CWPharma2
CLEAR WATERS FROM PHARMACEUTICALS

Interreg
Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Motivation for pharmaceuticals removal in Hillerød, HCR South

Target values and starting concentrations

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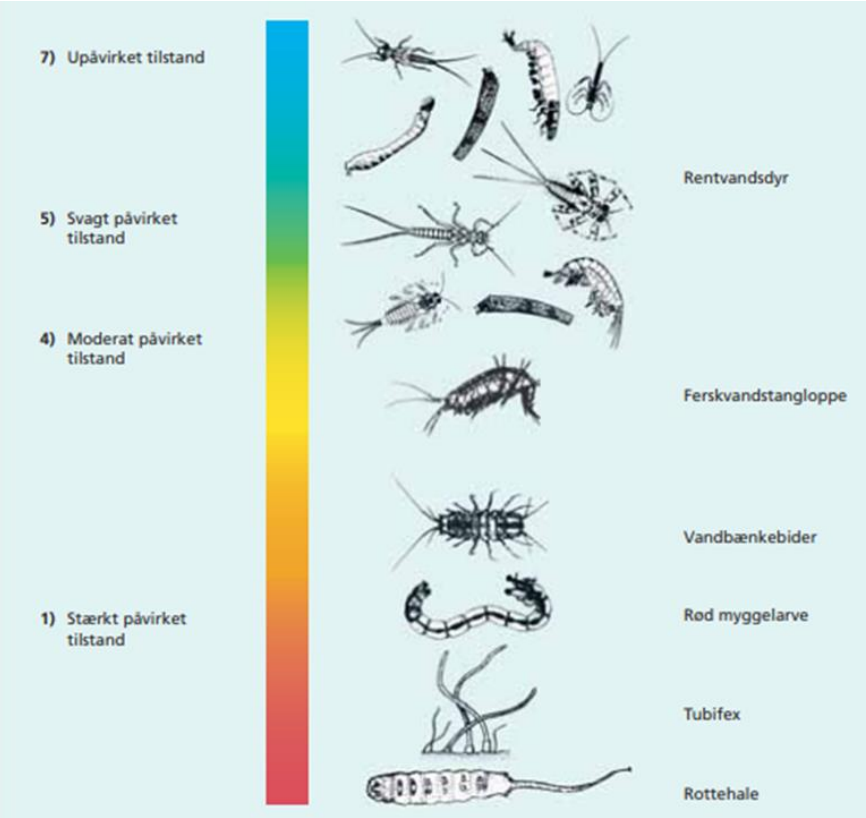
Load and current discharge demands

Load and discharge from HCR South in Hillerød, Denmark.

	2021* average load *incl. 18th of October	2021* average discharge *incl. 18th of October	Demands
Q [m^3/day]	15.744	16.008	18.356
SS [mg/l]	265	3,0	5,00
COD [mg/l]	541	24,7	75
TP [mg/l]	7,9	0,133	0,182
TN [mg/l]	42,8	2,35	3,66

Vision and aim for better cleaning



- Improved ecological conditions in rivers (change from red to green/blue status)
- Effluent fulfills PNEC (Predicted No Effect Concentrations)

New hospital and cleaning for pharmaceuticals

Current local hospital to be replaced by a large centralized regional hospital in 2025 (NHN).

No national demands on treatment of pharmaceuticals in wastewater.

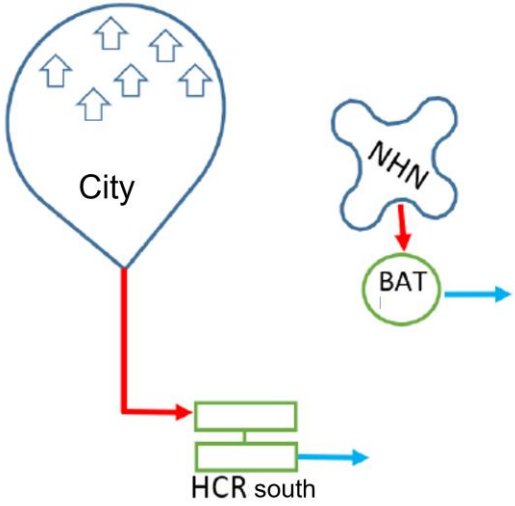
Currently no treatment for pharmaceuticals at HCR South.

