REPORT

Results from the Swedish National Screening Programme 2010

Subreport 3. Pharmaceuticals

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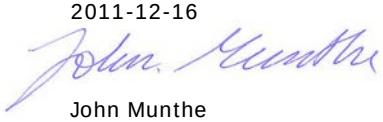

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Report Summary

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Results from the Swedish National Screening Programme 2010

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Summary

A screening study has been performed concerning pharmaceuticals. A total of 101 pharmaceuticals and 54 samples were included in the national programme and 67 samples were included in the regional programme. The sampling programme was focused on diffuse emissions from urban areas reflected in samples from waste water treatment plants (WWTPs) and their receiving waters. Biota samples (perch) from two background lakes and two of the receiving waters and also drinking water from two cities were also included. Of the 101 pharmaceuticals included 92 were detected in the WWTP influent of at least one WWTP, in levels that ranged from low ng/L up to 540 µg/L, with a median concentration of 53 ng/L. 66 pharmaceuticals were detected in the surface water samples in the range from low ng/L up to 1.8 µg/L. Measured surface water concentrations were evaluated by comparing them to critical environmental concentrations, i.e. the water concentration that is expected to cause a pharmacological effect in fish. This evaluation showed that five pharmaceuticals in these samples are expected to cause a pharmacological response in fish exposed to these waters. 23 pharmaceuticals were detected in seven biota (perch) samples. Low levels (low ng/L range) of 26 pharmaceuticals were detected in drinking water samples.

Keyword

pharmaceuticals , screening, waste water treatment plant, WWTP, sludge, surface water, biota, critical environmental concentration, CEC

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Summary

A screening study has been performed concerning Pharmaceuticals. Selection of pharmaceuticals included in the screening was based on ecotoxicological criteria, primarily potency and potential to bioconcentrate. In addition, antibiotics and some pharmaceuticals that have been included in previous screening programmes were also included. A total of 101 pharmaceuticals and 54 samples were included in the national programme and 67 samples were included in the regional programme.

The sampling programme was focused on diffuse emissions from urban areas reflected in samples from waste water treatment plants (WWTPs) and their receiving waters. Biota samples (perch) from two background lakes and two of the receiving waters and also drinking water from two cities were also included.

Of the 101 pharmaceuticals included in this study 92 were detected in the WWTP influent of at least one WWTP, in levels that ranged from low ng/L up to 540 μg/L, with a median concentration of 53 ng/L. Paracetamol was the pharmaceutical that was detected in highest amounts, up to 540 μg/L. 85 of the 101 pharmaceuticals included in this study were detected in the effluent of at least one WWTP, in levels that ranged from low ng/L up to 4 μg/L, with a median concentration of 35 ng/L. Diclofenac was the pharmaceutical that was detected in highest amounts (3.9 μg/L) in the effluent. Removal efficiencies and sludge concentrations from all four WWTPs are also presented.

Of the 101 pharmaceuticals included in this study 66 were detected in the surface water samples in the range from low ng/L up to 1.8 μg/L. Measured surface water concentrations were evaluated by comparing them to critical environmental concentrations, i.e. the water concentration that is expected to cause a pharmacological effect in fish. This evaluation showed that five pharmaceuticals in these samples are expected to cause a pharmacological response in fish exposed to these waters.

In this study 23 pharmaceuticals were detected in the seven biota (perch) samples. Concentrations were in the low μg/Kg range and highest detected levels were found in the perch caught in close proximity to the discharge point of WWTP Kungsängsverket (Uppsala) in River Fyris. Detected pharmaceuticals in biota correlate to the surface water concentrations and previous reports on the occurrence of pharmaceuticals in biota.

Low levels (low ng/L range) of 26 pharmaceuticals were detected in the drinking water samples. There was significant difference between the two drinking waters; only two pharmaceuticals could be detected in the samples from Umeå, carbamazepine and trimethoprim, while 26 pharmaceuticals were detected in the Stockholm samples.

Sammanfattning

En screeningundersökning av läkemedel har utförts. Urvalet av läkemedel i denna studie gjordes utifrån ekotoxikologiska kriterier, främst potens och potential att biokoncentrera. Som komplement till detta urval inkluderades också några antibiotika och några läkemedel som ingått i tidigare screeningundersökningar. Totalt 101 läkemedel och 54 prover ingick i den nationella screeningen och 67 prover ingick i den regionala screeningen.

Screeningundersökningen fokuserade på diffusa emissioner från tätbebyggda områden med betoning på inkommande och utgående avloppsvatten från avloppsreninsverk (ARV) och deras recipienter. Biotaprover (abborre) ingick också från två kontrollsjöar och två av recipienterna samt dricksvatten från två städer.

Av de 101 läkemedel som ingick i studien detekterades 92 i inkommande avloppsvatten i minst ett ARV, i halter mellan låga ng/L upp till 540 µg/L, median koncentration var 53 ng/L. Paracetamol uppmättes i högst halter, 540 µg/L. Av 101 läkemedel detekterades 85 i utgående avloppsvatten i minst ett ARV, i halter mellan låga ng/L upp till 4 µg/L, mediankoncentration var 35 ng/L. Diklofenak uppmättes i högst halter (3.9 µg/L) i utgående avloppsvatten. Avskiljningsgrad och koncentrationer i slam från alla fyra ARV presenteras också.

Av läkemedlen uppmättes 66 i ytvatten (låga ng/l upp till 1.8 µg/L) och de uppmätta halterna utvärderades genom att jämföra dem med kritiska miljökoncentrationer; dvs. den vattenkoncentration som förväntas orsaka en farmakologisk respons i fisk. Denna utvärdering visade att fem av läkemedlen uppmättes i halter som sannolikt orsakar en farmakologisk respons i fisk som exponeras för detta vatten.

I de sju biotaproverna detekterades totalt 23 läkemedel. Koncentrationerna var låga (låga µg/Kg) och de högsta detekterade halterna fanns i fisk fångad i närheten av Kungsängsverkets ARV (Uppsala) utsläppspunkt i Fyrisån. Uppmätta läkemedel i biota korrelerar med uppmätta halter i ytvattnet och med tidigare publicerade data av läkemedelsrester i biota.

I de sex dricksvattenproverna detekterades totalt 26 läkemedel (låga ng/L). Det var en signifikant skillnad mellan dricksvattnet i de bägge städerna, bara två läkemedel kunde detekteras i dricksvattnet från Umeå, karbamazepin och trimetoprim, medan 26 läkemedel detekterades i dricksvattenproverna från Stockholm.

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1 Introduction

As an assignment from the Swedish Environmental Protection Agency, screening studies of Polychlorinated naphtalenes (PCN), Fluorescent whitening agents (FWA) and Pharmaceuticals have been performed during 2010/2011.

The overall objectives of the screening studies are to determine concentrations of the selected substances in a variety of media in the Swedish environment, to highlight important transport pathways, and to assess the possibility of current emissions in Sweden. The results are presented in three separate reports according to Table 1.

Table 1. Substance groups included in the screening.

Substance group	Sub-report #
Polychlorinated naphtalenes (PCN)	1
Fluorescent whitening agents	2
Pharmaceuticals	3

The screening study has been carried out by Swedish Environmental Research Institute (IVL) together with Umeå University (UmU). The chemical analyses of the fluorescent whitening agents were undertaken at IVL, PCN and pharmaceuticals were analysed at UmU.

This sub-report concerns the screening of pharmaceuticals.

2 Pharmaceuticals as environmental pollutants

2.1 Background

Pharmaceuticals have been found in various environmental matrices worldwide in concentrations that range from low nanogram up to milligram per liter (Loos et al. 2009; Segura et al. 2009; Fatta-Kassinos et al. 2011, Santos et al. 2011). Pharmaceuticals enter the environment through our sewage system since many pharmaceuticals are not metabolized completely but excreted unchanged (Martindale 2011). Some point sources, such as pharmaceutical production units, can cause extremely elevated levels of pharmaceuticals in certain regions (Fick et al. 2009; Phillips et al. 2010), which has been shown to result in clear environmental impacts (Carlsson et al. 2010; Sanchez et al. 2011). Pharmaceuticals are potent, biologically active chemicals and there is an increased focus on the potentially negative effects of pharmaceuticals in the environment. Numerous laboratory studies on aquatic organisms have illustrated that various pharmaceuticals can cause negative effects on growth, development and reproduction (Lange et al. 2001; Fent et al. 2006; Kidd et al. 2007; Zeilinger et al. 2009; Santos et al. 2010). One effect that has been studied in detail is reproductive disorders in fish and it has been shown for example that ethinylestradiol causes severe reproductive disorders at low ng/L concentrations (Lange et al. 2001; Kidd et al. 2007). Levonorgestrel, a synthetic gestagen which is commonly used in oral contraceptives, was shown to inhibit reproduction in fathead minnow at concentrations below 1 ng/L (Zeilinger et al. 2009).

Since raw sewage and wastewater effluent is a major source of the pharmaceuticals detected in the environment, a lot of researchers has studied the characteristics of the removal processes in laboratory, semi and full scale (Lindberg et al. 2005; Vieno et al. 2005; Lindberg et al 2010; Gros et al. 2010; Jelic et al. 2011 Fatta-Kassinos et al. 2011, Santos et al. 2011).

2.2 Selection of pharmaceuticals to include in the screening

There is a wide range of pharmaceuticals available globally, e.g. to date there are more than 6000 pharmaceuticals on the global market (Martindale 2011). Therefore various prioritization approaches is used in order to select which pharmaceuticals that should be included in monitoring schemes. Different strategies have been applied; including usage of sales statistics and more rational strategies for example mode-of-action based tests (Huggett et al. 2003; Sanderson et al. 2004; Besse and Garric, 2008). One useful approach was suggested by Huggett et al. (Huggett et al. 2003) and has been named "the fish plasma model". This model is based on the assumption that if two species share the same drug target, the pharmaceuticals are expected to activate this target at roughly the same plasma

concentration. The fish plasma model generates a concentration ratio (CR) between the human therapeutic plasma concentrations (H_TPC) and a measured, or theoretically predicted, fish steady state plasma concentration ($F_{SS}PC$). If the concentration ratio is ≤ 1 then the plasma concentration in the exposed fish is equal to, or higher, than the plasma concentration that is known to cause a pharmacological response in humans. A lower ratio thus reflects a higher risk. One major benefit of this model is that it enables theoretical risks to be calculated for the great majority of pharmaceuticals, since human therapeutic plasma concentrations are readily available in the literature.

Fick et al (Fick et al. 2010) recently calculated the surface water concentration for 500 pharmaceuticals that theoretically would result in a pharmacologically relevant fish steady state plasma concentration. This surface water concentration was described as the "critical environmental concentration" and was derived from theoretically predicted $F_{SS}PCs$ and published human therapeutic plasma concentrations. By combining predicted or measured environmental concentrations, with the CEC values for these pharmaceuticals it is possible to predict or calculate CRs in a specific region.

Selection of pharmaceuticals included in the screening was based on this concept; in addition, antibiotics and some pharmaceuticals that have been included in previous screening programmes were also included. The majority of the samples (n=55) in the regional screening program (3.2) were analyzed for only seven of these substances.

3 Sampling strategy and study sites

3.1 National screening program

A sampling strategy was developed in order to determine concentrations of pharmaceuticals in the Swedish environment and to study the removal effiency of four Swedish wastewater treatment plants (WWTPs). The sampling programme was focused on diffuse emissions from urban areas and distribution from WWTPs and their receiving waters. The sampling programme also included samples from non-urban areas without direct impact of WWTPs, and drinking water. Biota samples (fish) from surface water that receive sewage effluent as well as samples from locations not affected by sewage effluent were also included. Individual samples are listed in Appendix 1.

The measurements from the WWTPs included influent, effluent and sludge. Surface water samples upstream and at several locations downstream of two of the included WWTPs, Stadskvarn, Skövde and Kungsängsverket, Uppsala, were analysed. The sampling program is summarized in Table 2.

Table 2. Samples included in the national screening program.

Type	WWTP influent	WWTP effluent	WWTP sludge	Surface water	Drinking water	Biota	Total
Background areas							
Lakes				2		2	4
Urban areas							
Skövde, Stadskvarn WWTP	3	3	1				7
Stockholm, Henriksdal WWTP	3	3	1				7
Umeå, Öhn WWTP	3	3	1				7
Uppsala, Kungsängsv. WWTP	3	3	1				7
Skövde				6		2	8
Uppsala				5		3	8
Drinking water, Stockholm					3		3
Drinking water, Umeå					3		3
Total	12	12	4	13	6	7	**54**

3.2 Regional screening program

In addition to the national screening program Swedish county administrative boards had the opportunity to collect and send samples for analysis. Several administrative counties participated and samples included effluent and sludge from municipal WWTPs, surface water and biota, Table 3.

Table 3 Samples included in the regional screening program. The number of samples are shown as x+y were x was analyzed for 101 substances and y for seven substances.

Type	WWTP Influent	WWTP Effluent	WWTP Sludge	Surface water	Biota	Sediment	Total
WWTPs	0+9	1+18	1+12				2+39
Rivers and lakes				2+8	8+5	0+3	10+16
Total	9	19	13	10	13	3	**12+55**

4 Methods

4.1 Sampling

Surface waters were sampled directly into 1 litre polyethene (PE) bottles at approximately 0.5 m depth using a telescopic bottle holder.

The staff at the different WWTPs collected influent and effluent water samples in 1 litre PE bottles and de-watered sludge from the anaerobic chambers into PE jars. The samples were stored frozen (-18°C) until analysis.

Fish were caught using fishing net and stored frozen. Perch was chosen in Skövde and Uppsala because it is one of the most stationary fish species in both investigated areas. Fish muscle was dissected from the dorsal muscle using solvent washed scalpels. A composite sample from around ten individuals from each site was prepared.

4.2 Analysis

4.2.1 Chemicals

All pharmaceutical reference standards were classified as analytical grade (>98%). Sulphuric acid (99.999%) were purchased from Sigma-Aldrich (Steinheim, Germany) and ethyl acetate (Analytical reagent, 99.8%) were purchased from Labscan Ltd., (Dublin, Ireland). $^{2}H_{6}$ -amitriptyline, $^{2}H_{10}$-carbamazepine, $^{13}C_{3}{}^{15}$N-ciprofloxacin , $^{2}H_{5}$-fluoxetine, $^{13}C_{6}$-sulfamethoxazole, , $^{13}C^{2}H_{3}$-tramadol and $^{13}C_{3}$-trimethoprim were bought from Cambridge Isotope Laboratories (Andover, MA, USA). $^{2}H_{5}$-oxazepam, $^{2}H_{7}$-promethazine, $^{2}H_{4}$-risperidone, and $^{13}C_{2}{}^{15}$N-tamoxifen were bought from Sigma-Aldrich (Steinheim, Germany). Methanol and acetonitrile were purchased in LC/MS grade quality (Lichrosolv - hypergrade, Merck, Darmstadt, Germany). The purified water was prepared by an Milli-Q Gradient ultrapure water system (Millipore, Billerica, USA), equipped with a UV radiation source. The buffering of the mobile phases was performed by addition of 1ml of formic acid (Sigma-Aldrich, Steinheim, Germany) to 1 L of solvent.

4.2.2 Sample preparation

All water samples (incoming sewage, treated effluent, surface and drinking water) (100 mL) were filtered through a 0.45 μm membrane filter (MF, Millipore, Sundbyberg, Sweden) and acidified to pH 3 using sulfuric acid. Then 50 ng of each of the 12 isotopically labelled pharmaceuticals used as internal and surrogate standards were added to each sample. Solid phase extraction (SPE) columns (Oasis HLB, 200mg, Waters Corporation, Milford, MA, USA) were pre-conditioned and equilibrated with 5.0 mL of methanol and 5.0 mL of de-ionized water. Samples were applied to the SPE columns at a flow rate of 5 mL min^{-1}. Water with 5 % methanol was used to wash the SPE column before eluting with 5 mL of methanol. Eluates were collected in 10 mL vials, evaporated to 20 μL under a gentle air stream, and dissolved in 5 % acetonitrile in water to a final volume of 1.0 mL.

Sludge samples were first freeze dried and 0.1 g (dry weight) were used for extration. Before extraction 50 ng of each internal and surrogate standard were added to the sludge. Extraction was sequentially performed first using 1.5 ml ethylacetate and methanol (1:1 mixture) followed by 1.5 ml methanol and water (7:3 mixture) with 5% triethylamine. Samples were homogenized for four minutes at 42 000 oscillations per minute, using a Mini Beadbeater (Biospec. Bartlesville, USA) with zirconium beads and then centrifuged at 14 000 revolutions per minute for 10 min. This protocol was followed for both eluent mixtures and the supernatants were combined, evaporated to 20 μL and reconstituted in 1 ml water and acetonitrile (95:5 mixture) with 0.1% formic acid.

Fish muscle samples (0.1 g) were extracted sequentially after addition of 50 ng of each internal and surrogate standard. Three sequential extractions were done; 1.5 ml methanol and water (7:3) with 0.1% formic acid; 1.5 ml acetonitrile and 1.5 ml acetonitrile. Samples were homogenized for four minutes at 42 000 oscillations per minute, using a Mini Beadbeater (Biospec. Bartlesville, USA) with zirconium beads and then centrifuged at 14 000 revolutions per minute for 10 min. This protocol was followed for all three eluent mixtures individually and the supernatants were combined, evaporated to 20 μL and reconstituted in 1 ml water and acetonitrile (95:5 mixture) with 0.1% formic acid.

4.2.3 Instrumental analysis

The same methodology as that reported by Grabic et al. (2011) was used for this analysis. In short, a triple stage quadrupole MS/MS TSQ Quantum Ultra EMR (Thermo Fisher Scientific, San Jose, CA, USA) coupled with an Accela LC pump (Thermo Fisher Scientific, San Jose, CA, USA) and a PAL HTC autosampler (CTC Analytics AG, Zwingen, Switzerland) were used as analytical system. Sample (20 μL) was loaded onto a Hypersil GOLD aQ TM column (50 mm x 2.1 mm ID, 5 μm particles, Thermo Fisher Scientific, San Jose, CA, USA) preceded by a guard column (2 mm×2.1 mm i.d, 5 μm particles) of the same packing material and from the same manufacturer. A gradient of flow and methanol and acetonitrile in water (all solvents buffered by 0.1% formic acid) was used for elution of analytes. The elution conditions were programmed as follows: 200 μL min^{-1} 10% methanol in water for 1 min isocratically, then composition is changed to 30/10/60 water/ acetonitrile / methanol and flow of 250 μL min^{-1} at 8 min. Then the column was washed by mixture ACN/ methanol 60/40 and flow of 300 μl min^{-1} in 9 minutes. These parameters were kept for 1 min and then they were switched to starting conditions and equilibrated for 4 min before next run.

Heated electrospray (HESI) and atmospheric pressure photo ionization (APPI) in positive and negative mode was used for ionisation of target compounds. Both first and third quadrupole were operated at resolution 0.7 FMWH, and two or three SRM transitions were monitored for each analyte. The setting of key parameters, SRM transitions, absolute recoveries, etc is stated in Grabic et al. (2011).

Samples were quantified using internal standard method. Several calibration standards covering all concentration range were measured before, in the middle and at the end of

sample sequences. The maximum difference between results at quantification and qualification mass transition was set to 30% as criterion for positive identification.

4.2.4 Quality control

Possible memory effects were evaluated by a blank injection of Milli-Q water after standard samples of varying concentrations. Field and laboratory blank samples were included in each batch. Standards were analyzed in a wide concentration range (0.005 ng ml^{-1} to 5000 ng ml^{-1}) and were used for evaluating the linearity, sensitivity - quantification limit (LOQ) defined as 10 times the standard deviation of the blank, reproducibility of retention, precision as repeatability, and column stability. Method recoveries were determined by spiking the standard solution to matrix at the following concentration levels: milliQ water (100 ng L^{-1}), surface water (100 ng L^{-1}) and sewage effluent (1000 ng L^{-1}). Analyte addition was made with the criteria that the spiking would be at a level at least three times the original concentration in surface water and sewage effluent, respectively.

5 Results and discussion, national program

No pharmaceuticals were detected in the laboratory blank samples and in the blank injections of Milli-Q water. Limit of quantification of the used methods are presented in appendix 3 and 4. The results of the measurements of the pharmaceuticals are presented in detail in Appendix 5-12 where the concentrations of the individual pharmaceuticals are given. All results from the regional screening program are presented in Appendix 13 and 14.

