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Selected compounds with relevance for EU regulation

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Screening program 2016 – Utvalgte stoffer relevant for EU regulering
Screening programme 2016 - Selected compounds with relevance for EU regulation

Summary - sammendrag

This report summarizes the findings of a screening study into the occurrence of selected solvents, siloxanes, flame retardants, bisphenols and other PBT compounds in effluents, sewage sludge, surface water, sediments, house dust, indoor air and biota.

Denne rapporten oppsummerer resultatene av en screeningundersøkelse om forekomst av utvalgte løsemidler, siloksaner, flammehemmere, bisfenoler og andre PBT-stoffer i avløp, slam, overflatevann, sedimenter, husstøv, inneluft og biota.

4 emneord

Screening, Miljøgifter, Oslofjord, Mjøsa

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Content

Summary

The screening programme for 2016 focused on the occurrence of selected compounds in wastewater from waste water treatment plants (WWTP) influent, effluent and sludge as well as in surface water, sediment and biota in Oslofjord and Lake Mjøsa. In addition, in 2016 also samples from the indoor environment like house dust and indoor air, were included for the first time. The criteria for selection were the potential harm of these compounds to the environment in Norway, their relevance for possible regulation within the EU, earlier findings in the environment, tonnage use of the compounds, and other relevant information. Among the selected compounds there are both solvents, flame retardants, bisphenols, antioxidants, personal care products, biocides, and pesticides.

The *linear siloxanes* were found in all emission-related sample types including the indoor environment. However, it is expected that exposure via environmental pathways are much lesser compared to the direct exposure via use of personal care products. The European Chemistry Agency (ECHA) has estimated the same tonnage for both L3 and L4 and a lower tonnage for L5. However, all studied matrices in this screening showed higher concentrations for L5 than for L3 and L4. These findings do not support the ECHA estimations, which states that either L3 and L4 are overestimated or more likely there are additional unidentified sources for L5.

The *volatile aromatic compounds;* di-isopropylbenzenes and 4-Isopropyl-1,1'-biphenyl, were frequently found both in WWTP sludge and indoor environmental samples, establishing their widespread use and emission. There is only one finding above LoD in brown trout, which is not enough evidence for persistence and bioaccumulation.

With the exception of Dibromoaldrin and Dechlorane 601, all selected *dechlorane compounds* were found regularly and at high concentrations in nearly all studied sample types including house dust. Their occurrence in biota is clear evidence for persistence and bioaccumulation. This group of compounds should be selected for further and more thorough studies.

The *prioritized bisphenols* BPAF and BPM were rarely or occasionally found in emission and house dust samples. BPAP was not found in any of the samples. On the other hand, the single finding of BPAF in house dust correspondeds with the highest concentration of the other bisphenols. The measured “reference” bisphenols were found in nearly all emission-related samples and clearly qualify for regularl monitoring. For the bisphenols, the estimated daily intake of house dust by ingestion may be as important as food intake, when calculating the total human exposure to bisphenols. A risk assessment based on comparison of the measured freshwater concentration of Lake Mjøsa with the PNEC for BPA, showed a MEC/PNEC ratio just below 1, which still can be characterized as a low environmental risk.

House dust was the only sample type where it was possible to detect *BAGDE-related compounds*. These compounds were found in all house dust samples and the measured concentrations were in the same range as BPA.

Triphenyl phosphorothioate (TPPT) was only found in influent and sewage sludge from HIAS.

The phosphorous flame retardant bisphenol A bis(diphenylphosphate) BPA-BDPP was only found in three of the house dust samplesat relatively high concentrations. In other studies, this compound seemed to be related to electronic equipment.

The plasticizer n-butylbenzene sulphonamide (NBBsulfone) was only detected in effluent from the landfill site Lindum.

The organotin compound Di-n-octyltin used in water based paints, was found in all house dust samples.

The synthetic musk compound methyl-cedryl-ketone was found at relatively high concentrations in all influent, effluent and sludge samples. The daily release for VEAS and HIAS were about 70 and 15 g respectively. This compound was also detected in some sediment samples from Lake Mjøsa. Methyl-cedryl-ketone was found in nearly all dust samples and also detected in several of the air samples.

The UV filter octocrylene was found in all emission related samples and in the recipient samples surface water and sediment. It was also found in all dust samples.

The following substances were not or only detected in a few samples in this study: Dibromoaldrin, Dechlorane 601, 2,4,6-Tris(tert-butyl)phenol (TTBP), 2,6-Di-tert-butyl-4-ethylphenol (DTEB), Bisphenol AF, Bisphenol AP, BFDGE, BFDGE-2HCL, BFDGE-2H20, Propargite, Bis(4-chlorophenyl) sulfone (BCPS), Phosphinic acid, bis(nonafluorobutyl) (PFPiA), 2-[methyl(1,1,2,2,3,3,4,4,4-nonafluorobutylsulfonyl)amino]ethyl prop-2-enoate (NFacrylat), and Undecenyl crylene.

Since the compounds selected for this study were of quite different chemical nature, it was not possible to fine-tune the analytical method to optimal performance for every single compound, resulting in sub-optimal LoD and higher numbers of non-detects. Other compounds like Propargite, BCPS, BPA-BDPP, and NBBSulfone, are readily biodegraded or biotransformed in fish resulting in low levels in the studied sample types

The following substances were occasionally detected (or frequently detected in only one sample type) in this study: HPP, BBM, BPM, BADGE-2HCL, BADGE-H20, BADGE-2H2O, OTP, and BPA-BDPP. All other compounds were detected frequently in two or more different matrices or in all samples of one sample type. Further investigation of the following compounds should therefore be considered: L3, L4, L5, diisopropylbenzenes, 4-isopropyl-1,1'-biphenyl, dechloranes, BPS, BPF, BPA, BADGE-group, NBBsulfone, di-noctyltin, methyl-cedryl-ketone, and octocrylene.

For most of the compounds, sufficient knowledge on human and environmental effects is lacking and only a very limited environmental risk assessment could be performed. Based on the PNEC for freshwater biota BPA is the only compound with a low (close to moderate) environmental risk

One of the major objectives in this study was to study the occurrence or absence of the selected compounds. The sample type with most positive findings was house dust. With the exception of pesticides and some purely industrial chemicals, most of the detected chemicals either are part of products used in indoor environment or are easily transported into houses. Furthermore, household dust is a comparable easy matrix to analyse, where the compounds of interest are not “diluted” or concealed by interfering biological material. In contrast to many other sample types like leachate water, sediment, and biota, household dust is very closely connected to the original product and the composition of the dust is reflecting the composition of relatively new products. Both dust and indoor air can therefore be applied as an early warning tool or watchdog to follow up new developments in the market and to verify reported tonnages.

Sammendrag

Screeningsundersøkelser har som mål å kartlegge forekomst, tilførsel, og miljøkonsekvens av nye miljøgifter i norsk og arktisk miljø. Kriterier for Screening 2016 er blant annet betydning av stoffet for kjemikalieregulering og andre nasjonale og internasjonale tiltak, indikasjoner/bevis på at stoffet har miljøgiftegenskaper (PBT) eller hormonforstyrrende egenskaper, stoffet er et kandidatstoff til kjemikalielister, stoffet er lite undersøkt i miljøet og høy bruk av stoffet nasjonalt og internasjonalt. De utvalgte stoffene er både løsemidler, flammehemmere, bisfenoler, antioksidanter, pleieprodukter, biocider og pesticider. Undersøkte prøvetyper er fra renseanlegg (innløp, utløp, slam) samt sigevann fra avfalldeponier; sediment, overflatevann og biota relatert til de undersøkte renseanlegg og husstøv og inneluft fra bolighus.

Lineære siloksaner ble funnet i alle utslippsprøver og innemiljøprøver. Det forventes at eksponering via husstøv og inneluft er lavere enn gjennom direkte bruk av pleieprodukter og kosmetikk. Den europeiske kjemikalie myndigheten (ECHA) estimerer samme forbruk for både L3 og L4, og noe lavere for L5. Allikevel viser alle undersøkte prøvetyper en høyere konsentrasjon av L5 sammenlignet med L3 og L4. Funnene i denne studien støtter derfor ikke ECHAs estimat. Dette kan skyldes at forbrukstall for L3 og L4 er overestimert eller at det finnes kilder for L5 som ikke er identifisert.

De flyktige aromatiske forbindelsene, di-isopropylbenzenes and 4-Isopropyl-1,1'-bifenyl, ble funnet hyppig i slam fra renseanlegg og i innmiljøprøvene som tyder på utstrakt bruk og utslipp av disse stoffer. Stoffene er kun funnet en gang i biota (ørret fra Mjøsa) som ikke er nok bevis for å kunne konkludere når det gjelder persistens og bioakkumulering.

Med unntak av dibromoaldrin og dekloran 601 ble alle utvalgte dekloran-forbindelser funnet regelmessig og ved høye konsentrasjoner i nesten alle prøvetyper inklusive husstøv. Regelmessige funn i biota er et klart bevis for persistens og bioakkumulering og denne gruppen bør derfor bli valgt for videre og grundigere undersøkelser.

De utvalgte bisfenolene BPAF og BPM ble kun funnet i noen få utslipps- og husstøvprøver. Det eneste funnet av BPAF i husstøv korrelerer også med høye konsentrasjoner av de andre bisfenolene. BPAP ble ikke påvist i det hele tatt. De undersøkte referanse-bisfenolene BPA, BPS, og BPF ble funnet i nesten alle utslippsprøver og kvalifiserer for en regulær overvåkning. En sammenligning av estimert daglig inntak av bisfenoler gjennom opptak og svelging av husstøv og opptak via vanlig mat viser at husstøv er en like viktig kilde for human bisfenolbelastning som mat.

Husstøv var den eneste prøvetypen hvor BADGE-relaterte stoffer ble påvist. Noen av disse stoffene ble påvist i alle husstøvprøver og de påviste konsentrasjonene var i samme størrelsesorden som BPA.

Trifenyl fosforotioate (TPPT) ble bare funnet i innløpsvann og slam fra HIAS renseanlegg.

Den fosforholdige flammehemmeren bisfenol A bis(difenylfosfate) BPA-BDPP ble bare funnet i tre husstøvprøver, men i relativt høye konsentrasjoner. Andre studier tyder på at forekomst kan relateres til elektronisk utstyr.

N-butylbenzensulfonamid (NBBsulfone) som brukes som mykgjører, ble kun detektert i sigevann fra Lindum avfallsdeponi.

Organotinn forbindelsen di-n-octyltin som brukes i vannbasert maling, ble påvist i alle husstøvprøver.

Parfymstoffet metylcedrylketon ble funnet i relativt høye konsentrasjoner i alle innløps- og utløpsvannprøver og slamprøver fra VEAS og HIAS. Daglig utslipp fra VEAS og HIAS ble beregnet til å være 70 og 15 g. Stoffet ble også påvist i noen sedimentprøver fra Mjøsa. Videre ble stoffet funnet i nesten alle husstøv-prøver og i noen inneluftprøver.

UV-filteret oktokrylen ble funnet i alle utslippsrelaterte prøver samt tilknyttet overflatevann og sediment. Stoffet ble også funnet i alle støvprøver.

Følgende stoffer ble aldri eller kun sporadisk detektert: Dibromoaldrin, Dechlorane 601, 2,4,6-Tris(tert-butyl)fenol (TTBP), 2,6-Di-tert-butyl-4-ethylfenol (DTEB), Bisfenol AF, Bisfenol AP, BFDGE, BFDGE-2HCL, BFDGE-2H20, Propargit, Bis(4-klorofenyl)sulfon (BCPS), Fosfinic acid, bis(nonafluorobutyl) (PFPiA), 2-[metyl(1,1,2,2,3,3,4,4,4-nonafluorobutylsulfonyl)amino]etyl prop-2-enoate (NFacrylat), og Undecenylkrylen.

Stoffene valgt til denne studien er kjemisk sett veldig forskjellige og det var ikke mulig å spesialtilpasse metodene til hvert eneste stoff. Noen av de oppnådde deteksjonsgrensene var derfor ikke helt optimale, noe som resulterte i et høyere antall av ikke-detekterte stoffer enn hva som hadde vært mulig under helt optimale betingelser. Stoffer slik som propargit, BCPS, BPA-BDPP og NBBSulfon, kan være lett biologisk nedbrytbare, slik at disse ikke kan påvises i de valgte prøvetypene.

Følgende stoffer ble påvist noen ganger i flere prøvetyper eller hyppig i en prøvetype: HPP, BBM, BPM, BADGE-2HCL, BADGE-H20, BADGE-2H2O, OTP, and BPA-BDPP.

Alle andre stoffer ble funnet hyppig i flere prøvetyper eller alltid i en prøvetype og kvalifiserer derfor til utdypende oppfølgingsundersøkelser: L3, L4, L5, di-isopropylbenzener, 4-isopropyl-1,1'-bifenyl, dekloraner, BPS, BPF, BPA, BADGE-gruppe, NBBsulfon, di-n-octyltin, metylcedrylketon, og oktokrylen.

For de fleste stoffer foreligger det ikke tilstrekkelig informasjon om helse- og miljøeffekter og dette begrenser muligheten for analyse av miljørisiko. Basert på PNEC for ferskvann og målingen i overflatevann, er BPA det eneste stoffet som kan klassifiseres med miljørisiko, i dette tilfellet en lav opp mot moderat miljørisiko.

Et av hovedmålene med studiet var å undersøke forekomst eller fravær av de utvalgte stoffene. Prøvetypen med størst antall positive funn var husstøv eller husstøv i kombinasjon med inneluft. Med unntak av pesticider og noen industrirelaterte stoffer blir de fleste undersøkte stoffer enten brukt i produkter innendørs eller blir veldig lett transportert inn i hus. Husstøv er en prøvetype som er lett å samle inn og som også er forholdsvis lett å analysere, siden stoffene valgt ut for analyse som regel ikke er maskert eller uttynnet av store mengder naturlige stoffer slik de forekommer i avløpsvann, slam og særlig biota. Husstøv er dessuten nærmere knyttet opp mot de potensielle kildene og en kopling mot mistenkte produkter kan være mulig. I motsetning til sigevann fra fyllinger, sedimenter og biota reflekterer husstøv gjerne også nye produkter. Innemiljøprøver anbefales derfor brukt som varslingssystem for nye stoffer som kommer inn på markedet samt for å verifisere innrapporterte produksjons-, import- og forbruksmengder.

