>Medroxyprogesterone acetate (MPA)</p> <p>MF: C₂₄H₃₄O₄</p> <p>CAS: 71-58-9</p> <p>MW: 386.52</p>		<p>LogK_{ow}: 4.09^d, 3.85ⁿ</p> <p>S_w (mg/L): 1.20^e, 2.21ⁱ</p> <p>pK_a: 17.82ⁱ</p> <p>VP (Pa): 8.94×10^{-7e}</p>
<p>Dienogest (DIE)</p> <p>MF: C₂₀H₂₅NO₂</p> <p>CAS: 65928-58-7</p> <p>MW: 311.42</p>		<p>LogK_{ow}: 2.34^e, 2.15^s</p> <p>S_w (mg/L): 57.1^e, 76.1ⁱ</p> <p>pK_a: 13.78ⁱ</p> <p>VP (Pa): 1.67×10^{-8e}</p>

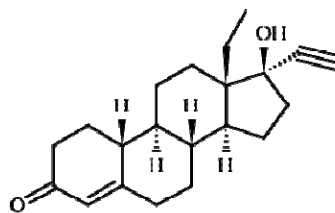
Gestodene (GES)		Log K_{ow} : 3.26 ^c S_w (mg/L): 56.2 ^e , 5.8 ⁱ , 8.12 ^t pK_a : 17.08 ⁱ VP (Pa): 1.50×10^{-7e}
MF: C ₂₁ H ₂₆ O ₂		
CAS: 60282-87-3		
MW: 310.43		
Progestins/MF ^a /CAS ^b /MW ^c	Structure	Physiochemical properties
Levonorgestrel (LNG)		Log K_{ow} : 3.48 ^c S_w (mg/L): 35.8 ^e , 5.8 ⁱ , 2.05 ^t pK_a : 17.91 ⁱ VP (Pa): 1.34×10^{-7e}
MF: C ₂₁ H ₂₈ O ₂		
CAS: 797-63-7		
MW: 312.45		
Medroxyprogesterone (MPG)		Log K_{ow} : 3.50 ^e S_w (mg/L): 22.2 ^e , 2.95 ^t pK_a : NA ^o VP (Pa): 2.58×10^{-8e}
MF: C ₂₂ H ₃₂ O ₃		
CAS: 520-85-4		
MW: 344.49		
Cyproterone acetate (CPA)		Log K_{ow} : 4.18 ^e , 3.1 ^t S_w (mg/L): 0.65 ^e , 1.5 ⁱ , 51.7 ^t pK_a : 17.83 ⁱ VP (Pa): 4.24×10^{-7e}
MF: C ₂₄ H ₂₉ ClO ₄		
CAS: 427-51-0		
MW: 416.94		
Etonogestrel (ETO)		Log K_{ow} : 3.89 ^e , 3.16 ^t S_w (mg/L): 57.1 ^e , 7.37 ⁱ pK_a : 17.99 ⁱ VP (Pa): 1.68×10^{-7e}
MF: C ₂₂ H ₂₈ O ₂		
CAS: 54048-10-1		
MW: 324.45		

Norgestrel^u (NGT)

MF: C₂₁H₂₈O₂

CAS: 6533-00-2

MW: 312.45



Log K_{ow} : 3.48^e

S_w (mg/L): 35.8^e, 5.83ⁱ, 1.7^t

pK_a : 17.91ⁱ

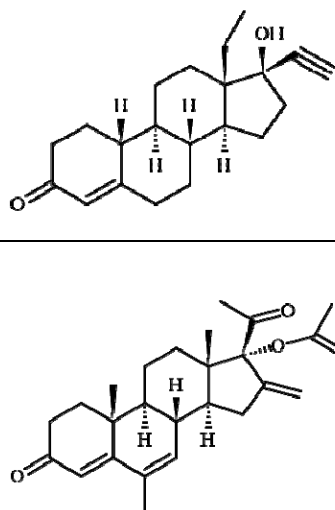
VP (Pa): 1.34×10^{-7e}

Melengestrol acetate (MLA)

MF: C₂₅H₃₂O₄

CAS: 2919-66-6

MW: 396.52



Log K_{ow} : 4.41^e, 3.93^f

S_w (mg/L): 0.55^e, 1.47ⁱ

pK_a : 17.54ⁱ

VP (Pa): 6.08×10^{-7e}

^a MF represents molecular formula.

^b CAS represents chemical abstracts service.

^c MW represents molecular weight.

^d Log K_{ow} represents octanol-water partition coefficient.

^e Log K_{ow} values were estimated by EPI suite program (KOWWIN v4.11).

^f Log K_{ow} values were obtained from Card et al. (2012a).

^g Log K_{ow} values were obtained from Machatha and Yalkowsky (2005).

^h S_w represents water solubility.

ⁱ S_w values were obtained from Wishart (2018).

^j pK_a represents dissociation constant.

^k pK_a values were obtained from Nghiem and Schafer (2002).

^l VP represents vapor pressure (Pa).

^m VP values were obtained from Adeel et al. (2017).

ⁿ pK_a values were obtained from Perrin DD (1977).

^o NA: not available.

^p $\text{Log}K_{ow}$ values were obtained from Lee et al. (2003).

^q $\text{Log}K_{ow}$ values were obtained from Khan et al. (2009).

^r $\text{Log}K_{ow}$ and S_w values were obtained from Ong et al. (2012a).

^s $\text{Log}K_{ow}$ values were obtained from Yang et al. (2020a).

^t $\text{Log}K_{ow}$ and S_w values were obtained from Liu et al. (2011).

^u NGT is a synthetic progestin comprising a 50% racemic mixture, so we provided the structures for both the stereoisomers.

Table S2 Sorption parameters for the estrogens.