5.1 Background areas

Several pharmaceuticals were detected in surface water and biota from freshwater background lakes. Low ng/L levels of 33 pharmaceuticals were detected in Lake Älgsjön (sample N1, appendix 6) and 27 pharmaceuticals were detected in Lake Tärnan (sample N2, appendix 6). Trace amounts of two pharmaceuticals were detected in fish from Lake Älgsjön (sample N3, appendix 7) and five pharmaceuticals in fish from Lake Tärnan (sample N4, appendix 7). These lakes represent background surface water with no connection to effluent from WWTPs, only direct antropogenic contamination from people in the region. This diffuse direct contamination produces a pattern that differs from the concentrations in treated effluent. For example common painkillers, e.g. paracetamol, that are removed to a large extent in WWTPs, can be found in relatively high amounts in diffuse contaminated locations , which has been seen in previous Swedish screening studies (Andersson et al. 2006; Remberger et al. 2009).

5.2 Sewage treatment plants

5.2.1 WWTP influent

Levels of pharmaceuticals were measured on three consecutive days in influent water to the WWTPs, with the exception of WWTP Kungsängsverket in Uppsala where the tree sampling days were taken once weekly for three weeks. The WWTPs in Skövde (Stadskvarn), Stockholm (Henriksdal), Umeå (Ön) and Uppsala (Kungsängsverket), are all relatively large, treating water from approximately 57 000, 835 000, 100 000 and 160 000 person equivalents respectively.

Of the 101 pharmaceuticals included in this study 92 were detected in the WWTP influent of at least one WWTP, see appendix 7. Levels ranged from low ng/L up to 540 µg/L, with a median concentration of 53 ng/L. Paracetamol was the pharmaceutical that was detected in highest amounts, up to 540 µg/L. Maximum, minimum and median concentrations of all detected pharmaceuticals in the studied WWTP influents are shown in figure 1. Measured levels in this study correlate to measured levels in the literature (eg. Santos et al 2010; Gros et al. 2011) as well as to the levels in a study made by the Swedish environmental protection agency (SEPA 2008) and previous national screening studies (Andersson et al. 2006; Woldegiorgis et al. 2007; Remberger et al. 2009). For example, thirty-one pharmaceuticals were included in both the SEPA report and this screening and most levels correlate, some variations can be seen eg. measured ibuprofen levels are lower and the diclofenac levels are higher in this screening (SEPA 2008).

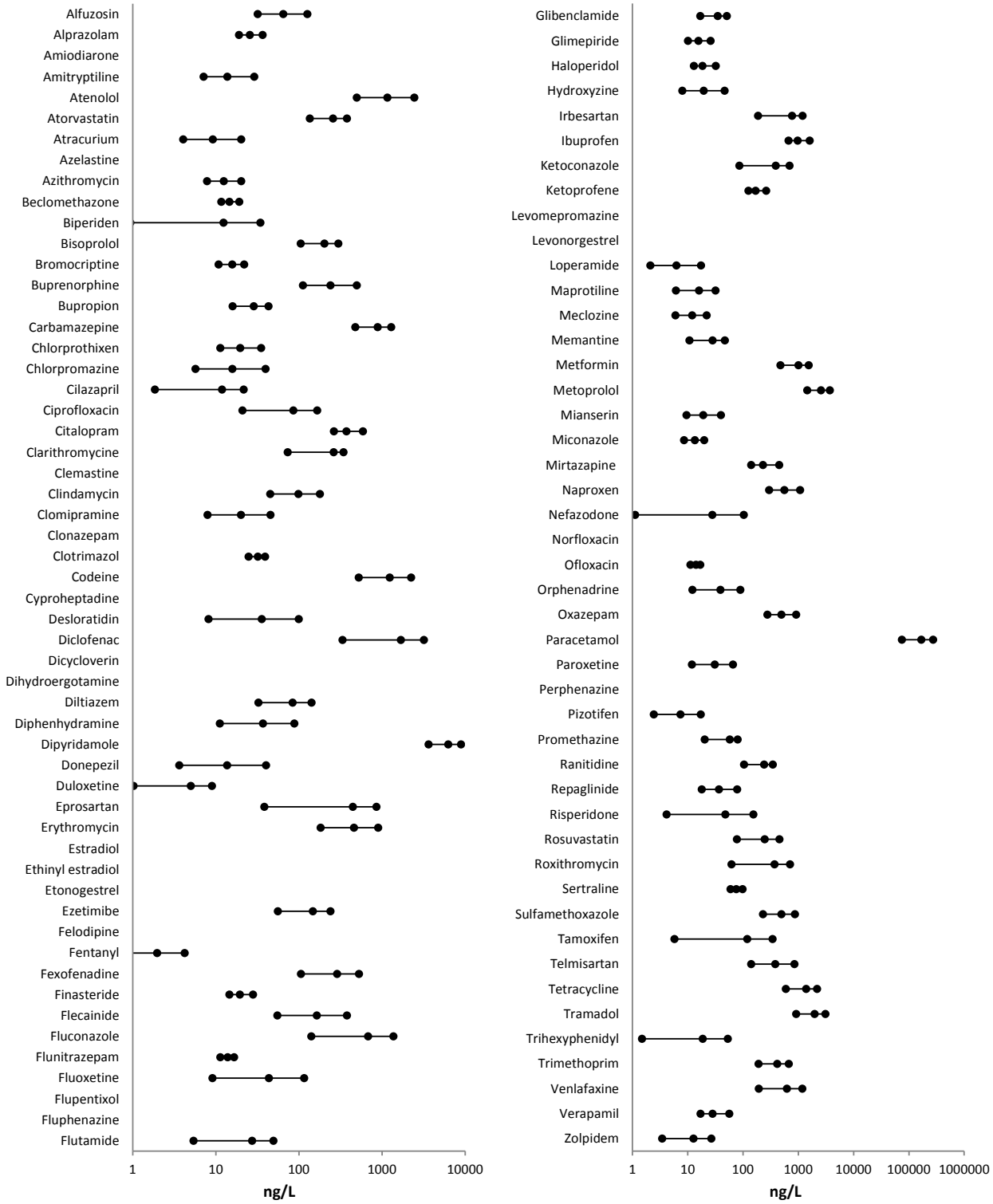

Figure 1. Minimum, average and maximum concentrations of pharmaceuticals in WWTP influent in four Swedish WWTPs (n=12).

5.2.2 WWTP effluent

Levels of pharmaceuticals were measured on three consecutive days in effluent sewage from the WWTPs, with the exception of WWTP Kungsängsverket in Uppsala where the tree sampling days were taken once weekly for three weeks.

Of the 101 pharmaceuticals included in this study 85 were detected in the effluent of at least one WWTP, see appendix 8. Levels ranged from low ng/L up to 4 µg/L, with a median concentration of 35 ng/L. Diclofenac was the pharmaceutical that was detected in highest amounts, up to 3.9 µg/L. Levels of paracetamol, the pharmaceutical that was detected in the highest amounts in WWTP influent, was dramatically reduced and did not exceed 580 ng/L. Maximum, minimum and median concentrations of all detected pharmaceuticals in the studied WWTP effluents are shown in figure 2. Measured levels of pharmaceuticals in the treated effluent correlate to measured levels in the literature (eg. Santos et al 2010; Gros et al. 2011) as well as to the levels in previous screening studies (Andersson et al. 2006; Woldegiorgis et al. 2007; Remberger et al. 2009). Of the thirty-one pharmaceuticals that were included in both this screening campaign and the SEPA report, most levels correlate, some variations can be seen eg. measured ibuprofen levels are lower in effluent as well and the diclofenac levels are higher in this screening (SEPA 2008).

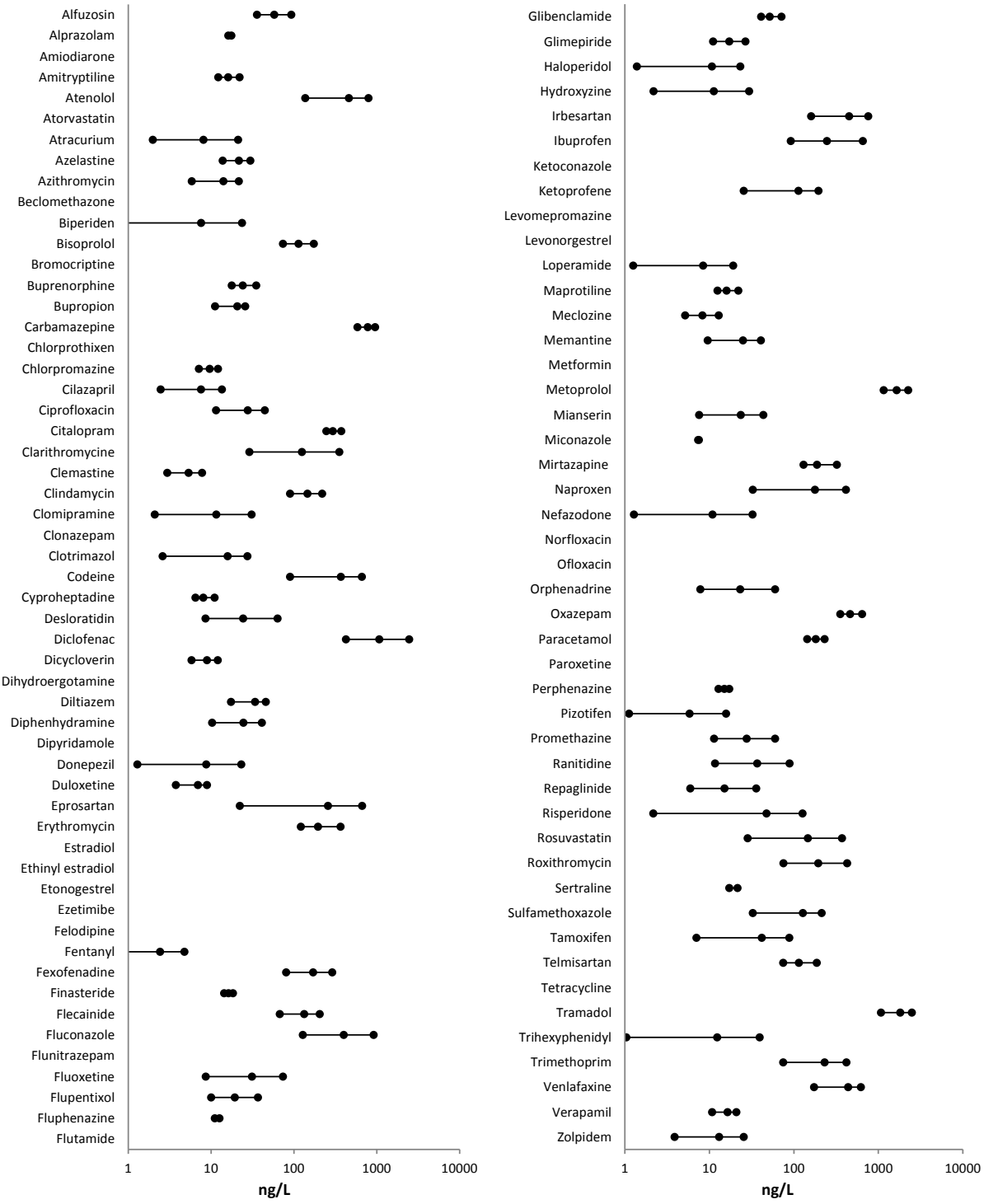

Figure 2. Minimum, average and maximum concentrations of pharmaceuticals in treated sewage effluent in four Swedish WWTPs (n=12).

5.2.3 Removal efficiency

Removal efficiencies were calculated according to the equation ((Infl – Effl) / Infl) and were based on the average values from the three sampling days, average from all four WWTPs are presented in Table 4.

Removal efficiencies in this study can be compared to the calculated removal efficiencies that were done in a SEPA report (SEPA 2008) and that were based on measured data from 2003-2008 from 43 Swedish WWTPs, see Table 4. This report uses a classification system where the removal rates are classified from A to F; A > 95%, B 94-80 %, C 79-50%, D 49-10%, E 9-0%, F < 0% (SEPA 2008). Only three pharmaceuticals, dipyradimole, paracetamol and tetracycline were classified as belonging to group A. Five pharmaceuticals, buprenorphine, flupentixol, fluphenazine, perphenazine and ranitidine were classified as belonging to group B, eighteen pharmaceuticals were classified to belong to group C and forty-two pharmaceuticals to group D. Seven pharmaceuticals were not removed at all and were classified as group E. Seventeen pharmaceuticals had negative removal rates and were classified as Group F.

Two pharmaceuticals that are commonly included in studies of removal efficiencies are diclofenac and carbamazepine, these had removal rates that ranged from negative values up to 64 and 33% respectively, which corresponds to removal rates previously measured in WWTPs (Vieno et al., 2007; Zhang et al., 2008, Zorita et al. 2009). Removal efficiencies in this study also correlate to values in previous screening studies (Andersson et al. 2006; Woldegiorgis et al. 2007; Remberger et al. 2009). Direct comparisons can be complicated, partly due to the fact that for pharmaceuticals that could only be detected in influent and not effluent, removal efficiencies were calculated using the LOQ and the analytical methods used have different LOQs.

Measurements of the removal efficiencies of the individual WWTPs are presented in appendix 9. These values vary a lot between the different pharmaceuticals and the different WWTPs, some like pharmaceuticals like paracetamol and naproxen have more or less the same removal efficiency in all investigated WWTPs but other pharmaceuticals like haloperidol have a removal rate of >90% in one WWTP and a negative removal rate in another. Pharmaceuticals have been shown to have large variations in different studies at different WWTPs (eg. Lindberg et al. 2005; Vieno et al. 2005; Zorita et al. 2009; Gros et al. 2010; Jelic et al. 2011) and this can be partially be explained by seasonal changes, individually treatment optimizations at each WWTPs, different conditions and loads of the WWTPs, etc.

Table 4. Average removal efficiencies (RR) and classifications into groups: A > 95%, B 94-80 %, C 79-50%, D 49-10%, E 9-0%, F < 0% (SEPA 2008)

	This study		SEPA 2008			This study		SEPA 2008	
	RR(%)	Group	RR(%)	Group		RR(%)	Group	RR(%)	Group
Alfuzosin	-2.1	F			Fluoxetine	13	D	-184	F
Alprazolam	> 38	> D			Flupentixol	80	B		
Amiodiarone					Fluphenazine	84	B		
Amitryptiline	-12	F			Flutamide	> 3.0	> E		
Atenolol	51	C	9	D	Glibenclamide	-67	F		
Atorvastatin	> 67	> C	96	A	Glimepiride	-44	F		
Atracurium	26	D			Haloperidol	28	D		
Azelastine	49	D			Hydroxyzine	50	C		
Azithromycin	-21	F			Ibuprofen	71	C	>85	> B
Beclomethazone	> 29	> D			Irbesartan	36	D		
Biperiden	36	D			Ketoconazole	> 62	> C	> 89	> B
Bisoprolol	39	D			Ketoprofene	36	D	>51	> C
Bromocriptine	> 65	> C			Levomepromazine				
Buprenorphine	87	B			Levonorgestrel				
Bupropion	24	D			Loperamide	-72	F		
Carbamazepine	-3	F	-40	F	Maprotiline	> -2.7	> F		
Chlorprothixen	> 8.0	> E			Meclozine	2	E		
Chlorpromazine	> 34	> D			Memantine	11	D		
Cilazapril	> 34	> D			Metformin	> 61	> C	70	C
Ciprofloxacin	61	C	69	C	Metoprolol	31	D	-24	F
Citalopram	11	D	-62	F	Mianserin	-28	F		
Clarithromycine	54	C			Miconazole	36	D		
Clemastine	-12	F			Mirtazapine	14	D		
Clindamycin	-73	F			Naproxen	72	C	>69	> C
Clomipramine	52	C			Nefazodone	2	E		
Clonazepam					Norfloxacin	> 17	> D	> 21	> D
Clotrimazol	30	D			Ofloxacin	> 7.0	> E	> 80	> B
Codeine	68	C	71	C	Orphenadrine	44	D		
Cyproheptadine	49	D			Oxazepam	-6	F	>-11	> F
Desloratidin	15	D			Paracetamol	100	A		
Diclofenac	28	D	11	D	Paroxetine	> 43	> D	> 4.1	E
Dicycloverin	-50	F			Perphenazine	89	B		
Dihydroergotamine					Pizotifen	30	D		
Diltiazem	42	D			Promethazine	51	C		
Diphenhydramine	16	D			Ranitidine	85	B	-431	F
Dipyridamole	> 99	A			Repaglinide	60	C		
Donepezil	30	D			Risperidone	-101	F		
Duloxetine	> 29	> D			Rosuvastatin	> 63	> C		
Eprosartan	46	D			Roxithromycin	> 39	> D		
Erythromycin	43	D	> 28	> D	Sertraline	71	C	18	D
Estradiol			>72	> C	Sulfamethoxazole	73	C	>48	> D
Ethinyl estradiol			> 42	> D	Tamoxifen	> 26	> D		
Etonogestrel					Telmisartan	58	C		
Ezetimibe	> 45	> D			Tetracycline	> 96	A	>80	> B
Felodipine			-2	F	Tramadol	-3	F		
Fentanyl	-30	F			Trihexyphenidyl	40	D		
Fexofenadine	37	D			Trimethoprim	39	D	>-17	> F
Finasteride	6	E			Venlafaxine	21	D		
Flecainide	0	E			Verapamil	26	D		
Fluconazole	33	D			Zolpidem	-7	F	23	D
Flunitrazepam	> 27	> D							

Several pharmaceuticals show negative removal rates, which indicate an increase in concentration in the treated effluent compared to the influent (Table 3 and appendix 9). Negative removal rates are often encountered in removal efficiencies studies and several researchers have reported this (Vieno et al. 2007; Zorita et al. 2009; Gros et al. 2010; Jelic et al. 2011). Negative removal can be explained, to some extent by the deconjugation of metabolites, such as eg. glucuronide conjugates, that are converted back to the original

compound in the WWTPs. Unless specific gluconiride conjugates are included in the screening this deconjugation will appear as negative removal. This variation can also be caused by variations in the consumption and the sampling protocol applied in this investigation, 24 hour composite samples for three consecutive days, are considered to be a robust strategy but it is not fool proof and sudden spikes could be missed.

5.2.4 WWTP sludge

Levels of pharmaceuticals in digested dewatered sludge from all four WWTPs were measured and the results are presented in figure 3 and appendix 10. Seventy-three pharmaceuticals were detected at levels range from low ng/Kg up to mg/Kg. The pharmaceutical that was detected at the highest level, 1.8 mg/Kg, was ketoconazole, an antimycotic, and similar levels have been detected previously in a Swedish screening study (Lindberg et al. 2010). Measured concentrations correlate to previously published levels (Lindberg et al. 2005; Andersson et al. 2006; Woldegiorgis et al. 2007; SEPA 2008; Jelic et al. 2011) with the exception of the fluoroquinolone antibiotic ciprofloxacin. In this study, levels of ciprofloxacin were an order of magnitude lower than in previous Swedish studies (Lindberg et al. 2005; SEPA 2008). This decrease can not be explained by a reduced usage or seasonal variations (data not shown).