1. Background and Introduction

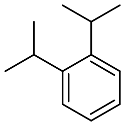
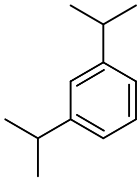
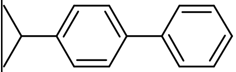
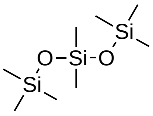
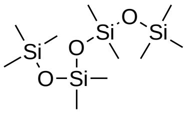
1.1 General

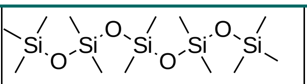
In 2016, the Norwegian Environment Agency nominated a large and diverse group of compounds for analysis in part 1 of its annual screening programme. The criteria for selection were the potential harm of these compounds to the environment in Norway, their relevance for possible regulation within the EU, earlier findings in the environment, tonnage use of the compounds, and other relevant information. The objective of the project was to establish the occurrence of these chemicals in the Norwegian indoor, marine and freshwater environments, with particular focus on their potential sources. The data on the occurrence of new potential harmful chemicals in the Norwegian environment presented in the report will contribute to future national or international legislation on a European or global level (UNEP).

1.2 Selected compounds

Table 1: Volatiles

Name, Acronym, CAS, Function, and Log K_{OW}

Name	Acronym	Structure	CAS	Function	Log K_{OW}
1,2-Diisopropylbenzene			577-55-9	Solvent	4,9
1,3-Diisopropylbenzene			99-62-7	Solvent	4,9
1,4-Diisopropylbenzene			100-18-5	Solvent	4,9
4-Isopropyl-1,1'-biphenyl			25640-78-2	Solvent	5,14
Octamethyltri-siloxane	L3		107-51-7	Solvent/ Impurity	5,7
Decamethyltetra-siloxane	L4		141-62-8	Solvent/ Impurity	7,1

Dodecamethylpenta-siloxane	L5		141-63-9	Solvent/ Impurity	7,4

Diisopropylbenzenes are produced as by-products of cumene synthesis in closed systems. Japan reported a yearly production of about 30 000 t/a and these chemicals were reported to be blended into gasoline and diesel (INCHEM, 2002). Eastman advertises 1,4-Diisopropylbenzene as a chemical intermediate for the preparation of stabilizers, polymers, synthetic lubricants, hydroperoxides, and a variety of other products. Reactions of DIPB include side chain modification by oxidation, dehydrogenation, and bromination. Ring substitution reactions include nitration, sulfonation, bromination, and acetylation (Eastman, 2017). According to ECHA's CoRAP justification reports diisopropylbenzenese were mainly used at industrial sites as process solvents for print inks and as intermediates. Total use in Europe for 1,4-diisopropylbenzene is estimated to 10 -100 t/a, and less for 1,3- and 1,2-diisopropylbenzene (BG-MSCA, 2016).

According to ECHA 4-Isopropyl-1,1'-biphenyl is used in coatings and adhesives with a total dissemination tonnage of about 1 – 10 t/a in Europe. The use includes wide dispersive indoor and outdoor use resulting in inclusion into or onto a matrix (MSCA-Germany, 2017). It is suspected to be PBT/vPvB.

According to ECHA Octamethyltrisiloxane (L3) is used as personal care products, coatings, sealants, heat transfer fluid, non-metal surface treatment agent - in situ treatment, use in electronics and optical product manufacturing and laboratory reagent. These cover industrial use, professional use and consumer use. The aggregated dissemination tonnage is estimated to about 100 – 1000 t/a (UK-REACH-CA, 2014). Decamethyltetrasiloxane (L4) has the same usage as L3 but a much higher aggregated dissemination tonnage of about 100 – 1000 t/a in Europe (UK-REACH-CA, 2015a). For dodecamethylpentasiloxane (L5) ECHA reports usage as personal care products, polymer preparation - formulation of release agent, in-situ non-metal surface treatment, laboratory reagent. These cover industrial use, professional use and consumer use. Total dissemination tonnage is about 10 – 100 t/a in Europe (UK-REACH-CA, 2015b).

Table 2: Dechloranes

Name, Acronym, CAS, Function, and Log K_{OW}

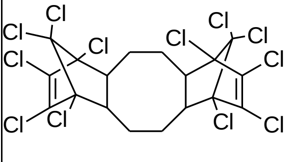
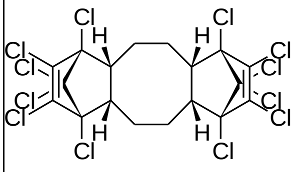
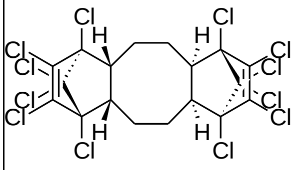
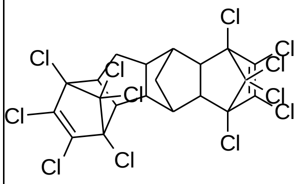
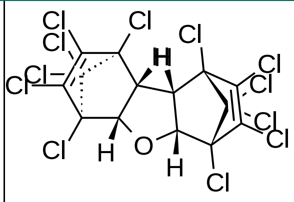
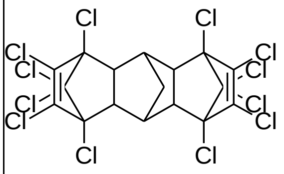
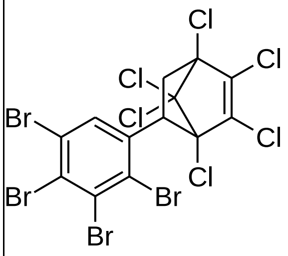
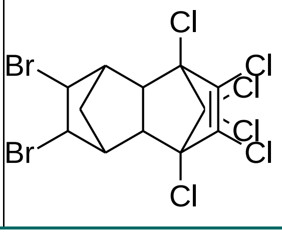
Name	Acronym	Structure	CAS	Function	Log K_{OW}
Dechlorane plus	DP		13560-89-9	Flame retardant	8,85
Dechlorane plus is existing as two different isomers, syn and anti, which are formed in the approximate ratio of 1:3:					

Table 2: Dechloranes

Name, Acronym, CAS, Function, and Log K_{OW}

Name	Acronym	Structure	CAS	Function	Log K_{OW}
Dechlorane plus syn	synDP		135821-03-3	Flame retardant	8,85
Dechlorane plus anti	antiDP		135821-74-8	Flame retardant	8,85
Dechlorane 601	Dec601		13560-90-2	Flame retardant	9,22
Dechlorane 602	Dec602		31107-44-5	Flame retardant	7,37
Dechlorane 603	Dec603		13560-92-4	Flame retardant	8,24
Dechlorane 604	Dec604		34571-16-9	Flame retardant	8,84
Dibromoaldrin	DBALD		20389-65-5	Flame retardant	5,77

Under the heading dechlorane we find different dechloranes and the closely related dibromoaldrin. All of them are used as flame retardants or are impurities or metabolites of DP and are polycyclic and highly chlorinated (or partly brominated) compounds. As the production of these compounds start with hexachlorocyclopentadiene (HCCP) they are chemically closely related to Mirex and a lot of other pesticides.

There is a growing international interest in dechlorane related compounds with an increasing number of scientific papers and reports on this compound group. A review study in 2011 on Dechlorane Plus (DP) summarized the available information as following: Dechlorane Plus (DP) is a high production volume and very persistent compound. DP is a global contaminant and has recently been detected along a pole-to-pole transect of the Atlantic Ocean. There seems to be one production site in North America and at least one in China. Beside DP there are other closely related compounds in the environment. These DP analogs have also been detected globally. Modeling data are in agreement with available environmental data, proposing DP and analogs to be persistent, bioaccumulative, and long-range transported (Sverko et al., 2011).

Table 3: Phenoles, bisphenoles and phenolic antioxidants

Name, Acronym, CAS, Function, and Log K_{OW}

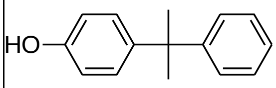
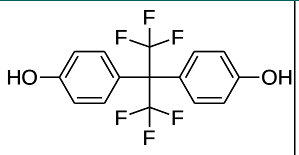
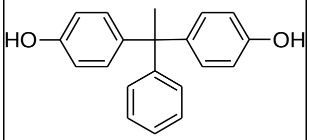
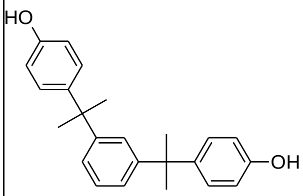
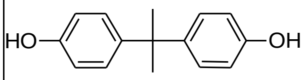
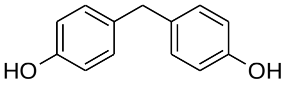
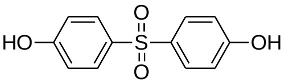
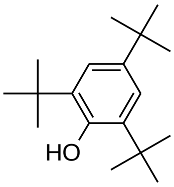
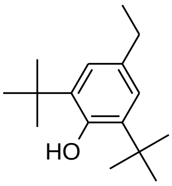
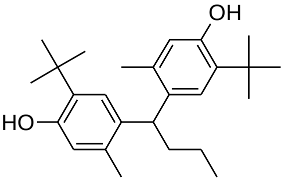
Name	Acronym	Structure	CAS	Function	Log K_{OW}
4-Cumylphenol or Hydroxydiphenyl-propane	HPP		599-64-4	Metabolite of detergents	3,88
Bisphenol AF	BPAF		1478-61-1	Monomer	4,52
Bisphenol AP	BPAP		1571-75-1	Monomer	3,99
Bisphenol M	BPM		13595-25-0	Monomer	5,49
Bisphenol A	BPA		80-05-7	Monomer	3,24
Bisphenol F	BPF		620-92-8	Monomer	2,57
Bisphenol S	BPS		80-09-1	Monomer	8,93

Table 3: Phenoles, bisphenoles and phenolic antioxidants

Name, Acronym, CAS, Function, and Log K_{OW}

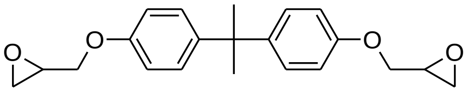
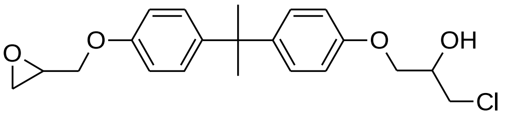
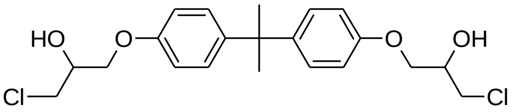
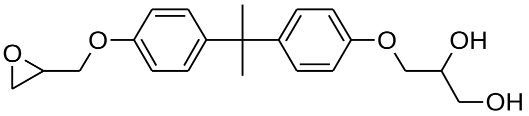
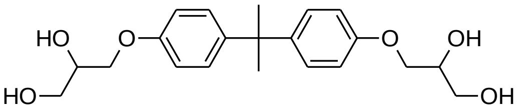
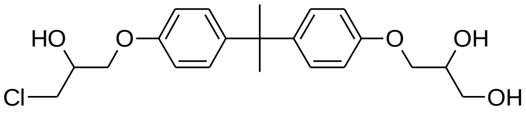
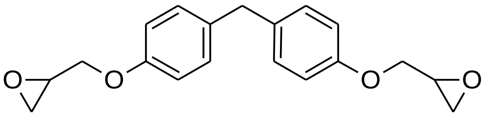
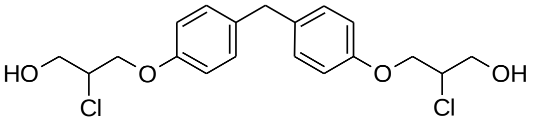
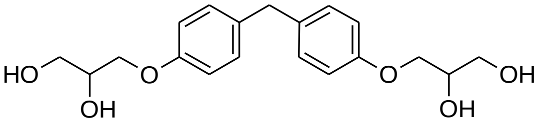
Name	Acronym	Structure	CAS	Function	Log K_{OW}
2,4,6-Tris(tert-butyl)phenol	TTBP or AO246		732-26-3	Antioxidant	5,93
2,6-Di-tert-butyl-4-ethylphenol	DBEP or AO		4130-42-1	Antioxidant	5,24
4,4'-Butane-1,1-diylbis(2-tert-butyl-5-methylphenol	BBM or AO44B25		85-60-9	Antioxidant	7,43

Bisphenol A (BPA) has received a lot of attention through the last decade and the available information has been summarized in several reviews (Chen et al., 2016). BPA is one of the chemicals with highest production worldwide. It is used in the production of polycarbonate and epoxy resins, in many consumer products as food containers, paper products (e.g., thermal receipts), water pipes, toys, medical equipment, and electronics. BPA is ubiquitous in the environment and humans. A large number of studies have documented negative health effects of BPA. The widespread human exposure and associated health effects has led to regulations on the production and usage of BPA in North America and the European Union. Public concern and regulations on BPA have stimulated the development of replacements for BPA. Some substances, structurally similar to BPA, have already been used in the production of polycarbonate and epoxy resins and are commonly denoted as bisphenols. More than 15 bisphenols are known to be used for industrial applications. BPF, BPS, and BPAF are among the main substitutes of BPA in the manufacturing of polycarbonate plastics and epoxy resins. In addition, BPF has a broad range of applications such as lacquers, varnishes, liners, adhesives plastics, and water pipes, as well as in dental sealants, oral prosthetic devices, tissue substitutes and coatings for food packaging. BPS is commonly used in epoxy glues, can coatings and thermal receipt papers, as well as in sulfonated poly(ether ketone ether sulfone) (S-PEKES) and as an additive in dyes and tanning agents. BPAF is a cross-linker in fluoroelastomers, electronics and optical fibers, and is used as monomer for polyimides, polyamides, polyesters, polycarbonate copolymers and other specialty polymers (Honeywell, 2017). The production of BPAF in the US was reported to range from 5 to 250 t/a between 1986 and 2002. There is general little information on total dissemination tonnage of other bisphenol analogues. Recent studies, however, suggest that the production and application of some bisphenol analogues are on the rise globally (Chen et al., 2016). Bisphenol AP is used as raw material for polycarbonate, polyester, and epoxy resins (HonshuChemical, 2017). Bisphenol M is used raw material for cyanate esters (Kandelbauer, 2014).

Hindered phenols are popular antioxidants as they are scavenging peroxy radicals and thereby terminating radical chain reactions. These chemicals are used in plastic, rubber, and other elastomers, cosmetics, pharmaceuticals, and food to slow down the oxidation process. Different hindered phenolic antioxidants have recently be detected in sewage water, sludge and house dust samples (Liu, Lin, Ruan, & Jiang, 2017; Liu, Ruan, Song, Lin, & Jiang, 2015; Liu, Song, Lin, Ruan, & Jiang, 2015).