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
Estrone	Soil	1.3	85	2	12			26				3.34	(Ying and Kookana, 2005)
Estrone	Soil	0.85	84	4	10			26				3.49	(Ying and Kookana, 2005)
Estrone	Soil	1.8	27	23	48			54				3.48	(Ying and Kookana, 2005)
Estrone	soil	2.9	52	20	25			108				3.57	(Ying and Kookana, 2005)
Estrone	PL (27) soil	3.11	23	40	37	29.4		39.9				3.10	(Caron et al., 2010)
Estrone	MBU (3) soil	5.99	33	51	16	20.6		36.4				2.99	(Caron et al., 2010)
Estrone	BT(24) soil	2.49	38	36	26	24.1		30.2				3.19	(Caron et al., 2010)
Estrone	AP (26) soil	2.54	42	37	21	24.1		41.3				3.23	(Caron et al., 2010)
Estrone	MMG(15)soil	1.63	49	32	19	18		24.2				3.20	(Caron et al., 2010)
Estrone	FG (6) soil	2.38	33	38	29	26.1		40.9				3.23	(Caron et al., 2010)
Estrone	MG (20) soil	1.01	41	35	24	15.7		18.0				3.26	(Caron et al., 2010)
Estrone	Br.C (17) soil	0.95	40	35	25	15.9		16.5				3.26	(Caron et al., 2010)
Estrone	DBr.C(18)soi 1	1.51	49	32	19	19		25.7				3.25	(Caron et al., 2010)
Estrone	Bl.C (41) soil	2.68	39	37	24	25.1		40.3				3.20	(Caron et al., 2010)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
Estrone	DGC (9) soil	3.13	25	41	34	31.9		40.3				3.10	(Caron et al., 2010)
Estrone	GL (23) soil	2.92	27	40	33	24.2		34.1				3.12	(Caron et al., 2010)
Estrone	DGL (13) soil	2.96	36	39	25	24.2		31.9				3.18	(Caron et al., 2010)
Estrone	U (41) soil	1.87	22.8	50.2	27	22.8		28.1				3.21	(Caron et al., 2010)
Estrone	M (39) soil	2.09	22.1	52.9	25	22.1		32.6				3.21	(Caron et al., 2010)
Estrone	L (41) soil	3.14	24.6	49.4	26	24.6		37.7				3.15	(Caron et al., 2010)
Estrone	Irrigated soil	2.6	13	39	48	37.9	66		13.1	ug ¹⁻ⁿ L ⁿ g ⁻¹	1.08		(Durán-Álvarez et al., 2014)
Estrone	Rainfed soil	0.8	26.5	48.5	25	12.1	18		7.1	ug ¹⁻ⁿ L ⁿ g ⁻¹	1.23		(Durán-Álvarez et al., 2014)
Estrone	Manawatu	3.3	87	11	2	9.7	13.6	40.49	35.99	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.99	3.42	(Sarmah et al., 2008)
Estrone	Horotiu	5.5	19	58	23	36	224	50.17	42.19	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.96	3.46	(Sarmah et al., 2008)
Estrone	Pukehoke	2.4	5	31	64	30	48.9	12.29	10.85	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.82	3.06	(Sarmah et al., 2008)
Estrone	C32	1.1	88	7	5	4.3		11.2				3.00	(Card et al., 2012b)
Estrone	D36	4	17	47	36	15.5		17.8				2.64	(Card et al., 2012b)
Estrone	FC	7.7	17	46	37	20.2		36.2				2.67	(Card et al., 2012b)
Estrone	250 um soil							32.1	8.7	ugg ⁻¹ /mgL ⁻¹	1.37	3.17	(Gineys et al., 2012)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
Estrone	Sand	0.1	98.8	1.2	0			4.7	4		1.12	3.62	(Karnjanapiboonwong et al., 2010)
Estrone	Sandy loam	1.3	74	10	16			67.7	67.1		1.54	3.72	(Karnjanapiboonwong et al., 2010)
Estrone	Silt loam	2.5	34	54	12			121.6	113.8		1.1	3.69	(Karnjanapiboonwong et al., 2010)
Estrone	Horotiu	8.2	34	48	17	28.2	19.7	37.5	44	mg ¹⁻ⁿ L ⁿ kg ⁻¹	1.115	2.66	(Scherr et al., 2010)
Estrone	Hamilton	4	19	51	30	17.2	22.3	34.2	34.2	mg ¹⁻ⁿ L ⁿ kg ⁻¹	1.001	2.93	(Scherr et al., 2010)
Estrone	Te Kowhai	5	9	54	37	21.7	19.7	71.7	57.2	mg ¹⁻ⁿ L ⁿ kg ⁻¹	0.837	3.15	(Scherr et al., 2010)
Estrone	Whole silty lo1	2.55				16.6	19.9	75.1				3.47	(Sangster et al., 2015)
Estrone	Sand 1	2.1				4.0	14.2	45.94				3.34	(Sangster et al., 2015)
Estrone	Silt large 1	0.87				3.3	4.55	25.68				3.47	(Sangster et al., 2015)
Estrone	Silt small 1	1.45				4.6	6	19.11				3.12	(Sangster et al., 2015)
Estrone	Clay 1	6.39				29.3	41.7	254.40				3.6	(Sangster et al., 2015)
Estrone	Colloid 1	4.17				42.3	47.9	182.03				3.64	(Sangster et al., 2015)
Estrone	Whole sand 2	0.23				0.23	1.36	1.1				2.6	(Sangster et al., 2015)
Estrone	EPA-13 sediment	4.5					12.5		-0.745	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.876		(Yu et al., 2004)
Estrone	EPA-15 sediment	0.95	15.6	48.7	35.7		15.2		-0.614	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.66		(Yu et al., 2004)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
Estrone	EPA-18 sediment	0.66	34.6	25.8	39.5		12.6		-1.013	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.7		(Yu et al., 2004)
Estrone	EPA-21 sediment	1.88	50.2	42.7	7.1		6.96		-0.611	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.746		(Yu et al., 2004)
Estrone	EPA-23 sediment	2.38	17.3	13.6	69.1		33.2		-0.544	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.767		(Yu et al., 2004)
Estrone	EPA-26 sediment	1.48	1.6	55.4	42.9		16.2		-0.662	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.703		(Yu et al., 2004)