The responsibility lies with the polluter (the hospital).

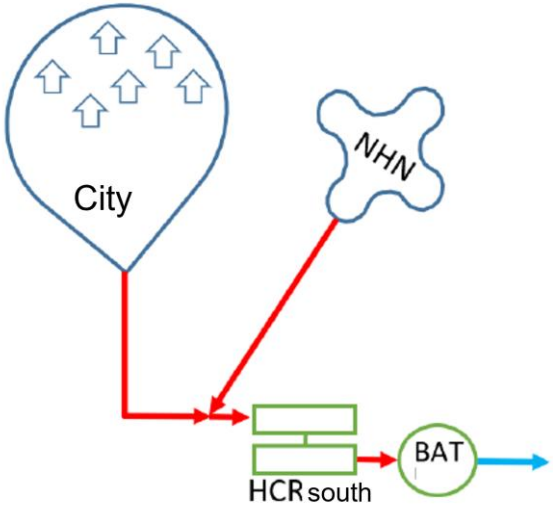
New hospital and cleaning for pharmaceuticals

Three scenarios:

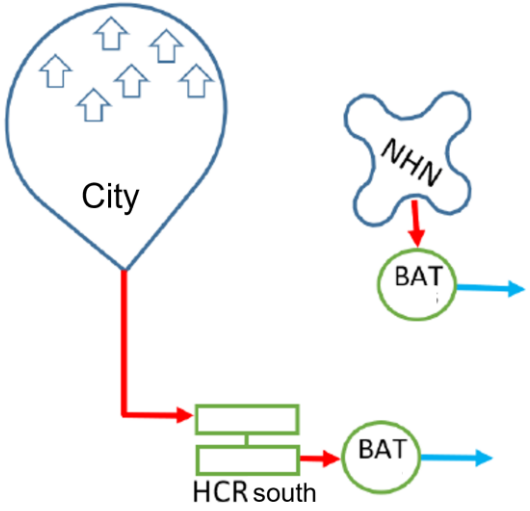
1. Cleaning at source (NHN):



2. Cleaning at HCR South:



3. Cleaning at both NHN & HCR South:



Theoretical removal for three scenarios

API	Scenario 1 total out [g/year]	Scenario 1 total reduction [%]	Scenario 2 total out [g/year]	Scenario 2 total reduction [%]	Scenario 3 total out [g/year]	Scenario 3 total reduction [%]
Painkiller A	326.117	23	42.410	90	37.253	91
Painkiller B	2.082.969	20	258.931	90	232.281	91
Anti inflam-matory agent	87.040	0	8.704	90	8.703	90
Cancer treatment	2.303	95	4.597	90	2.298	95
Strong painkiller	16,8	1	1,71	90	1,71	90
Antibiotic	7.791	3	801	90	790	90
Immune repressant	309	48	59	90	44	93