Table 4: Phenoles, bisphenoles and phenolic antioxidants

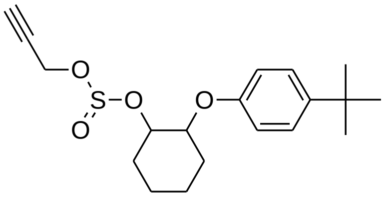
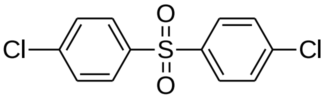
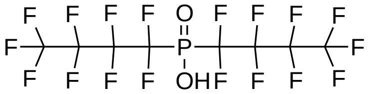
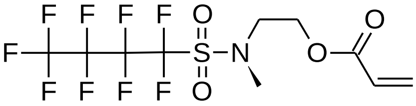
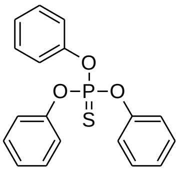
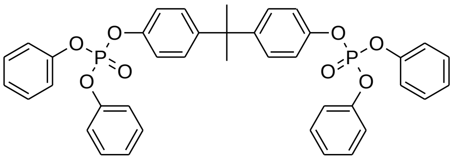
Name, Acronym, CAS, Function, and Log K_{OW}

Name	Structure	CAS	Log K_{OW}
BADGE		1675-54-3	3,43
BADGE-HCl		13836-48-1	3,66
BADGE-2HCl		4809-35-2	4,01
BADGE-H_2O		76002-91-0	2,96
BADGE-$2H_2O$		5581-32-8	1,86
BADGE-HCl-H_2O		227947-06-0	2,24
BFDGE		2095-03-6	2,49
BFDGE-2HCl		374772-79-9	2,97
BFDGE-$2H_2O$		72406-26-9	1,47

Reaction of BPA with epichlorhydrin results in Bisphenol A diglycidyl ether (BADGE). A similar reaction with BPF results in Bisphenol F diglycidyl ether (BFDGE). Both are one of the main compounds used for production of epoxy resins. Like their parent compounds BPA, BPF BADGE and BFDGE are HPV chemicals used in different applications. BADGE containing resins are one of the most used polymers used as coating in food and beverage cans (Berger & Oehme, 2000).

Table 5: Pesticides, POPs, PFAS, phosphor based antioxidants and phosphor flame-retardants

Name, CAS, Function, and Log K_{OW}

Name	Structure	CAS	Function	Log K_{OW}
Propargite		2312-35-8	Pesticide	5,0
Bis(4-chlorophenyl) sulfone (BCPS)		80-07-9	Monomer	3,9
Phosphinic acid, bis(nonafluorobutyl) (PFPiA)		52299-25-9	Intermediate Short chain PFAS	5,3
2-[methyl(1,1,2,2,3,3,4,4,4-nonafluorobutylsulfonyl)amino]ethyl prop-2-enoate (NFacrylat)		67584-55-8	Coating, repellent, dye, monomer	3,2
O,O,O-Triphenyl phosphorothioate (TPPT)		597-82-0	Lubricant, corrosion inhibitor, antioxidant	6,3
Bisphenol A bis(bisphenyl-phosphate) (BPA-BDPP)		5945-33-5	Flame retardant	10,8

Propogite has been used as a pesticide (acaricide) since the 1970s and has been found in residue of several food products.

Bis(4-chlorophenyl) sulfone (BCPS), is a starting material for the production of thermostable polymers, including polysulfones and polyether sulfones (Kwiatkowski, Brode, Kawakami, & Bedwin, 1974). BCPS is also used as dental plastics (Shintani, 1995) and can be present in commercial DDT formulations. BCPS have been reported in perch from Latvian (Olsson & Bergman, 1995), and in several marine biological samples from Sweden and guillemot eggs Nordström (Norstrom, Olsson, Olsson, & Bergman, 2004). With a K_{ow} around 4 BCPS is thought to bio accumulate.

Nonafluorobutyl phosphinic acid (PFPiA) might be used as a replacement for several long chain PFCAs together with their C6/C6 chain equivalents as emulsifier in different industrial processes including the production of PTFE and PVDF polymers. No environmental levels of C4/C4 PFPiA have been reported. The C6/C6 PFPiA equivalent has been found in sewage sludge (2.6 ng/g), indoor dust (nd-525 ng/g) and Trout from the Great Lakes (1.6-8.8 ng/g) Wang (Z. Y. Wang, Cousins, Berger, Hungerbuhler, & Scheringer, 2016).

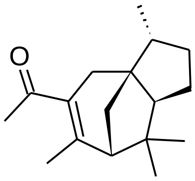
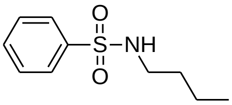
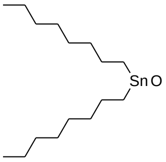
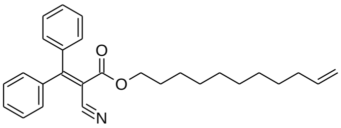
Methyl nonafluorobutylsulfonyl ethyl propenoate is listed as an aqueous fluororchemical used as an abrasion resistant coating. Other application include monomer for acrylate based polymers, and as a dispersible fluorochemical both water and oil repellent.

Bisphenol A bis(bisphenyl phosphate) (BPA-BDPP) is used as flame retardant in resins.

Triphenyl phosphorothioate (Irgalube TPPT) is an additive for lubricants, grease and hydraulic fluids. It is wear and pressure resistance with high thermal stability. No environmental levels of this triphenyl phosphorothionate are reported.

Table 6: Synthetic musk, plasticizers, organo metals and UV compounds

Name, CAS, Function, and Log K_{OW}

Name	Structure	CAS	Function	Log K_{OW}
[3R-(3α,3aβ,7β,8aα)]-1-(2,3,4,7,8,8a-hexahydro-3,6,8,8-tetramethyl-1H-3a,7-methanoazulen-5-yl)ethan-1-one (Methyl Cedryl ketone)		32388-55-9	Musk	5,02
n-Butylbenzene sulphonamide (NBBSulfone)		3622-84-2	Plasticiser	2,1
Di-n-octyltin oxide		870-08-6	Stabilizer	-
10-undecenyl 2-cyano-3,3-diphenylpropenoate		947701-81-6	UV-filter	4,0

2. Materials and Methods

2.1 Sampling stations and sample collection

2.1.1 House dust and indoor air

Sampling strategy
Screening of indoor residential environments was performed by collecting dust samples and passive air samples from ten private houses in the Oslo area. The houses were selected to cover different levels of population density, from the urban centre of Oslo to the semi-rural areas around Oslo. The selected houses included houses sampled in a previous study on PFAS in house dust as well as newly selected houses. Passive air samples were collected using two types of samplers: i) polyurethane foam passive air samplers (PUF-PAS), and ii) XAD resin PAS (XAD-PAS). The two sampler types were deployed concurrently inside the selected houses, in the main living area of the house at ~2.5 m height, for 12 weeks from the end of June to middle of September 2016. Floor dust samples were collected in each house at the retrieval of the PUF-PAS.

A questionnaire was completed by the inhabitants at the end of the sampling to provide information on the houses and their inhabitants (Table 7).

Table 7: Characterization of the sampled houses

	Building characterization					**Inhabitants (n=)**		Last painted
ID	Typol. classification*		Const. year	Size	Building material	Total	Children	
1	SFH		1997	120	Wood	3	1	**<1 year**
2	SFH	Vertically split	1998	125	Wood	4	2	>1 year
3	SFH		1986	140	Wood	4	2	**<1 year**
4	SFH	Horizontally split	1965	115	Wood	3	1	>1 year
5	SFH	Vertically split	1956	130	Bricks	4	2	**<1 year**
6	SFH		1999	200	Wood	2	0	**<1 year**
7	SFH				Wood	3	1	
8	AB		1890	55	Bricks	2	0	>1 year
9	AB		1928	104	Bricks	2	0	>1 year
10	SFH		1986	160	Wood	4	2	>1 year

*) Typology classification according to the TABULA building typology, developed by the EPISCOPE project (http://episcope.eu/welcome/). AB is apartment block and SFH is single family house as defined for Norway (http://webtool.building-typology.eu).

Passive air sampling

The PUF-PAS consisted of PUF disks with 15 cm diameter, 1.5 cm thickness, 424 cm2 total surface area, 0.030 g/cm3 density (Sunde Skumplast, Norway). The PUF disks were deployed in protective chambers consisting of one stainless steel bowl (30 cm diameter) above the disk to protect from gravitational deposition of large particles. The PUF disks were pre-cleaned by soxhlet extraction in acetone for 8 h and hexane for 8 h, dried under vacuum and then wrapped in double layers of aluminium foil and zip-lock bags.

XAD-PAS consisted of an XAD-2 adsorbent placed inside a metal mesh cylinder (10 cm long, 2 cm diameter, 63 cm2 total surface area). The mesh cylinders were pre-cleaned in soap and solvent and further baked in 450 °C. The XAD-2 was dried over night at 105 °C, pre-cleaned by soxhlet extraction in acetone for 8 h and dichloromethane for 8 h, and dried in room temperature. The mesh cylinders were filled with approximately 10 g of XAD-2, capped at both ends and wrapped in double layers of aluminium foil and zip lock bags.

At site, the PUF disks and XAD filled mesh cylinders were taken out from the ziplock bags and aluminium foil and deployed according to Figure 1.

Figure 1: Air sampling equipment: PUF-PAS (top) and XAD-PAS (bottom), used to perform screening in indoor residential environments.

Floor dust sampling

The participants were asked to clean normally until one week before sampling and then not to vacuum clean or wet clean the floors in the rooms during the last week before sampling so that all samples would reflect an accumulation time of about one week.

Floor dust samples were collected on a cellulose filter using an industrial vacuum cleaner (Nilfisk GM 80P) equipped with a special forensic nozzle with a one-way filter housing (KTM

AB, Bålsta, Sweden) placed in the front of the vacuum cleaner tube (Bornehag et al., 2004; Huber, Haug, & Schlabach, 2011) (Figure 2). After sampling a lid was put on the filter housing, and the whole sampling compartment was wrapped in double layers of alumina foil, placed in two sealed plastic bags and stored at -20˚C until sample preparation.

Figure 2: Sampling equipment for sampling of floor dust in indoor residential environments.

The filter housings were weighed before and after sampling in order to measure the total amount of collected dust. Before the second weighing, larger pieces in the dust (such as hairs, food pieces, stones etc) were discarded leaving a defined dust sample. The amount of dust was used to obtain levels in ng per g of dust as well as to estimate the dust loading in each room.

Each dust sample (including the cellulose filter) was then split in six parts based on the total amount of dust in the sample. The amount in each fraction ranged from 100-200 mg of dust.

QA/QC

Field blanks for the three sampling methods were collected and analysed to control for possible contamination during sampling, transport, storage and analysis. The field blanks included one filter for dust sampling, and one PUF disk plus one XAD in mesh cylinder for passive air sampling. These were transported together with the real samples on each sampling day (i.e. one set per day, n=3 in total). Each dust filter was opened and inserted into the nozzle once, then repacked in double layer of alumina foil, two plastic bags and stored in freezer next to exposed samples until sample preparation. The PUF disks and XAD mesh cylinders were opened and kept in the room during deployment of the real samples, then repacked and stored as the dust filters. All field blanks underwent the same analytical procedure as the real samples.

2.1.2 Wastewater treatment plants

All of the wastewater treatment works (WWTW) samples were collected by staff at the respective plants. Five 24-hour, flow proportional composite effluent samples were collected by means of the automatic sampling equipment found at both WWTWs for routine monitoring. The effluent samples were collected in clean glass bottles and shipped to NIVA. Sludge samples were collected using a procedure based on the 'Mattilsynet' guideline for the sampling of sludge, compost and other waste-based fertilizer products (Bøen and Paulsrud 2013) and the established procedure for collecting sludge samples to Miljøprøvebanken (Vogelsang 2016). Five core samples of mixed sludge were collected from each facility. Each mixed sample was transferred to 4 glass sample jars using pre-washed stainless steel equipment provided by NIVA.

HIAS receives wastewater from approximately 52,000 people from the municipalities of Hamar, Løten, Ringsaker, and Stange. The plant is located at Ottestad on Lake Mjøsa with the discharge point at a depth of 15 m around 250 m from the shore. Approximately 6.8 million m^3 wastewater is treated mechanically, biologically (not N removal) and chemically each year (250 litres per second). The sludge is treated by thermal hydrolysis (the Cambi process at 160°C) prior to anaerobic digestion at 38°C.

Vestfjorden avløpsselskap (VEAS) at Slemmestad is Norway´s largest WWTW receiving municipal wastewater from a population of around 615,000 in Oslo, Bærum, Asker, Røyken and Nesodden. The plant annually receives between 100-110 million m^3 of wastewater that is treated mechanically, chemically and biologically (post-denitrification). On average on a dry day VEAS treats 2300-3000 litres per second. Annually VEAS treats 100-110 mill m^3 wastewater. The sludge is treated by anaerobic digestion, dewatered and dried in a thermal vacuum drier. The treated effluent is discharged at a depth of approx. 45 m depth in the Oslofjord (entrapment depth of ca. 20 m).

2.1.3 Landfill Leachate

Leachate sampling was performed using an ISCO 6712 automatic sampler for collecting a 24 hr composite sample from Lindum Resource and Recycling AS. Flow data were obtained from the plants' own water flow measurements.

Lindum Resource and Recycling is located in Drammen and receives solid waste from the Drammen Region. Leachate from the landfill is heavily influenced by incoming groundwater, especially in the wake of heavy rainfall events. The total annual leachate volume in the period 2000-2006 was at 366,000 to 910,000 m^3. All the leachate goes through an aerated lagoon with subsequent sedimentation before it is pumped to Solumstranda WWTW.

2.1.4 Surface water and sediment (Lake Mjøsa)

Surface water

Water samples were collected at five stations with a Ruttner water sampler, at 15 meters depth (26th May 2015). The water samples were taken at the corresponding sediment sample stations. Each water sample was transferred to two l litre PE bottles and stored cold until analysis.

Sediment

Five pooled samples of sediment were taken along a gradient from the discharge point to HIAS and south. Each pooled sample consisted of three individual subsamples taken from the upper

0-2 cm sediment layer at a water depth of 25–35 m. We used a gravity corer with a core tube and a retractable sediment stopper in stainless steel. The samples were transferred to heat-treated (500°C) glass containers sealed with heat-treated aluminium foil underneath the lids. The core tube and other sectioning equipment used were thoroughly cleaned with acetone and cyclohexane (HPLC grade) before use, and direct hand contact with the sampling matrix was avoided. They samples were stored frozen (20°C) until analysis.

2.1.5 Fish samples (Lake Mjøsa)

From Lake Mjøsa, during August 2016, brown trout (*Salmo trutta*), was caught north of the town of Gjøvik at a depth of 5 –20 m. The caught trout were transported alive in a water filled container to the shore for biological sampling similar to the sampling procedure for the screening project in 2015. Subsequently the fish were wrapped in aluminium foil and frozen for later dissection of muscle samples for chemical analysis. At no time were the fish allowed to be in contact with plastics or other potentially contaminated surfaces. The time between catch and transfer to the freezer took no longer than 4 hours.