Estrone	BS1 sediment	0.41	98.2	0.2	1.6		8.8	66.8	61.6	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.96	4.21	(Chen et al., 2012)
Estrone	BS2 sediment	1.21	98.2	1.4	10.4		4.8	47.4	28.3	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.65	3.59	(Chen et al., 2012)
Estrone	BS3 sediment	3.96	80.3	21.7	0.5		10.2	55.5	33.9	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.51	3.15	(Chen et al., 2012)
Estrone	BS4 sediment	1.81	96.3	2.2	1.5		4.3	11.9	11.7	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.99	2.82	(Chen et al., 2012)
Estrone	Drummer	2.91	13	65.8	21.2	26.5		48.1	44.8	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.65	3.22	(Das et al., 2004)
Estrone	EPA1	0.22	93.9	0	6.1	1.07		3.4				3.19	(Das et al., 2004)
17β-estradiol	Chelsea soil	5.45					3.92		0.177	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.593	3.73	(Yu et al., 2004)
17β-estradiol	Soil	1.3	85	2	12			55				3.62	(Ying and Kookana, 2005)
17β-estradiol	Soil	0.85	84	4	10			31				3.56	(Ying and Kookana, 2005)
17β-estradiol	Soil	1.8	27	23	48			30				3.44	(Ying and Kookana, 2005)
17β-estradiol	soil	2.9	52	20	25			123				3.63	(Ying and Kookana, 2005)
17β-estradiol	EPA14 soil	0.48	2	34	64	18.9		83.2				3.46	(Lee et al., 2003)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
17 β -estradiol	7CB soil	7.5	68.8	24.4	6.8	41		101.9				3.13	(Mashtare et al., 2011)
17 β -estradiol	Coloma-32 soil	0.6	88	7	5	4.3		18.8				3.47	(Mashtare et al., 2011)
17 β -estradiol	Drummer-36 soil	2.3	17	47	36	15.5		32.6				3.15	(Mashtare et al., 2011)
17 β -estradiol	EPA-14 soil	0.5	2.1	34.4	63.6	18.9		4.4				2.96	(Mashtare et al., 2011)
17 β -estradiol	Oak-soil	0.5	92	4	4	2.7		6.6				3.11	(Mashtare et al., 2011)
17 β -estradiol	Raub soil	1.4	10.5	65.7	23.8	23.3		17.9				3.12	(Mashtare et al., 2011)
17 β -estradiol	Toronto soil	1.3	12	68	20	11.2		14.8				3.06	(Mashtare et al., 2011)
17 β -estradiol	PL (27) soil	3.11	23	40	37	29.4		28.1				2.94	(Caron et al., 2010)
17 β -estradiol	MBU (3) soil	5.99	33	51	16	20.6		33.8				2.88	(Caron et al., 2010)
17 β -estradiol	BT(24) soil	2.49	38	36	26	24.1		20.9				3.00	(Caron et al., 2010)
17 β -estradiol	AP (26) soil	2.54	42	37	21	24.1		27				3.06	(Caron et al., 2010)
17 β -estradiol	MMG (15) soil	1.63	49	32	19	18		19.0				3.09	(Caron et al., 2010)
17 β -estradiol	FG (6) soil	2.38	33	38	29	26.1		27.9				3.07	(Caron et al., 2010)
17 β -estradiol	MG (20) soil	1.01	41	35	24	15.7		12.4				3.10	(Caron et al., 2010)
17 β -estradiol	Br.C (17) soil	0.95	40	35	25	15.9		11.8				3.11	(Caron et al., 2010)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
17 β -estradiol	DBr.C (18) soil	1.51	49	32	19	19		18.3				3.10	(Caron et al., 2010)
17 β -estradiol	Bl.C (41) soil	2.68	39	37	24	25.1		28.5				3.04	(Caron et al., 2010)
17 β -estradiol	DGC (9) soil	3.13	25	41	34	31.9		27.2				2.94	(Caron et al., 2010)
17 β -estradiol	GL (23) soil	2.92	27	40	33	24.2		22.6				2.94	(Caron et al., 2010)
17 β -estradiol	DGL (13) soil	2.96	36	39	25	24.2		23.2				3.00	(Caron et al., 2010)
17 β -estradiol	U (41) soil	1.87	22.8	50.2	27	22.8		21				3.07	(Caron et al., 2010)
17 β -estradiol	M (39) soil	2.09	22.1	52.9	25	22.1		20.8				3.03	(Caron et al., 2010)
17 β -estradiol	L (41) soil	3.14	24.6	49.4	26	24.6		26.9				2.99	(Caron et al., 2010)
17 β -estradiol	Irrigated soil	2.6	13	39	48	37.9	66		9.5	ug ¹⁻ⁿ L ⁿ g ⁻¹	1.14		(Durán-Álvarez et al., 2014)
17 β -estradiol	Rainfed soil	0.8	26.5	48.5	25	12.1	18		5.1	ug ¹⁻ⁿ L ⁿ g ⁻¹	1.37		(Durán-Álvarez et al., 2014)
17 β -estradiol	Manawatu	3.3	87	11	2	9.7	13.6	35.84	33.44	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.95	3.23	(Sarmah et al., 2008)
17 β -estradiol	Horotiu	5.5	19	58	23	36	224	170.5	182.7	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.98	3.29	(Sarmah et al., 2008)
17 β -estradiol	Egmont	9.7	32	39	29	42		66.70	62.67	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.7	3.01	(Sarmah et al., 2008)
17 β -estradiol	Pukehoke	2.4	5	31	64	30	48.9	14.08	11.44	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.7	3.36	(Sarmah et al., 2008)
17 β -estradiol	Groseclose	2.2				5.45		21.84				3.00	(Kozarek et al., 2008)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
17 β -estradiol	Myatt	1.8				4.61		21.35				3.22	(Kozarek et al., 2008)
17 β -estradiol	Cecil Bt	0.1				3.76		9.88				3.99	(Kozarek et al., 2008)
17 β -estradiol	C32	1.1	88	7	5	4.3		7.65				2.84	(Card et al., 2012b)
17 β -estradiol	D36	4	17	47	36	15.5		26.2				2.81	(Card et al., 2012b)