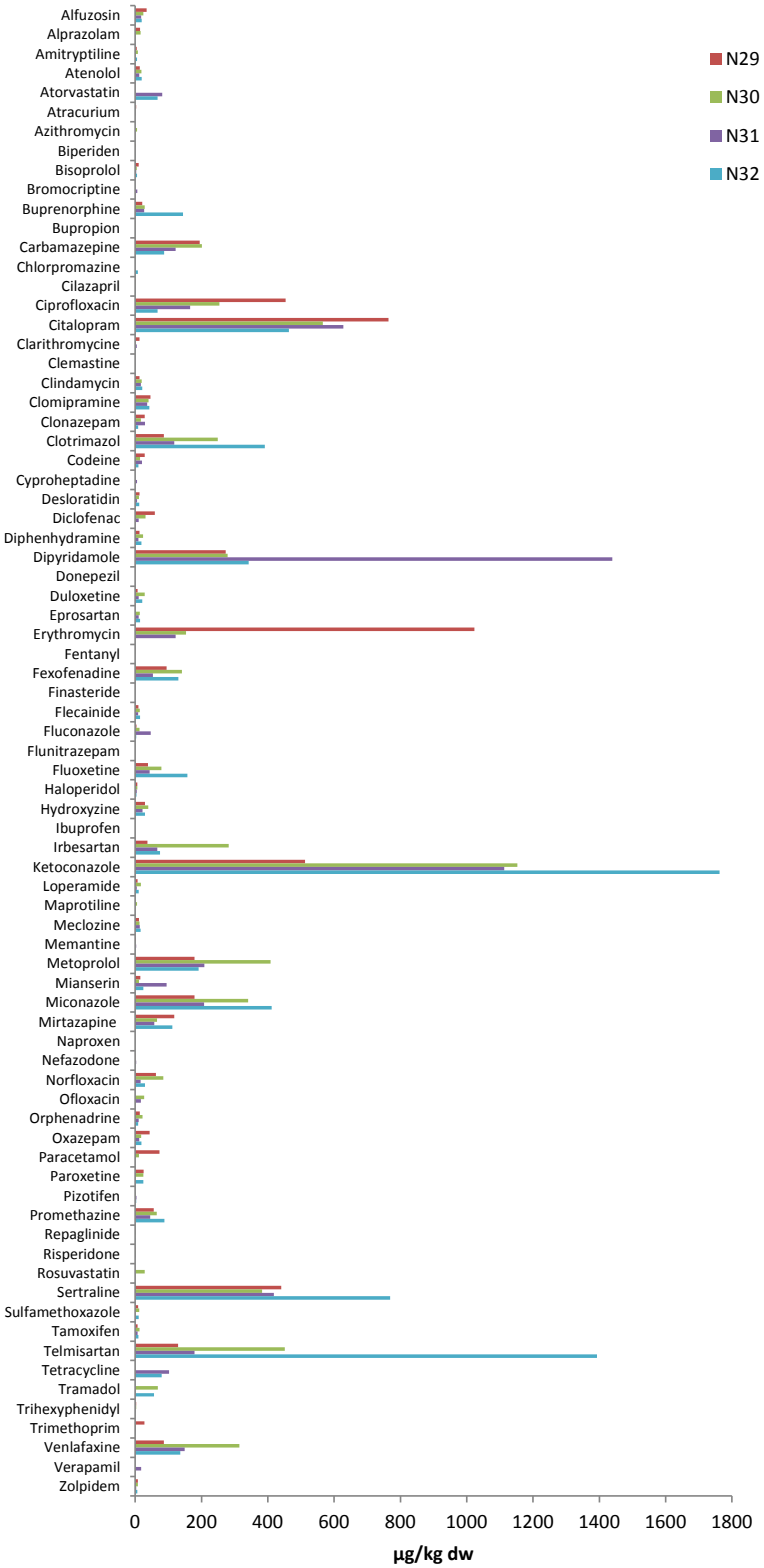

Figure 3. Detected pharmaceuticals (µg/Kg) in dewatered digested sludge from the WWTPs Stadskvarn, Skövde (N29), Henriksdal, Stockholm (N30), Ön, Umeå (N31) and Kungsängsverket, Uppsala (N32).

5.3 Surface water

Of the 101 pharmaceuticals included in this study 66 were detected in the surface water samples in the range of low ng/l up to 1.8 µg/L, figures 4 and 5 (appendix 5). Detected levels are comparable with the lower ranges found in a European-wide survey that included samples from 122 Rivers in 27 European countries (Loos et al. 2009) and levels found in previous screening studies (Andersson et al. 2006; Woldegiorgis et al. 2007; Remberger et al. 2009; Daneshvar et al. 2010). A total of 13 surface samples were analyzed, two samples (N1 and N2) were taken at lakes in a background area in Södermanland County (see 5.1. Background areas) and 11 samples were taken up- and downstream of the WWTPs Stadskvarn (Skövde) and Kungsängsverket (Uppsala). These two WWTPs both receive hospital wastewater and both discharge their treated effluent in small/moderate Rivers. Samples taken downstream of these WWTPs, N35-N38 and N40-N43, can therefore be considered to be effluent-dominated surface water samples.

Effluent from WWTP Stadskvarn, Skövde, discharges into the creek Mörkebäcken. The average effluent flow 2010 was 13 100 m^3/day (546 m^3/h). The natural flow in Mörkebäcken varies but is almost always considerably lower. The creek empties via Svesån and Örnboån into Ösan which eventually empties in Lake Vänern (Bratt 2011). Surface water was sampled at two sites upstream the effluent discharge point; -5 km (N34, Ösan), -1 m (N33) and at four points downstream; 5 m (N35), 50 m (N36), 500 m (N37), (all in Mörkebäcken) and 5 km (N38, Ösan). The sampling was done in November when the flow in Mörkebäcken was relatively high, resulting in an initial dilution factor of around two. There were also high flows from several covered trenches leading to further dilution between the sampling sites N36 and N37.

Several pharmaceuticals were detected at the two upstream sites and the pattern, high levels of common antibiotics and NSAIDs, indicate that this is caused by diffuse anthropogenic influence, Figure 4. Levels at site N35, 5 m downstream, is consistently lower that at site N36 50 m downstream, which indicate insufficient mixing prior sampling site N35.

Elevated levels of some common antibiotics and NSAIDs at sites N37 and N38 indicates that these sites are influenced by both sewage effluent and diffuse anthropogenic sources.

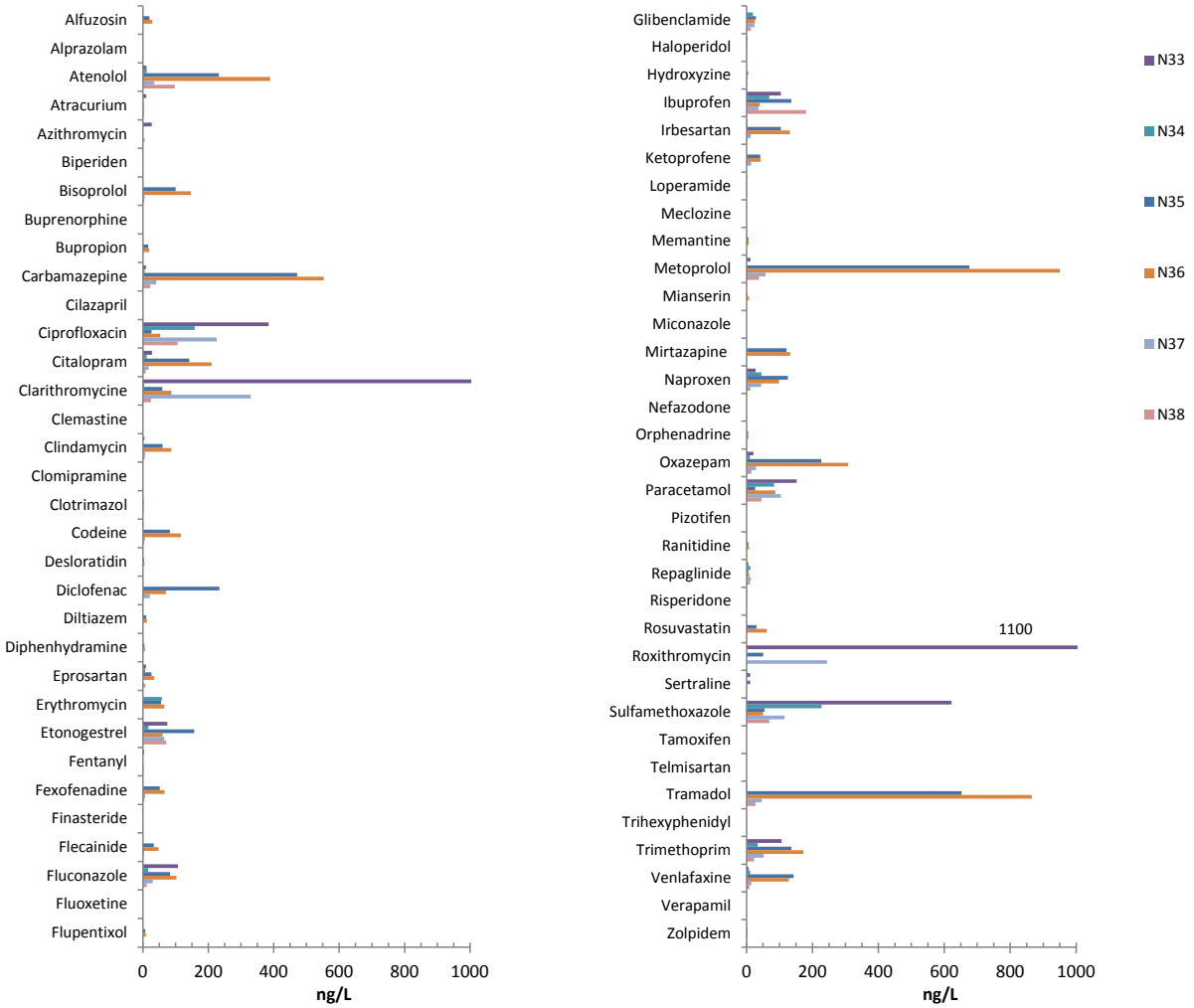

Figure 4. Detected pharmaceuticals (ng/L) in surface water samples from Skövde (N33 – N38).

The effluent from WWTP Kungsängsverket, Uppsala, discharges into River Fyris. Surface water was sampled upstream the sewage effluent discharge point; -1.7 km (N39) and at four points downstream; 5 m (N40), 150 m (N41), 3.5 km (N42) and 4.6 km (N43). Concentrations of pharmaceuticals clearly increased in the first downstream sample and then sequentially decreased in the following samples (Figure 5). The annual average flow in Fyrisån is 8.6 m^3/s and the average effluent flow from WWTP Kungsängsverket is 2 200 m^3/h (Uppsala vatten, 2011), i.e. a mean dilution factor of 14.

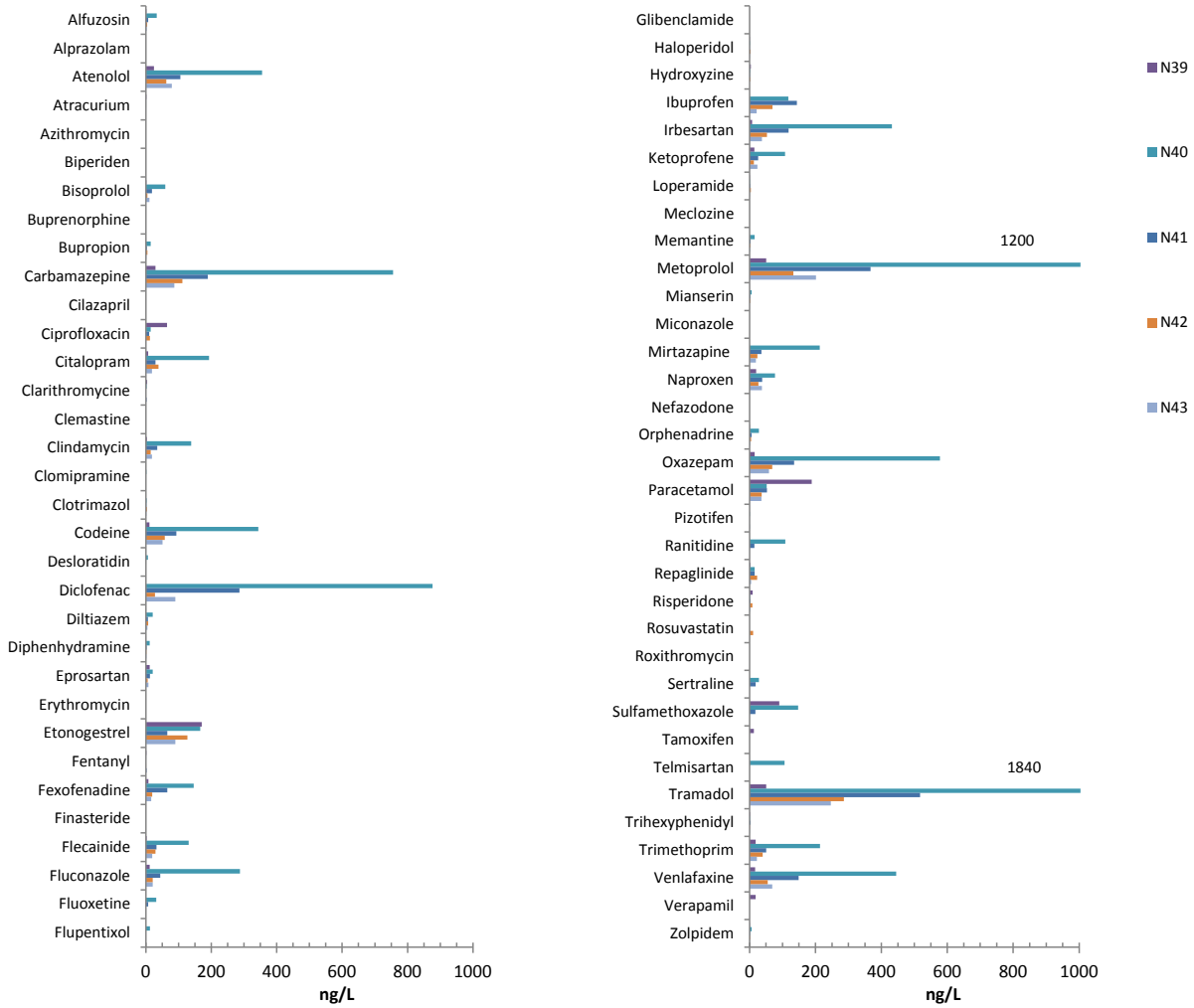

Figure 5. Detected pharmaceuticals (ng/L) in surface water samples from Uppsala (N39 – N43).

One way to evaluate the pharmaceuticals potential to cause adverse effects at given water concentrations is to compare the measured levels to the corresponding critical environmental concentration (CEC) values for each pharmaceutical (Fick et al. 2010). CEC is calculated as the water concentration that would elevate the plasma concentration in exposed fish to a level equal to the human therapeutic plasma concentration. Concentration ratios (CEC to measured concentration) of 1 or below indicate that the measured level of that pharmaceutical is expected to cause a pharmacological effect in fish. However, it should be stressed that concentration ratios only reflect the probability for pharmacological interactions to occur, and not whether the interactions would be adverse or not.

A total of 465 observations of pharmaceuticals in surface water were made in this study, distributed between 66 pharmaceuticals and 13 samples (appendix 11). Out of these 465 observations, 13 (3 %) had a concentration ratio below 1, i.e. the water concentration of the specific pharmaceutical in these samples are expected to cause a pharmacological

response in fish exposed to these waters and 57 (12 %) had a concentration ratio between 1 and 10, figure 6.

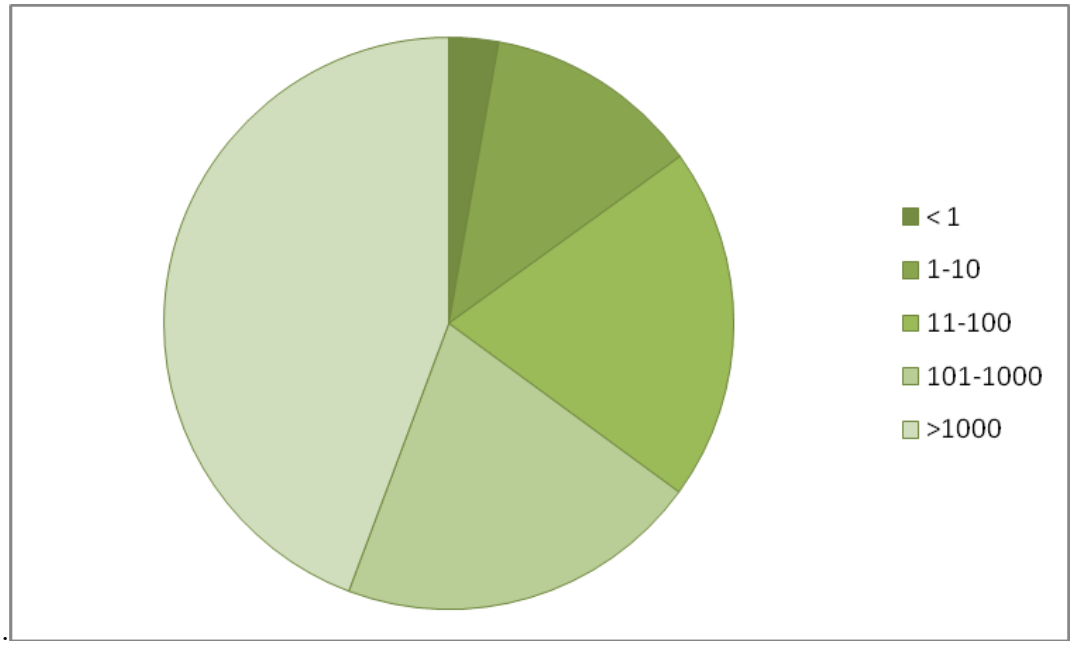

Figure 6. Histogram of concentration ratios in surface water samples N1, N2, N33 – N43. Number of observations in each class are; <1 = 13 (2.8%), 1-10 = 57 (12%), 11-100 = 93 (20%), 101-1000 = 96 (21%), >1000 = 206 (44%).

Five pharmaceuticals were detected at levels below their CEC value. Three were measured in the most polluted surface water samples; the antidepressant citalopram (at sites N36 and N40), the antipsychotic drug flupentixol (at sites N35, N36 and N40), the hypertension drug irbesartan (at sites N35, N36 and N40-N42) and two at the background areas; the opioid buprenorphine (at site N1), the antihistamine meclozine (at sites N1 and N2).

Buprenorphine was only detected in surface water at one site and the measured level of 15 ng/L was close to the LOQ of 10 ng/L. Buprenorphine was also detected in one of the three drinking water samples from Stockholm, which implies that these results could be analytical artefacts. It should be emphasized however, that no pharmaceuticals were detected in the laboratory blank samples or the preceeding blank injections of Milli-Q water. Meclozine however, was detected in surface water at levels, 59 ng/L and 25 ng/L in N1 and N2 respectively, which is well above the detection limit of 5 ng/L.

Ten additional pharmaceuticals were detected at levels that were between 1-10 of their CEC values; alprazolam, bupropion, clarithromycine, clemastine, diclofenac, haloperidol, loperamide, sertraline, tramadol and verapamil. 11 of the 70 observations of with a concentration ratio < 10, were made in the background area samples and nine were made in the upstream samples. Some of these observations were close to the detection limit and the results should not be extrapolated to far, but these findings suggest that diffuse anthropogenic sources can cause elevated levels of pharmaceuticals, at specific sites, that could cause adverse effects.

It should be emphasized that the pharmaceuticals that were included in this screening were selected based on their potential to be present in Swedish surface waters in concentrations close to their CEC values. The fact that 15 pharmaceuticals out of 101 were detected at concentrations expected to cause a pharmacological effect in fish can therefore not be extrapolated to pharmaceuticals in general.

CEC values can also be used to evaluate the relevancy of the LOQs of the analytical methods used in a screening. When comparing the CEC values with the LOQs for all pharmaceuticals, nine pharmaceuticals were shown to have a LOQ that was higher than the CEC value. This implies that levels of these pharmaceuticals that are expected to cause a pharmacological effect in fish could be reported as below LOQ and these findings would go undetected. Azelastine, buprenorphine, estradiol, ethinyl estradiol, felodipine, flupentixol, levomepromazine, meclozine and perphenazine all have inadequate LOQs.

5.4 Biota

In this study 23 pharmaceuticals were detected in the seven biota (perch) samples, figure 7 (appendix 6). Samples were taken from perch caught in; Älgsjön (N3), Lake Tärnan (N4), upstream (N50) and downstream (N51) WWTP Stadskvarn, Skövde, upstream (N52) and (N53, N54) downstream WWTP Kungsängsverket, Uppsala (appendix 1). Concentrations were in the low μg/Kg range and highest detected levels were found in the perch (N53) caught in close proximity to the WWTP Kungsängsverkets (Uppsala) discharge point in River Fyris, figure 7 (appendix 6). Most of the pharmaceuticals detected in the biota samples are directly correlated to the levels in corresponding surface water, (appendix 5 and appendix 6). Studies of pharmaceutical accumulation in fish in effluent-dominated rivers in the US have shown similar levels of diphenhydramine, sertraline and fluoxetine (Brooks et al. 2005; Ramirez et al. 2009; Schultz et al. 2010).