Before preparing muscle samples of the trout, the individual samples were thawed and total length and weight were registered. They were then scraped clean of mucus with a solvent washed knife and placed on a cutting board covered with solvent rinsed aluminium foil. For each fish a solvent cleaned set of stainless steel dissection tools was used. We dissected the sagittal otoliths, and determined sex and maturity after opening of the abdomen. We dissected out samples of lateral skeleton muscles and transferred them to heat treated (500°C) glass containers sealed with heat treated aluminium foil underneath the lids. The samples were then frozen (-20°C). This way 10 individual liver and fillet samples were prepared.

To reduce the risk of contamination during catch and sample preparation, all personnel involved avoided use of personal care products at least 24 hours in advance. Also, dissection and preparing of samples took place outside in a non-urban area. Dissection equipment and aluminium foil that could be in direct contact with the samples were cleaned with acetone and cyclohexane (HPLC grade) before use, and direct hand contact with the sampling matrix was avoided.

Table 8. Coordinates for the Lake Mjøsa water, sediment and biota sampling stations

Station	Date	Depth (m)	UTM 33E	UTM 33 N	°E	°N
Sediments/water						
St-1	August 2016	sed.: 35, water: 15	285400	6743100	11.059	60.766
St-2	August 2016	sed.: 25, water: 15	285941	6742150	11.075	60.759
St-3	August 2016	sed.: 25, water: 15	285932	6740684	11.072	60.744
St-4	August 2016	sed.: 25, water: 15	286479	6739302	11.084	60.732
St-5	August 2016	sed.: 25, water: 15	287021	6737370	11.096	60.715

Fish						
St-1	August 2016	20-35	286400	6743600	11.059	60.766

2.1.6 Rat samples (Oslo /Akershus)

Rat samples from the Oslo area were acquired from Anticimex and send frozen to NIVAs laboratory facilities. Before analysis the rat samples were thawed and the liver removed from the carcass for analysis.

2.2 Chemical analysis

2.2.1 Volatile compounds

The methods were based on previously developed methods for cyclic dimethylsiloxanes (D4 – D6). Prior to work-up all samples were spiked with isotope-labeled internal standard D18-Diisopropylbenzene ($C_{12}D_{18}$). It was not possible to purchase 1,2-diisopropylbenzene as a pure standard. A technical mixture of diisopropylbenzene isomers contained more than 98 % of 1,3- and 1,4-diisopropylbenzene and only traces of the 1,2-isomer and therefore it was not possible to analyse 1,2- diisopropylbenzene with sufficient confidence and it was necessary to remove it from the list of target compounds.

Aqueous samples

Aqueous samples were analyzed directly by static headspace method, 15 ml aliquot was used.

Air samples

Air samples were collected over a defined period of time on a pre-cleaned XAD-2 sorbent (ca 10 g per sampler). Due to suspected very high levels of siloxanes, an aliquot of the XAD sorbent was taken for analysis (ca 0.5g, ca. 1/20 of the whole) and the aliquot and the bulk were extracted with hexane and analyzed in parallel. The difference between results from an aliquot and from the bulk were typically 10-20%, normally lower for aliquots. The average of the two was reported.

Solid samples

Sediment, sludge and dust samples (ca. 1g) were extracted with 4ml of Acetinitrile-Hexane mixture (1:1). Hexane layer was used for GC-MS analysis.

Biota

Biota samples (0.5 or 1g) were extracted with 4ml of Acetinitrile-Hexane mixture (1:3). Hexane layer was used for GC-MS analysis.

Instrumental analysis
Prior to analysis a recovery standard, tetrakis(trimethylsilyloxy)silane was added to final extracts. Instrumental analysis. Final extracts were analyzed on Agilent 7890A Gas Chromatograph equipped with 30m DB-5 MS column and coupled with 5975C Mass Selective Detector. Injected volumes were 2.5ml of gas phase in case of headspace analysis of aqueous samples and 10ul of liquid extract for all other samples.

2.2.2 Dechlorane compounds

Sample extraction and clean-up
Prior to extraction, the samples were added a mixture of isotope labelled PCB and dechloranes for quantification purposes. The water-, sediment-and biota-samples were extracted with organic solvents and concentrated under nitrogen flow, followed by a clean-up procedure using concentrated sulphuric acid and a silica column to remove lipids and other interferences prior to analysis.

Analysis
Prior to analysis, all samples were concentrated to ~150 µL sample volume. The extracts were injected into an Agilent 7890N GC system coupled to an Agilent 7200 QToF mass spectrometer operated in electron capture negative ionization mode (GC-ECNI-HRMS) and PCB-153 and the dechlorane compounds were quantified based on the use of internal standards.

2.2.3 Hindered phenolic antioxidant compounds

Extraction
Prior to extraction, the samples were added a mixture of isotope labelled PCBs, PBDEs, HBCCD and DDT standards, for quantification purposes.

Sludge, sediment, and house dust samples
Sludge, sediment, and house dust samples were extracted with accelerated solvent extraction and further cleaned with SPE.

Biological samples
Biological samples were extracted using ultrasonic assisted liquid extraction, cleaned on a Florisil column and with dSPE (C18). Remaining interferences were removed with SPE.

Analysis
With the exception of HBCDD, all compounds were quantified on GC-HRMS (Waters Autospec), while an LC-ToF (Waters Premier) or LC-QToF (Agilent 6530/50) were utilised to quantify HBCDD.
Water samples (150 ml) were spiked with isotopically labelled internal standards and extracted by solid phase extraction. SPE columns were conditioned with ethyl acetate,

acetonitrile and with MilliQ water, the samples were then extracted and analytes eluted with ethyl acetate. Afterwards solvent was exchanged either to toluene or methanol.

Instrumental analysis

The hindered phenolic antioxidants were analysed either with the Agilent 1290 UHPLC coupled to Agilent 6550 HR-QTOF or Waters Acquity UPLC copied to Waters LCT HR-TOF system operated in a negative electrospray ionisation mode. Separation of antioxidants was achieved with the use of Waters HSS T3 column (1.8 µm, 150 x 2.1 mm) with a gradient of water and methanol used as a mobile phase.

2.2.4 Bisphenols

Aqueous samples

Water samples (150 ml) were spiked with isotopically labelled internal standards and extracted by solid phase extraction. SPE columns were conditioned with ethyl acetate, acetonitrile and with MilliQ water, the samples were then extracted and analytes eluted with ethyl acetate. Afterwards solvent was exchanged either to toluene or methanol.

Sludge, sediment, and house dust samples

Sludge, sediment, and house dust samples were extracted with accelerated solvent extraction and further cleaned with SPE.

Biological samples

Biological samples were extracted using ultrasonic assisted liquid extraction, cleaned on a Florisil column and with dSPE (C18). Remaining interferences were removed with SPE.

Instrumental analysis

The bisphenols were analysed either with the Agilent 1290 UHPLC coupled to Agilent 6550 HR-QTOF or Waters Acquity UPLC copied to Waters LCT HR-TOF system operated in a negative electrospray ionisation mode. Separation of bisphenols was achieved with the use of Waters HSS T3 column (1.8 µm, 150 x 2.1 mm) with a gradient of water and methanol used as a mobile phase.

2.2.5 BADGE- and BFDGE-related compounds

Aqueous samples

Water samples (150 ml) were spiked with isotopically labelled internal standards and extracted by solid phase extraction. SPE columns were conditioned with ethyl acetate, acetonitrile and with MilliQ water, the samples were then extracted and analytes eluted with ethyl acetate. Afterwards solvent was exchanged either to toluene or methanol.

Sludge, sediment, and dust samples

Sludge, sediment, and dust samples were extracted with accelerated solvent extraction and further cleaned with SPE.

Biological samples

Biological samples were extracted using ultrasonic assisted liquid extraction, cleaned on a Florisil column and with dSPE (C18). Remaining interferences were removed with SPE.

Instrumental analysis

The BADGE- and BFDGE-related compounds were analysed with Waters Acquity UPLC coupled to Waters LCT HR-TOF system operated in a positive electrospray ionisation mode. Separation of BADGE- and BFDGE-related compounds was achieved with the use of Agilent Zorbax SB-C18 column (1.8 µm, 50 x 2.1 mm) with a gradient of 5mM ammonium acetate in water and 5mM ammonium acetate in methanol used as a mobile phase.

2.2.6 Pesticides, POPs, PFAS, phosphor based antioxidants and phosphor flame-retardants (LC-HRMS)

Extraction

Isotopic labeled internal standards (ILIS) were not commercially available and therefore these compounds were not spiked into the samples. Addition standard curves were analyzed by spiking the target compounds into the samples at 100, 250, 500, 750 and 1000 ng L^{-1}. Three different extraction procedures were followed according to the sample matrix:

Waters samples

Wastewater samples (10% acetonitrile – kill bug) were extracted using the Waters Oasis HLB µElution plates, 30 µm (Milford, MA, USA). Hereafter, 1 ml of sample was centrifuged at 13 min^{-1} for 5 min at 4°C and the supernatant was used for µSPE. The plate was conditioned by washing and rinsing with 1 ml of MeOH and 1 ml of ultrapure water under suction. The wastewater samples were loaded onto the plate under suction and washed with 1 ml of ultrapure water. The plate was vacuum dried for 5 minutes. Analytes were eluted into a 96 well plate using 50 µl of 1% NH4OH in MeOH, 50 µl of 1% FA in MeOH and 100 µl of MeOH. Together with the 30 samples (10 VEAS, 10 HIAS, 5 Lindum [Lindum samples were diluted 1:10 with miliQ water] and 5 Mjøsa), addition standard curves were also analyzed by spiking the target compounds into the samples at 100, 250, 500, 750 and 1000 ng L^{-1}. Lindum samples were diluted 1:10 with miliQ water.

Solid samples (sediments, sludge, and biota)

100 mg of dried sediments and sludge, and 1000 mg of wet fish fillet and rat liver were extracting following this procedure:

1) Adding the following reagent: 2 mL of 0.1M zinc sulfate solution, 7 mL acetonitrile and 2 spatula sodium chloride.
2) Adding internal standard for the GC-compounds ((tripentyl tinchloride, d12-chrysene and ^{13}C18-triphenylphosphate)

3) 0.5 minutes vortex and 30 minutes sonication
4) Centrifuge x 2000 for 5 minutes
5) Acetonitrile (upper layer) was transferred into a glass vial, evaporate with nitrogen from aprox. 3mL to 1 mL, clean-up with PSA and transferred into a LC vials for analysis.
6) In parallel, for GC analysis, 2 mL of HCl were added into the sediment and fish fillet “leftovers” from previous extraction (no sludge) and let it sit for 1 hour.
7) Then, 8 mL of miliQ water, the remaining acetonitrile from LC extraction and 50 mL of DCM were added
8) Vortex and centrifuged x2000 for 5 minutes
9) AKR collect the DCM and perform the rest of the sample prep and analysis

Dust and air (XAD) samples
Liquid-liquid extraction was performed using 3 x 7 mL of DCM sonicating for 20 minutes. The final eluent was centrifuged x 2000 for 5 minutes and transferred into a new vial for evaporation with nitrogen. Extract was evaporated to almost dryness (few hundreds µL) and reconstituted in methanol (this operation was repeated 3 times). Final volume for injection was 1 mL of methanol.

2.2.7 Synthetic musk, plasticizers, organo metals and UV compounds (GC-MS)

Solid samples (sediments, sludge and biota)
The dcm-ekstracts were transferred to 2 ml cyclohexan, and 1ml 0,1M sodium acetat and 1 ml 2% tetraethylborate was added. The samples were vortexed for 1 minute and centrifuged. The cyclohexane extracts were washed with 2 ml 0.1M sulphuric acid. The cyclohexane extracts were cleaned by GPC and PSA.

Dust and air (XAD) samples
The methanol extracts from the dust samples were diluted in 0.1 M sodium acetate, added 2% tetraethylborate and isohexane and then vigorously shaken. The iso-hexane extracts were added PSA as a clean-up prior to the instrumental analysis. The XAD extracts were transferred to cyclohexane and added PSA as a clean-up.

Water
Internal standards (tripentyl tinchloride, d12-chrysene and 13C18-triphenylphosphate) and sodium acetate (0,1M) was added to the water samples (0.9 liter) and the pH was adjusted to pH=4 with acetic acid. The samples were then derivatized with tetraethyl borate and extracted with iso-hexane. The extracts were evaporated to 1ml and cleaned by using GPC and PSA prior to the analysis.

Analysis
The analysis was performed by using a gas chromatograph (Agilent 6990N) coupled to a mass selective detector (Agilent 5730 Network) operated in SIM mode.

The quantification was done by using addition standard curves where the different matrices were spiked with the target compounds at 20-250ng/g (20-250 ng/l).

2.3 Uncertainties

When performing environmental screening studies for contaminants of emerging concern, all steps in the process, starting with study design, selection of the sampling sites, sampling frequency, time of sampling, performing the sampling, the transport and storage of samples, chemical analysis and data treatment, to some extent generate some degree of uncertainty. To estimate quantitatively the contribution of all steps is an extreme difficult task. However, we estimate that the uncertainty for such screening analysis are higher than for routine monitoring of PCBs or other legacy POPs. Whereas we expect a total expanded measurement uncertainty of about 25 to 30 % for PCBs, this value might be as high as 40 to 50 % for new emerging compounds as measured in this report.

3. Results and discussion

A complete data table with all analytical results is attached in the appendix. A summary of the results showing the detection frequency of all studied compounds in all matrices on a scale from 0 to 4 is given in Table 9 with O equivalent to detected in less than 5 % of all samples and 4 equivalent to detected in more than 90 % of all measured samples. A more detailed description and discussion of the details are given in the following chapters.