17 β -estradiol	FC	7.7	17	46	37	20.2		52.1				2.83	(Card et al., 2012b)
17 β -estradiol	DX soil	1.91	18	40	42	27.1	28.48		0.791	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.361		(Li et al., 2013)
17 β -estradiol	Soil1	1.18	75.63	21.76	2.61			13.4	26.2	mg ¹⁻ⁿ L ⁿ kg ⁻¹	1.07	3.4	(Zhang et al., 2012)
17 β -estradiol	Soil 2	2.27	81.17	17.29	1.54			33.7	57.5	mg ¹⁻ⁿ L ⁿ kg ⁻¹	0.74	3.3	(Zhang et al., 2012)
17 β -estradiol	SOIL A	1.9	79	13	8	15		35.2				2.87	(Amin et al., 2012)
17 β -estradiol	Soil B	1.6	72	17	11	8		29.6				3.22	(Amin et al., 2012)
17 β -estradiol	Soil C	1.2	72	17	11	8		23.6				3.02	(Amin et al., 2012)
17 β -estradiol	EPA-6	0.72	0.2	31.2	68.6	33						4.3	(Takigami et al., 2011)
17 β -estradiol	EPA-14	0.48	2.1	34.4	63.6	19						4.3	(Takigami et al., 2011)
17 β -estradiol	Sand	0.1	98.8	1.2	0			3.8	4.3		1.18	3.58	(Karnjanapiboonwong et al., 2010)
17 β -estradiol	Sandy loam	1.3	74	10	16			115.8	134.9		1.12	3.95	(Karnjanapiboonwong et al., 2010)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K _d (L/Kg)	K _f	K _f unit	1/n _s	LogK _{oc}	Reference
17β-estradiol	Silt loam	2.5	34	54	12			198	207.3		1.1	3.9	(Karnjanapiboon wong et al., 2010)
17β-estradiol	Whole silty lo1	2.55				16.6	19.9	71.9				3.45	(Sangster et al., 2015)
17β-estradiol	Sand 1	2.1				4.0	14.2	22.50				3.03	(Sangster et al., 2015)
17β-estradiol	Silt large 1	0.87				3.3	4.55	17.36				3.3	(Sangster et al., 2015)
17β-estradiol	Silt small 1	1.45				4.6	6	20.02				3.14	(Sangster et al., 2015)
17β-estradiol	Clay 1	6.39				29.3	41.7	180.09				3.45	(Sangster et al., 2015)
17β-estradiol	Colloid 1	4.17				42.3	47.9	123.07				3.47	(Sangster et al., 2015)
17β-estradiol	Whole sand 2	0.23				0.23	1.36	2.54				3.04	(Sangster et al., 2015)
17β-estradiol	Sand	0.94	99.8	0	0.2				34	ng ¹⁻ⁿ mL ⁿ g ⁻¹	0.8		(Cindy et al., 2006)
17β-estradiol	Tillage soil 1	0.85	62	18	20	3		19.12	36.92	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.92	3.35	(Sangsupan et al., 2006)
17β-estradiol	Tillage soil 2	0.43	60.7	15.3	24	3.3		13.25	28.28	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.87	3.19	(Sangsupan et al., 2006)
17β-estradiol	No Tillage soil1	0.88	63.3	19.3	17.3	2.9		21.9	36.35	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.92	3.37	(Sangsupan et al., 2006)
17β-estradiol	No Tillage soil2	0.38	65.3	18	16.7	3.6		9.56	24.31	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.87	3.06	(Sangsupan et al., 2006)
17β-estradiol	EPA-13 sediment	4.5					12.5		-0.129	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.728	3.68	(Yu et al., 2004)
17β-estradiol	EPA-15 sediment	0.95	15.6	48.7	35.7		15.2		0.010	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.475	3.8	(Yu et al., 2004)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
17 β -estradiol	EPA-18 sediment	0.66	34.6	25.8	39.5		12.6		-0.255	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.55	3.78	(Yu et al., 2004)
17 β -estradiol	Aquifer sediment	0.5	83	1.1	3.1	2.4			21.8	ug ¹⁻ⁿ L ⁿ kg ⁻¹	2.5	3.64	(Ying et al., 2003)
17 β -estradiol	EPA1 sediment	0.22	94	0	6	1.1		3.56			-	3.21	(Lee et al., 2003)
17 β -estradiol	BS1 sediment	0.41	98.2	0.2	1.6		8.8	56.8	1660	ug ¹⁻ⁿ L ⁿ kg ⁻¹	2.1	3.93	(Chen et al., 2012)
17 β -estradiol	BS2 sediment	1.21	98.2	1.4	10.4		4.8	166	141.1	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.95	4.14	(Chen et al., 2012)
17 β -estradiol	BS3 sediment	3.96	80.3	21.7	0.5		10.2	78	76.3	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.05	3.29	(Chen et al., 2012)
17 β -estradiol	BS4 sediment	1.81	96.3	2.2	1.5		4.3	7.9	8.19	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.88	2.73	(Chen et al., 2012)
17 β -estradiol	Drummer	2.91	13	65.8	21.2	26.5		83.2	43.4	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.74	3.46	(Das et al., 2004)
17 β -estradiol	EPA1	0.22	93.9	0	6.1	1.07		3.56				3.21	(Das et al., 2004)
17 α -estradiol	7CB soil	7.5	68.8	24.4	6.8	41		62.4				2.92	(Mashtare et al., 2011)
17 α -estradiol	Coloma-32 soil	0.6	88	7	5	4.3		9.9				3.19	(Mashtare et al., 2011)
17 α -estradiol	Drummer-36 soil	2.3	17	47	36	15.5		22.8				3	(Mashtare et al., 2011)
17 α -estradiol	EPA-14 soil	0.5	2.1	34.4	63.6	18.9		2.8				2.77	(Mashtare et al., 2011)
17 α -estradiol	Oak-soil	0.5	92	4	4	2.7		6.2				3.08	(Mashtare et al., 2011)
17 α -estradiol	Raub soil	1.4	10.5	65.7	23.8	23.3		11.4				2.93	(Mashtare et al., 2011)
17 α -estradiol	Toronto soil	1.3	12	68	20	11.2		10.7				2.92	(Mashtare et al.,