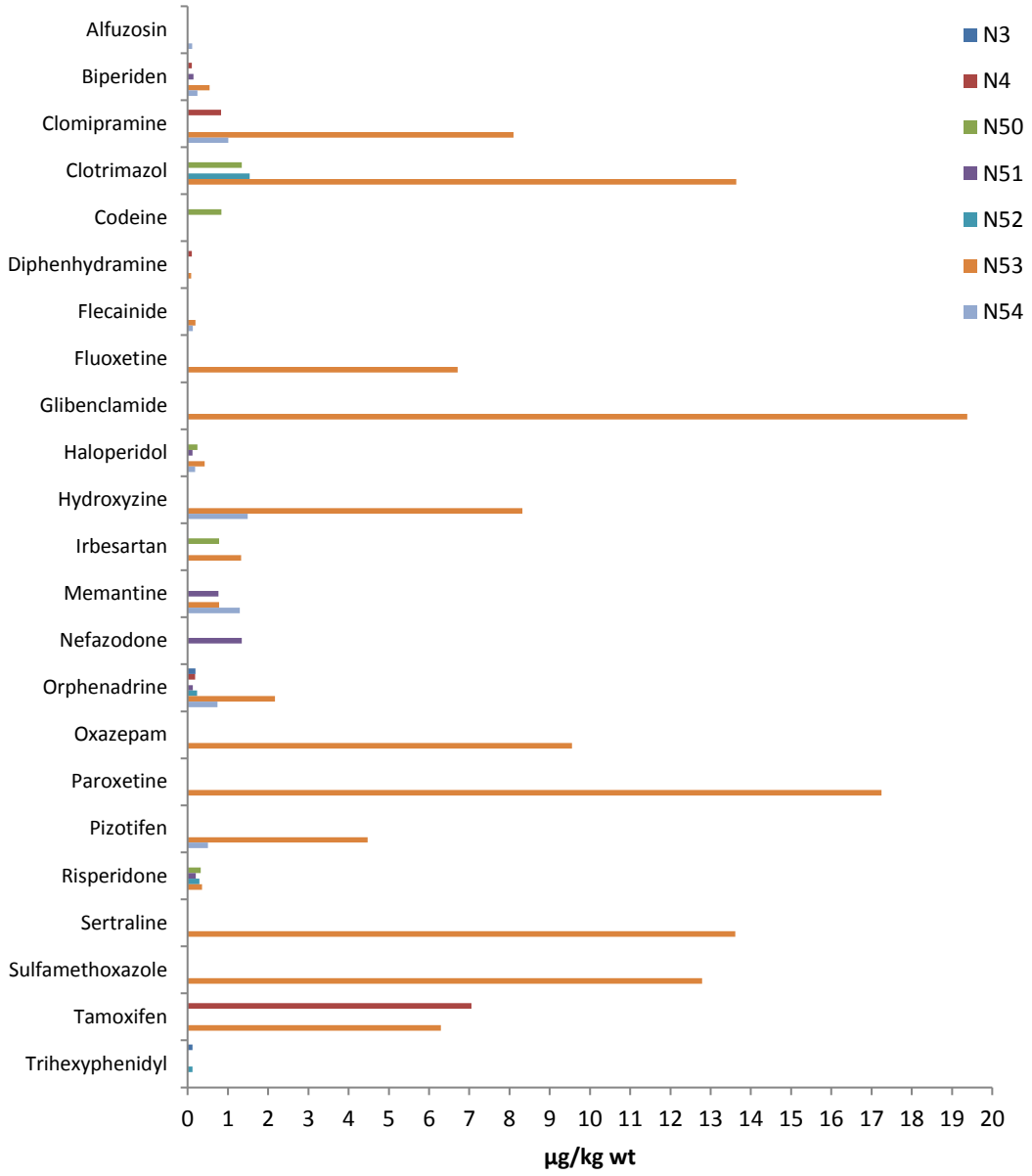

Figure 7. Detected pharmaceuticals (µg/Kg) in biota samples N3, N4, N50 – N54.

5.5 Drinking water

Low levels (low ng/L range) of 26 pharmaceuticals were detected in the drinking water samples, figure 8 (appendix 12). There was a significant difference between the drinking water in Stockholm (N44-N46) and Umeå (N47-N49). Only two pharmaceuticals could be detected in the samples from Umeå, carbamazepine and trimethoprim, while 26 pharmaceuticals were detected in the Stockholm samples. Surface water from Lake Mälaren is used as drinking water source in Stockholm while artificial bank filtrated ground-water is used as drinking water source in Umeå, which could explain this difference. Diclofenac was detected in fairly high concentrations in one of the three drinking water samples from Stockholm and the possibility of a contaminated sample can not be excluded even though no pharmaceuticals could be found in the corresponding laboratory blanks.

Several pharmaceuticals have been detected in drinking water world-wide, typically in the low ng/L range (Jones et al. 2005; Benotti et al. 2009; Huerta-Fontela et al. 2011; Santos et al: 2011). The World Health Organization recently presented a technical report on the presence of pharmaceuticals in drinking water (WHO 2011). Their conclusion was that adverse human health impacts are very unlikely from exposure of pharmaceutical residues in drinking water and that it is not necessary to implement routine monitoring programmes (WHO 2011).

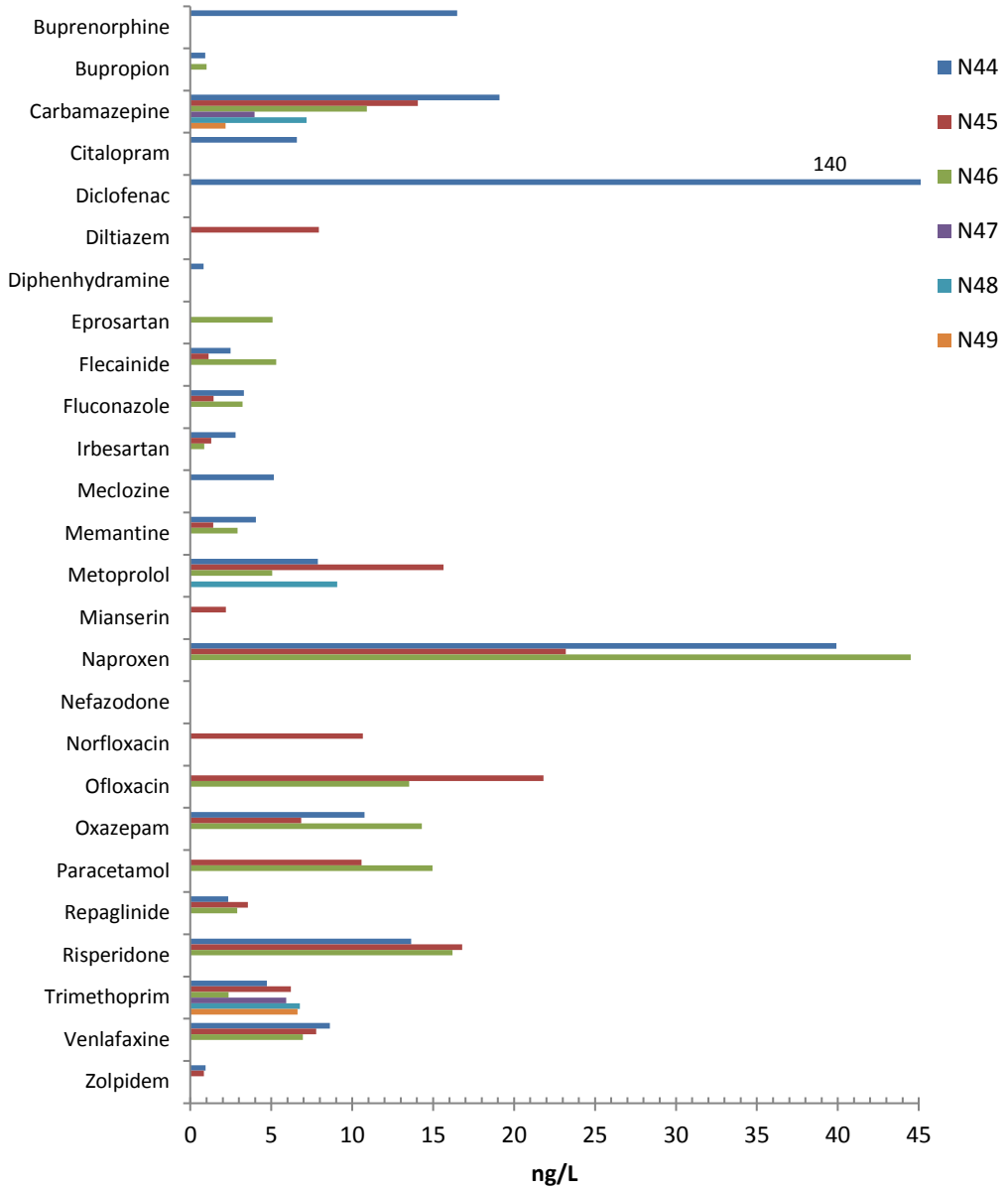

Figure 8. Detected pharmaceuticals (ng/L) in drinking water samples from Stockholm (N44 – N46) and Umeå (N47 – N49).

6 Results, regional program

WWTP influents (n=9) were analysed for seven substances. Carbamazepine, ketoconazole and sertraline were found in most waters but not in concentrations higher than in the national program. In the national program metformin was found in influents to Umeå and Uppsala WWTPs, but not in influents to Skövde or Henriksdal (Stockholm). However, metformin was found in all regional samples in concentrations similar to Umeå and Uppsala.

WWTP effluents (n=19) were analysed for seven substances. Carbamazepine was found in all samples but in concentrations in the lower range of what was found nationally. In the national program metformin was found only in effluent from Umeå WWTP. Regionally it was found in 13 out of 19 effluents, the concentrations were highest in Skelleftå and Piteå. One effluent (Visby) was analysed for 101 substances. The results were for most substances in the lower range of the national results. One substance (clonazepam) was detected in this sample only, not in any of the national effluents.

In the sludge samples (n=12) analysed for seven substances carbamazepine and ketoconazole was found in the same concentration range as in the national program. Concentrations of sertraline in sludge from Skellefteå and Sundsvall were somewhat higher than found nationally. Sludge from Visby was analysed for 101 substances. Concentrations of dipyridamole and trihexyphenidyl were higher than found nationally.

Eight surface waters were analysed for seven substances. The sample from Varnumsviken, Kristinehamn stood out as showing the highest results for carbamazepine and sertraline. Ketoconazole and metformin was found in this, but not in any other surface water.

Surface water from Gothemsån and Djupasjön was analysed for 101 substances. Buprenorphine was detected in both but not in any other surface water. Three substances (dicycloverin, hydroxyzine, perphenazine) was found in Gothemsån in higher concentrations than in any other surface water. Six substances (buprenorphine, nefazodone, paroxetine, pizotifen, tetracycline, trihexyphenidyl) were found in Djupasjön in higher concentrations than in any other surface water.

Five perch samples was analysed for seven substances. None of these were detected.

In the eight biota samples analysed for 101 substances, four were detected that was not found in the national samples; carbamazepin in the eel from Askeröfjorden, buprenorphine in the roach from Djupasjön, bupropion in the mussel from downstream Ryaverket WWTP and fluconazole in the perch from Runn, Falun. None of the remaining substances were found in a higher concentration than in the national program. The highest number of substances (10) was found in the eel from Askeröfjorden.

7 Conclusions

- Most of the pharmaceuticals in the screening (91%) were detected in WWTP influent clearly showing that this is the primary source of environmental residues of pharmaceuticals in Sweden.
- Most of the pharmaceuticals in the screening (84%) were also detected in WWTP effluent and the median concentration dropped by one third from WWTP influent (53 ng/L) to WWTP effluent (35 ng/L).
- Several pharmaceuticals were detected in high levels in sewage sludge.
- Two thirds of the pharmaceuticals (65%) were detected in the surface water samples; in the range low ng/L to 1.8 μg/L. Highest detected levels were found in close proximity to discharge points of WWTPs. In this study 15 out of 101 pharmaceuticals were detected at such levels that they are expected to cause a pharmacological response in fish exposed to these waters.
- Several pharmaceuticals (23%) were detected in the biota samples. Concentrations were in the low μg/Kg range. Highest detected levels were found in the perch caught in close proximity to the WWTP Kungsängsverkets (Uppsala) discharge point in River Fyris. This indicates that effluent-dominated surface water in Sweden cause uptake of pharmaceuticals in fish.
- Several pharmaceuticals (26%) were detected in drinking water samples. However, recent WHO guidelines clearly indicates that adverse human health impacts are very unlikely from exposure of pharmaceutical residues in drinking water at the detected levels (low ng/L range) and that it is not necessary to include pharmaceuticals in routine monitoring programmes for drinking water.

Suggestions for further studies:

- As some of the pharmaceuticals were found in lakes with no load from WWTP effluents, at environmental relevant concentrations, further studies of lakes affected by private sewers only would be interesting
- High levels of several pharmaceuticals were detected in the four sewage samples included in this study and the use of sludge in agriculture and for other purposes makes it interesting to study life-time and mobility of pharmaceuticals in this matrix.
- The particle bound fraction of pharmaceuticals was not explicitly investigated in this study but is important for uptake in biota and would be of great interest to study further.

8 Acknowledgement

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References

Andersson, J., Woldegiorgis, A., Remberger, M., Kaj. L., Ekheden, Y., Dusan, B., Svenson, A., Brorström-Lunden, E., Dye, C., Schlabach, M. 2006. Results from the Swedish National Screening Programme 2005. Subreport 1: Antibiotics, Anti-inflammatory substances and Hormones.

Benotti, M.J., Trenholm, R.A., Vanderford, B.J., Holady, J.C., Stanford, B.D., Snyder, S.A. 2009. Pharmaceuticals and Endocrine Disrupting Compounds in US Drinking Water. Environmental Science & Technology 43 (3), 597-603.

Besse, J.P. and Garric, J. 2008. Human pharmaceuticals in surface waters implementation of a prioritization methodology and application to the French situation. Toxicology Letters 176 (2), 104-123.

Bratt, Pernilla 2011 WWTP Stadskvarn, personal communication

Brooks, B.W., Chambliss, C.K., Stanley, J.K., Ramirez, A., Banks, K.E., Johnson, R.D., Lewis, R.J. 2005. Determination of select antidepressants in fish from an effluent-dominated stream. Environmental Toxicology and Chemistry 24 (2), 464-469.

Carlsson, G., Örn, S., Larsson, D.G.J. 2009. Effluent from Bulk Drug Production Is Toxic to Aquatic Vertebrates. Environmental Toxicology and Chemistry 28 (12), 2656-2662.

Daneshvar, A., Svanfelt, J., Kronberg, L., Prevost, M., Weyhenmeyer, G.A. 2010. Seasonal variations in the occurrence and fate of basic and neutral pharmaceuticals in a Swedish river-lake system. Chemosphere 80 (3), 301-309.

Fatta-Kassinos, D., Meric, S., Nikolaou, A. 2011. Pharmaceutical residues in environmental waters and wastewater: current state of knowledge and future research. Analytical and Bioanalytical Chemistry 399 (1), 251-275.

Fent, K., Weston, A.A., Caminada, D., 2006. Ecotoxicology of human pharmaceuticals. Aquatic Toxicology 76 (2), 122-159.

Fick, J., Söderstrom, H., Lindberg, R.H., Phan, C., Tysklind, M., Larsson, D.G.J., 2009. Contamination of Surface, Ground, and Drinking Water from Pharmaceutical Production. Environ Toxicol Chem 28, 2522-2527.

Fick, J., Lindberg, R.H., Tysklind, M., Larsson, D.G.J. 2010. Predicted critical environmental concentrations for 500 pharmaceuticals. Regulatory Toxicology and Pharmacology 58 (3), 516-523.

Grabic, R., Fick, J., Lindberg, R.H., Fedorova, G., Tysklind, M., 2011. Multi-residue method for trace level determination of 100 pharmaceuticals in environmental samples by liquid chromatography coupled to triple quadrupole mass spectrometry. Submitted

Gros, M., Petrovic, M., Ginebreda, A., and Barcelo, D., 2010. Removal of pharmaceuticals during wastewater treatment and environmental risk assessment using hazard indexes. Environment International 36 (1), 15-26.

Huerta-Fontela, M., Galceran, M.T., Ventura, F. 2011. Occurrence and removal of pharmaceuticals and hormones through drinking water treatment. Water Research 45 (3), 1432-1442.

Huggett, D.B., Cook, J.C., Ericson, J.F., Williams, R.T. 2003., A theoretical model for utilizing mammalian pharmacology and safety data to prioritize potential impacts of human pharmaceuticals to fish. Hum Ecol Risk Assess 9, 1789-1799.

Jelic, A.,Gros, M., Ginebreda, A., Cespedes-Sanchez, R., Ventura, F., Petrovic, M., Barcelo, D. 2011. Occurrence, partition and removal of pharmaceuticals in sewage water and sludge during wastewater treatment. Water research 45:1165-1176

Jones, O.A., Lester, J.N., Voulvoulis, N. 2005. Pharmaceuticals: a threat to drinking water? Trends in Biotechnology 23 (4), 163-167.

Kidd, K.A., Blanchfield, P.J., Mills, K.H., Palace, V.P., Evans, R.E., Lazorchak, J.M., and Flick,R.W. (2007) Collapse of a fish population after exposure to a synthetic estrogen. Proceedings of the National Academy of Sciences of the United States of America 104 (21), 8897-8901.

Lange, R., Hutchinson, T.H., Croudace, C.P., Siegmund, F., Schweinfurth, H., Hampe, P., Panter, G.H., and Sumpter, J.P. (2001) Effects of the synthetic estrogen 17 alpha-ethinylestradiol on the life-cycle of the fathead minnow (Pimephales promelas). Environmental Toxicology and Chemistry 20 (6), 1216-1227.

Lindberg, R.H., Wennberg, P., Johansson, M.I., Tysklind, M., Andersson, B.A.V. 2005. Screening of human antibiotic substances and determination of weekly mass flows in five sewage treatment plants in Sweden. Environmental Science & Technology 39 (10), 3421-3429.

Lindberg, R.H., Fick, J., Tysklind, M. 2010. Screening of antimycotics in Swedish sewage treatment plants - Waters and sludge. Water Research 44 (2), 649-657.

Loos, R., Gawlik, B.M., Locoro, G., Rimaviciute, E., Contini, S., Bidoglio, G., 2009. EU-wide survey of polar organic persistent pollutants in European river waters. Environ Pollut 157, 561-568.

Martindale S. C. Sweetman (Ed), Martindale: The Complete Drug Reference. Pharmaceutical Press. Electronic version, , London, 2011

Phillips, P.J., Smith, S.G., Kolpin, D.W., Zaugg, S.D., Buxton, H.T., Furlong, E.T., Esposito, K., Stinson, B. 2010. Pharmaceutical Formulation Facilities as Sources of Opioids and Other Pharmaceuticals to Wastewater Treatment Plant Effluents. Environmental Science & Technology 44 (13), 4910-4916.

Ramirez, A.J., Brain, R.A., Usenko, S., Mottaleb, M.A., O'Donnell, J.G., Stahl, L.L., Wathen, J.B., Snyder, B.D., Pitt, J.L., Perez-Hurtado, P., Dobbins, L.L., Brooks, B.W., Chambliss, C.K. 2009. Occurrence of Pharmaceuticals and Personal Care Products in Fish: Results of A National Pilot Study in the United States. Environmental Toxicology and Chemistry 28 (12), 2587-2597.

Remberger, M., Wiklund, P., Woldegiorgis, A., Viktor, T., Kaj. L., Brorström-Lunden, E. 2009. Anti-inflammatory and analgesic drugs in WWTP influent and effluent streams and the occurrence in the aquatic environment.

Sanderson, H., Johnson, D.J., Reitsma, T., Brain, R.A., Wilson, C.J., Solomon, K.R. 2004. Ranking and prioritization of environmental risks of pharmaceuticals in surface waters. Regulatory Toxicology and Pharmacology 39 (2), 158-183.

Santos, L.H.M.L., Araujo, A.N., Fachini, A., Pena,A., Delerue-Matos, C., Montenegro, M.C.B.S. 2010. Ecotoxicological aspects related to the presence of pharmaceuticals in the aquatic environment. Journal of Hazardous Materials 175 (1-3), 45-95.

Sanchez, W., Sremski, W., Piccini, B., Palluel, O., Maillot-Marechal, E., Betoulle, S., Jaffal, A., Ait-Aissa, S., Brion, F., Thybaud, E., Hinfray, N., Porcher, J-M Adverse effects in wild fish living downstream from pharmaceutical manufacture discharges Environment International 37:1342-1348

Schultz, M.M., Furlong, E.T., Kolpin, D.W., Werner, S.L., Schoenfuss, H.L., Barber, L.B., Blazer, V.S., Norris, D.O., Vajda, A.M. 2010. Antidepressant Pharmaceuticals in Two US Effluent-Impacted Streams: Occurrence and Fate in Water and Sediment, and Selective Uptake in Fish Neural Tissue. Environmental Science & Technology 44 (6), 1918-1925.

Segura, P.A., Francois, M., Gagnon, C., Sauve, S., 2009. Review of the Occurrence of Anti-infectives in Contaminated Wastewaters and Natural and Drinking Waters. Environmental Health Perspectives 117, 675-684.

SEPA 2008. Avloppsreningsverkens förmåga att ta hand om läkemedelsrester och andra farliga ämnen. Naturvårdsverket Rapport 5794 (in Swedish).