Table 9: Detection frequency for all studied compounds

Compound	Emission					Recipient			
	WWTP Effluent	Leachate water	Sludge	House dust	Indoor air	Surface watera.	Sediment	Rat	Brown trout
L3	na	na	4	4	4	na	na	0	0
L4	na	4	4	4	4	na	na	0	0
L5	na	4	4	4	4	na	na	0	3
Di-isopropylbenzenes	na	0	3	1	4	0	na	0	1
4-Isopropyl-1,1'-biphenyl	na	0	3	4	0	0	na	0	0
Dibromoaldrin	0	0	0	0	na	na	0	0	0
Dec 601	0	0	0	0	na	na	0	0	0
Dec 602	0	4	0	0	na	na	0	0	4
Dec 603	0	4	0	1	na	na	0	0	0
Dec 604	0	0	3	3	na	na	0	0	0
DP syn	0	4	4	3	na	na	0	4	0
DP anti	1	4	4	2	na	na	0	3	0
PCB-153	0	4	4	4	na	na	3	4	4
HPP	0	0	3	0	0	0	0	0	0
TTBP	1	0	0	0	0	0	0	0	0
BBM	1	0	2	0	0	0	0	0	0
DTEB	0	0	0	0	0	0	0	0	0
BPS	4	4	3	4	na	0	0	0	0
BPF	1	3	3	4	na	0	0	0	0
BPA	2	4	4	4	na	3	0	0	0
BPAF	0	0	0	1	na	0	0	0	0
BPAP	0	0	0	0	na	0	0	0	0
BPM	0	0	2	0	na	0	0	0	0
BADGE	na	na	na	na	na	na	na	na	na
BADGE-HCL	0	0	1	3	na	0	1	0	0

Table 9: Detection frequency for all studied compounds

Compound	Emission					Recipient			
	WWTP Effluent	Leachate water	Sludge	House dust	Indoor air	Surface watera.	Sediment	Rat	Brown trout
BADGE-2HCL	0	0	0	3	na	0	0	0	0
BADGE-H20	0	0	1	2	na	0	0	0	0
BADGE-2H20	0	1	0	3	na	0	1	0	0
BADGE-HCL-H2O	0	0	0	4	na	0	3	0	0
BFDGE	0	0	0	1	na	0	0	0	0
BFDGE-2HCL	0	0	0	1	na	0	0	0	0
BFDGE-2H20	0	0	0	0	na	0	0	0	0
Propargite	0	0	0	0	0	0	0	0	1
NBBSulfone	0	4	0	0	0	0	0	0	0
OTP	0	0	3	0	0	0	0	0	0
BPA-BDPP	0	0	0	2	0	0	0	0	0
TPPT	0	0	0	0	na	0	0	0	na
NFacrylat	0	0	0	0	na	0	0	0	na
Di-n-octyltin	0	0	0	4	na	0	0	0	0
BCPS	0	0	0	0	0	0	0	0	0
Methyl-cedryl-ketone	4	0	4	3	3	0	2	0	0
Undecenyl crylene	0	0	0	1	na	0	0	0	0
Octocrylene	4	4	4	4	na	4	4	na	0

na): not analysed or not possible to analyse

0): not detected (0 %)

1): rarely detected (< 10 %)

2): detected from time to time (10 – 49 %)

3): detected frequently (50 – 89 %)

4): detected in all samples (> 90%)

3.1 Different volatile compounds

Seven different volatile organic compounds were on the list of interesting compounds: four substituted aromatic compounds: 1,2-Diisopropylbenzene, 1,3-Diisopropylbenzene, 1,4-Diisopropylbenzene, and 4-Isopropyl-1,1'-biphenyl; and three linear methylsiloxanes: octamethyltrisiloxane (L3), decamethyltetrasiloxane (L4), and dodecamethylpentasiloxane

(L5). As mentioned above it was not possible to purchase 1,2-diisopropylbenzene as a pure standard and it was necessary to remove this compound from the list of target compounds.

3.1.1 Sewage and landfill samples

None of the volatile target compounds were detected in influent samples of the VEAS WWTP. By accident, the extracts of the HIAS influent samples were lost during instrumental analysis and it was not possible to repeat analysis. In the landfill leachate from Lindum L4 and L5 were detected with a concentration of 2,4 to 3,1 ng/L for L4 and 3,7 to 4,4 ng/l for L5. Due to its very low boiling point, it was not possible to identify and quantify L3 in aqueous samples. None of the volatile aromatics was detected above LoD (~3 to 10 ng/L) in the studied waste water samples.

Table 10: Volatile concentrations in sludge samples from VEAS and HIAS WWTP

	L3	L4	L5	1,3-diisopropylbenzene	1,4-diisopropylbenzene	4-Isopropyl-1,1'-biphenyl
Sample type	(Min - max) **Average*** Detection frequency			**ng/g d.w.**		
VEAS Sludge	(2,2 - 3,1) **2,5** 100 %	(16 - 18) **15** 100 %	(366 - 405) **377** 100 %	(1,7 - 2,0) **1,8** 100 %	(<0,2 - 2,5) **1,2** 60 %	(1,6 - 2,2) **1,9** 100 %
HIAS Sludge	(5,8 - 7,3) **6,5** 100 %	(30 - 33) **32** 100 %	(350 - 402) **383** 100 %	(<2,0 - 2,1) **1,7** 60 %	(1,1 - 2,3) **1,7** 80 %	(<0,13 - 0,39) **0,25** 60 %

*): For the non-detects LoD/2 was used, when calculating the average.

In all sludge samples both from the VEAS and HIAS WWTP the siloxanes L3, L4, and L5 were detected. The average concentration for VEAS WWTP was 2,5, 17, and 380 ng/g d.w. for L3, L4 and L5 respectively. The average concentration for HIAS WWTP was 6.5, 32, and 380 ng/g d.w. for L3, L4 and L5 respectively. Also, the volatile aromatics were found in sludge samples quite frequently. Both 1,3-diisopropylbenzene and 1,4-diisopropylbenzene were found with a concentration of about 2 ng/g d.w. in nearly all samples from VEAS and HIAS. 4-Isopropyl-1,1'-biphenyl was found with about 2 ng/g d.w. in the VEAS samples, however, with around 0,4 ng/g d.w. in the HIAS sludge.

The fact that both the linear siloxanes and the diisopropylbenzenes were found in similar concentrations in VEAS and HIAS sludge can be an indication for a very widespread and homogenous distribution and use of these chemicals. 4-Isopropyl-1,1'-biphenyl, on the other hand, shows a tenfold higher concentration in VEAS sludge compared to sludge from HIAS WWTP. As VEAS has a much bigger catchment area than HIAS and receives also waste water from numerous small and medium industrial enterprises, this might indicate that 4-Isopropyl-1,1'-biphenyl has lesser application areas than the linear siloxanes and diisopropylbenzenes independent of the absolute consumption/emission of these compounds.

3.1.2 Surface water samples

In the surface water samples from Mjøsa L4 and L5 were detected with a concentration of between 3,7 and 24,4 ng/L (avg: 8,8 ng/L) and 5 and 9,5 ng/L (avg: 7,5 ng/L). In two water samples 1,3-Diisopropylbenzene was found with a concentration of 3,4 and 4,0 ng/L very close to the LoD.

3.1.3 Biota samples

In trout samples from Mjøsa only L5 were frequently detected, however, the measured concentrations are within < 0,03 to 0,11 ng/g f.w. close to or below LoD. L4 was not detected at all and L3 only in one sample with 0.05 ng/g f.w. just above LoD. 1,4-Diisopropylbenzene was found in one sample of brown trout with a concentration of about 0,19 ng/g f.w. None of the other volatile aromatics were found in trout samples.

3.1.4 House dust and indoor air

Taking into account the small available sample size and the volatility of the target compounds, it is surprising that it was possible to detect the linear siloxanes in house dust samples. L3 was detected in all dust samples with a quite uniform concentration ranging from 0,23 to 1,25 ng/g (avg: 0,46 ng/g). L4 was found from < 0,2 to 1,6 ng/g (avg: 0,71 ng/g). Whereas L5 shows a higher variability ranging from < 10 to 464 ng/g (avg: 173 ng/g). 4-Isopropyl-1,1'-biphenyl was detected in all dust samples ranging from 0,25 to 15,2 ng/g (avg: 2,27 ng/g. The di-isopropylbenzenes were only detected in one dust sample with a concentration of 9,17 and 7,96 ng/g of the 1,3- and 1,4-isomer.

Both the linear siloxanes and the di-isopropylbenzenes were found in all indoor air samples. L3 was detected with a concentration ranging from 1,64 to 743 ng/m^3 (avg: 88 ng/m^3). L4 was detected with a concentration ranging from 1,64 to 36,6 ng/m^3 (avg: 14 ng/m^3). L5 was detected with a concentration ranging from 5,57 to 1460 ng/m^3 (avg: 200 ng/m^3). 1,3-di-isopropylbenzene was detected with a concentration ranging from 0,45 to 4,72 ng/m^3 (avg: 2,14 ng/m^3). 1,4-di-isopropylbenzene was detected with a concentration ranging from 0,51 to 3,61 ng/m^3 (avg: 1,8 ng/m^3). 4-Isopropyl-1,1'-biphenyl was not detected in indoor air samples.

Table 11: Volatile concentrations in dust and indoor air samples from the Oslo area

	L3	L4	L5	1,3-di-isopropyl-benzene	1,4-di-isopropyl-benzene	4-Isopropyl-1,1'-biphenyl
Sample type	(Min - max) **Average*** Detection frequency			**ng/g and ng/m^3**		
House dust	(0,23 - 1,3) **0,46** 100 %	(<0,2 - 1,6) **0,64** 89 %	(<10 - 464) **98** 55 %	(<0,5 - 9,2) **1,3** 22 %	(<0,6 - 8,0) **1,3** 11 %	(0,25 - 15) **2,3** 100 %
Indoor air	(1,6 - 743) **88** 100 %	(1,1 - 37) **14** 100 %	(5,6 - 1460) **195** 100 %	(0,45 - 4,7) **2,1** 100 %	(0,51 - 3,6) **1,8** 100 %	(<0,2 - <1,1) **0,22** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

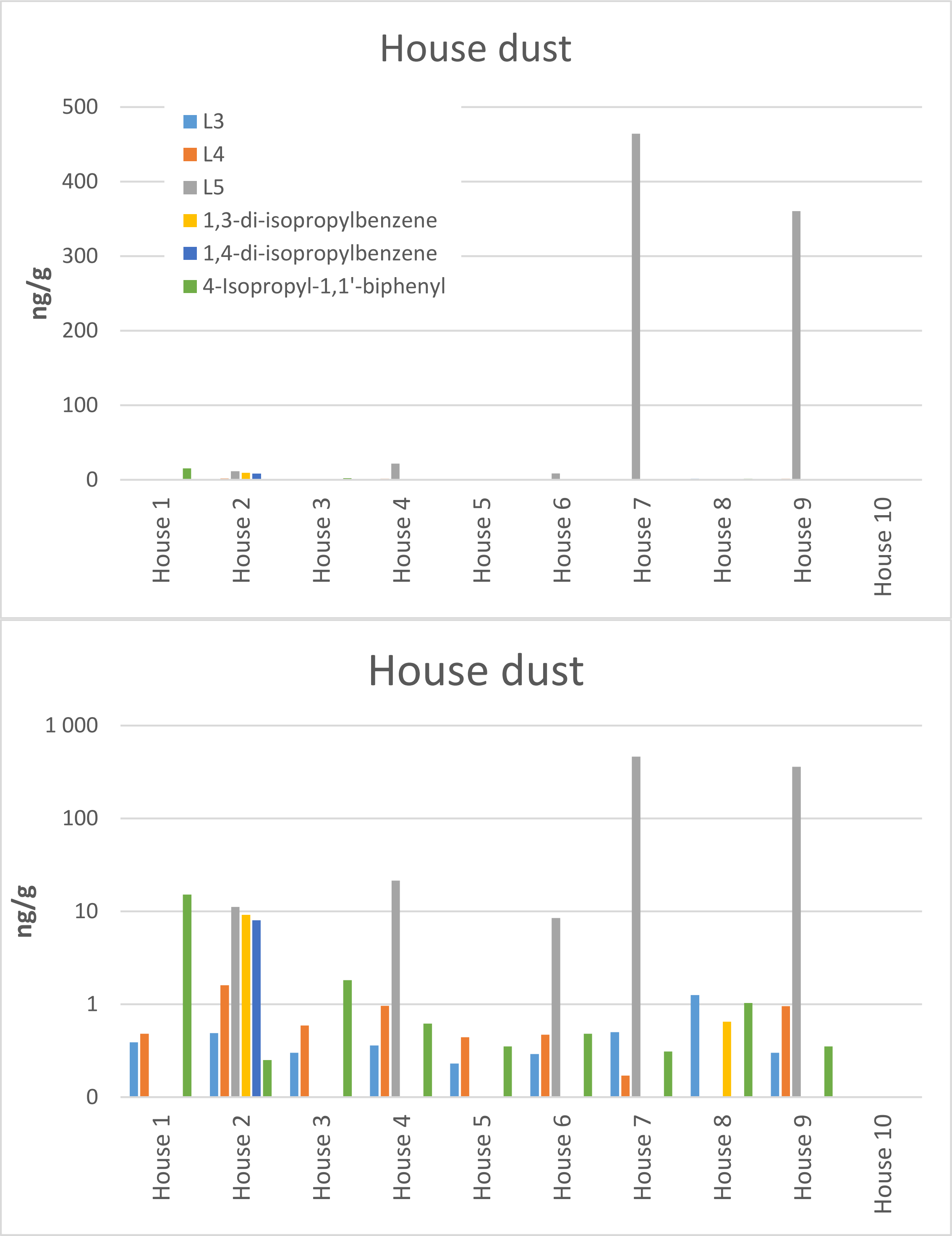


Figure 3: House dust concentration of linear siloxanes and some volatile aromatics. Concentration given in ng/g, linear scale top figure, logarithmic scale bottom figure.