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
													2011)
17 α -estradiol	7CB soil	7.5	68.8	24.4	6.8	41		62.4				2.92	(Mashtare et al., 2011)
17 α -estradiol	Coloma-32 soil	0.6	88	7	5	4.3		9.9				3.19	(Mashtare et al., 2011)
17 α -estradiol	Drummer-36 soil	2.3	17	47	36	15.5		22.8				3	(Mashtare et al., 2011)
17 α -estradiol	EPA-14 soil	0.5	2.1	34.4	63.6	18.9		2.8				2.77	(Mashtare et al., 2011)
17 α -estradiol	Oak-soil	0.5	92	4	4	2.7		6.2				3.08	(Mashtare et al., 2011)
17 α -estradiol	Raub soil	1.4	10.5	65.7	23.8	23.3		11.4				2.93	(Mashtare et al., 2011)
17 α -estradiol	Toronto soil	1.3	12	68	20	11.2		10.7				2.92	(Mashtare et al., 2011)
17 α -estradiol	7CB soil	7.5	68.8	24.4	6.8	41		62.4				2.92	(Mashtare et al., 2011)
Estriol	Soil	1.3	85	2	12			17				3.11	(Ying and Kookana, 2005)
Estriol	Soil	0.85	84	4	10			9				3.05	(Ying and Kookana, 2005)
Estriol	Soil	1.8	27	23	48			16				2.94	(Ying and Kookana, 2005)
Estriol	Soil	2.9	52	20	25			68				3.37	(Ying and Kookana, 2005)
Estriol	PL (27) soil	3.11	23	40	37	29.4		25.5				2.90	(Caron et al., 2010)
Estriol	MBU (3) soil	5.99	33	51	16	20.6		33.3				2.86	(Caron et al., 2010)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
Estriol	BT(24) soil	2.49	38	36	26	24.1		22.8				3.05	(Caron et al., 2010)
Estriol	AP (26) soil	2.54	42	37	21	24.1		33.6				3.14	(Caron et al., 2010)
Estriol	MMG (15) soil	1.63	49	32	19	18		16.0				3.02	(Caron et al., 2010)
Estriol	FG (6) soil	2.38	33	38	29	26.1		25.4				3.02	(Caron et al., 2010)
Estriol	MG (20) soil	1.01	41	35	24	15.7		9.8				3.00	(Caron et al., 2010)
Estriol	Br.C (17) soil	0.95	40	35	25	15.9		9.2				2.99	(Caron et al., 2010)
Estriol	DBr.C (18) soil	1.51	49	32	19	19		15.3				3.04	(Caron et al., 2010)
Estriol	Bl.C (41) soil	2.68	39	37	24	25.1		32.2				3.09	(Caron et al., 2010)
Estriol	DGC (9) soil	3.13	25	41	34	31.9		30.0				2.98	(Caron et al., 2010)
Estriol	GL (23) soil	2.92	27	40	33	24.2		20.6				2.90	(Caron et al., 2010)
Estriol	DGL (13) soil	2.96	36	39	25	24.2		23.1				3.04	(Caron et al., 2010)
Estriol	U (41) soil	1.87	22.8	50.2	27	22.8		19.6				3.03	(Caron et al., 2010)
Estriol	M (39) soil	2.09	22.1	52.9	25	22.1		22.2				3.04	(Caron et al., 2010)
Estriol	L (41) soil	3.14	24.6	49.4	26	24.6		27.6				3.01	(Caron et al., 2010)
Estriol	BS1 sediment	0.41	98.2	0.2	1.6		8.8	23.7	16.2	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.63	3.76	(Chen et al., 2012)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
Estriol	BS2 sediment	1.21	98.2	1.4	10.4		4.8	17.7	18.6	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.1	3.17	(Chen et al., 2012)
Estriol	BS3 sediment	3.96	80.3	21.7	0.5		10.2	27.7	29.6	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.08	2.85	(Chen et al., 2012)
Estriol	BS4 sediment	1.81	96.3	2.2	1.5		4.3	2.8	3.44	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.86	2.19	(Chen et al., 2012)
Estriol	Sand	0.1	98.8	1.2	0			2.2	2.9		1.11	3.34	(Karnjanapiboonwong et al., 2010)
Estriol	Sandy loam	1.3	74	10	16			8.6	17.1		1.96	2.82	(Karnjanapiboonwong et al., 2010)
Estriol	Silt loam	2.5	34	54	12			18.6	23.8		1.45	2.87	(Karnjanapiboonwong et al., 2010)
17 α -ethinylestradiol	Chelsea soil	5.45					3.92		-0.462	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.86	3.55	(Yu et al., 2004)
17 α -ethinylestradiol	Soil	1.3	85	2	12			77				3.77	(Ying and Kookana, 2005)
17 α -ethinylestradiol	Soil	0.85	84	4	10			62				3.86	(Ying and Kookana, 2005)
17 α -ethinylestradiol	soil	1.8	27	23	48			78				3.64	(Ying and Kookana, 2005)
17 α -ethinylestradiol	Soil	2.9	52	20	25			122				3.62	(Ying and Kookana, 2005)
17 α -ethinylestradiol	Bloomfield soil	0.36	81	11	8	4.4		3.91				3.04	(Lee et al., 2003)
17 α -ethinylestradiol	Drummer1 soil	2.91	13	66	21	26.5		23.4				2.91	(Lee et al., 2003)
17 α -ethinylestradiol	Manawatu	3.3	87	11	2	9.7	13.6	12.44	12.36	ug ¹⁻ⁿ L ⁿ g ⁻¹	1	2.59	(Sarmah et al., 2008)
17 α -ethinylestradiol	Horotiu	5.5	19	58	23	36	224	22.33	18.52	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.97	3.14	(Sarmah et al., 2008)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
17 α -ethinylestradiol	Egmont	9.7	32	39	29	42		105.4	113	ug ¹⁻ⁿ L ⁿ g ⁻¹	1.1	3.44	(Sarmah et al., 2008)
17 α -ethinylestradiol	Pukehoke	2.4	5	31	64	30	48.9	16.56	15.46	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.9	3.11	(Sarmah et al., 2008)
17 α -ethinylestradiol	Matawhero	2	11	62	27	30		15.2	14.69	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.95	2.46	(Sarmah et al., 2008)
17 α -ethinylestradiol	Waikiki	6.6	7	69	24	48	16.1	235.9	232.7	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.98	3.59	(Sarmah et al., 2008)
17 α -ethinylestradiol	DX soil	1.91	18	40	42	27.1	28.48		0.126	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.772		(Li et al., 2013)
17 α -ethinylestradiol	Sand	0.1	98.8	1.2	0			1	1.8		2.08	3.02	(Karnjanapiboonwong et al., 2010)
17 α -ethinylestradiol	Sandy loam	1.3	74	10	16			176.2	118.6		0.72	4.13	(Karnjanapiboonwong et al., 2010)
17 α -ethinylestradiol	Silt loam	2.5	34	54	12			196.8	169.4		0.96	3.9	(Karnjanapiboonwong et al., 2010)
17 α -ethinylestradiol	Bulk 8 soil	1.15										3.85	(Ke et al., 2010)
17 α -ethinylestradiol	Sand	0.94	99.8	0	0.2				27	ng ¹⁻ⁿ mL ⁿ g ⁻¹	1		(Cindy et al., 2006)
17 α -ethinylestradiol	sand	0.94	99.8	0	0.2				28	ng ¹⁻ⁿ mL ⁿ g ⁻¹	1		(Cindy et al., 2006)
17 α -ethinylestradiol	Silty loam	2.66				5.81			30	ng ¹⁻ⁿ mL ⁿ g ⁻¹	0.9		(Cindy et al., 2006)
17 α -ethinylestradiol	Silty clay	3.07				29.66			96	ng ¹⁻ⁿ mL ⁿ g ⁻¹	1.04		(Cindy et al., 2006)
17 α -ethinylestradiol	Clay loam	3.76				48.69			121	ng ¹⁻ⁿ mL ⁿ g ⁻¹	1.18		(Cindy et al., 2006)
17 α -ethinylestradiol	EPA-13 sediment	4.5					12.5		-0.791	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.893	3.53	(Yu et al., 2004)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area (m ² /g)	K_d (L/Kg)	K_f	K_f unit	$1/n_s$	Log K_{oc}	Reference
17 α -ethinylestradiol	EPA-15 sediment	0.95	15.6	48.7	35.7		15.2		-0.612	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.667	3.58	(Yu et al., 2004)
17 α -ethinylestradiol	EPA-18 sediment	0.66	34.6	25.8	39.5		12.6		-0.636	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.612	3.59	(Yu et al., 2004)
17 α -ethinylestradiol	EPA-21 sediment	1.88	50.2	42.7	7.1		6.96		-0.899	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.851	3.55	(Yu et al., 2004)
17 α -ethinylestradiol	EPA-26 sediment	1.48	1.6	55.4	42.9		16.2		-1.158	ug ¹⁻ⁿ L ⁿ g ⁻¹	0.878	3.54	(Yu et al., 2004)
17 α -ethinylestradiol	EPA1 sediment	0.22	94	0	6	1.1	-	2.31			-	3.02	(Lee et al., 2003)
17 α -ethinylestradiol	BS1 sediment	0.41	98.2	0.2	1.6		8.8	35.8	34	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.96	3.94	(Chen et al., 2012)
17 α -ethinylestradiol	BS2 sediment	1.21	98.2	1.4	10.4		4.8	107	196.3	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.34	3.94	(Chen et al., 2012)
17 α -ethinylestradiol	BS3 sediment	3.96	80.3	21.7	0.5		10.2	207	220	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1	3.72	(Chen et al., 2012)
17 α -ethinylestradiol	BS4 sediment	1.81	96.3	2.2	1.5		4.3	0.8	26.5	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.8	3.24	(Chen et al., 2012)