Uppsala Vatten 2011 Miljörapport 2010 Kungsängsverket http://www.uppsalavatten.se/sv/omoss/Anlaggningar/VA-anlaggningar/Avloppsreningsverk/

WHO 2011. Pharmaceuticals in Drinking-water. WHO reference number: WHO/HSE/WSH/11.05

Woldegiorgis, A., Green, J., Remberger, M., Kaj. L., Brorström-Lunden, E., Dye, C., Schlabach, M. 2007. Results from the Swedish National Screening Programme 2006. Subreport 4: Pharmaceuticals.

Vieno, N.M., Tuhkanen, T., Kronberg, L., 2005. Seasonal variation in the occurrence of pharmaceuticals in effluents from a sewage treatment plant and in the recipient water. Environmental Science and Technology 39(21), 8220-8226

Vieno, N.M., Tuhkanen, T., Kronberg, L., 2007. Elimination of pharmaceuticals in sewage treatment plants in Finland. Water Research 41 (5), 1001-1012.

Zeilinger, J., Steger-Hartmann, T., Maser, E., Goller, S., Vonk, R., Lange, R., 2009. Effects of synthetic gestagens on fish reproduction. Environmental Toxicology and Chemistry 28 (12), 2663-2670.

Zhang, Y. J., Geissen, S. U., Gal, C., 2008. Carbamazepine and diclofenac: Removal in wastewater treatment plants and occurrence in water bodies. Chemosphere 73(8), 1151-1161.

Zorita, S., Martensson, L., Mathiasson, L., 2009. Occurrence and removal of pharmaceuticals in a municipal sewage treatment system in the south of Sweden. Science of the Total Environment 407 (8), 2760-2770.

Appendix 1 Sample table, National screening

Type	Municipality	Site	Matrix	Sampling date	Coord. RT90	
N1	Katrineholm	Älgsjön	Surface water	2010-09-08	6552912	1532301
N2	Vallentuna	Tärnan	Surface water	2011-02-13	6608668	1644632
N3	Katrineholm	Älgsjön, Perch	Biota	2010-09-08	6552912	1532301
N4	Vallentuna	Tärnan, Perch	Biota	2010-09-07	6608668	1644632
N5	Skövde	WWTP Stadskvarn, 24 h composite	Influent	2010-11-15	6475757	1387219
N6	Skövde	WWTP Stadskvarn, 24 h composite	Influent	2010-11-16	6475757	1387219
N7	Skövde	WWTP Stadskvarn, 24 h composite	Influent	2010-11-17	6475757	1387219
N8	Stockholm	WWTP Henriksdal, 24 h composite	Influent	2010-11-29	6578812	1631124
N9	Stockholm	WWTP Henriksdal, 24 h composite	Influent	2010-11-30	6578812	1631124
N10	Stockholm	WWTP Henriksdal, 24 h composite	Influent	2010-12-01	6578812	1631124
N11	Umeå	WWTP Ön, 24 h composite	Influent	2010-10-19	7085160	1720924
N12	Umeå	WWTP Ön, 24 h composite	Influent	2010-10-20	7085160	1720924
N13	Umeå	WWTP Ön, 24 h composite	Influent	2010-10-21	7085160	1720924
N14	Uppsala	WWTP Kungsängsverket, 24 h composite	Influent	2010-10-28	6637475	1603969
N15	Uppsala	WWTP Kungsängsverket, 24 h composite	Influent	2010-11-24	6637475	1603969
N16	Uppsala	WWTP Kungsängsverket, 24 h composite	Influent	2010-12-01	6637475	1603969
N17	Skövde	WWTP Stadskvarn, 24 h composite	Effluent	2010-11-16	6475757	1387219
N18	Skövde	WWTP Stadskvarn, 24 h composite	Effluent	2010-11-17	6475757	1387219
N19	Skövde	WWTP Stadskvarn, 24 h composite	Effluent	2010-11-18	6475757	1387219
N20	Stockholm	WWTP Henriksdal, 24 h composite	Effluent	2010-11-29	6578812	1631124
N21	Stockholm	WWTP Henriksdal, 24 h composite	Effluent	2010-11-30	6578812	1631124
N22	Stockholm	WWTP Henriksdal, 24 h composite	Effluent	2010-12-01	6578812	1631124
N23	Umeå	WWTP Ön, 24 h composite	Effluent	2010-10-19	7085160	1720924
N24	Umeå	WWTP Ön, 24 h composite	Effluent	2010-10-20	7085160	1720924
N25	Umeå	WWTP Ön, 24 h composite	Effluent	2010-10-21	7085160	1720924
N26	Uppsala	WWTP Kungsängsverket, 24 h composite	Effluent	2010-10-28	6637475	1603969
N27	Uppsala	WWTP Kungsängsverket, 24 h composite	Effluent	2010-11-24	6637475	1603969
N28	Uppsala	WWTP Kungsängsverket, 24 h composite	Effluent	2010-12-01	6637475	1603969
N29	Skövde	WWTP Stadskvarn	Sludge	2010-11-17	6475757	1387219
N30	Stockholm	WWTP Henriksdal	Sludge	2010-12-01	6578812	1631124
N31	Umeå	WWTP Ön	Sludge	2010-10-21	7085160	1720924
N32	Uppsala	WWTP Kungsängsverket	Sludge	2010-10-29	6637475	1603969
N33	Skövde	Skövde WWTP upstream, Mörkebäcken, -1 m	Surface water	2010-11-17	6475757	1387219
N34	Skövde	Skövde WWTP upstream, Ösan, Varola, -5 km	Surface water	2010-11-17	6476381	1401322
N35	Skövde	Skövde WWT downstream, 1, 5 m	Surface water	2010-11-17	6475629	1387439
N36	Skövde	Skövde WWTP downstream, 50 m	Surface water	2010-11-17	6475593	1387509
N37	Skövde	Skövde WWTP downstream, 500 m	Surface water	2010-11-17	6475829	1388063
N38	Skövde	Skövde WWTP downstream, Ösan, 5 km	Surface water	2010-11-17	6483623	1389635
N39	Uppsala	Upstream WWTP Kungsängsv., Islandsfallet, -1.7 km	Surface water	2010-10-26	6638712	1602921
N40	Uppsala	Downstream WWTP Kungsängsv. 5 m	Surface water	2010-10-26	6637312	1603770
N41	Uppsala	Downstream WWTP Kungsängsv. 150 m	Surface water	2010-10-26	6637256	1603806
N42	Uppsala	Downstream WWTP Kungsängsv., Ultuna, 3.5 km	Surface water	2010-10-26	6634102	1604680
N43	Uppsala	Downstream WWTP Kungsängsv. Flottsund, 4.6 km	Surface water	2010-10-26	6631161	1604268
N44	Stockholm	Drinking water, Valhallavägen 81	Drinking water	2010-10-22	6582765	1629037
N45	Stockholm	Drinking water, Valhallavägen 81	Drinking water	2010-10-25	6582765	1629037
N46	Stockholm	Drinking water, Valhallavägen 81	Drinking water	2010-10-27	6582765	1629037
N47	Umeå	Drinking water, Umeå University	Drinking water	2010-10-21	7086879	1721726
N48	Umeå	Drinking water, Umeå University	Drinking water	2010-10-23	7086879	1721726
N49	Umeå	Drinking water, Umeå University	Drinking water	2010-10-25	7086879	1721726
N50	Skövde	WWTP Skövde biota upstream Ösan, Varola, -5 km	Biota	2010-11-19	6469683	1392843
N51	Skövde	WWTP Skövde biota downstream, 5 km	Biota	2010-11-19	6483263	1389635
N52	Uppsala	WWTP Kungsängsverket biota upstream, Perch	Biota	2010-09-28	6624246	1612705
N53	Uppsala	WWTP Kungsängsverket biota downstream 1, Perch	Biota	2010-10-26	6637197	1603849
N54	Uppsala	WWTP Kungsängsverket biota downstream 2, Perch	Biota	2010-10-26	6624074	1603970

Appendix 2 Sample table, Regional screening

Type	Municipality	Site	Matrix	Sampling date	Coord. RT90	
R1	Borlänge	WWTP Borlänge	Effluent	2010-09-27 - 10-03	6705951	1482832
R2	Falun	WWTP Främby, week composite	Effluent	2010-11-1 to 7	6718593	1491668
R3	Falun	Runn, Främbyviken, Perch	Biota	2010-09-24	6718593	1491668
R4	Gotland	WWTP Visby, 24 h composite	Effluent	2010-10-26	6391515	1647282
R5	Gotland	WWTP Visby	Sludge	2010-10-26	6391515	1647282
R6	Gotland	Gothemsån, Åminne	Surface water	2010-10-25	6391370	1676270
R7	Alvesta	WWTP Alvesta, 24 h composite	Influent	2010-10-6	6307670	1423430
R8	Alvesta	WWTP Alvesta, 24 h composite	Effluent	2010-10-6	6307670	1423430
R9	Lessebo	WWTP Lessebo, 24 h composite	Influent	2010-12-13	6291100	1466460
R10	Lessebo	WWTP Lessebo, 24 h composite	Effluent	2010-12-13	6291100	1466460
R11	Ljungby	WWTP Ljungby, 24 h composite	Influent	2010-12-13	6300900	1385300
R12	Ljungby	WWTP Ljungby, 24 h composite	Effluent	2010-12-13	6300900	1385300
R13	Markaryd	WWTP Markaryd, 24 h composite	Influent	2010-10-14	6262850	1362850
R14	Markaryd	WWTP Markaryd, 24 h composite	Effluent	2010-10-14	6262850	1362850
R15	Tingsryd	WWTP Tingsryd, 24 h composite	Influent		6264950	1449750
R16	Tingsryd	WWTP Tingsryd, 24 h composite	Effluent		6264950	1449750
R17	Uppvidinge	WWTP Uppvidinge, grab sample	Influent	2010-11-10	6337800	1473850
R18	Uppvidinge	WWTP Uppvidinge, 24 h composite	Effluent	2010-11-10	6337800	1473850
R19	Växjö	WWTP Växjö	Influent	2010-10-28	6303900	1436200
R20	Växjö	WWTP Växjö	Effluent	2010-10-28	6303900	1436200
R21	Växjö	WWTP Växjö	Sludge	2010-10-28	6303900	1436200
R22	Älmhult	WWTP Älmhult, 24 h composite	Influent	2010-10-12	6268000	1396200
R23	Älmhult	WWTP Älmhult, 24 h composite	Effluent	2010-10-12	6268000	1396200
R24	Luleå	WWTP Uddebo	Effluent	2010-10-5	7287600	1795760
R25	Luleå	WWTP Uddebo, 24 h composite	Sludge	2010-09	7287600	1795760
R26	Piteå	WWTP Sandholmens	Effluent	2010-09-14	7254300	1764000
R27	Piteå	WWTP Sandholmens, 24 h composite	Sludge	2010-09-14	7254300	1764000
R28	Katrineholm	Djulösjön	Sediment	2010-09-23	6538709	1524632
R29	Katrineholm	Djulösjön, Perch	Biota	2010-10	6538709	1524632
R30	Katrineholm	Djulösjön	Surface water	2010-09-23	6538709	1524632
R31	Eskilstuna	WWTP Ekeby, 24 h composite	Influent	2010-09-22		
R32	Eskilstuna	WWTP Ekeby, 24 h composite	Effluent	2010-09-22		
R33	Eskilstuna	WWTP Ekeby, after wetland,24 h composite	Effluent	2010-09-22		
R34	Eskilstuna	WWTP Ekeby	Sludge	2010-09-22		
R35	Eskilstuna	Eskilstunaån	Sediment	2010-09-23	6585808	1537404
R36	Eskilstuna	Eskilstunaån, Perch	Biota	2010 v37-40	6585808	1537404
R37	Eskilstuna	Eskilstunaån	Surface water	2010-09-23	6585808	1537404
R38	Nyköping	Mellanfjärden	Sediment	2010-09-23	6514178	1573670
R39	Nyköping	Mellanfjärden, Perch	Biota	2010-06	6514178	1573670
R40	Nyköping	Mellanfjärden	Surface water	2010-09-23	6514178	1573670
R41	Strängnäs	WWTP Strängnäs, 24 h composite	Effluent	2010-09-21		
R42	Strängnäs	WWTP Strängnäs	Sludge	2010-09-21		
R43	Arvika	Kyrkviken1, Kinna	Surface water	2010-09-29	6618369	1316821
R44	Arvika	Kyrkviken2, Djupviken	Surface water	2010-09-29	6616973	1317110
R45	Arvika	Kyrkviken3, Djuphålan	Surface water	2010-09-29	6617758	1318778
R46	Arvika	Kyrkviken4, Utlopp reningsverk	Surface water	2010-09-29	6618513	1319506
R47	Arvika	Kyrkviken 5, Perch	Biota	2010-09-17	6619017	1318691
R48	Kristinehamn	WWTP Fiskartorpet, 24 h composite	Effluent	2010-09-30		
R49	Kristinehamn	WWTP Fiskartorpet	Sludge	2010-09-30		
R50	Kristinehamn	Varnumsviken, Perch	Biota	2010-09-16	6643965	1313873
R51	Kristinehamn	Varnumsviken	Surface water	2010-09-28	6579200	1401400
R52	Säffle	WWTP Säffle	Sludge	2010-09-21		
R53	Lycksele	WWTP Lycksele, 24 h composite	Effluent	2010-10-20		
R54	Lycksele	WWTP Lycksele	Sludge	2010-10-20		
R55	Skellefteå	WWTP Tuvan, 24 h composite	Effluent	2010-10-12		
R56	Skellefteå	WWTP Tuvan	Sludge	2010-10-18		
R57	Sundsvall	WWTP Fillanverken	Sludge	2011-01-03		
R58	Sundsvall	WWTP Tivoliverket	Sludge	2011-01-03		
R59	Örnsköldsvik	WWTP Knorthem	Sludge	2010-12-23		
R60	Borås	Djupasjön, downstream Gässlösa, Eel	Biota	2010-09-16	6400298	1327321
R61	Borås	Djupasjön, downstream Gässlösa, Perch	Biota	2010-09-16	6400298	1327321

Type	Municipality	Site	Matrix	Sampling date	Coord. RT90	
R62	Borås	Djupasjön, downstream Gässlösa, Roach	Biota	2010-09-16	6400298	1327321
R63	Borås	Djupasjön, downstream Gässlösa	Surface water	2010-09-16 - 17	6400298	1327321
R64	Stenungsund	Askeröfjorden, Eel	Biota	2010-11-17	6448922	1264844
R65	Stenungsund	Askeröfjorden, Flounder	Biota	2010-11-17	6448096	1264885
R66	Stenungsund	Askeröfjorden, Common mussel	Biota	2010-10-18	6448420	1264813
R67	Göteborg	Ryaverket, 6,5 km downstream effluent outlet, Common mussel	Biota	2010-10-05	6402890	1260750

Appendix 3. Limit of quantification in surface, sewage and drinking water of the used analytical method.

Name	LOQ	Name	LOQ	Name	LOQ
	ng/L		ng/L		ng/L
Alfuzosin	0.1	Diphenhydramine	0.1	Memantine	0.5
Alprazolam	10	Dipyridamole	50	Metformin	100
Amiodiarone	50	Donepezil	0.5	Metoprolol	5.0
Amitryptiline	5.0	Duloxetine	1.0	Mianserin	1.0
Atenolol	5.0	Eprosartan	5.0	Miconazole	5.0
Atorvastatin	50	Erythromycin	50	Mirtazapine	10
Atracurium	0.5	Estradiol	10	Naproxen	10
Azelastine	5.0	Ethinyl estradiol	10	Nefazodone	0.5
Azithromycin	5.0	Etonogestrel	0.5	Norfloxacin	10
Beclomethazone	10	Ezetimibe	50	Ofloxacin	10
Biperiden	0.1	Felodipine	10	Orphenadrine	0.1
Bisoprolol	0.1	Fentanyl	0.5	Oxazepam	5.0
Bromocriptine	5.0	Fexofenadine	5.0	Paracetamol	10
Buprenorphine	10	Finasteride	10	Paroxetine	10
Bupropion	0.1	Flecainide	0.1	Perphenazine	10
Carbamazepine	1.0	Fluconazole	0.5	Pizotifen	0.5
Chlorprothixen	10	Flunitrazepam	10	Promethazine	10
Chlorpromazine	5.0	Fluoxetine	5.0	Ranitidine	5.0
Cilazapril	1.0	Flupentixol	5.0	Repaglinide	0.5
Ciprofloxacin	10	Fluphenazine	10	Risperidone	0.1
Citalopram	5.0	Flutamide	5.0	Rosuvastatin	10
Clarithromycine	1.0	Glibenclamide	10	Roxithromycin	50
Clemastine	0.5	Glimepiride	10	Sertraline	10
Clindamycin	1.0	Haloperidol	0.1	Sulfamethoxazole	5.0
Clomipramine	0.5	Hydroxyzine	0.5	Tamoxifen	5.0
Clonazepam	5.0	Ibuprofen	0.5	Telmisartan	50
Clotrimazol	1.0	Irbesartan	10	Tetracycline	50
Codeine	0.5	Ketoconazole	50	Tramadol	0.5
Cyproheptadine	5.0	Ketoprofene	10	Trihexyphenidyl	0.1
Desloratidin	0.5	Levomepromazine	100	Trimethoprim	0.1
Diclofenac	10	Levonorgestrel	10	Venlafaxine	0.5
Dicycloverin	5.0	Loperamide	0.5	Verapamil	10
Dihydroergotamine	50	Maprotiline	5.0	Zolpidem	0.5
Diltiazem	0.5	Meclozine	5.0		

Appendix 4. Limit of quantification in sludge samples of the used analytical method.

Name	LOQ	Name	LOQ	Name	LOQ
	µg/Kg		µg/Kg		µg/Kg
Alfuzosin	0.1	Diphenhydramine	0.1	Memantine	0.5
Alprazolam	10	Dipyridamole	50	Metformin	100
Amiodiarone	50	Donepezil	0.5	Metoprolol	5.0
Amitryptiline	5.0	Duloxetine	1.0	Mianserin	1.0
Atenolol	5.0	Eprosartan	5.0	Miconazole	5.0
Atorvastatin	50	Erythromycin	50	Mirtazapine	10
Atracurium	0.5	Estradiol	10	Naproxen	10
Azelastine	5.0	Ethinyl estradiol	10	Nefazodone	0.5
Azithromycin	5.0	Etonogestrel	0.5	Norfloxacin	10
Beclomethazone	10	Ezetimibe	50	Ofloxacin	10
Biperiden	0.1	Felodipine	10	Orphenadrine	0.1
Bisoprolol	0.1	Fentanyl	0.5	Oxazepam	5.0
Bromocriptine	5.0	Fexofenadine	5.0	Paracetamol	10
Buprenorphine	10	Finasteride	10	Paroxetine	10
Bupropion	0.1	Flecainide	0.1	Perphenazine	10
Carbamazepine	1.0	Fluconazole	0.5	Pizotifen	0.5
Chlorprothixen	10	Flunitrazepam	10	Promethazine	10
Chlorpromazine	5.0	Fluoxetine	5.0	Ranitidine	5.0
Cilazapril	1.0	Flupentixol	5.0	Repaglinide	0.5
Ciprofloxacin	10	Fluphenazine	10	Risperidone	0.1
Citalopram	5.0	Flutamide	5.0	Rosuvastatin	10
Clarithromycine	1.0	Glibenclamide	10	Roxithromycin	50
Clemastine	0.5	Glimepiride	10	Sertraline	10
Clindamycin	1.0	Haloperidol	0.1	Sulfamethoxazole	5.0
Clomipramine	0.5	Hydroxyzine	0.5	Tamoxifen	5.0
Clonazepam	5.0	Ibuprofen	0.5	Telmisartan	50
Clotrimazol	1.0	Irbesartan	10	Tetracycline	50
Codeine	0.5	Ketoconazole	50	Tramadol	0.5
Cyproheptadine	5.0	Ketoprofene	10	Trihexyphenidyl	0.1
Desloratidin	0.5	Levomepromazine	100	Trimethoprim	0.1
Diclofenac	10	Levonorgestrel	10	Venlafaxine	0.5
Dicycloverin	5.0	Loperamide	0.5	Verapamil	10
Dihydroergotamine	50	Maprotiline	5.0	Zolpidem	0.5
Diltiazem	0.5	Meclozine	5.0		

Appendix 5. Surface water from Katrineholm (N1), Vallentuna (N2), Skövde (N33-38) and Uppsala (N39-43).