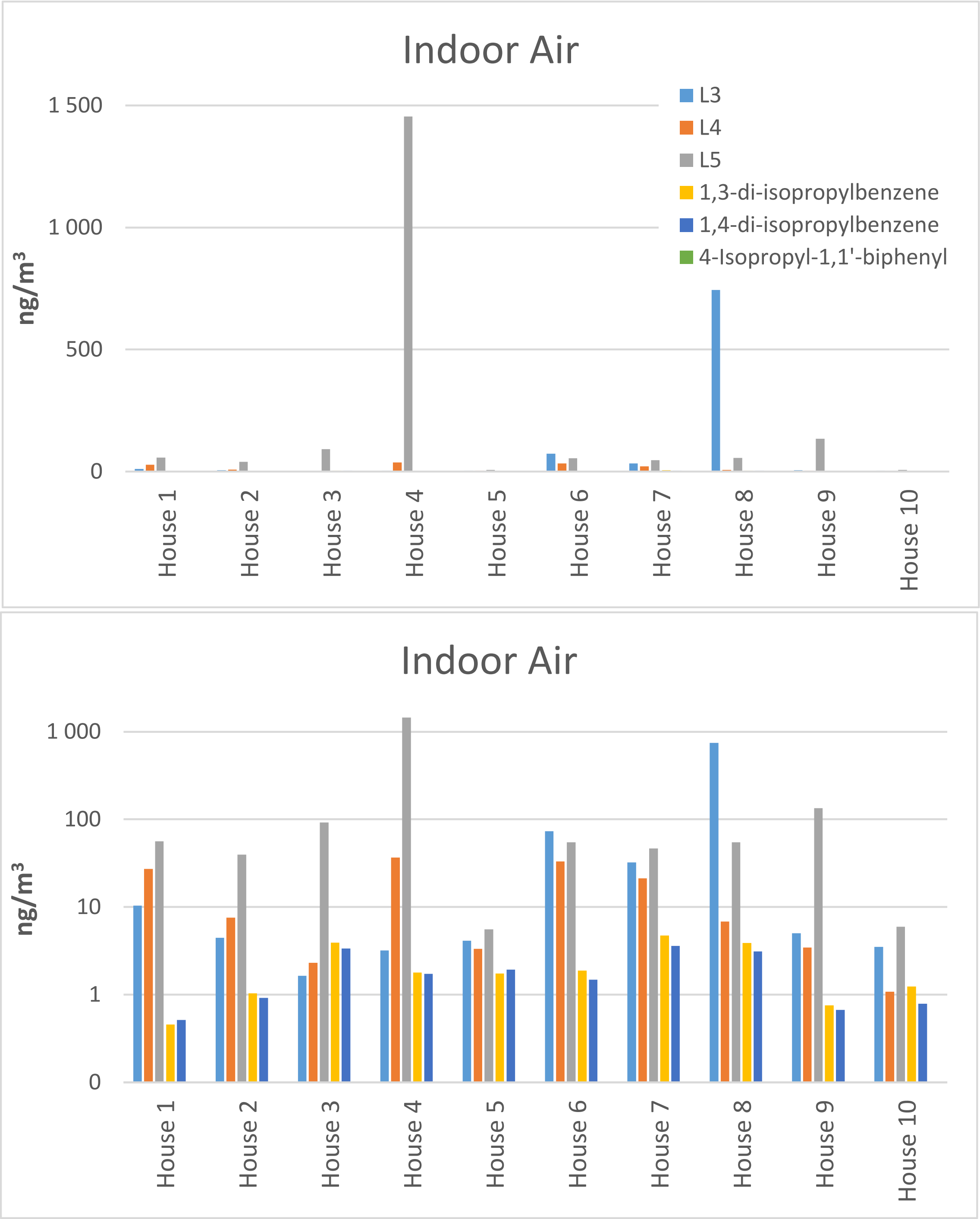


Figure 4: Indoor air concentration of linear siloxanes and some volatile aromatics. Concentration given in ng/m^3*, linear scale top figure, logarithmic scale bottom figure.*

ECHA estimated the same dissemination tonnage for both L3 and L4 and a lower tonnage for L5 (see Chapter 1.2). As in all studied matrices L5 showed the highest concentration, this study do not support these estimations, either L3 and L4 are overestimated or more likely there are additional unidentified sources for L5.

In a recent American study based on 60 houses (mixture of homes, schools, laboratories and other work places) and looking for five cyclic and nine linear siloxanes, similar air concentrations for linear siloxanes in homes were found (Tran & Kannan, 2015). This group estimated also a mean daily exposure to total siloxanes measured for all locations of the study of around 19,1 µg/day. However, the daily exposure rate from personal care products via inhalation, ingestion, and dermal absorption are probably much higher and was estimated to 307 mg/day for the US women (Horii & Kannan, 2008).

3.2 Dechloranes

PCB-153 and seven dechlorane related compounds were targeted: Dechlorane 601 (Dec601), Dechlorane 602 (Dec602), Dechlorane 603 (Dec60), Dechlorane 604 (Dec604), Dechlorane plus syn (DPsyn), Dechlorane plus anti (DPanti), and Dibromoaldrin.

3.2.1 Sewage and leachate samples

The two Dechlorane plus isomers DPsyn and DPanti were detected in most sewage and leachate samples including influent samples, a few effluent samples and all sludge samples from VEAS and HIAS as well as all leachate water samples from Lindum, see Table 12 and Appendix. The obtained concentrations of the two DPs were 100-1000 times higher in leachate water samples from Lindum than those in WWTP samples.
Dec604 was detected only in sludge samples from both VEAS and HIAS, while Dec602 and 603 only were detected in leachate water from Lindum. The detected levels of Dec602 and 603 were 100-10000 times lower than those of DPsyn and DPanti.

PCB-153 was not detected in any of the effluent samples but was detected in some influent samples and in all sludge and leachate samples. The highest concentrations for PCB-153 were found in the leachate samples, 100-1000 times higher than in influent and sludge samples from both VEAS and HIAS. The levels of PCB-153 were similar, slightly lower or slightly higher than those of DPsyn and DPanti, depending on the matrix.

The levels of DPsyn, DPanti and PCB-153 in the matrices were distributed sludge>influent>effluent.

Table 12: Dechlorane concentrations in influent, effluent, and sludge samples from VEAS and HIAS WWTP

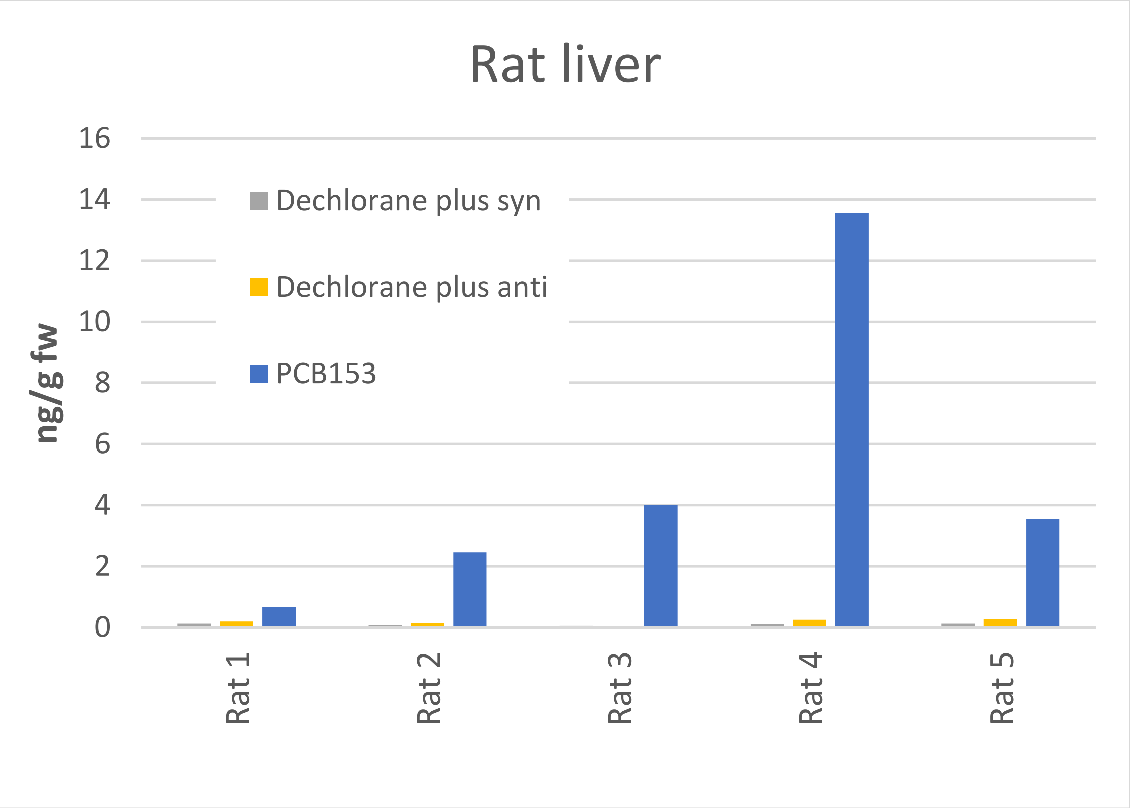
Sample type	Dec 602	Dec 603	Dec 604	DPsyn	DPanti	PCB-153
		(Min – max) **Average*** Detection frequency			ng/L or ng/g d.w.	
VEAS Influent	(<0,1 - <0,1) **<0,05** 0 %	(<0,1 - <0,1) **<0,05** 0 %	(<0,2 - <0,2) **<0,1** 0 %	(<0,1 - 0,73) **0,24** 60 %	(<0,4 - 4,09) **1,59** 60 %	(<0,2 - 0,58) **0,28** 40 %
VEAS Effluent	(<0,1 - <0,1) **<0,05** 0 %	(<0,1 - <0,1) **<0,05** 0 %	(<0,2 - <0,2) **<0,1** 0 %	(<0,1 - 0,16) **0,07** 20 %	(<0,4 - 0,53) **0,32** 40 %	(<0,2 - <0,2) **<0,1** 0 %
VEAS Sludge	(<0,1 - <0,1) **<0,05** 0 %	(<0,1 - <0,1) **<0,05** 0 %	(0,88 - 1,69) **1,4** 100 %	(0,80 - 0,96) **0,91** 100 %	(2,22 - 3,55) **3,0** 100 %	(2,23 - 18,4) **5,7** 100 %
HIAS Influent	(<0,1 - <0,1) **<0,05** 0 %	(<0,1 - <0,1) **<0,05** 0 %	(<0,2 - <0,2) **<0,1** 0 %	(<0,1 - 1,1) **0,79** 80 %	(<0,4 - 4,8) **2,7** 80 %	(<0,1 - 1,1) **0,62** 80 %
HIAS Effluent	(<0,1 - <0,1) **<0,05** 0 %	(<0,1 - <0,1) **<0,05** 0 %	(<0,2 - <0,2) **<0,1** 0 %	(<0,1 - <0,1) **<0,05** 0 %	(<0,4 - <0,4) **<0,2** 0 %	(<0,2 - <0,2) **<0,1** 0 %
HIAS Sludge	(<0,1 - <0,1) **<0,05** 0 %	(<0,1 - <0,1) **<0,05** 0 %	(<0,05 - 1,3) **0,71** 60 %	(0,89 - 1,6) **1,1** 100 %	(2,3 - 6,9) **3,6** 100 %	(0,97 - 3,7) **2,4** 100 %
Leachate Lindum	(2,6 - 5,2) **3,8** 100 %	(0,05 - 0,06) **0,05** 100 %	(<0,2 - <0,2) **<0,1** 0 %	(101 - 127) **113** 100 %	(198 - 290) **262** 100 %	(137 - 218) **175** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

3.2.2 Sediment and biota samples

In sediment samples from Lake Mjøsa none of the selected dechloranes were detected above LoD. In samples of brown trout from the same lake Dec602 was the only dechlorane found just above LoD with an average concentration of 0,01 ng/g w.w.

In liver samples from rats from Oslo both DPs were found frequently with average concentrations of 0,1 and 0,2 ng/g w.w. for DPsyn and DPanti respectively.



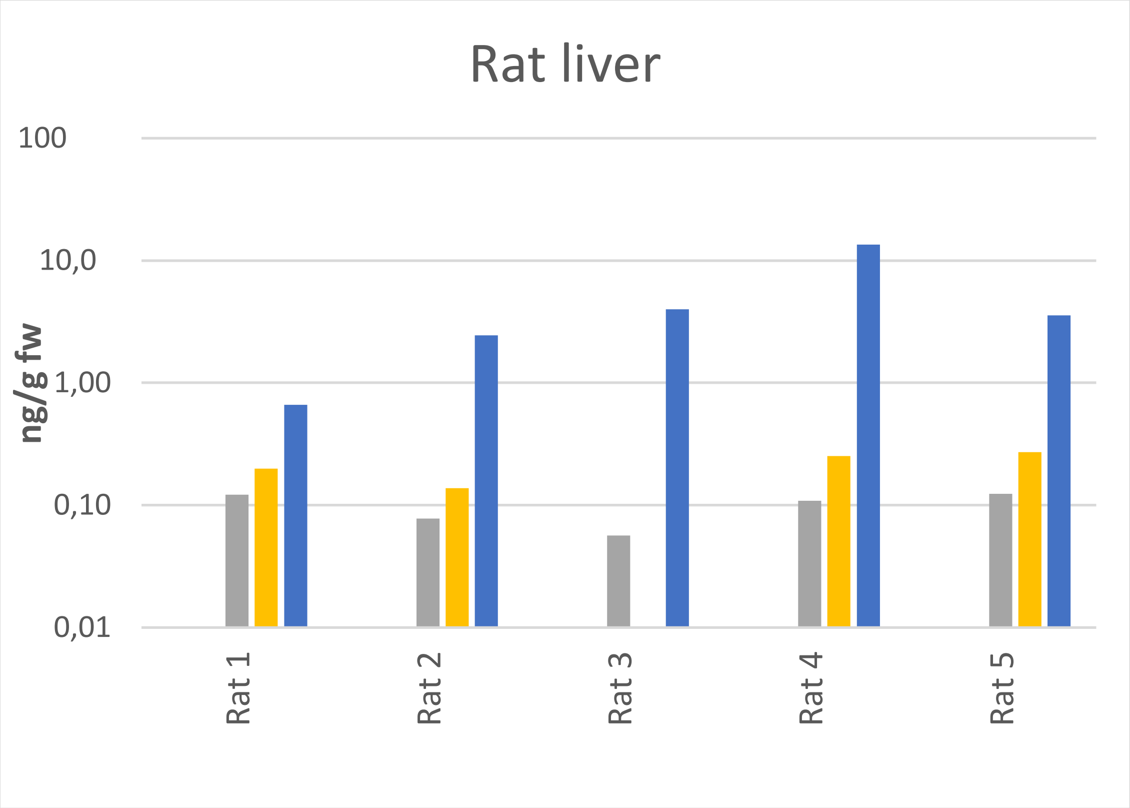


Figure 5: Concentration of DPsyn, DPanti, and PCB-153 in rat liver samples. Concentration given in ng/g, linear scale top figure, logarithmic scale bottom figure. House dust samples.

Three of the targeted dechloranes were frequently detected in the house dust samples; Dec604, DPsyn and DPanti. Highest concentrations in house dust were found for DPsyn and DPanti. Interestingly, in house dust the concentrations of PCB-153 were ten times lower than DPsyn and DPanti. This is in contrast to the sewage, leachate and biota samples in which PCB-153 was similar or slightly higher than the two DP compounds. Compared to the other selected sample types the concentration of these compounds are widely spread among the house dust samples. This was caused by two houses with outstanding concentrations.