Table S3 Sorption parameters for the androgens.

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K _d (L/Kg)	K _f	K _f unit	1/n _s	LogK _{oc}	Reference
Testosterone	EPA14 soil	0.48	2	34	64	18.9		16				3.52	(Lee et al., 2003)
Testosterone	Bloomfield soil	0.36	81	11	8	4.4		7.2				3.3	(Lee et al., 2003)
Testosterone	Drummer 7 soil	2.39						42.7				3.25	(Lee et al., 2003)
Testosterone	Toronto soil	4.4	12	68	20	11		27.3				3.32	(Lee et al., 2003)
Testosterone	HAL1	1.28	18	62	20	13.9	12.61	50.54	38.82	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.7996	3.6	(Ma et al., 2015)
Testosterone	HAL2	1.16	15	65	20	16.9	13.52	42.05	33.67	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.7582	3.87	(Ma et al., 2015)
Testosterone	HAL3	0.76	13	62	25	17.5	17.4	36.11	32.22	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.8573	3.7	(Ma et al., 2015)
Testosterone	NP1	1.05	33	55	12	12.3	13.37	17.25	16.47	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.8025	3.25	(Ma et al., 2015)
Testosterone	NP2	0.76	30	60	10	13.2	14.12	11.95	11.89	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.7927	3.23	(Ma et al., 2015)
Testosterone	NP3	0.41	35	55	10	15.8	13.22	9.8	9.98	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.7602	3.42	(Ma et al., 2015)
Testosterone	Iowa1	0.65	77	13	10	13.8	1.71	11.16	10.6	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.7974	3.24	(Ma et al., 2015)
Testosterone	Iowa2	0.7	5	60	35	36.2	23.03	78.57	74.46	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.9683	4.05	(Ma et al., 2015)
Testosterone	Kaolin	0	10.05			2	10.05	36.99	35.28	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.9159		(Ma et al., 2015)
Testosterone	Montmorillonite	0	31.82			76.4	31.82	623.9	795.7	ug ¹⁻ⁿ mL ⁿ g ⁻¹	1.2458		(Ma et al., 2015)
Testosterone	Bentonite	0				85.2		318.21	283	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.7263		(Ma et al., 2015)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K_d (L/Kg)	K_f	K_f unit	1/n _s	Log K_{oc}	Reference
Testosterone	Clay1	1.15	0	0	100		52.21	329.46	303.69	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.9849		(Ma et al., 2015)
Testosterone	Clay2	1.15	0	0	100		77.66	803.23	1,109.76	ug ¹⁻ⁿ mL ⁿ g ⁻¹	1.0604		(Ma et al., 2015)
Testosterone	Sand	0.12					2.32	42.33				2.55	(Qi et al., 2014)
Testosterone	Medium silt	0.09					1.02	55.12				2.79	(Qi et al., 2014)
Testosterone	Fine Silt	1.72					23.3	80.32				2.67	(Qi et al., 2014)
Testosterone	Clay 1	1.97					52.21	329.46				2.22	(Qi et al., 2014)
Testosterone	Clay2	1.97					77.66	803.23				2.61	(Qi et al., 2014)
Testosterone	250 um soil	2.16	12	72	16	9.33		37.7	10.3	ugg ⁻¹ /mgL ⁻¹	1.22	3.24	(Gineys et al., 2012)
Testosterone	Whole silty lo1	2.55				16.6	19.9	43.3				3.23	(Sangster et al., 2015)
Testosterone	Sand 1	2.1				4.0	14.2	35.6				3.23	(Sangster et al., 2015)
Testosterone	Silt large 1	0.87				3.3	4.55	12.290				3.15	(Sangster et al., 2015)
Testosterone	Silt small 1	1.45				4.6	6	24.06				3.22	(Sangster et al., 2015)
Testosterone	Clay 1	6.39				29.3	41.7	149.80				3.37	(Sangster et al., 2015)
Testosterone	Colloid 1	4.17				42.3	47.9	53.72				3.11	(Sangster et al., 2015)
Testosterone	Whole sand 2	0.23				0.23	1.36	3.45				3.18	(Sangster et al., 2015)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K_d (L/Kg)	K_f	K_f unit	1/n _s	Log K_{oc}	Reference
Testosterone	Bulk soil 1	0.95						79.9				3.92	(Qi and Zhang, 2016)
Testosterone	SDA 1	0.57					0.59	47.2				3.92	(Qi and Zhang, 2016)
Testosterone	STA 1	0.6					1.63	63.5				4.02	(Qi and Zhang, 2016)
Testosterone	Clay 1	1.97					2.59	189.4				3.98	(Qi and Zhang, 2016)
Testosterone	HAL-Colloid 1	10.5					4.14	207.8				3.3	(Qi and Zhang, 2016)
Testosterone	HAL-Colloid 2	11					6.2	493.6				3.65	(Qi and Zhang, 2016)
Testosterone	HAL-Colloid 3	16.4					10.34	691				3.62	(Qi and Zhang, 2016)
Testosterone	Bulk soil 2	0.68						36.7				3.73	(Qi and Zhang, 2016)
Testosterone	SDA 2	0.21					0.35	20.1				3.98	(Qi and Zhang, 2016)
Testosterone	STA 2	0.86					2.58	43.2				3.7	(Qi and Zhang, 2016)
Testosterone	Clay 2	2.36					2.59	106.2				3.65	(Qi and Zhang, 2016)
Testosterone	Colloid 1	13.3					4.14	114.5				2.93	(Qi and Zhang, 2016)
Testosterone	Colloid 2	18.5					6.2	208				3.05	(Qi and Zhang, 2016)
Testosterone	Colloid 3	26.3					10.34	181.2				2.84	(Qi and Zhang, 2016)
