

Supplementary Materials

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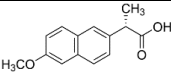

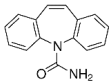
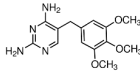
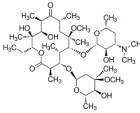

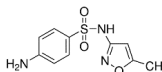
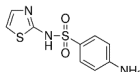
Table S1. Physicochemical properties of the target pharmaceuticals.

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Table S1. Physicochemical properties of target pharmaceuticals.

Compounds	Structure	Water solubility (mg/L)	pK _a	LogK _{ow}	LogK _{oc}	LogD _{ow}	Half-life surface water (hour)	Henry's law constant (atm m ³ /mol)
Naproxen		4.41×10 ¹	4.39	3.18	2.525	0.33	360	3.39×10 ⁻¹⁰
Acetylsalicylic acid		4.6×10 ³	3.5	1.19	2.0	-2.31	151.2	1.30×10 ⁻⁹
Carbamazepine		1.77×10 ¹	13.9	2.45	3.59	2.45	900	1.08×10 ⁻¹⁰
Trimethoprim		2.33×10 ³	7.12	0.91	2.857	1.13	1440	2.39×10 ⁻¹⁴
Clarithromycin		3.42×10 ⁻¹	8.99	3.16	2.174	2.31	-	1.73×10 ⁻²⁹
Sulfamethazine		1.12×10 ⁴	7.6/2.3	0.89	2.282	0.66	900	3.05×10 ⁻¹³
Sulfamethoxazole		3.94×10 ³	5.7/1.8	0.89	2.412	-0.43	900	9.56×10 ⁻¹³
Sulfathiazole		3.73×10 ²	2.0/7.1	0.047	2.3	-0.22	-	5.80×10 ⁻¹⁴

Water solubility, octanol-water partition coefficient (Log K_{ow}), soil organic carbon-water partition coefficient (Log K_{oc}), pK_a and distribution coefficients (Log D_{ow} at pH =7) for ionizable compounds and surface water half-life were compiled using EPI Suite.

Table S2. WWTPs information investigated in this study

WWTP (name)	Area	Capacity (m ³ d ⁻¹) ^a		Treatment technologies
		Design	Operation	
WWTP-1 (Wonju)	SHR	156,000	120,595	NPR
WWTP-2 (Moonmak)	SHR	7,000	4,811	BNR
WWTP-3 (Gwangju)	SHR	25,000	24,572	HBR, SBAF
WWTP-4 (Gonjiam)	SHR	23,000	21,694	SBF
WWTP-5 (Yangbeol)	SHR	20,000	7,216	SBAF
WWTP-6 (Samri)	SHR	5,000	4,211	SBAF
WWTP-7 (Icheon)	SHR	43,000	40,277	DeNiPho
WWTP-8 (Danweol)	SHR	2,000	1,863	MSBR
WWTP-9 (Yongmoon)	SHR	4,900	3,388	MBR
WWTP-10 (Danweol)	SHR	1,700	1,432	KNR
WWTP-11 (Injebukmeon)	NHR	2,000	1,482	SBR
WWTP-12 (Cheongsan)	IHR	2,100	1,125	MSBR
WWTP-13 (Dongducheon)	IHR	86,000	74,327	CNR
WWTP-14 (Guri)	HR	160,000	150,169	MLE
WWTP-15 (Jingeon)	HR	100,000	107,981	CSBR
WWTP-16 (Tancheon)	HR	900,000	733,833	MLE
WWTP-17 (Gwacheon)	HR	30,000	20,577	DeNiPho
WWTP-18 (Seongnam)	HR	460,000	346,611	CAS
WWTP-19 (Jongrang)	HR	1,590,000	1,234,376	CAS, MLE, SBAF
WWTP-20 (Parkdal)	HR	250,000	126,348	CSBR
WWTP-21 (Suksu)	HR	300,000	226,695	MLE
WWTP-22 (Gulpo)	HR	900,000	672,461	DeNiPho
WWTP-23 (Geumchon)	HR	44,000	28,853	MBR, HDF
WWTP-24 (Samsong)	HR	16,000	7,153	CSBR

^aaverage daily value (2015), NPR: nitrogen and phosphorus removal process, BNR: biological nutrient removal process, SBAF: SK biological aerated filters, SBF: suspended bio filter, HBR: suspended bio filter, MSBR: modified sequencing batch reactor, DeNiPho: activated sludge treatment with biological removal of nitrogen and phosphorous, KNR: Kwon's nutrient removal, MBR: membrane bio reactor, SBR: sequencing batch reactor, CNR: cilium nutrient removal process, MLE: modified Ludzack-Ettinger process, CSBR: constants sequencing batch process, CAS: conventional activated sludge process, HDF: Hanhwa dynamic flow

Source: South Korea Ministry of Environment, 2016-17 Sewerage statistics and 2016-17 Operation status of wastewater treatment plants.

Table S3. Analytical MS/MS conditions and retention time of the target pharmaceuticals.

Compounds	R.T.	Precursor (m/z)	Quantitation ion (m/z)	Cone energy (V)	Collision energy (V)	Ionization mode
ASA	4.07	137.1	46.1	10	9	ESI(-)
NPX	7.52	229.1	170	18	15	ESI(-)
CBZ	6.02	237.2	194.2	36	18	ESI(+)
CTM	5.9	748.3	158.1	38	28	ESI(+)
TMP	2.5	291.1	230.2	40	22	ESI(+)
SMX	4.33	253.9	156	28	17	ESI(+)
SMZ	3.39	279.1	186	32	17	ESI(+)
STZ	2.62	255.9	156	22	17	ESI(+)

Table S4. Summary results for mean concentration and frequency detection of pharmaceuticals at each site of Han River watershed.

Sites	Mean Concentration ($\mu\text{g L}^{-1}$)	Frequency detection (%)
SR-1	0.0841	37.5
SR-2	0.0442	34.4
SR-3	0.0522	34.4
SR-4	0.0678	65.6
SR-5	0.0201	31.3
SR-6	0.0071	6.3
SR-7	0.0107	15.6
NR-1	0.0857	6.3
NR-2	0.0345	12.5
NR-3	0.0131	21.9
NR-4	0.0095	25.0
NR-5	0.0223	12.5
IHR-1	0.1591	75.0
IHR-2	0.0189	46.9
IHR-3	0.0632	3.1
IHR-4	0.0234	50.0
HR-1	0.1087	59.4
HR-2	0.1530	50.0
HR-3	0.0226	37.5
HR-4	0.2281	53.1
HR-5	0.1874	53.1
HR-6	0.0315	31.3
HR-7	0.1042	59.4
HR-8	0.0526	53.1