Table 13: Dechlorane concentrations in house dust samples

Sample type	Dec 603	Dec 604	DPsyn	DPanti	PCB-153
	(Min – max) **Average*** Detection frequency		ng/g		
House dust	(<0,05 - 0,06) **0,03** 11 %	(<0,1 - 4,6) **1,3** 78 %	(<1 - 77) **12** 78 %	(<1 - 56) **14** 78 %	(0,06 – 10) **1,5** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

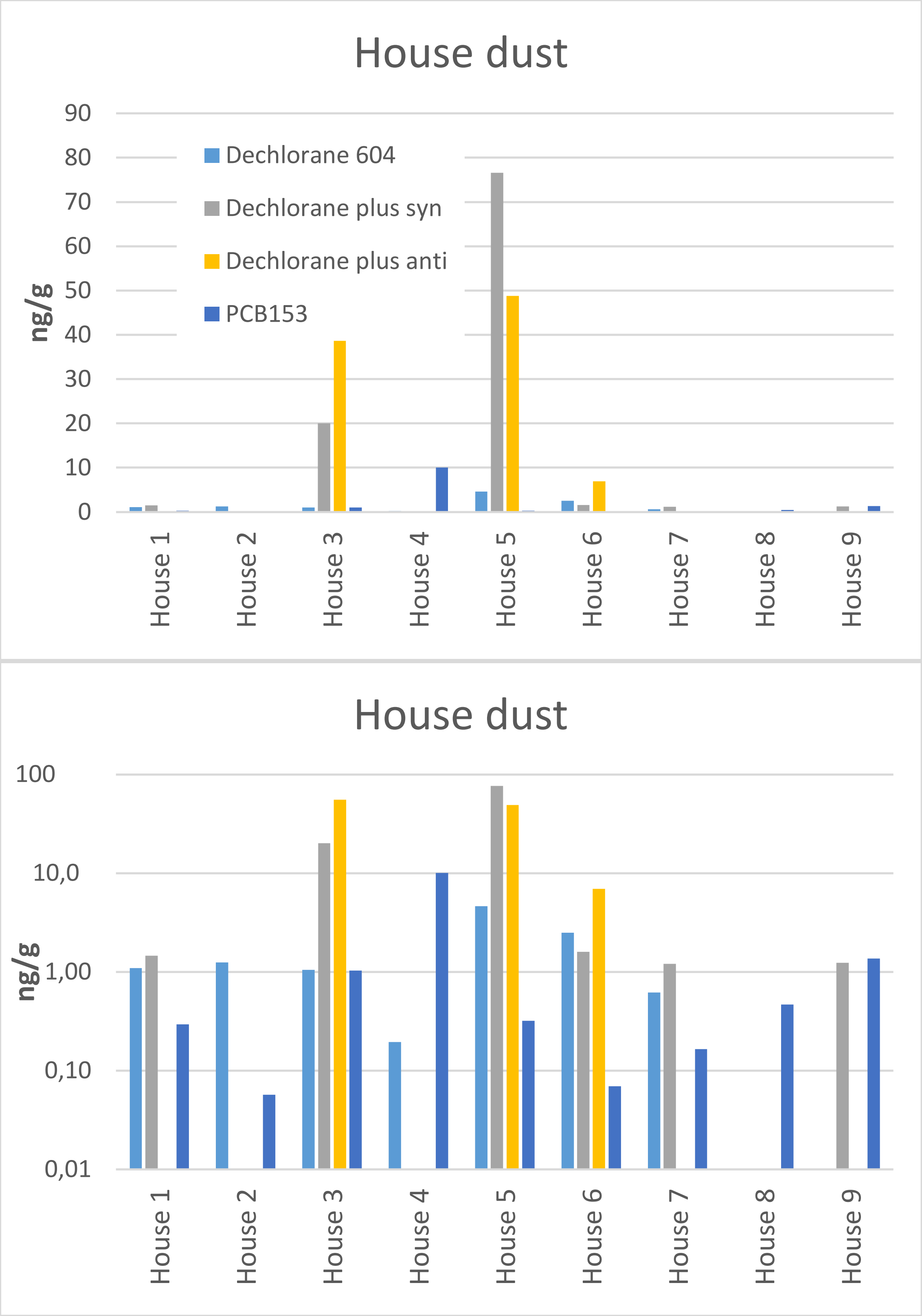


Figure 6: House dust concentration of dechloranes and PCB-153. Concentration given in ng/g, linear scale top figure, logarithmic scale bottom figure.

3.3 Hindered phenolic antioxidants

For most of the selected compounds, it was possible to achieve LoDs more or less in line or better as estimated during the contracting process. However, this is not true for the hindered phenols, which were used as antioxidants. Several different methods have been tested during method development and QA/QC. However, none of the methods cited in recent publications were optimal for the selected compounds, thus, LoD was not as low as expected and it was only possible to detect two of the four selected antioxidants in sludge samples.

Table 14: Concentration of antioxidants in influent, effluent, and sludge samples from VEAS and HIAS WWTP, leachate from Lindum landfill

Sample	HPP	TTBP	BBM	DTEB
	(Min - max) **Average*** Detection frequency		**ng/g d.w.**	
VEAS Sludge	(<10 - 12) 6,4 20 %	(<10 - <10) 5,0 0 %	(<15 - 58) 18 20 %	(<10 - <10) 5,0 0 %
HIAS Sludge	(<10 - 78) 50 80 %	(<10 - <10) 5,0 0 %	(<15 - 221) 50 20 %	(<10 - <10) 5,0 0 %

*): For the non-detects LoD/2 was used, when calculating the average.

3.4 Bisphenols

Two emerging bisphenols were targeted for this study: BPAP and BPM. In addition, BPA, BPF, BPS, BPAF were targeted as “reference” compounds. Neither BPAP nor BPAF were found above LoD in the environmental samples selected for this study.

3.4.1 Sewage and leachate samples

It was not possible to detect BPAF or BPAP in any of the sewage and leachate samples above LoD (1 – 5 ng/L, ~1 ng/g dw). BPS was detected in all matrices and BPA was detected in all matrices except effluent samples from VEAS. BPF and BPM were detected in influent samples but not in effluent samples. Highest concentrations were found in leachate water samples. BPS was the dominant bisphenol compound in effluent water while BPA was dominant in sludge and leachate water. The concentrations of the bisphenols were higher in influent samples than effluent samples. A larger difference in concentrations was seen for BPA than the other detected bisphenols.

Table 15: Concentration of biphenols in influent, effluent, and sludge samples from VEAS and HIAS WWTP, leachate from Lindum landfill

Sample	BPS	BPF	BPA	**BPM**
	(Min - max) **Average*** Detection frequency		**ng/L or ng/g d.w.**	
VEAS Influent	(370 - 496) **440** 100 %	(<90 - 111) **69** 40 %	(<450**) - 536) **318** 40 %	(<2 - 17) **6** 20 %
VEAS Effluent	(221 - 354) **271** 100 %	(<15 - <15) **8** 0 %	(<30 - <30) **15** 0 %	(<5 - <5) **2,5** 0 %
VEAS Sludge	(3 - 10) **6** 100 %	(<20 - <20) **10** 0 %	(79 - 157) **131** 100 %	(<0,5 - 193) **40** 80 %
HIAS Influent	(481 - 602) **543** 100 %	(<90 - 120) **89** 80 %	(1 480 - 4 080) **2 454** 100 %	(<2 - 4) **2** 20 %
HIAS Effluent	(221 - 354) **271** 100 %	(<15 - <15) **8** 0 %	(<30 - <30) **15** 100 %	(<5 - <5) **2,5** 0 %
HIAS Sludge	(<2 - 41) **31** 80 %	(26 - 68) **42** 100 %	(1 500 - 1 610) **1 563** 100 %	(<0,5 - <0,5) **0,3** 0 %
Leachate Lindum	(3 600 - 6 320) **4 608** 100 %	(<200 - 395) **265** 60 %	(82 600 - 317 000) **147 400** 100 %	(<5 - <5) **3** 0 %

*): For the non-detects LoD/2 was used, when calculating the average.

**): As the analytical method was adjusted for best sensitivity of the main target compounds BPAP and BPM, it was not possible to achieve optimal sensitivity for BPA for this study.

3.4.2 Surface water, sediment, and biota

None of the main target compounds (BPAP and BPM) were detected in surface water samples from Lake Mjøsa. From the six bisphenols targeted in this study, only BPA was possible to detect in these environmental samples (<200 to 1560 ng/L; avg 622 ng/L in 3 of 5 samples). These concentrations are unusual high, higher than the measured corresponding effluents. A recent study with samples from lakes in China, Korea, Japan, and USA showed a concentration range from LoD up to 13 000 ng/L. Without further investigations, it is not possible to decide, if this is an artefact or a representative concentration. Great care has been taken to avoid contamination during sampling, storage or analysis, and the risk for such an event is low, however, not zero. A possible explanation could a direct emission from recreational boats or from the bank of the lake.

3.4.3 House dust

Bisphenols were found in in high concentrations in all house dust samples from the Oslo area (Table 16).

Table 16: Concentration of bisphenols in house dust samples from Oslo area

Sample	BPS	BPF	BPA	BPAF
	(Min - max) **Average*** Detection frequency			ng/g
House dust	(23 - 1 230) **488** 100 %	(22 - 1 740) **401** 100 %	(839 - 9 690) **3 050** 100 %	(<10 - 490) **50** 0 %

*): For the non-detects LoD/2 was used, when calculating the average.

Figure 7: House dust concentration of bisphenols. Concentration given in ng/g, linear scale top figure, logarithmic scale bottom figure.

As expected, BPA showed in average the highest concentration in the house dust, followed by BPS and BPF. However, for two houses (# 2 and 3) BPS exceeded the concentration of BPA. The range of detected concentrations of bisphenols in house dust were larger than the ranges in other sample matrices with a factor of 10 between the lowest and highest concentrations for the different compounds. House 6 shows the highest concentrations for BPA and BPF, and this was also the only house, where it was possible to detect BPAF at rather high concentrations.

It was not possible to detect BPAP or BPM in any of the house dust samples above LoD (10 ng/g dw).

The measured concentrations are in the same range as what was measured earlier in house dust samples from all over the world (W. Wang et al., 2015). A recent study from (K. Larsson et al., 2017) also found levels of bisphenols in dust from pre-schools in Sweden in the same range as was found in this study (2300 ng/g of BPA and 260 ng/g of BPS).
It has been shown that dust ingestion in many cases can be a major exposure pathway for humans and especially for toddlers (Harrad et al., 2008; Harrad et al., 2009; Jones-Otazo et al., 2005). Based on the US EPA approach an estimated daily intake (EDI) through dust ingestion was calculated for these measurements (US-EPA, 2011; W. Wang et al., 2015) as shown in Table 18.

Table 17: Estimated daily intake (EDI) of bisphenols via house dust ingestion for samples from Oslo area

Sample	BPS	BPF	BPA	**BPAF**
	Low/high EDI in ng/kg b.w./day			
House dust	0,18/2,1	0,15/1,7	1,1/13	0,02/0,21

Recently, the Norwegian Public Health Institute has measured the BPA concentrations in Norwegian Food and estimated an EDI for a typical food basket to be in the range of 0,34 to 48, ng/kg bw /day (Sakhi et al., 2014). Our measurements in dust point to the conclusion that dust ingestion may be as important as food intake for the total exposure to bisphenols.

3.5 BADGE and BFDGE

Before start of this study we were uncertain, if it was possible to establish a quantitative method for BADGE and BFDGE related compounds, and only a semi-quantitative suspect screening approach was decided. Fortunately, it was possible to develop a quantitative method with an acceptable analytical quality for BADGE- and BFDGE-related compounds with the exception of BADGE. The BADGE/BFDGE compounds were frequently detected in house dust but rarely in the other matrices. Only BADGE-HCl-H20 was detected in sediment from Lake Mjøsa.

3.5.1 House dust

Five of the targeted BADGE-related compounds were found very frequently in house dust samples from the Oslo area (Table 18). Highest concentrations were found for BADGE-2H2O.

Table 18: Concentration of BADGE-related compounds in house dust samples from Oslo area

Sample	BADGE-HCl	BADGE-2HCl	BADGE-H2O	BADGE-2H2O	BADGE-HCl-H2O
	(Min - max) **Average*** Detection frequency			**ng/L or ng/g d.w.**	
House dust	(<15 - 375) **92** 55 %	(<30 - 900) **216** 89 %	(<5 - 145) **31** 44 %	(<170 - 2 600) **1 271** 89 %	(35 - 280) **147** 100 %

*): For the non-detects LoD/2 was used, when calculating the average.

The measured concentrations are in the same range as what was measured earlier in house dust samples from US, China, Korea and Japan (L. Wang et al., 2012).

As for the bisphenols the daily intake via dust ingestion was estimated for the BADGE-related compounds (see Table 19). However, since the contamination of BADGE-related compounds of food is very much related to the leakage from canned food packages, the average dietary exposure is difficult to estimate in a reliable way, and no recent dietary uptake study, which could be used for comparison, were found.

Table 19: Estimated daily intake (EDI) of BADGE-related compounds via house dust ingestion for samples from Oslo area

Sample	BADGE-HCl	BADGE-2HCl	BADGE-H2O	BADGE-2H2O	BADGE-HCl-H2O
	Low/high EDI in ng/kg b.w./day				
House dust	0,03/0,39	0,08/0,93	0,01/013	0,48/5,5	0,06/0,63

These estimated daily intake rates are in the same order of magnitude as estimated by an American research group based on indoor air measurements at both working places and private homes (Xue, Wan, & Kannan, 2016).

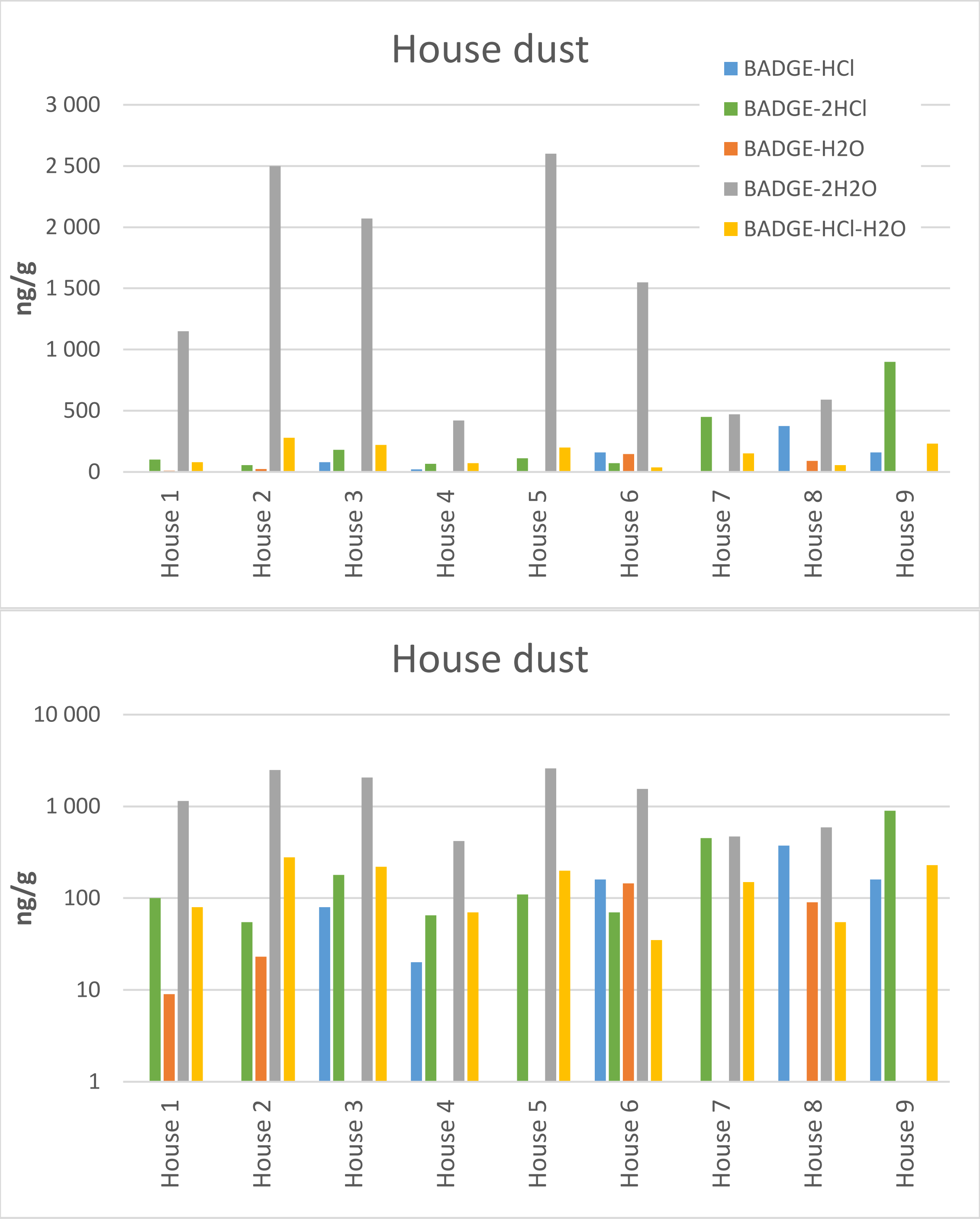


Figure 8: House dust concentration of BADGE-related compounds. Concentration given in ng/g, linear scale top figure, logarithmic scale bottom figure.