Testosterone	Tillage soil 1	0.85	62	18	20	3		11.39	29.36	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.85	3.13	(Sangsupan et al., 2006)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K_d (L/Kg)	K_f	K_f unit	1/n _s	Log K_{oc}	Reference
Testosterone	Tillage soil 2	0.43	60.7	15.3	24	3.3		5.04	14.81	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.84	2.77	(Sangsupan et al., 2006)
Testosterone	No Tillage soil1	0.88	63.3	19.3	17.3	2.9		13.52	25.83	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.9	3.18	(Sangsupan et al., 2006)
Testosterone	No Tillage soil2	0.38	65.3	18	16.7	3.6		5	13.59	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.85	2.74	(Sangsupan et al., 2006)
Testosterone	EPA1 sediment	0.22	94	0	6	1.1		4.57				3.32	(Lee et al., 2003)
Testosterone	Drummer	2.91	13	65.8	21.2	26.5		42.7	59.1	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.62	3.17	(Das et al., 2004)
Testosterone	EPA1	0.22	93.9	0	6.1	1.07		4.57				3.32	(Das et al., 2004)
Androstenedione	Drummer	2.91	13	65.8	21.2	26.5		142	27.9	ug ¹⁻ⁿ mL ⁿ g ⁻¹	0.51	3.69	(Das et al., 2004)
Androstenedione	EPA1	0.22	93.9	0	6.1	1.07		19.3				3.69	(Das et al., 2004)
17 α -trenbolone	EPA-14 soil	0.48	2	34	64	18.8		2.2				2.65	(Bushra et al., 2009)
17 α -trenbolone	Coloma-32 soil	0.64	81	11	8	4.3		5.3				2.92	(Bushra et al., 2009)
17 α -trenbolone	Toronto soil	1.3	12	68	20	11		6.3				2.68	(Bushra et al., 2009)
17 α -trenbolone	Drummer-36 soil	2.3	17	47	36	15.5		17				2.87	(Bushra et al., 2009)
17 α -trenbolone	7CB soil	7.5	24	69	7	41		41				2.74	(Bushra et al., 2009)
17 α -trenbolone	Sand-soil	0.06						1.72				2.46	(Yang et al., 2019)
17 α -trenbolone	DU soil	3.8	44	23	33	19.3			19.78	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.87		(Robinson et al., 2017)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K_d (L/Kg)	K_f	K_f unit	1/n _s	Log K_{oc}	Reference
17 α -trenbolone	MSL soil	1.8	64	11	25	18.1			7.22	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.88		(Robinson et al., 2017)
17 α -trenbolone	MT soil	0.9	34	21	45	26.8			5.36	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.86		(Robinson et al., 2017)
17 α -trenbolone	OE soil	3.1	58	11	21	26.7			8.49	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.87		(Robinson et al., 2017)
17 α -trenbolone	RM soil	0.9	82	3	15	10.9			4.32	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.90		(Robinson et al., 2017)
17 β -trenbolone	EPA-14 soil	0.48	2	34	64	18.8		4.7				2.99	(Bushra et al., 2009)
17 β -trenbolone	Coloma-32 soil	0.64	81	11	8	4.3		10.6				3.22	(Bushra et al., 2009)
17 β -trenbolone	Toronto soil	1.3	12	68	20	11		14.5				3.05	(Bushra et al., 2009)
17 β -trenbolone	Drummer-36 soil	2.3	17	47	36	15.5		32.6				3.15	(Bushra et al., 2009)
17 β -trenbolone	7CB soil	7.5	24	69	7	41		73.5				2.99	(Bushra et al., 2009)
17 β -trenbolone	Sand-soil	0.06						1.88				2.50	(Yang et al., 2019)
Trendione	EPA-14 soil	0.48	2	34	64	18.8		20.6				3.63	(Bushra et al., 2009)
Trendione	Coloma-32 soil	0.64	81	11	8	4.3		20.1				3.5	(Bushra et al., 2009)
Trendione	Toronto soil	1.3	12	68	20	11		30				3.36	(Bushra et al., 2009)
Trendione	Drummer-36 soil	2.3	17	47	36	15.5		44.7				3.29	(Bushra et al., 2009)
Trendione	7CB soil	7.5	24	69	7	41		100.7				3.13	(Bushra et al., 2009)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K_d (L/Kg)	K_f	K_f unit	1/n _s	Log K_{oc}	Reference
Trendione	Sand-soil							3.48				2.76	(Yang et al., 2019)
Trendione	DU soil	3.8	44	23	33	19.3			46.89	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.94		(Robinson et al., 2017)
Trendione	MSL soil	1.8	64	11	25	18.1			24.76	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.95		(Robinson et al., 2017)
Trendione	MT soil	0.9	34	21	45	26.8			22.98	mg ¹⁻ⁿ mL ⁿ g ⁻¹	1.08		(Robinson et al., 2017)
Trendione	OE soil	3.1	58	11	21	26.7			46.13	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.99		(Robinson et al., 2017)
Trendione	RM soil	0.9	82	3	15	10.9			20.12	mg ¹⁻ⁿ mL ⁿ g ⁻¹	0.95		(Robinson et al., 2017)
17 α -methyltestosterone	Sand	0	95.3	2	2.7		58.8	4.6					(Ong et al., 2012b)
17 α -methyltestosterone	Laterite soil	0.07	74	12.8	13.2		7.5	1.2				3.22	(Ong et al., 2012b)
17 α -methyltestosterone	Garden soil 1	0.56	18.6	34	47.4		49.1	49.4				3.95	(Ong et al., 2012b)
17 α -methyltestosterone	Garden soil 2	1.06	42	23.6	34.4		37.9	119.7				4.05	(Ong et al., 2012b)
17 α -methyltestosterone	Garden soil 3	1.36	17.8	28.8	53.4		62.6	122.8				3.96	(Ong et al., 2012b)