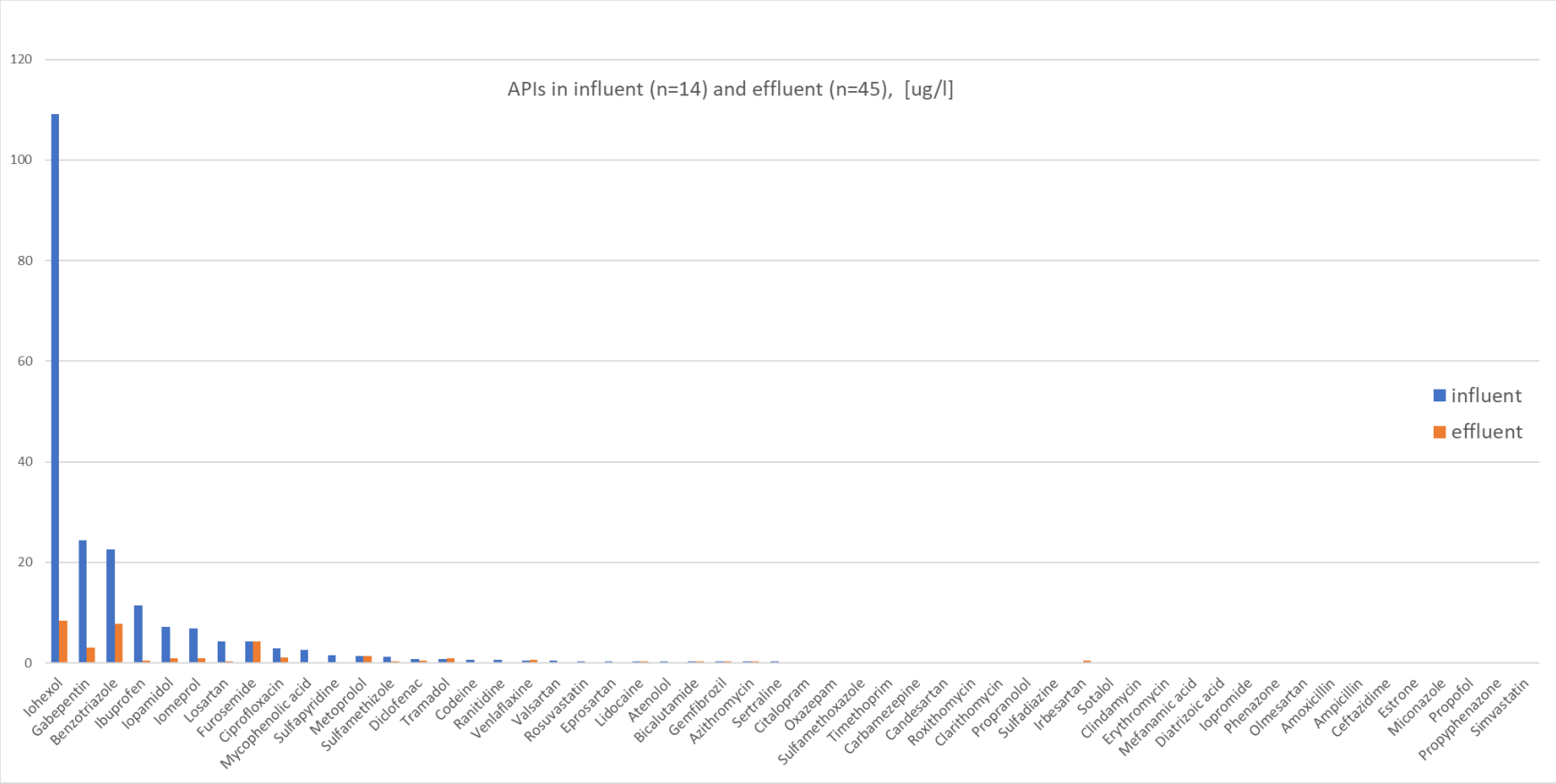
New hospital and cleaning for pharmaceuticals

June 2020:

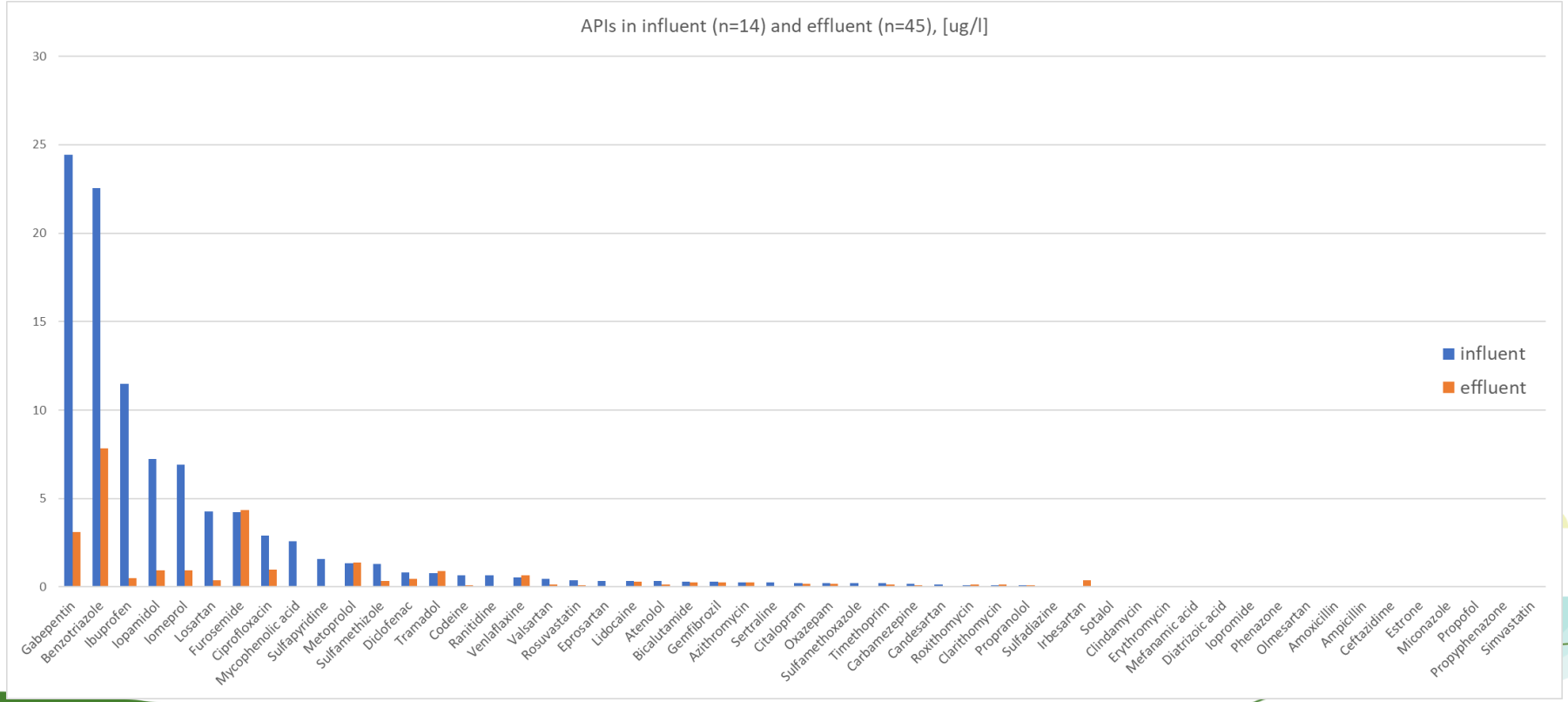
Local council decision to work on the possibility to remove pharmaceuticals from the wastewater from the new central hospital at HCR South.

This work should include a suggestion for control program for effluent values of APIs in order to be able to design the right plant and for economic estimations

APIs in influent and effluent



APIs in influent and effluent



API PNEC values

Pharmaceuticals	DK PNEC Fresh water [µg/l]	Ref. A CWPHARMA PNEC values Fresh water [µg/l]	Factor of difference
17α-Ethinylestradiol	0,000075	0,000408	**5**
17β-Estradiol	0,0001	0,0000323	**3**
Sertraline	0,00052	1,07	**2.058**
Ciprofloxacine	0,005	0,0051	**1**
Clarithromycin	0,06	0,00391	**15**
Erythromycin	0,04	0,0835	**2**
Diclofenac	0,1	0,0852	**1**
Ofloxacin	0,1	0,0204	**5**
Venlafaxin	0,1	3,22	**32**
Sulfamethoxazole	0,12	0,0438	**3**
Candesartan	0,12	0,421	**4**
Atorvastatin	0,2	2,1	**11**
Doxycyklin	0,3	0,00391	**77**
Citalopram	0,51	15,4	**30**
Amlodipine	1	0,0995	**10**
Trimethoprim	10	508	**51**
Allopurinol	2,33	100	**43**
Sulfadiazine	4,6	0,135	**34**
Bisoprolol	35,6	8	**4**
Metoprolol	75	4,38	**17**
Atenolol	128	194	**2**