	N1	N2	N33	N34	N35	N36	N37	N38	N39	N40	N41	N42	N43
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name													
Alfuzosin	2.9	1.1	0.26	0.22	20	28	0.56	0.45	1.3	33	6.5	3.7	2.1
Alprazolam	17	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amiodiarone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amitryptiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atenolol	<LOQ	<LOQ	11	11	230	390	35	97	24	360	100	62	79
Atorvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atracurium	2.9	<LOQ	9.9	1.6	1.7	2.6	3.2	2.7	1.1	0.66	0.55	<LOQ	<LOQ
Azelastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Azithromycin	<LOQ	<LOQ	27	<LOQ	<LOQ	<LOQ	5.4	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Beclomethazone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Biperiden	1.4	6.4	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Bisoprolol	<LOQ	0.63	0.18	0.1	100	150	5.5	3.4	1.2	59	18	4.7	10
Bromocriptine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Buprenorphine	15	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Bupropion	5.6	2.5	0.46	0.45	16	19	1.3	0.81	0.37	14	3	4.5	1.3
Carbamazepine	12	9.4	8.8	4.9	470	550	40	22	29	760	190	110	87
Chlorprothixen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Chlorpromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Cilazapril	4	1.5	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ciprofloxacin	<LOQ	12	380	160	26	52	230	110	64	14	10	12	<LOQ
Citalopram	16	18	27	12	140	210	17	8.5	6.6	190	29	38	18
Clarithromycine	<LOQ	39	1100	3.7	59	87	330	24	3.5	2.1	<LOQ	<LOQ	3.3
Clemastine	0.68	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clindamycin	<LOQ	<LOQ	4.2	<LOQ	60	87	6.5	5.4	3.1	140	34	15	18
Clomipramine	0.64	<LOQ	0.54	<LOQ	0.52	<LOQ	<LOQ	<LOQ	<LOQ	1	<LOQ	<LOQ	<LOQ
Clonazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clotrimazol	<LOQ	<LOQ	<LOQ	1	1.9	1.2	2.1	<LOQ	<LOQ	1.9	1.6	3.1	1.1
Codeine	<LOQ	2.4	1.2	<LOQ	82	120	6.2	2.8	10	340	93	57	50
Cyproheptadine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Desloratidin	<LOQ	<LOQ	<LOQ	<LOQ	3.3	4.4	<LOQ	<LOQ	<LOQ	6	0.68	<LOQ	<LOQ
Diclofenac	<LOQ	<LOQ	<LOQ	<LOQ	230	70	21	<LOQ	<LOQ	880	290	28	90
Dicycloverin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dihydroergotamine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diltiazem	<LOQ	<LOQ	<LOQ	<LOQ	9.7	12	0.56	0.5	0.55	20	5.9	7.1	4.3
Diphenhydramine	0.15	<LOQ	0.066	0.32	4.2	6.3	0.089	0.26	0.054	11	2.2	1.2	1.1
Dipyridamole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Donepezil	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Duloxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Eprosartan	8.5	<LOQ	9.3	7	26	35	<LOQ	7.5	12	21	12	5.6	7.2
Erythromycin	<LOQ	<LOQ	<LOQ	57	55	65	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ethinyl estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Etonogestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ezetimibe	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Felodipine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fentanyl	<LOQ	<LOQ	4	0.91	<LOQ	<LOQ	2.2	1.7	1.7	0.92	<LOQ	0.78	3
Fexofenadine	<LOQ	<LOQ	<LOQ	<LOQ	51	66	6.9	4.7	7.6	150	65	19	16
Finasteride	42	12	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flecainide	2.1	9.5	0.93	0.88	32	47	2.9	2.2	2.5	130	32	29	19
Fluconazole	4.6	1.8	110	16	83	100	30	11	11	290	43	21	21
Flunitrazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fluoxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	32	6.3	<LOQ	<LOQ
Flupentixol	<LOQ	<LOQ	<LOQ	<LOQ	6.9	8.7	<LOQ	<LOQ	<LOQ	12	<LOQ	<LOQ	<LOQ
Fluphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flutamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Glibenclamide	<LOQ	<LOQ	<LOQ	19	29	25	24	13	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Glimepiride	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

	N1	N2	N33	N34	N35	N36	N37	N38	N39	N40	N41	N42	N43
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name													
Haloperidol	<LOQ	<LOQ	2.8	0.93	2.2	2	1.1	0.67	0.24	1.4	0.7	3	0.47
Hydroxyzine	2.3	1.5	<LOQ	0.57	4.8	2.9	1	2.1	4.1	2.1	1.8	2.7	<LOQ
Ibuprofen	34	65	100	69	140	40	36	180	<LOQ	120	140	69	21
Irbesartan	16	2.2	2	3.3	100	130	12	3.1	8	430	120	52	37
Ketoconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ketoprofene	<LOQ	<LOQ	<LOQ	<LOQ	41	42	13	<LOQ	15	110	26	13	24
Levomepromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levonorgestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Loperamide	3.6	2.1	2.2	0.87	1.2	1.6	1.9	2.7	0.67	1.6	2.5	3.6	0.58
Maprotiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Meclozine	59	25	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Memantine	0.63	0.74	0.59	0.62	5.1	6.5	<LOQ	0.6	<LOQ	15	3.5	2.3	1.6
Metformin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Metoprolol	<LOQ	6.1	12	<LOQ	680	950	57	37	51	1200	370	130	200
Mianserin	<LOQ	<LOQ	<LOQ	<LOQ	2.8	6.7	<LOQ	<LOQ	<LOQ	6.3	2.7	2.7	<LOQ
Miconazole	19	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Mirtazapine	<LOQ	<LOQ	<LOQ	<LOQ	120	130	<LOQ	<LOQ	<LOQ	210	36	23	19
Naproxen	<LOQ	41	28	45	130	98	44	11	20	77	38	27	38
Nefazodone	0.71	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Norfloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ofloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Orphenadrine	0.47	<LOQ	<LOQ	<LOQ	4.7	5.7	0.93	0.63	1.2	28	5.9	4.4	1.5
Oxazepam	9.6	<LOQ	21	10	230	310	28	15	16	580	130	69	59
Paracetamol	12	19	150	83	26	87	100	45	190	52	53	37	36
Paroxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Perphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Pizotifen	0.71	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	1	<LOQ	<LOQ	0.74
Promethazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ranitidine	<LOQ	<LOQ	<LOQ	<LOQ	5.4	6.8	<LOQ	<LOQ	<LOQ	110	15	<LOQ	<LOQ
Repaglinide	54	1.6	5.6	11	5.7	8	13	9.7	2.5	16	15	23	4.5
Risperidone	<LOQ	<LOQ	1.6	1.9	1.1	2.1	<LOQ	<LOQ	9.4	1.6	2.1	8.6	1.7
Rosuvastatin	<LOQ	<LOQ	<LOQ	<LOQ	30	61	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	11	<LOQ
Roxithromycin	<LOQ	<LOQ	1100	<LOQ	50	<LOQ	240	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Sertraline	<LOQ	<LOQ	11	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ	28	18	<LOQ	<LOQ
Sulfamethoxazole	<LOQ	91	620	230	54	50	120	69	90	150	18	<LOQ	<LOQ
Tamoxifen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	13	<LOQ	<LOQ	<LOQ	<LOQ
Telmisartan	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	110	<LOQ	<LOQ	<LOQ
Tetracycline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tramadol	6	<LOQ	2.3	1.4	650	870	46	27	51	1800	520	290	250
Trihexyphenidyl	<LOQ	<LOQ	0.45	1.9	<LOQ	0.75	0.85	1.3	1.6	1.4	3.3	0.5	0.91
Trimethoprim	15	6.8	110	34	140	170	52	22	18	210	50	39	23
Venlafaxine	36	16	6	11	140	130	15	8.6	17	440	150	55	69
Verapamil	20	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	19	<LOQ	<LOQ	<LOQ	<LOQ
Zolpidem	2.1	2.5	0.53	0.56	2.4	3.1	0.51	<LOQ	0.6	6	1.8	1.7	1.1

Appendix 6. Biota samples from Katrineholm (N3), Vallentuna (N4), Skövde (N50, 51) and Uppsala (N52-54).

	N3	N4	N50	N51	N52	N53	N54
	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
Name							
Alfuzosin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.11
Alprazolam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amiodiarone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amitryptiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atenolol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atorvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atracurium	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Azelastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Azithromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Beclomethazone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Biperiden	<LOQ	0.1	<LOQ	0.14	<LOQ	0.54	0.24
Bisoprolol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Bromocriptine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Buprenorphine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Bupropion	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Carbamazepine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Chlorprothixen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Chlorpromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Cilazapril	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ciprofloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Citalopram	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clarithromycine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clemastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clindamycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clomipramine	<LOQ	0.83	<LOQ	<LOQ	<LOQ	8.1	1
Clonazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clotrimazol	<LOQ	<LOQ	1.3	<LOQ	1.5	14	<LOQ
Codeine	<LOQ	<LOQ	0.84	<LOQ	<LOQ	<LOQ	<LOQ
Cyproheptadine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Desloratidin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diclofenac	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dicycloverin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dihydroergotamine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diltiazem	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diphenhydramine	<LOQ	0.1	<LOQ	<LOQ	<LOQ	0.089	<LOQ
Dipyridamole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Donepezil	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Duloxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Eprosartan	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Erythromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ethinyl estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Etonogestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ezetimibe	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Felodipine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fentanyl	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fexofenadine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Finasteride	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flecainide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.19	0.12
Fluconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flunitrazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fluoxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	6.7	<LOQ
Flupentixol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fluphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flutamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Glibenclamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	19	<LOQ
Glimepiride	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

	N3	N4	N50	N51	N52	N53	N54
	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
Name							
Haloperidol	<LOQ	<LOQ	0.24	0.12	<LOQ	0.42	0.19
Hydroxyzine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	8.3	1.5
Ibuprofen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Irbesartan	<LOQ	<LOQ	0.78	<LOQ	<LOQ	1.3	<LOQ
Ketoconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ketoprofene	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levomepromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levonorgestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Loperamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Maprotiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Meclozine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Memantine	<LOQ	<LOQ	<LOQ	0.76	<LOQ	0.78	1.3
Metformin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Metoprolol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Mianserin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Miconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Mirtazapine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Naproxen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Nefazodone	<LOQ	<LOQ	<LOQ	1.3	<LOQ	<LOQ	<LOQ
Norfloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ofloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Orphenadrine	0.19	0.18	<LOQ	0.13	0.23	2.2	0.74
Oxazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	9.6	<LOQ
Paracetamol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Paroxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	17	<LOQ
Perphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Pizotifen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	4.5	0.5
Promethazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ranitidine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Repaglinide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Risperidone	<LOQ	<LOQ	0.32	0.2	0.29	0.36	<LOQ
Rosuvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Roxithromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Sertraline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	14	<LOQ
Sulfamethoxazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	13	<LOQ
Tamoxifen	<LOQ	7.1	<LOQ	<LOQ	<LOQ	6.3	<LOQ
Telmisartan	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tetracycline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tramadol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Trihexyphenidyl	0.12	<LOQ	<LOQ	<LOQ	0.12	<LOQ	<LOQ
Trimethoprim	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Venlafaxine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Verapamil	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Zolpidem	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

Appendix 7. Influent sewage water from WWTPs in Skövde (N5-7), Stockholm (N8-10), Umeå (N11-13) and Uppsala (N14-16).

	N5	N6	N7	N8	N9	N10	N11	N12	N13	N14	N15	N16
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name												
Alfuzosin	40	39	16	72	50	62	34	45	40	220	88	67
Alprazolam	12	35	21	12	17	28	21	<LOQ	28	60	21	29
Amiodiarone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amitryptiline	5.2	11	7.7	7.1	<LOQ	<LOQ	7.5	19	5.7	47	16	24
Atenolol	540	550	780	330	570	590	1100	1100	1100	4900	1200	1200
Atorvastatin	<LOQ	<LOQ	<LOQ	160	110	<LOQ	460	470	210	260	<LOQ	<LOQ
Atracurium	2.2	8	2.8	16	6.3	2.5	2.6	6	3.5	29	17	15
Azelastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	40	29	11
Azithromycin	<LOQ	7.8	<LOQ	6	14	11	13	9.5	<LOQ	44	7.4	9.1
Beclomethazone	<LOQ	<LOQ	<LOQ	12	<LOQ	<LOQ	18	<LOQ	20	<LOQ	13	<LOQ
Biperiden	0.63	<LOQ	1.2	10	1.4	<LOQ	10	<LOQ	6.9	70	13	20
Bisoprolol	180	220	230	86	110	120	190	180	220	560	170	160
Bromocriptine	<LOQ	<LOQ	<LOQ	11	<LOQ	<LOQ	<LOQ	14	<LOQ	13	<LOQ	31
Buprenorphine	74	190	180	31	89	210	200	74	330	1000	280	210
Bupropion	12	46	12	15	17	16	30	34	30	82	25	23
Carbamazepine	380	560	480	370	560	540	1600	1200	1100	2600	580	680
Chlorprothixen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	11	<LOQ	12	<LOQ	78	13	15
Chlorpromazine	<LOQ	<LOQ	5.8	<LOQ	<LOQ	12	6.3	5.1	<LOQ	68	11	<LOQ
Cilazapril	34	4.4	<LOQ	12	1.1	1.8	1.6	3	1	42	15	8.6
Ciprofloxacin	44	86	96	270	110	120	65	130	53	30	12	<LOQ
Citalopram	310	390	280	250	300	370	200	340	240	1000	430	330
Clarithromycine	52	54	110	350	290	400	620	320	65	480	38	370
Clemastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	4.2	2.8	0.94
Clindamycin	37	53	47	43	52	48	160	180	190	230	72	60
Clomipramine	5.3	3.2	15	11	17	14	15	7.4	16	72	25	40
Clonazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clotrimazol	<LOQ	<LOQ	<LOQ	25	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	59	19	39
Codeine	390	620	560	840	1200	1300	1100	1100	1100	4200	1300	1200
Cyproheptadine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	49	9.6	7.9
Desloratidin	5.3	10	9.3	27	36	12	8.2	9.5	13	170	87	38
Diclofenac	390	120	500	1400	900	1800	1700	2800	970	7000	1200	1500
Dicycloverin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	8	<LOQ	<LOQ
Dihydroergotamine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	55	<LOQ	<LOQ
Diltiazem	31	34	33	59	63	66	94	120	87	270	86	71
Diphenhydramine	6.5	11	15	40	36	32	14	12	10	200	32	29
Dipyridamole	6400	8500	5200	4900	6300	6200	9200	14000	3900	6900	1800	2100
Donepezil	5.2	3.9	1.9	9.8	7.8	1.4	5.3	5.4	2.1	70	31	20
Duloxetine	<LOQ	1	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	11	11	4.5
Eprosartan	29	27	60	390	460	430	1700	570	290	940	240	220
Erythromycin	160	240	150	330	130	260	390	620	530	2100	77	550
Estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ethinyl estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Etonogestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ezetimibe	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	56	240	<LOQ	<LOQ
Felodipine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fentanyl	0.54	0.76	0.58	2.4	0.52	1.5	1.4	1.7	1.5	8.4	2.8	1.5
Fexofenadine	89	110	120	180	200	290	300	360	220	1100	250	240
Finasteride	17	12	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	19	12	28	<LOQ	<LOQ
Flecainide	62	48	56	87	120	120	95	140	120	710	230	200
Fluconazole	97	170	150	170	270	290	1200	1600	1300	2100	400	410
Flunitrazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	12	<LOQ	11	17	<LOQ	<LOQ
Fluoxetine	8.2	10	<LOQ	38	39	41	<LOQ	12	7.1	240	35	72
Flupentixol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	72	72	7.5
Fluphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	130	120	16
Flutamide	<LOQ	<LOQ	<LOQ	5.4	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	110	23	12
Glibenclamide	19	11	21	<LOQ	<LOQ	36	31	64	10	74	48	30
Glimepiride	11	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	10	<LOQ	<LOQ	<LOQ	26	<LOQ
Haloperidol	12	18	14	8.5	18	14	9.6	20	8.6	69	20	6.9

	N5	N6	N7	N8	N9	N10	N11	N12	N13	N14	N15	N16
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name												
Hydroxyzine	6	8.1	9.8	14	5.9	22	6.3	12	11	61	40	37
Ibuprofen	560	590	840	470	980	960	940	830	670	1900	1900	990
Irbesartan	150	160	250	1100	920	1500	560	600	620	2600	380	360
Ketoconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	130	57	73	1200	<LOQ	150
Ketoprofene	150	160	130	120	120	140	270	250	260	160	160	110
Levomepromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levonorgestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Loperamide	3	1.4	1.9	1.8	3.3	2.3	2.6	5.1	1.3	21	18	13
Maprotiline	<LOQ	11	<LOQ	5.5	<LOQ	6.7	17	20	8.3	52	19	25
Meclozine	6	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	8.1	<LOQ	<LOQ	22	<LOQ	<LOQ
Memantine	9.3	12	11	21	19	22	29	37	35	86	30	24
Metformin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	460	540	410	1500	<LOQ	<LOQ
Metoprolol	1200	1500	1700	1300	1800	1800	3700	3300	3600	6800	2000	2300
Mianserin	5.9	10	12	13	8.8	6.4	17	21	14	65	33	21
Miconazole	9.7	<LOQ	7.4	<LOQ	<LOQ	<LOQ	9.9	13	<LOQ	48	6.5	5.6
Mirtazapine	160	210	150	150	140	130	150	170	150	870	280	210
Naproxen	460	580	460	280	280	330	1100	1100	980	410	400	290
Nefazodone	<LOQ	1.1	<LOQ	6.9	2	4.9	3.5	1.5	3.5	220	53	40
Norfloxacin	<LOQ	<LOQ	<LOQ	12	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ofloxacin	<LOQ	<LOQ	<LOQ	17	<LOQ	<LOQ	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ
Orphenadrine	9.9	11	15	38	22	35	17	20	31	180	30	54
Oxazepam	220	290	310	360	440	460	390	280	380	1800	500	470
Paracetamol	50000	76000	98000	57000	95000	98000	270000	170000	280000	540000	150000	130000
Paroxetine	<LOQ	<LOQ	12	33	<LOQ	18	<LOQ	12	29	130	39	28
Perphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	89	140	<LOQ
Pizotifen	<LOQ	2.2	2.6	4.5	3.6	3.9	6.7	2.3	8.1	35	8.7	8.1
Promethazine	130	12	<LOQ	19	19	23	<LOQ	<LOQ	<LOQ	190	29	22
Ranitidine	150	77	86	300	150	310	170	440	420	380	62	310
Repaglinide	17	14	23	45	8	4.8	26	26	42	140	29	62
Risperidone	1.9	5.4	5.1	46	33	3.6	4.3	4.4	7.7	270	140	41
Rosuvastatin	76	57	98	93	220	190	410	600	360	530	97	210
Roxithromycin	50	<LOQ	73	850	390	890	350	550	75	370	<LOQ	390
Sertraline	21	50	110	60	70	47	98	30	160	96	49	110
Sulfamethoxazole	270	230	200	240	370	580	350	1000	110	1500	870	250
Tamoxifen	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	5.8	930	64	34
Telmisartan	<LOQ	<LOQ	<LOQ	110	130	180	180	140	<LOQ	1400	520	620
Tetracycline	<LOQ	<LOQ	<LOQ	600	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	4500	1200	750
Tramadol	780	1000	920	770	1100	1100	3000	2700	3000	6100	1500	1700
Trihexyphenidyl	0.62	2.3	<LOQ	17	1.9	7.2	4.4	12	19	110	29	20
Trimethoprim	150	230	190	260	310	350	490	510	440	1400	350	300
Venlafaxine	130	240	210	320	420	520	640	660	790	2200	620	700
Verapamil	18	25	22	16	17	19	20	17	14	110	37	22
Zolpidem	4.3	4.2	1.8	18	10	7.2	10	9.5	7.6	44	19	16

Appendix 8. Effluent from WWTPs in Skövde (N17-19), Stockholm (N20-22), Umeå (N23-25) and Uppsala (N26-28).