Table S4 Sorption parameters for the progestins

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K _d (L/Kg)	K _f	K _f unit	1/n _s	LogK _{oc}	Reference
Melengestrol acetate	C32	1.1	88	7	5	4.3		11.7				3.03	(Card et al., 2012b)
Melengestrol acetate	D36	4	17	47	36	15.5		63.9				3.20	(Card et al., 2012b)
Melengestrol acetate	FC	7.7	17	46	37	20.2		71.4				3.96	(Card et al., 2012b)
Progesterone	Wholesilty lo1	2.55				16.6	19.9	207.2				3.91	(Sangster et al., 2015)
Progesterone	Sand 1	2.1				4.0	14.2	289.88				4.14	(Sangster et al., 2015)
Progesterone	Silt large 1	0.87				3.3	4.55	218.53				4.4	(Sangster et al., 2015)
Progesterone	Silt small 1	1.45				4.6	6	117.86				3.91	(Sangster et al., 2015)
Progesterone	Clay 1	6.39				29.3	41.7	610.24				3.98	(Sangster et al., 2015)
Progesterone	Colloid 1	4.17				42.3	47.9	1071.86				4.41	(Sangster et al., 2015)
Progesterone	Wholesand 2	0.23				0.23	1.36	33.3				4.16	(Sangster et al., 2015)
Progesterone	sand-soil	0.127						2.15				3.23	(Yang et al., 2020b)
Altrenogest	sand-soil	0.06						3.14				2.72	(Yang et al., 2019)
Altrenogest	S1	0.82	62	34	4	4.37	5.66	7.76	9.56	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.93	2.98	(Yang et al., 2020a)
Altrenogest	S2	2.19	59	28	13	6.71	11.4	15.6	22.1	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.92	2.85	(Yang et al., 2020a)
Altrenogest	S3	4.16	41	49	10	11.4	25.6	47.1	46.4	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.10	3.05	(Yang et al., 2020a)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K _d (L/Kg)	K _f	K _f unit	1/n _s	LogK _{oc}	Reference
Altrenogest	S4	2.26	22	61	17	11.7	19.5	47.1	55.4	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.96	3.32	(Yang et al., 2020a)
Altrenogest	S5	2.2	59	31	10	9.66	11.7	47	36.8	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.08	3.37	(Yang et al., 2020a)
Chlormadinone acetate	S1	0.82	62	34	4	4.37	5.66	17.1	17.6	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.06	3.32	(Yang et al., 2020a)
Chlormadinone acetate	S2	2.19	59	28	13	6.71	11.4	38	38.5	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.81	3.24	(Yang et al., 2020a)
Chlormadinone acetate	S3	4.16	41	49	10	11.4	25.6	61.5	95.7	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.94	3.17	(Yang et al., 2020a)
Chlormadinone acetate	S4	2.26	22	61	17	11.7	19.5	343.5	431.7	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.93	4.18	(Yang et al., 2020a)
Chlormadinone acetate	S5	2.2	59	31	10	9.66	11.7	133.6	181.8	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.97	3.82	(Yang et al., 2020a)
Megestrol acetate	S1	0.82	62	34	4	4.37	5.66	20.2	28.9	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.85	3.39	(Yang et al., 2020a)
Megestrol acetate	S2	2.19	59	28	13	6.71	11.4	41.9	45	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.91	3.28	(Yang et al., 2020a)
Megestrol acetate	S3	4.16	41	49	10	11.4	25.6	58.6	73.1	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.98	3.15	(Yang et al., 2020a)
Megestrol acetate	S4	2.26	22	61	17	11.7	19.5	901.4	846.5	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.62	4.6	(Yang et al., 2020a)
Megestrol acetate	S5	2.2	59	31	10	9.66	11.7	353.5	331.9	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.19	4.25	(Yang et al., 2020a)
Drospirenone	S1	0.82	62	34	4	4.37	5.66	25.2	46.1	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.71	3.49	(Yang et al., 2020a)
Drospirenone	S2	2.19	59	28	13	6.71	11.4	43.1	47.2	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.93	3.29	(Yang et al., 2020a)
Drospirenone	S3	4.16	41	49	10	11.4	25.6	90.3	93.1	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.96	3.34	(Yang et al., 2020a)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K _d (L/Kg)	K _f	K _f unit	1/n _s	LogK _{oc}	Reference
Drospirenone	S4	2.26	22	61	17	11.7	19.5	472.3	600.9	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.11	4.32	(Yang et al., 2020a)
Drospirenone	S5	2.2	59	31	10	9.66	11.7	178.8	224.4	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.94	3.95	(Yang et al., 2020a)
Medroxyprogesterone acetate	S1	0.82	62	34	4	4.37	5.66	17.7	27.5	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.79	3.33	(Yang et al., 2020a)
Medroxyprogesterone acetate	S2	2.19	59	28	13	6.71	11.4	33	44.7	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.85	3.18	(Yang et al., 2020a)
Medroxyprogesterone acetate	S3	4.16	41	49	10	11.4	25.6	41.6	69.5	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.87	3.00	(Yang et al., 2020a)
Medroxyprogesterone acetate	S4	2.26	22	61	17	11.7	19.5	704.5	716.2	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.41	4.49	(Yang et al., 2020a)
Medroxyprogesterone acetate	S5	2.2	59	31	10	9.66	11.7	275.6	255.8	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.06	4.14	(Yang et al., 2020a)
Medroxyprogesterone acetate	sand-soil	0.127						1.78				3.15	(Yang et al., 2020b)
Dienogest	S1	0.82	62	34	4	4.37	5.66	3.16	3.48	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.95	2.59	(Yang et al., 2020a)
Dienogest	S2	2.19	59	28	13	6.71	11.4	5.73	10.5	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.8	2.42	(Yang et al., 2020a)
Dienogest	S3	4.16	41	49	10	11.4	25.6	23	27.1	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.96	2.74	(Yang et al., 2020a)
Dienogest	S4	2.26	22	61	17	11.7	19.5	22.1	40.1	ug ¹⁻ⁿ L ⁿ kg ⁻¹	0.77	2.99	(Yang et al., 2020a)
Dienogest	S5	2.2	59	31	10	9.66	11.7	14.2	14	ug ¹⁻ⁿ L ⁿ kg ⁻¹	1.08	2.85	(Yang et al., 2020a)
Dienogest	S1	0.8	64	29	7	4.37	5.65	3.08				3.20	(Yang et al., 2020c)
Dienogest	S2	1.65	75	20	5	5.83	7.07	6.82				2.9	(Yang et al., 2020c)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K _d (L/Kg)	K _f	K _f unit	1/n _s	LogK _{oc}	Reference
Dienogest	S3	2.19	59	28	13	6.71	11.4	9.19				2.77	(Yang et al., 2020c)
Dienogest	S4	3.06	45	48	7	11.6	12.8	19.8				2.97	(Yang et al., 2020c)
Dienogest	S5	4.16	41	49	10	12.6	25.6	19.5				2.82	(Yang et al., 2020c)
Gestodene	S1	0.8	64	29	7	4.37	5.65	5.22				3.42	(Yang et al., 2020c)
Gestodene	S2	1.65	75	20	5	5.83	7.07	9.79				3.05	(Yang et al., 2020c)
Gestodene	S3	2.19	59	28	13	6.71	11.4	12				3.22	(Yang et al., 2020c)
Gestodene	S4	3.06	45	48	7	11.6	12.8	25.2				3.27	(Yang et al., 2020c)
Gestodene	S5	4.16	41	49	10	12.6	25.6	24.3				3.16	(Yang et al., 2020c)
Levonorgestrel	S1	0.8	64	29	7	4.37	5.65	5.13				3.27	(Yang et al., 2020c)
Levonorgestrel	S2	1.65	75	20	5	5.83	7.07	10.6				3.06	(Yang et al., 2020c)
Levonorgestrel	S3	2.19	59	28	13	6.71	11.4	16.7				3.21	(Yang et al., 2020c)
Levonorgestrel	S4	3.06	45	48	7	11.6	12.8	32.3				3.26	(Yang et al., 2020c)
Levonorgestrel	S5	4.16	41	49	10	12.6	25.6	33.2				3.16	(Yang et al., 2020c)
Medroxyprogesterone	S1	0.8	64	29	7	4.37	5.65	8.51				3.38	(Yang et al., 2020c)
Medroxyprogesterone	S2	1.65	75	20	5	5.83	7.07	17.7				3.15	(Yang et al., 2020c)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K _d (L/Kg)	K _f	K _f unit	1/n _s	LogK _{oc}	Reference
Medroxyprogesterone	S3	2.19	59	28	13	6.71	11.4	14.9				3.39	(Yang et al., 2020c)
Medroxyprogesterone	S4	3.06	45	48	7	11.6	12.8	38.8				3.44	(Yang et al., 2020c)
Medroxyprogesterone	S5	4.16	41	49	10	12.6	25.6	39.5				3.34	(Yang et al., 2020c)
Cyproterone acetate	S1	0.8	64	29	7	4.37	5.65	12.8				3.55	(Yang et al., 2020c)
Cyproterone acetate	S2	1.65	75	20	5	5.83	7.07	28.2				3.46	(Yang et al., 2020c)
Cyproterone acetate	S3	2.19	59	28	13	6.71	11.4	34.8				3.39	(Yang et al., 2020c)
Cyproterone acetate	S4	3.06	45	48	7	11.6	12.8	60				3.56	(Yang et al., 2020c)
Cyproterone acetate	S5	4.16	41	49	10	12.6	25.6	82.8				3.47	(Yang et al., 2020c)
Etonogestrel	S1	0.8	64	29	7	4.37	5.65	9.34				3.07	(Yang et al., 2020c)
Etonogestrel	S2	1.65	75	20	5	5.83	7.07	16.1				2.99	(Yang et al., 2020c)
Etonogestrel	S3	2.19	59	28	13	6.71	11.4	21.8				3.00	(Yang et al., 2020c)
Etonogestrel	S4	3.06	45	48	7	11.6	12.8	34.9				3.06	(Yang et al., 2020c)
Etonogestrel	S5	4.16	41	49	10	12.6	25.6	42.6				3.01	(Yang et al., 2020c)
Norgestrel	S1	0.8	64	29	7	4.37	5.65	3.96				2.69	(Yang et al., 2020c)
Norgestrel	S2	1.65	75	20	5	5.83	7.07	15.2				2.96	(Yang et al., 2020c)

Sex hormone	Medium	OC%	Sand%	Loam%	Clay%	CEC (cmol/kg)	Surface area(m ² /g)	K_d (L/Kg)	K_f	K_f unit	1/n _s	Log K_{oc}	Reference
Norgestrel	S3	2.19	59	28	13	6.71	11.4	13.3				2.78	(Yang et al., 2020c)
Norgestrel	S4	3.06	45	48	7	11.6	12.8	17.9				2.77	(Yang et al., 2020c)
Norgestrel	S5	4.16	41	49	10	12.6	25.6	22				2.74	(Yang et al., 2020c)

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