API Environmental Risk (DK values)

Environmental risk at HCR South	Effluent (PEC) HCR South 2019 avg [µg/l]	PNEC freshwater µg/l]	Risk (PEC/PNEC) 2019
Sertralin (antidepressive)	0,01	0,00052	19
Mefanamic acid (pain)	0,007	0,001	7,4
Estrone (hormone)	0,00094	0,00016	5,89
Metoprolol (stress and fear)	0,562	0,1	5,6
Ciprofloxacin (antibiotic)	0,016	0,005	3,2
Clarithromycin (antibiotic)	0,19	0,06	3,2
Erythromycin (antibiotic)	0,04	0,02	2
Venlafaxin (antibiotic)	0,2	0,1	2
Azithromycin (antibiotic)	0,128	0,09	1,4
Bicalutamid (prostate cancer)	0,121	0,1	1,2
Cefuroxime (antibiotic)	0,516	0,6	0,86
Candesartan (blood pressure)	0,097	0,12	0,81
Ceftazidime (antibiotic)	0,098	0,13	0,75
Roxithromycin (antibiotic)	0,096	0,15	0,64
Amoxicillin (antibiotic)	0,048	0,078	0,62
Gemfibrozil (Cholesterol)	0,08	0,15	0,53
Sulfamethoxazole (antibiotic)	0,05	0,12	0,42
Furosemid (blood pressure)	3,02	31	0,3
Tramadol (pain)	0,369	2,25	0,164
Carbamezepine (epilepsia)	0,078	0,5	0,16
Amisulprid (psychofarmica)	0,02	0,17	0,12

Suggested control program at HCR South

APIs suggested for control program	DK PNEC freshwater [µg/l]	Detection-limit [µg/l]	Inlet HCR Syd mean [µg/l]	Outlet HCR Syd mean [µg/l]	Demand in µg/l
Azithromycin	0,09	0,01	0,104	0,128	0,09
Metoprolol	75	0,01	1,263	1,36	75
Diclofenac	0,1	0,01	0,811	0,451	0,1
Venlaflaxine	0,1	0,01	0,502	0,634	0,1
Sulfadiazine	4,6	0,01	0,062	0,029	4,6
Trimethoprim	10	0,01	0,165	0,137	10
Guideline					
Erythromycin	0,02	0,003	0,019	0,068	0,02
Amoxillin	0,078	0,05	<0,05	<0,05	0,078
Sulfamethoxazole	0,12	0,01	0,195	0,047	0,12
Gabapentin	missing	0,03	23,12	3,073	100
Bicalutamide	1	0,01	0,273	0,251	1
Sulfamethizole	2,54	0,01	1,207	0,353	2,54
Citalopram	0,51	0,003	0,226	0,163	0,51
Indicator parameters					
17α-Ethinylestradiol	0,000075	0,0002	<0,02*	<0,0004*	Measurement
17β-Estradiol	0,0001	0,002	0,010*	<0,002*	Measurement
Iohexol	1.000.000	0,05	114	7,88	Measurement

* Data from 2019

Criteria:

- Found in measurable concentrations
- Accredited analysis
- PNEC > detection level

Guideline from CWPharma - BAT

CWPharma
CLEAR WATERS FROM PHARMACEUTICALS

Guideline for advanced API removal

GoA3.4: Optimization and control of advanced treatment

December 2020

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Guideline from CWPharma - BAT