	N17	N18	N19	N20	N21	N22	N23	N24	N25	N26	N27	N28
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name												
Alfuzosin	24	43	40	34	66	38	77	38	58	110	62	110
Alprazolam	13	<LOQ	19	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	18	14	11	31
Amiodiarone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amitryptiline	<LOQ	<LOQ	<LOQ	<LOQ	14	<LOQ	18	6.1	<LOQ	16	22	28
Atenolol	300	520	670	130	150	130	920	550	920	600	300	350
Atorvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	210	<LOQ	110	<LOQ	<LOQ	<LOQ
Atracurium	1.2	1.5	3.2	0.72	16	1.1	2.8	2.7	3.6	27	18	19
Azelastine	<LOQ	<LOQ	<LOQ	<LOQ	30	<LOQ	<LOQ	<LOQ	<LOQ	9.8	9.4	22
Azithromycin	<LOQ	6.6	5.1	22	27	17	17	<LOQ	8.2	23	10	17
Beclomethazone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Biperiden	0.57	0.62	1.3	1.8	12	0.15	0.84	1.8	0.92	26	6.9	38
Bisoprolol	100	170	250	67	86	69	150	94	120	110	59	88
Bromocriptine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	5.6
Buprenorphine	10	12	42	20	11	22	47	36	23	38	12	16
Bupropion	12	25	41	9.1	13	11	33	18	19	21	17	27
Carbamazepine	460	750	930	550	610	600	1100	660	860	1100	790	990
Chlorprothixen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	36
Chlorpromazine	<LOQ	<LOQ	<LOQ	<LOQ	7.1	<LOQ	<LOQ	<LOQ	<LOQ	10	6	20
Cilazapril	<LOQ	2.5	<LOQ	<LOQ	6.7	<LOQ	<LOQ	<LOQ	<LOQ	8.3	3.9	28
Ciprofloxacin	18	10	19	28	42	49	23	46	65	12	<LOQ	<LOQ
Citalopram	170	260	360	240	280	230	480	260	370	350	250	300
Clarithromycine	<LOQ	42	16	35	45	110	200	88	780	47	42	77
Clemastine	<LOQ	<LOQ	<LOQ	0.52	15	<LOQ	<LOQ	<LOQ	<LOQ	2.9	1.8	4.2
Clindamycin	62	110	160	79	100	90	280	150	230	200	140	160
Clomipramine	1.6	2.3	2.4	2	30	1.3	5.2	0.81	1.3	29	15	49
Clonazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clotrimazol	<LOQ	<LOQ	<LOQ	5.5	29	<LOQ	3.8	2.2	1.8	28	20	35
Codeine	110	180	250	78	110	78	780	540	670	580	450	600
Cyproheptadine	<LOQ	<LOQ	<LOQ	<LOQ	6.5	<LOQ	6.6	<LOQ	<LOQ	<LOQ	5.4	17
Desloratidin	8	10	15	6	30	8.4	6.5	10	8.9	81	42	67
Diclofenac	280	410	590	420	450	590	1300	430	1000	3900	1500	2100
Dicycloverin	<LOQ	<LOQ	<LOQ	<LOQ	5.8	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	12
Dihydroergotamine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diltiazem	11	17	24	44	55	39	100	54	80	40	30	46
Diphenhydramine	13	7.7	11	36	44	28	13	9.2	10	54	26	43
Dipyridamole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Donepezil	0.8	1.4	1.7	0.95	24	0.6	2.4	1	3.3	22	16	32
Duloxetine	<LOQ	<LOQ	<LOQ	2.7	14	<LOQ	14	4	<LOQ	2.1	1.5	7.7
Eprosartan	36	20	12	210	340	230	870	580	550	98	69	85
Erythromycin	73	250	120	100	230	110	420	150	530	94	53	220
Estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ethinyl estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Etonogestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ezetimibe	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Felodipine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fentanyl	1.1	<LOQ	0.54	1.5	3.7	1.1	1.3	2.7	2.2	4.9	3.1	6.3
Fexofenadine	62	87	94	110	140	140	270	110	170	370	220	290
Finasteride	17	<LOQ	20	<LOQ	<LOQ	<LOQ	<LOQ	20	12	<LOQ	<LOQ	14
Flecainide	51	62	90	130	150	130	140	97	120	230	160	220
Fluconazole	72	140	170	140	180	170	1100	660	980	520	280	390
Flunitrazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fluoxetine	12	<LOQ	5.2	17	63	15	13	6.8	11	81	47	94
Flupentixol	10	11	12	<LOQ	<LOQ	<LOQ	40	35	35	8.6	8.6	13
Fluphenazine	<LOQ	<LOQ	<LOQ	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	14
Flutamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	34	<LOQ	64
Glibenclamide	42	53	28	<LOQ	71	<LOQ	57	53	46	41	41	44
Glimepiride	14	<LOQ	13	<LOQ	<LOQ	<LOQ	26	39	15	11	<LOQ	11
Haloperidol	1.7	0.97	1.5	2	22	0.88	20	39	11	7.1	9.5	14

	N17	N18	N19	N20	N21	N22	N23	N24	N25	N26	N27	N28
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name												
Hydroxyzine	1.8	2.4	2.4	2.9	21	1.6	5.8	3.8	4.6	22	16	51
Ibuprofen	120	73	84	110	42	210	480	990	490	140	110	100
Irbesartan	100	160	220	490	560	630	460	200	300	1100	530	640
Ketoconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	120	<LOQ	<LOQ
Ketoprofene	62	120	110	18	29	29	220	200	160	170	120	120
Levomepromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levonorgestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Loperamide	1.3	1.5	0.94	0.89	28	0.5	4	3.4	3.5	14	19	25
Maprotiline	<LOQ	<LOQ	<LOQ	<LOQ	13	<LOQ	19	6.3	<LOQ	18	21	27
Meclozine	<LOQ	7.9	5.8	<LOQ	<LOQ	<LOQ	15	13	9.8	<LOQ	<LOQ	5.1
Memantine	6.5	8.9	13	13	20	13	43	29	51	31	25	45
Metformin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	370	<LOQ	290	<LOQ	<LOQ	<LOQ
Metoprolol	680	1100	1700	1400	1500	1400	2800	1600	2300	2000	1400	1800
Mianserin	7.2	8.6	6.8	5.2	16	5.6	61	24	45	35	26	42
Miconazole	<LOQ	7.4	<LOQ	<LOQ	<LOQ	<LOQ	9.2	8.4	5.9	<LOQ	<LOQ	7.4
Mirtazapine	130	180	200	120	170	100	180	81	130	410	230	330
Naproxen	110	230	180	42	30	26	450	490	300	130	69	82
Nefazodone	<LOQ	0.96	1.6	1	22	0.81	1.9	<LOQ	2.1	16	10	70
Norfloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ofloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	14	<LOQ	<LOQ	<LOQ
Orphenadrine	5.6	7.5	12	13	22	14	9.7	5.7	8	81	35	62
Oxazepam	250	340	540	490	440	500	450	280	340	730	530	660
Paracetamol	390	100	120	580	99	17	230	160	48	410	11	15
Paroxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	33	<LOQ	44
Perphenazine	<LOQ	<LOQ	<LOQ	<LOQ	17	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	13
Pizotifen	0.98	1.7	0.62	0.75	7.3	<LOQ	0.96	3.8	<LOQ	19	6.5	22
Promethazine	12	<LOQ	<LOQ	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ	61	33	86
Ranitidine	<LOQ	6.8	16	21	20	23	32	9.1	34	150	36	77
Repaglinide	9.8	6.9	11	3	11	4.3	10	13	4.9	40	17	51
Risperidone	2.6	1.8	2	5.2	79	7.2	74	14	3.3	130	85	160
Rosuvastatin	25	42	52	<LOQ	<LOQ	<LOQ	540	220	350	15	<LOQ	42
Roxithromycin	<LOQ	<LOQ	<LOQ	<LOQ	80	<LOQ	220	87	980	90	<LOQ	60
Sertraline	<LOQ	22	12	28	<LOQ	19	28	<LOQ	13	25	15	32
Sulfamethoxazole	36	30	31	190	170	290	78	53	140	280	110	130
Tamoxifen	<LOQ	<LOQ	<LOQ	<LOQ	29	<LOQ	5.1	9	<LOQ	12	45	210
Telmisartan	<LOQ	<LOQ	<LOQ	75	98	52	120	56	73	180	120	250
Tetracycline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tramadol	730	1100	1300	1200	1500	1300	3000	1700	2300	2800	2100	2600
Trihexyphenidyl	0.57	1.7	0.86	1.3	17	1.1	2.5	1.6	3.5	47	13	58
Trimethoprim	120	210	220	60	84	81	510	320	420	350	190	210
Venlafaxine	120	160	240	330	460	350	680	470	580	660	500	700
Verapamil	<LOQ	11	<LOQ	13	29	<LOQ	15	20	11	18	14	25
Zolpidem	2.9	3.9	4.8	7.6	20	7.8	18	6.2	8.4	19	16	41

Appendix 9. Removal efficiencies in four Swedish WWTPs (%).

	Skövde[a]	**Stockholm**[b]	**Umeå**[c]	**Uppsala**[d]
	(%)	(%)	(%)	(%)
Name				
Alfuzosin	-13	25	-45	25
Alprazolam	29	> 47	27	49
Amiodiarone				
Amitryptiline	> 37	-97	-12	24
Atenolol	20	72	28	83
Atorvastatin		> 63	58	> 81
Atracurium	55	28	25	-5
Azelastine				49
Azithromycin	25	-113	-12	17
Beclomethazone		> 17	> 47	> 23
Biperiden	9	18	86	31
Bisoprolol	17	30	38	71
Bromocriptine		> 55	> 64	75
Buprenorphine	86	84	82	96
Bupropion	-11	31	26	50
Carbamazepine	-51	-20	33	25
Chlorprothixen		> 9	> 17	-2
Chlorpromazine	> 13	41	> 12	70
Cilazapril	87	-35	> 46	39
Ciprofloxacin	79	76	46	43
Citalopram	19	18	-42	49
Clarithromycine	60	82	-6	81
Clemastine		e		-12
Clindamycin	-142	-88	-25	-38
Clomipramine	73	21	81	32
Clonazepam				
Clotrimazol		31	e	29
Codeine	66	92	40	76
Cyproheptadine		e	e	49
Desloratidin	-34	41	17	36
Diclofenac	-27	64	50	23
Dicycloverin		e		-50
Dihydroergotamine				> 9.1
Diltiazem	47	27	22	73
Diphenhydramine	2	0	11	53
Dipyridamole	> 99	> 99	> 99	> 99
Donepezil	65	-34	48	42
Duloxetine	> 0.1	e		57
Eprosartan	41	39	22	82
Erythromycin	19	39	29	87
Estradiol				
Ethinyl estradiol				
Etonogestrel				
Ezetimibe			> 11	> 79
Felodipine				
Fentanyl	-31	-43	-35	-13
Fexofenadine	24	42	38	45
Finasteride	-28		-3	50
Flecainide	-22	-25	-1	46
Fluconazole	8	33	33	59
Flunitrazepam			> 13	> 41
Fluoxetine	5	19	-8	36
Flupentixol	e		e	80
Fluphenazine		e		84
Flutamide		> 7.4		-1
Glibenclamide	-141	-97	-49	17
Glimepiride	-23		-167	58
Haloperidol	91	39	-83	68
Hydroxyzine	72	39	52	36

	Skövde[a]	Stockholm[b]	Umeå[c]	Uppsala[d]
	(%)	(%)	(%)	(%)
Name				
Ibuprofen	86	85	20	93
Irbesartan	14	52	46	32
Ketoconazole			> 42	82
Ketoprofene	34	80	26	5
Levomepromazine				
Levonorgestrel				
Loperamide	41	-297	-21	-12
Maprotiline	> 55	-113	16	31
Meclozine	-14		-56	77
Memantine	12	26	-22	28
Metformin			30	> 93
Metoprolol	21	12	37	53
Mianserin	19	5	-150	13
Miconazole	13		32	63
Mirtazapine	2	7	17	29
Naproxen	65	89	61	74
Nefazodone	-16	-73	29	69
Norfloxacin		> 17		
Ofloxacin		> 41	-27	
Orphenadrine	30	48	66	33
Oxazepam	-38	-13	-2	31
Paracetamol	100	100	100	100
Paroxetine	> 17	> 61	> 51	41
Perphenazine		e		89
Pizotifen	54	-1	58	8
Promethazine	83	46		25
Ranitidine	89	92	93	65
Repaglinide	49	68	70	53
Risperidone	48	-11	-457	17
Rosuvastatin	48	> 94	19	90
Roxithromycin	> 19	89	-32	80
Sertraline	72	60	79	72
Sulfamethoxazole	86	45	81	80
Tamoxifen	> 55	e	-22	74
Telmisartan		46	48	78
Tetracycline		> 92		> 98
Tramadol	-16	-35	20	19
Trihexyphenidyl	29	26	79	26
Trimethoprim	4	76	13	63
Venlafaxine	10	10	17	47
Verapamil	49	-21	10	66
Zolpidem	-13	-1	-20	4

[a] WWTP Stadskvarn
[b] WWTP Henriksdal
[c] WWTP Ön
[d] WWTP Kungsängsverket
[e] Detected in effluent but not in influent

Appendix 10. Dewatered digested sludge from WWTPs in Skövde[a] (N29), Stockholm[b] (N30), Umeå[c] (N31) and Uppsala[d] (N32).

	N29	**N30**	**N31**	**N32**
	µg/Kg	µg/Kg	µg/Kg	µg/Kg
Name				
Alfuzosin	34	25	17	20
Alprazolam	14	16	<LOQ	<LOQ
Amiodiarone	<LOQ	<LOQ	<LOQ	<LOQ
Amitryptiline	5	7.8	<LOQ	5.4
Atenolol	13	19	12	19
Atorvastatin	<LOQ	<LOQ	82	67
Atracurium	3.2	1.6	1.4	<LOQ
Azelastine	<LOQ	<LOQ	<LOQ	<LOQ
Azithromycin	<LOQ	5.6	<LOQ	<LOQ
Beclomethazone	<LOQ	<LOQ	<LOQ	<LOQ
Biperiden	0.89	0.62	0.32	0.92
Bisoprolol	10	4.3	2.8	5.4
Bromocriptine	<LOQ	<LOQ	6.3	<LOQ
Buprenorphine	21	29	27	140
Bupropion	0.3	0.61	0.2	0.14
Carbamazepine	190	200	120	87
Chlorprothixen	<LOQ	<LOQ	<LOQ	<LOQ
Chlorpromazine	<LOQ	<LOQ	<LOQ	8.1
Cilazapril	1.1	1.6	1.2	1.2
Ciprofloxacin	450	250	170	68
Citalopram	760	570	630	460
Clarithromycine	13	1.4	4.5	2
Clemastine	<LOQ	<LOQ	0.51	0.57
Clindamycin	13	19	17	21
Clomipramine	46	40	36	42
Clonazepam	29	17	30	8.5
Clotrimazol	87	250	120	390
Codeine	29	14	20	9.5
Cyproheptadine	<LOQ	<LOQ	5.3	<LOQ
Desloratidin	13	11	5.4	12
Diclofenac	59	31	10	<LOQ
Dicycloverin	<LOQ	<LOQ	<LOQ	<LOQ
Dihydroergotamine	<LOQ	<LOQ	<LOQ	<LOQ
Diltiazem	<LOQ	<LOQ	<LOQ	<LOQ
Diphenhydramine	13	23	9.8	19
Dipyridamole	270	280	1400	340
Donepezil	<LOQ	<LOQ	<LOQ	<LOQ
Duloxetine	7.4	28	10	21
Eprosartan	<LOQ	14	10	14
Erythromycin	1000	150	120	<LOQ
Estradiol	<LOQ	<LOQ	<LOQ	<LOQ
Ethinyl estradiol	<LOQ	<LOQ	<LOQ	<LOQ
Etonogestrel	<LOQ	<LOQ	<LOQ	<LOQ
Ezetimibe	<LOQ	<LOQ	<LOQ	<LOQ
Felodipine	<LOQ	<LOQ	<LOQ	<LOQ
Fentanyl	0.79	0.72	<LOQ	<LOQ
Fexofenadine	95	140	54	130
Finasteride	<LOQ	<LOQ	<LOQ	<LOQ
Flecainide	10	13	9	14
Fluconazole	3.5	13	47	3.1
Flunitrazepam	<LOQ	<LOQ	<LOQ	<LOQ
Fluoxetine	39	79	43	160
Flupentixol	<LOQ	<LOQ	<LOQ	<LOQ
Fluphenazine	<LOQ	<LOQ	<LOQ	<LOQ
Flutamide	<LOQ	<LOQ	<LOQ	<LOQ
Glibenclamide	<LOQ	<LOQ	<LOQ	<LOQ
Glimepiride	<LOQ	<LOQ	<LOQ	<LOQ
Haloperidol	6.2	6.6	4.7	3.7

	N29	**N30**	**N31**	**N32**
	µg/Kg	µg/Kg	µg/Kg	µg/Kg
Name				
Hydroxyzine	29	39	22	29
Ibuprofen	<LOQ	<LOQ	<LOQ	<LOQ
Irbesartan	37	280	67	75
Ketoconazole	510	1200	1100	1800
Ketoprofene	<LOQ	<LOQ	<LOQ	<LOQ
Levomepromazine	<LOQ	<LOQ	<LOQ	<LOQ
Levonorgestrel	<LOQ	<LOQ	<LOQ	<LOQ
Loperamide	6.9	17	4.5	11
Maprotiline	<LOQ	5.2	<LOQ	<LOQ
Meclozine	12	13	13	16
Memantine	1.9	0.91	3.1	2.1
Metformin	<LOQ	<LOQ	<LOQ	<LOQ
Metoprolol	180	410	210	190
Mianserin	16	11	94	25
Miconazole	180	340	210	410
Mirtazapine	120	66	57	110
Naproxen	<LOQ	<LOQ	<LOQ	<LOQ
Nefazodone	0.8	0.81	2.9	2.3
Norfloxacin	62	84	16	30
Ofloxacin	<LOQ	27	17	<LOQ
Orphenadrine	13	22	10	8.8
Oxazepam	43	18	12	18
Paracetamol	73	11	<LOQ	<LOQ
Paroxetine	25	24	<LOQ	24
Perphenazine	<LOQ	<LOQ	<LOQ	<LOQ
Pizotifen	<LOQ	1.6	3.7	2.6
Promethazine	55	64	45	88
Ranitidine	<LOQ	<LOQ	<LOQ	<LOQ
Repaglinide	0.84	1.2	<LOQ	1.3
Risperidone	1.2	2.1	1.9	0.75
Rosuvastatin	<LOQ	28	<LOQ	<LOQ
Roxithromycin	<LOQ	<LOQ	<LOQ	<LOQ
Sertraline	440	380	420	770
Sulfamethoxazole	8.8	12	<LOQ	11
Tamoxifen	6.7	13	7.5	9.6
Telmisartan	130	450	180	1400
Tetracycline	<LOQ	<LOQ	100	79
Tramadol	<LOQ	68	<LOQ	57
Trihexyphenidyl	2.7	2.5	1.3	0.54
Trimethoprim	27	2.2	2.5	1.1
Venlafaxine	86	310	150	140
Verapamil	<LOQ	<LOQ	18	<LOQ
Zolpidem	7.7	8.3	3.2	5.9

[a] WWTP Stadskvarn
[b] WWTP Henriksdal
[c] WWTP Ön
[d] WWTP Kungsängsverket

Appendix 11. Calculated concentration ratios (CR) in Katrineholm (N1), Vallentuna (N2), Skövde (N33-38) and Uppsala (N39-43). See 2.2 and 5.3 for aditional information.