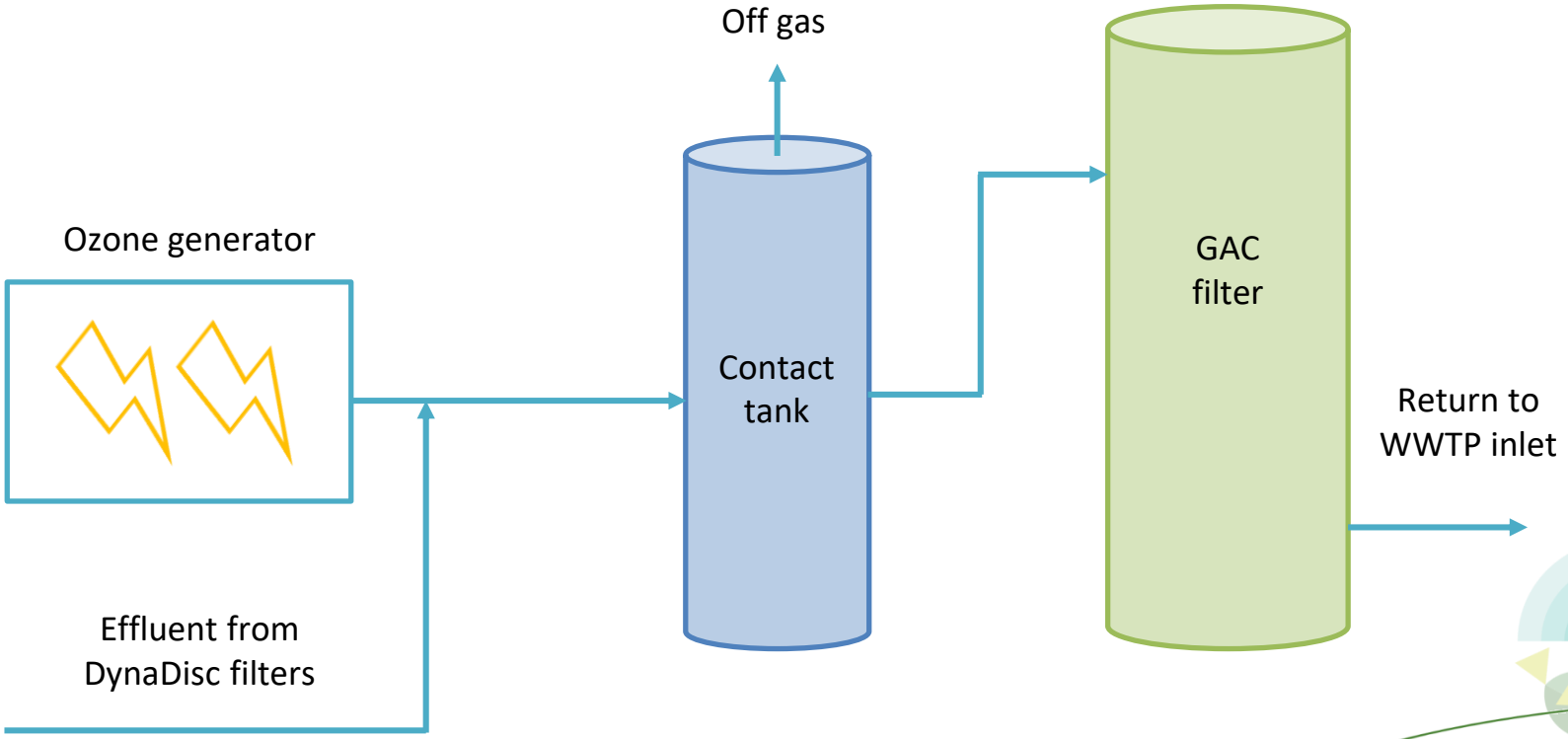
API / micropollutant	Activated carbon	Ozonation
Amisulpride Carbamazepine Citalopram Clarithromycin Diclofenac Hydrochlorothiazide Metoprolol Tramadol Venlafaxine	good – very good (> 70%)	
Benzotriazole Irbesartan Oxipurinol*	good – very good (> 70%)	moderate – average (≈ 30 – 70 %)
Candesartan Formylaminoantipyrine* Olmesartan Sulfamethoxazole	moderate – average (≈ 30 – 70 %)	good – very good (> 70%)
Valsartan Valsartan acid*	moderate – average (≈ 30 – 70 %)	
Gabapentin	none – low (< 30 %)	moderate – average (≈ 30 – 70 %)

Activated carbon and ozonation are both proven methods for removal of pharmaceuticals.

A combination of the two processes was investigated.

The combined process gives a very secure removal for most APIs

CWPharma 2 – Pilot test at HCR South



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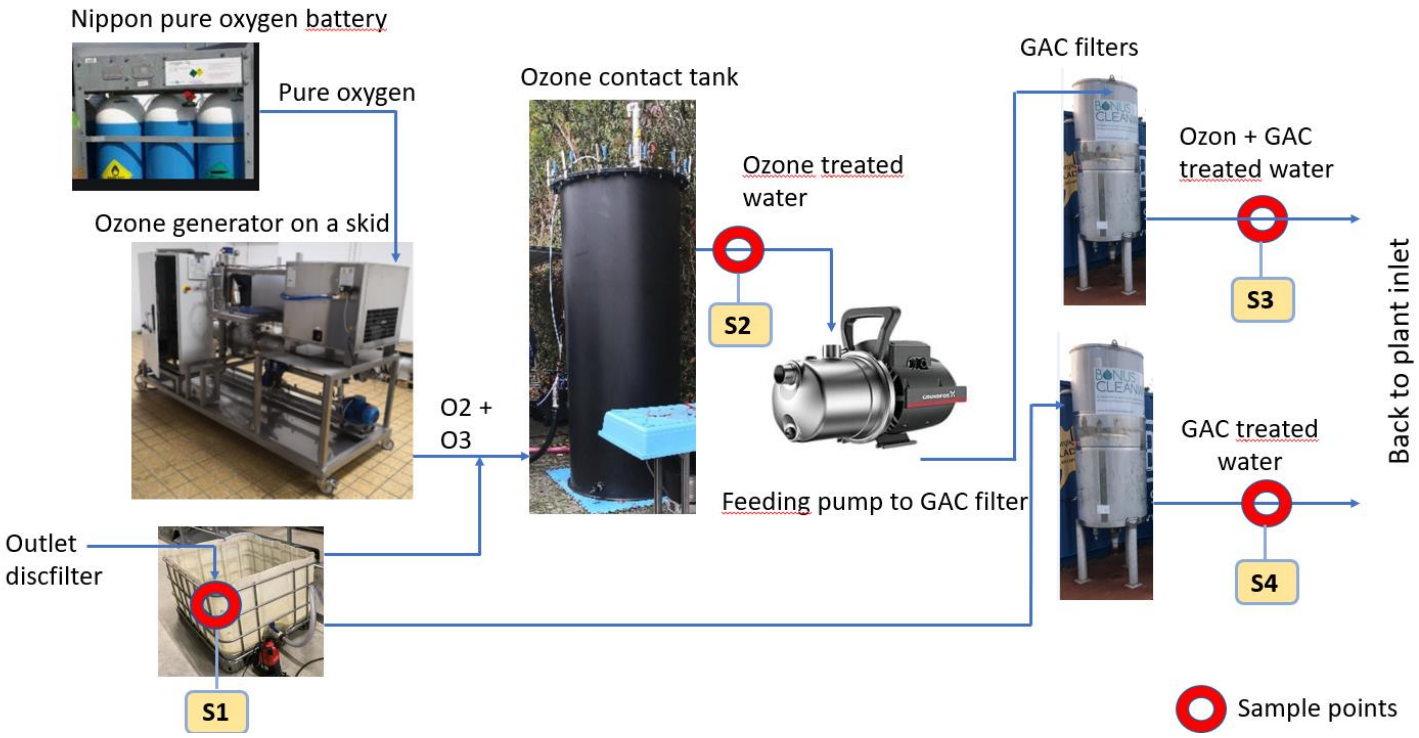

10 doses tested,
4-6 repetitions for each:

0.15 mg O_3/mg DOC
0.25 mg O_3/mg DOC
…..
1.05 mg O_3/mg DOC

CWPharma 2 – Pilot test at HCR South

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