	N1	N2	N33	N34	N35	N36	N37	N38	N39	N40	N41	N42	N43
Name													
Alfuzosin	344	908	3842	4541	50	36	1784	2220	768	30	154	270	476
Alprazolam	3												
Atenolol			72030	72030	3445	2032	22638	8168	33014	2201	7923	12780	10030
Atracurium	b		b	b	b	b	b	b	b	b	b		
Azithromycin			48				241						
Biperiden	66	15											
Bisoprolol		5486	19200	34560	35	23	628	1016	2880	59	192	735	346
Buprenorphine	0.1												
Bupropion	21	46	252	258	7.3	6.1	89	143	314	8.3	39	26	89
Carbamazepine	28875	36861	39375	70713	737	630	8662	15750	11948	456	1824	3150	3983
Cilazapril	125	334											
Ciprofloxacin		2E+06	50000	1E+05	7E+05	4E+05	82609	2E+05	3E+05	1E+06	2E+06	2E+06	
Citalopram	8.8	7.8	5.2	12	1.0	0.7	8.3	17	21	0.7	4.9	3.7	7.8
Clarithromycine		186	7	1964	123	84	22	303	2076	3460			2202
Clemastine	1.1												
Clindamycin			31313		2192	1512	20233	24354	42424	939	3868	8768	7306
Clomipramine	17		20		21					11			
Clotrimazol				b	b	b	b			b	b	b	b
Codeine		11092	22183		325	222	4294	9507	2662	78	286	467	532
Desloratidin					96	72				53	465		
Diclofenac					20	65	217			5	16	163	51
Diltiazem					2875	2324	49793	55768	50698	1394	4726	3927	6485
Diphenhydramine	13567		30833	6359	485	323	22865	7827	37685	185	925	1696	1850
Eprosartan	b		b	b	b	b		b	b	b	b	b	b
Erythromycin				b	b	b							
Fentanyl			8.3	36			15	19	19	36		42	11
Fexofenadine					397	306	2931	4303	2661	135	311	1064	1264
Finasteride	6.7	23											
Flecainide	940	208	2124	2244	62	42	681	898	790	15	62	68	104
Fluconazole	1E+06	3E+06	45455	3E+05	60241	50000	2E+05	5E+05	5E+05	17241	1E+05	2E+05	2E+05
Fluoxetine										15	78		
Flupentixol					0.6	0.45				0.3			
Glibenclamide				6.4	4.2	4.8	5.0	9.3					
Haloperidol			2.3	7.0	3.0	3.3	5.9	10	27	4.6	9.3	2.2	14
Hydroxyzine	3122	4787		12598	1496	2476	7181	3420	1751	3420	3989	2660	
Ibuprofen	5727	2996	1947	2822	1391	4868	5409	1082		1623	1391	2822	9272
Irbesartan	3.1	23	25	15	0.5	0.4	4.2	16	6.3	0.1	0.4	1.0	1.4
Ketoprofene					1195	1166	3768		3265	445	1884	3768	2041
Loperamide	1.9	3.2	3.0	7.7	5.6	4.2	3.5	2.5	10	4.2	2.7	1.9	12
Meclozine	0.07	0.16											
Memantine	3540	3014	3780	3597	437	343		3717		149	637	970	1394
Metoprolol		2523	1283		23	16	270	416	302	13	42	118	77
Mianserin					97	41				43	101	101	
Miconazole	b												
Mirtazapine					116	107				67	388	607	735
Naproxen		20195	29571	18400	6369	8449	18818	75273	41400	10753	21789	30667	21789
Nefazodone	24												
Orphenadrine	3494				349	288	1766	2606	1368	59	278	373	1095
Oxazepam	3200		1463	3072	134	99	1097	2048	1920	53	236	445	521
Paracetamol	2E+06	1E+06	2E+05	3E+05	9E+05	3E+05	2E+05	5E+05	1E+05	5E+05	5E+05	6E+05	7E+05
Pizotifen	12									8.5			11
Ranitidine					43140	34258				2118	15530		
Repaglinide	b	b	b	b	b	b	b	b	b	b	b	b	b
Risperidone			81	68	117	61			14	81	61	15	76
Rosuvastatin					39	19						107	
Roxithromycin			295		6488		1352						
Sertraline			4.6		4.6					1.8	2.8		
Sulfamethoxazole		1E+06	2E+05	4E+05	2E+06	2E+06	8E+05	1E+06	1E+06	7E+05	5E+06		
Tamoxifen									b				

	N1	N2	N33	N34	N35	N36	N37	N38	N39	N40	N41	N42	N43
Name													
Telmisartan										b			
Tramadol	800		2087	3428	7.4	5.5	104	178	94	2.7	9.2	17	19
Trihexyphenidyl			191	45		115	101	66	54	61	26	172	95
Trimethoprim	2E+05	5E+05	30000	97059	23571	19412	63462	2E+05	2E+05	15714	66000	84615	1E+05
Venlafaxine	170	382	1019	556	44	47	407	711	360	14	41	111	89
Verapamil	1.2								1.3				
Zolpidem	448	376	1774	1679	392	303	1843		1567	157	522	553	855

Appendix 12. Drinking water from Stockholm (N44-46) and Umeå (N47-49).

	N44	N45	N46	N47	N48	N49
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name						
Alfuzosin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Alprazolam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amiodiarone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amitryptiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atenolol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atorvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atracurium	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Azelastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Azithromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Beclomethazone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Biperiden	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Bisoprolol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Bromocriptine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Buprenorphine	16	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Bupropion	0.91	<LOQ	1	<LOQ	<LOQ	<LOQ
Carbamazepine	19	14	11	4	7.2	2.2
Chlorprothixen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Chlorpromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Cilazapril	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ciprofloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Citalopram	6.6	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clarithromycine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clemastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clindamycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clomipramine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clonazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clotrimazol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Codeine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Cyproheptadine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Desloratidin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diclofenac	140	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dicycloverin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dihydroergotamine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diltiazem	<LOQ	7.9	<LOQ	<LOQ	<LOQ	<LOQ
Diphenhydramine	0.82	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dipyridamole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Donepezil	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Duloxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Eprosartan	<LOQ	<LOQ	5.1	<LOQ	<LOQ	<LOQ
Erythromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ethinyl estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Etonogestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ezetimibe	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Felodipine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fentanyl	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fexofenadine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Finasteride	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

	N44	N45	N46	N47	N48	N49
	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Name						
Flecainide	2.5	1.1	5.3	<LOQ	<LOQ	<LOQ
Fluconazole	3.3	1.4	3.2	<LOQ	<LOQ	<LOQ
Flunitrazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fluoxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flupentixol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fluphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flutamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Glibenclamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Glimepiride	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Haloperidol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Hydroxyzine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ibuprofen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Irbesartan	2.8	1.3	0.86	<LOQ	<LOQ	<LOQ
Ketoconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ketoprofene	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levomepromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levonorgestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Loperamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Maprotiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Meclozine	5.2	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Memantine	4.1	1.4	2.9	<LOQ	<LOQ	<LOQ
Metformin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Metoprolol	7.9	16	5.1	<LOQ	9.1	<LOQ
Mianserin	<LOQ	2.2	<LOQ	<LOQ	<LOQ	<LOQ
Miconazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Mirtazapine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Naproxen	40	23	45	<LOQ	<LOQ	<LOQ
Nefazodone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Norfloxacin	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ
Ofloxacin	<LOQ	22	14	<LOQ	<LOQ	<LOQ
Orphenadrine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Oxazepam	11	6.9	14	<LOQ	<LOQ	<LOQ
Paracetamol	<LOQ	11	15	<LOQ	<LOQ	<LOQ
Paroxetine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Perphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Pizotifen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Promethazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ranitidine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Repaglinide	2.3	3.6	2.9	<LOQ	<LOQ	<LOQ
Risperidone	14	17	16	<LOQ	<LOQ	<LOQ
Rosuvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Roxithromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Sertraline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Sulfamethoxazole	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tamoxifen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Telmisartan	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tetracycline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tramadol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Trihexyphenidyl	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Trimethoprim	4.7	6.2	2.3	5.9	6.8	6.6
Venlafaxine	8.6	7.8	7	<LOQ	<LOQ	<LOQ
Verapamil	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Zolpidem	0.94	0.84	<LOQ	<LOQ	<LOQ	<LOQ

Appendix 13. Results from the regional screening program, samples R1-R2 and R7-R59. Samples were analyzed for seven pharmaceuticals; beclomethasone (BEC), Carbamazepine (CAR), felodipine (FEL), ketoconazole (KET), levonorgestrel (LEV), metformin (MET) and sertraline (SER).

Sample	Unit	BEC	CAR	FEL	KET	LEV	MET	SER
R1	ng/L	<LOQ	390	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R2	ng/L	<LOQ	430	<LOQ	<LOQ	<LOQ	320	20
R7	ng/L	<LOQ	120	<LOQ	84	<LOQ	530	<LOQ
R8	ng/L	<LOQ	180	<LOQ	58	<LOQ	170	<LOQ
R9	ng/L	<LOQ	71	<LOQ	<LOQ	<LOQ	280	<LOQ
R10	ng/L	<LOQ	120	<LOQ	<LOQ	<LOQ	150	<LOQ
R11	ng/L	<LOQ	220	<LOQ	73	<LOQ	390	25
R12	ng/L	<LOQ	340	<LOQ	56	<LOQ	520	<LOQ
R13	ng/L	<LOQ	570	<LOQ	58	<LOQ	600	15
R14	ng/L	<LOQ	170	<LOQ	<LOQ	<LOQ	330	18
R15	ng/L	<LOQ	170	<LOQ	69	<LOQ	470	15
R16	ng/L	<LOQ	250	<LOQ	<LOQ	<LOQ	320	<LOQ
R17	ng/L	<LOQ	75	<LOQ	<LOQ	<LOQ	380	25
R18	ng/L	<LOQ	67	<LOQ	<LOQ	<LOQ	160	<LOQ
R19	ng/L	<LOQ	240	<LOQ	220	<LOQ	350	83
R20	ng/L	<LOQ	240	<LOQ	<LOQ	<LOQ	<LOQ	13
R21	µg/Kg	<LOQ	92	<LOQ	700	<LOQ	<LOQ	510
R22	ng/L	<LOQ	110	<LOQ	<LOQ	<LOQ	300	<LOQ
R23	ng/L	<LOQ	170	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R24	ng/L	<LOQ	250	<LOQ	<LOQ	<LOQ	240	<LOQ
R25	µg/Kg	<LOQ	73	<LOQ	600	<LOQ	<LOQ	310
R26	ng/L	<LOQ	310	<LOQ	<LOQ	<LOQ	790	10
R27	µg/Kg	12	47	<LOQ	640	<LOQ	<LOQ	510
R28	µg/Kg	<LOQ	2.5	<LOQ	<LOQ	<LOQ	<LOQ	47
R29	µg/Kg	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R30	ng/L	<LOQ	6.6	<LOQ	<LOQ	<LOQ	<LOQ	11
R31	ng/L	<LOQ	220	<LOQ	<LOQ	<LOQ	390	18
R32	ng/L	<LOQ	200	<LOQ	<LOQ	<LOQ	130	49
R33	ng/L	<LOQ	190	<LOQ	<LOQ	<LOQ	140	<LOQ
R34	µg/Kg	<LOQ	35	<LOQ	490	<LOQ	<LOQ	810
R35	µg/Kg	<LOQ	1.8	<LOQ	<LOQ	<LOQ	<LOQ	14
R36	µg/kg	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R37	ng/L	<LOQ	8.3	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R38	µg/Kg	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R39	µg/kg	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R40	ng/L	<LOQ	19	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R41	ng/L	<LOQ	210	<LOQ	<LOQ	<LOQ	<LOQ	22
R42	µg/Kg	<LOQ	43	<LOQ	360	<LOQ	<LOQ	640
R43	ng/L	<LOQ	8	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R44	ng/L	<LOQ	5	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R45	ng/L	<LOQ	9	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R46	ng/L	<LOQ	14	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R47	µg/kg	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R48	ng/L	<LOQ	150	<LOQ	<LOQ	<LOQ	<LOQ	20
R49	µg/Kg	<LOQ	35	<LOQ	540	<LOQ	<LOQ	880
R50	µg/kg	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R51	ng/L	<LOQ	1500	<LOQ	130	<LOQ	1400	100
R52	µg/Kg	<LOQ	14	<LOQ	430	<LOQ	<LOQ	230
R53	ng/L	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
R54	µg/Kg	<LOQ	70	<LOQ	820	<LOQ	<LOQ	520
R55	ng/L	<LOQ	270	<LOQ	<LOQ	<LOQ	920	27
R56	µg/Kg	<LOQ	81	<LOQ	1100	<LOQ	<LOQ	1700
R57	µg/Kg	<LOQ	78	<LOQ	490	<LOQ	<LOQ	1200
R58	µg/Kg	<LOQ	150	<LOQ	620	<LOQ	<LOQ	810
R59	µg/Kg	<LOQ	54	<LOQ	470	<LOQ	<LOQ	710

Appendix 14. Results from the regional screening program, samples R3-R6 and R60-R67. Samples were analyzed for 101 pharmaceuticals.

	R3	R4	R5	R6	R60	R61	R62	R63	R64	R65	R66	R67
	µg/Kg	ng/L	µg/Kg	ng/L	µg/Kg	µg/Kg	µg/Kg	ng/L	µg/Kg	µg/Kg	µg/Kg	µg/Kg
Name												
Alfuzosin	<LOQ	18	10	1.1	<LOQ	<LOQ	<LOQ	3.1	<LOQ	<LOQ	0.1	0.2
Alprazolam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amiodiarone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Amitryptiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atenolol	<LOQ	460	38	19	<LOQ	<LOQ	<LOQ	25.1	<LOQ	<LOQ	<LOQ	<LOQ
Atorvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Atracurium	<LOQ	2.6	0.8	0.8	<LOQ	<LOQ	<LOQ	1.5	<LOQ	<LOQ	<LOQ	<LOQ
Azelastine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Azithromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Beclomethazone	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Biperiden	<LOQ	0.6	0.2	<LOQ	<LOQ	<LOQ	<LOQ	1.4	<LOQ	<LOQ	<LOQ	<LOQ
Bisoprolol	<LOQ	38	4.3	0.4	<LOQ	<LOQ	<LOQ	3.4	<LOQ	<LOQ	<LOQ	<LOQ
Bromocriptine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Buprenorphine	<LOQ	64	100	33	<LOQ	<LOQ	17	29	<LOQ	<LOQ	<LOQ	<LOQ
Bupropion	<LOQ	2.7	0.5	0.7	<LOQ	<LOQ	<LOQ	0.9	<LOQ	<LOQ	<LOQ	0.15
Carbamazepine	<LOQ	290	89	7.4	<LOQ	<LOQ	<LOQ	39	1.0	<LOQ	<LOQ	<LOQ
Chlorprothixen	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Chlorpromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Cilazapril	<LOQ	2.8	2.6	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ciprofloxacin	<LOQ	<LOQ	120	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Citalopram	<LOQ	116	500	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clarithromycine	<LOQ	1.8	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clemastine	<LOQ	1.8	1.0	3.4	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clindamycin	<LOQ	31	5.9	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clomipramine	<LOQ	1.2	42	<LOQ	<LOQ	<LOQ	<LOQ	1.4	0.64	<LOQ	<LOQ	<LOQ
Clonazepam	<LOQ	17	19	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Clotrimazol	<LOQ	3.8	92	2.4	<LOQ	<LOQ	<LOQ	5.1	1.0	<LOQ	<LOQ	<LOQ
Codeine	<LOQ	230	16	8.0	<LOQ	<LOQ	<LOQ	6.2	<LOQ	<LOQ	<LOQ	<LOQ
Cyproheptadine	<LOQ	11	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Desloratidin	<LOQ	1.7	11	1.1	<LOQ	<LOQ	<LOQ	3.5	<LOQ	<LOQ	<LOQ	<LOQ
Diclofenac	<LOQ	<LOQ	20	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dicycloverin	<LOQ	<LOQ	<LOQ	6.2	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Dihydroergotamine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Diltiazem	<LOQ	15.0	0.8	<LOQ	<LOQ	<LOQ	<LOQ	0.6	<LOQ	<LOQ	<LOQ	<LOQ
Diphenhydramine	<LOQ	7.4	10	0.4	<LOQ	<LOQ	<LOQ	2.1	<LOQ	<LOQ	<LOQ	<LOQ
Dipyridamole	<LOQ	<LOQ	4000	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Donepezil	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Duloxetine	<LOQ	<LOQ	15	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Eprosartan	<LOQ	17	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Erythromycin	<LOQ	<LOQ	550	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ethinyl estradiol	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Etonogestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ezetimibe	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Felodipine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fentanyl	<LOQ	0.8	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	1.0	<LOQ	<LOQ	<LOQ	<LOQ
Fexofenadine	<LOQ	11	43	<LOQ	<LOQ	<LOQ	<LOQ	9.5	<LOQ	<LOQ	<LOQ	<LOQ
Finasteride	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flecainide	<LOQ	19	6.1	0.2	<LOQ	<LOQ	<LOQ	2.7	<LOQ	<LOQ	0.1	<LOQ
Fluconazole	0.9	55	2.6	3.9	<LOQ	<LOQ	<LOQ	6.4	<LOQ	<LOQ	<LOQ	<LOQ
Flunitrazepam	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Fluoxetine	<LOQ	<LOQ	55	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flupentixol	<LOQ	6.8	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	6.3	<LOQ	<LOQ	<LOQ	<LOQ
Fluphenazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Flutamide	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Glibenclamide	<LOQ	<LOQ	<LOQ	14.6	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Glimepiride	<LOQ	10.2	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

	R3	R4	R5	R6	R60	R61	R62	R63	R64	R65	R66	R67
	µg/Kg	ng/L	µg/Kg	ng/L	µg/Kg	µg/Kg	µg/Kg	ng/L	µg/Kg	µg/Kg	µg/Kg	µg/Kg
Name												
Haloperidol	0.13	1.5	4.4	1.5	0.16	<LOQ	0.16	0.4	0.15	<LOQ	0.13	0.52
Hydroxyzine	<LOQ	9.9	22	19	<LOQ	<LOQ	<LOQ	12	2. 9	<LOQ	<LOQ	<LOQ
Ibuprofen	<LOQ	39.1	<LOQ	47.4	<LOQ	<LOQ	<LOQ	41.9	<LOQ	<LOQ	<LOQ	<LOQ
Irbesartan	<LOQ	19	8.7	3.9	<LOQ	<LOQ	<LOQ	12	0.66	<LOQ	<LOQ	<LOQ
Ketoconazole	<LOQ	<LOQ	550	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ketoprofene	<LOQ	184.1	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	11.2	<LOQ	<LOQ	<LOQ	<LOQ
Levomepromazine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Levonorgestrel	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Loperamide	<LOQ	0.8	5.5	<LOQ	<LOQ	<LOQ	<LOQ	1.5	<LOQ	<LOQ	<LOQ	<LOQ
Maprotiline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Meclozine	<LOQ	<LOQ	16	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Memantine	<LOQ	11	2.9	1.6	<LOQ	<LOQ	<LOQ	1.4	1.1	0.65	<LOQ	<LOQ
Metformin	<LOQ	230	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Metoprolol	<LOQ	1400	130	85	<LOQ	<LOQ	<LOQ	90	<LOQ	<LOQ	<LOQ	<LOQ
Mianserin	<LOQ	4.1	32	3.1	<LOQ	<LOQ	<LOQ	2.6	<LOQ	<LOQ	<LOQ	<LOQ
Miconazole	<LOQ	<LOQ	170	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Mirtazapine	<LOQ	35	47	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Naproxen	<LOQ	236.5	<LOQ	21.8	<LOQ	<LOQ	<LOQ	49	<LOQ	<LOQ	<LOQ	<LOQ
Nefazodone	<LOQ	2.9	0.9	2.8	<LOQ	<LOQ	<LOQ	5.9	<LOQ	<LOQ	<LOQ	<LOQ
Norfloxacin	<LOQ	<LOQ	19	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ofloxacin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Orphenadrine	<LOQ	4.6	13	0.9	<LOQ	<LOQ	<LOQ	0.5	0.32	<LOQ	<LOQ	<LOQ
Oxazepam	<LOQ	140	14	<LOQ	<LOQ	<LOQ	<LOQ	39	6.7	<LOQ	<LOQ	<LOQ
Paracetamol	<LOQ	320	15	22	<LOQ	<LOQ	<LOQ	90	<LOQ	<LOQ	<LOQ	<LOQ
Paroxetine	<LOQ	<LOQ	26	<LOQ	<LOQ	<LOQ	<LOQ	30	<LOQ	<LOQ	<LOQ	<LOQ
Perphenazine	<LOQ	12	<LOQ	19.5	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Pizotifen	<LOQ	<LOQ	0.9	<LOQ	<LOQ	<LOQ	0.89	2.5	0. 7	<LOQ	<LOQ	<LOQ
Promethazine	<LOQ	<LOQ	47	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Ranitidine	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Repaglinide	<LOQ	1.0	0.8	1.6	<LOQ	<LOQ	<LOQ	0.7	<LOQ	<LOQ	<LOQ	<LOQ
Risperidone	0.12	5.0	0.7	8.6	<LOQ	<LOQ	<LOQ	12	<LOQ	<LOQ	0.22	0.13
Rosuvastatin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	10.2	<LOQ	<LOQ	<LOQ	<LOQ
Roxithromycin	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Sertraline	<LOQ	<LOQ	320	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Sulfamethoxazole	<LOQ	100	<LOQ	17	<LOQ	<LOQ	<LOQ	44	<LOQ	<LOQ	<LOQ	<LOQ
Tamoxifen	<LOQ	<LOQ	7.0	11	<LOQ	<LOQ	<LOQ	6.0	<LOQ	<LOQ	<LOQ	<LOQ
Telmisartan	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tetracycline	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Tramadol	<LOQ	300	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Trihexyphenidyl	<LOQ	0.4	9.0	<LOQ	<LOQ	<LOQ	0.15	2.1	0.14	<LOQ	<LOQ	<LOQ
Trimethoprim	<LOQ	50	1.6	8.4	<LOQ	<LOQ	<LOQ	5.0	<LOQ	<LOQ	<LOQ	<LOQ
Venlafaxine	<LOQ	170	150	17	<LOQ	<LOQ	<LOQ	47	<LOQ	<LOQ	<LOQ	<LOQ
Verapamil	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
Zolpidem	<LOQ	2.3	3.2	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