3.6 Persistent Organic Pollutants

3.6.1 WTTP influent, effluent and sewage sludge, landfill leachate lake sediments and surface water, household dust

The pesticide propargite was not found in any of the influent, effluent, leachate, sediment, surface water or household dust samples above the LoD of the methods used. The LoD ranged from 10-100 ng/g or ng/L depending on the sample type. With a predicted biodegradation half life of 5 days ("Chemistry Dashboard," 2017) propargite can be classified as readily biodegradable.

Chlorophenylsulphone (BCPS) levels were under the analytical LoD for all samples (10-160 ng/g or ng/L for all sample except leachate water 1500-3300 ng/L). The detection limit for the fish samples was 5-10 ng/g. Levels of BCPS have been reported in Perch (40-100 ng/g) and Grey Seal (41-220 ng/g) from the Baltic (C. Larsson et al., 2004). Low levels were found in Arctic Char (nd-7.3 ng/g) from Lake Vättern in Sweden. With a predicted biodegradation half life of 11 days ("Chemistry Dashboard," 2017) BCPS can be classified as readily biodegradable.

Levels of both fluoro based chemicals, nonafluorobutyl phosphinic acid (PFPiA) and methyl nonafluorobutylsulfonyl ethyl propenoate (NFacrylat) were all below LoD (10-100 ng/g or ng/L). No environmental levels for comparison were found in the international peer reviewed literature. Only the equivalent C6/C6 PFPiA has been found in sewage sludge, indoor dust and lake trout at concentration well below the analytical LoD of the methods used.

Triphenyl phosphorothioate (TPPT) was found in both influent and sewage sludge from HIAS at a concentration of range of 138-322 ng/g in sewage sludge and 57-107 ng/L in the influent. No TPPT was found in the effluent of HIAS or the samples from the VEAS WWTP and all samples were below 10-100 ng/g or ng/L.

The phosphor flame retardant bisphenol A bis(diphenylphosphate) BPA-BDPP was only found in three of the house dust samples at concentrations of 248-1123 ng/g. BPA-BDPP was not found in any of the other samples at levels over the LoD (5-100 ng/g or ng/L). In dust samples from Greece, The Netherlands, and Sweden, the highest concentrations were found in dust samples collected on electronic equipment with BPA-BDPP levels ranging from <0,1 to 1300 µg/g. BPA-BDPP levels in dust collected further away from the electronics (source) were usually lower (Brandsma, Sellstrom, de Wit, de Boer, & Leonards, 2013).

With exception of TPPT all compounds of this group show predicted biodegradation half lifes below 16 days ("Chemistry Dashboard," 2017) and can thus be classified as readily biodegradable.

3.6.2 Biota samples

The pesticide propargite was found in Trout between the analytical limit of detection (LoD) and the limit of quantification (LOQ). This indicates that Propargite (10-25 ng/g) might be present in the trout samples but that there is a relatively large uncertainty at this level for the used methods. Both interfering compounds and a limit amount of sample hampered the detection of Propargite in trout. The results presented are indicative and need to be confirmed with a larger amounts of sample. In addition, Propargite has not been registered or used in Norway and no records of use could be found. Surface water in the same area did not contain Propargite, but levels of Propargite could be the result of bio accumulation due to the relatively large Kow of 5,1.

However, both propargite and many of the other compounds of this group show rather short fish biotransformation half life around 0,1 – 4 days for all compounds ("Chemistry Dashboard," 2017), which might explain why these compounds were rarely detected in biota samples.

3.7 Synthetic musk, plasticizers, organo metals and UV compounds.

3.7.1 Influent and effluent WWTP, sewage and leachate samples, surface water and sediments.

The plasticizer n-butylbenzene sulphonamide (NBBsulfone) was only detected in effluent from the landfill site Lindum at a concentration range of 302 - 478 ng/L. The amount of leachate from the landfill varies from day to day and year to year. On a yearly basis 366 000 to 910 000 m3 of leachate is leaving the landfill. When the samples were taken in the period from 20.09. to 27.09. and average amount of leachate was 583 m^3, this would indicate that on average 216 mg of n-butylbenzene sulphonamide is release to the environment.

The phosphor organic flame retardant Bisphenol A bis(diphenylphosphate) (BPA-BDPP) was not found in any of the samples at levels above the LoD (5-100 ng/g or ng/L).

The organotin compound di-n-octyltin was found just above the LoQ in one sewage sludge sample from HIAS, in the other the samples the levels were between the LOQ and LoD and should be interpreted some indicative. One of the applications for di-n-octyltin oxide is the use of water based paints, when applying the paint di-octyltin could be released.

The synthetic musk compound methyl-cedryl-ketone was found at relatively high concentration in all influent, effluent and sludge samples. The concentration in the influent of the VEAS WTTP averaged 1860 ng/L while the concentrations in the HIAS WTTP were 10360 ng/L. The effluent of the VEAS WTTP contained 299 ng/L, which results in an estimated release per day of 68.8 g of the synthetic musk during week the measurements were performed. For the HIAS the daily release for the same week was 15.2 g based on an average effluent concentration of 704 ng/L. Concentrations in the sewage sludge from both VEAS and HIAS WTTP ranged from 3800-5100 ng/g. In addition, methyl-cedryl-ketone was found in sediment in two of the five sediment samples from Lake Mjøsa at concentration of 620 and 730 ng/g. In the other three sample methyl-cedryl-ketone could not be detected due to a relative high LoD (910-1500 ng/g) due to interference during analysis.

The UV filter 10-undecenyl 2-cyano-3,3-diphenylpropenoate (Undecenyl crylene) was not found in any of the samples above the LoDs varying between 10-2000 ng/g or ng/L depending on sample seize or sample type. In contrast the UV filter Octocrylene (CAS: 6197-30-4) which was analysed simultaneously in the same samples was found in all samples in concentrations in the ug/g or ug/L range. Octocrylene was also the only compound which was found in the surface water at concentrations varying from 17-115 ng/L.

3.7.2 Biota samples

None of the Synthetic musk, plasticizers, organo metals and UV compounds were found in the rat liver or trout samples at levels above the detection limit.

3.7.3 House dust and indoor air

The phosphor organic flame retardant BPA-BDPP was detected in three of the house dust samples at levels between 248 to 1123 ng/g. In addition to the flame retardant, the house dust contained both UV-filters, synthetic musk and organotin compounds. The targeted UV filter, undecenyl crylene, was not found in any of the dust samples above the LoD (15-400 ng/g). However, a similar UV filter (Octocrylene) analysed in the same samples was found at concentrations from 6-14 000 ng/g. In addition, the synthetic musk Methyl Cedryl Ketone was found in 7 of the 9 dust samples (330-7200 ng/g) and in the air samples (710-6500 ng/sample).

The organotin compound Di-n-octyltin used in water based paints, was also found in all house dust samples at concentrations ranging from 7-165 ng/g. There is evidence from literature that organic tin oxide compounds have the potential to disrupt endocrine systems (AT-EE, 2015) and this compound group should therefore be selected for further and profounder studies.

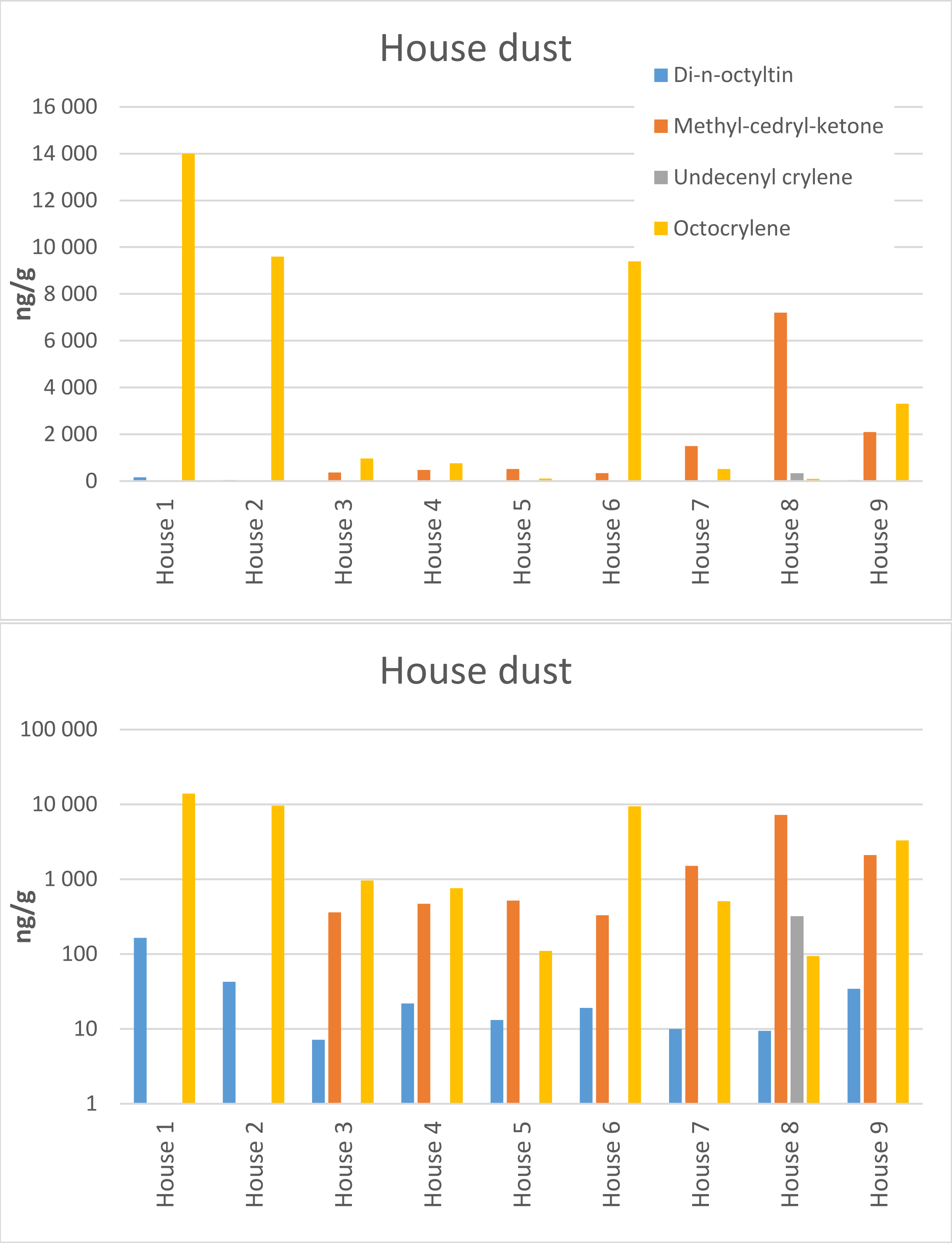


Figure 9: House dust concentration of UV filter and organotin compounds. Concentration given in ng/g. Linear scale top figure, logarithmic scale bottom figure.

3.8 Risk assessment

A preliminary risk assessment has been made on basis of detected levels in effluent samples and published PNEC values ((https://echa.europa.eu).

Bisphenol S (BPS) was found in the effluent of both VEAS and HIAS at average concentrations of 271 ng/L and 446 ng/l respectively. These levels are far below the PNEC values given for BPS in Table 20.

Table 20: PNEC Bisphenol S[1]
PNEC aqua (freshwater) 0.27 mg/L (assessment factor 10)
PNEC freshwater (intermittent releases) 0.55 mg/L
PNEC aqua (marine water) 0.027 mg/L (assessment factor 100)
PNEC WWTP 20 mg/L (assessment factor 10)
PNEC sediment (freshwater) 3.36 mg/kg sediment dw
PNEC sediment (marine water) 0.336 mg/kg sediment dw

[1] (https://echa.europa.eu/registration-dossier/-/registered-dossier/14986/6/1)

Bisphenol A (BPA) was found at similar concentrations as BPS at both VEAS and HIAS 299 ng/L and 704 ng/L. These concentrations are well below the intermittent release PNEC but relatively close to the PNEC for fresh water. However, surface water from Mjøsa contained BPA at concentrations ranging from less than LOD (< 200 ng/g) to 1560 ng/L. The highest levels measured are very close to the PNEC, which means that the environmental risk can be classified as low to moderate. The average including the samples under the LOD the EC/PNEC ration is = 0.03.

Table 21: PNEC Bisphenol A[2]
PNEC aqua (freshwater) 1.74 µg/L (assessment factor 50)
PNEC freshwater (intermittent release) 8.6 µg/L
PNEC aqua (marine water) 0.174 µg/L (assessment factor 500)
PNEC WWTP 10 mg/L (assessment factor 10)
PNEC sediment (freshwater) 24.4 mg/kg sediment dw
PNEC sediment (marine water) 2.44 mg/kg sediment dw

[2] (https://echa.europa.eu/registration-dossier/-/registered-dossier/12524/6/1)

The synthetic musk Methyl Cedryl Ketone was found in effluent of both VEAS and HIAS at average concentrations of 299 ng/L and 704 ng/L respectively. Also two of the sediment samples from Lake Mjøsa contained levels of Methyl Cedryl Ketone (620-730 ng/g) which is well below the PNEC given in Table 2.

Table 22: Methyl Cedryl Ketone[3]
PNEC aqua (freshwater) 1.74 µg/L (assessment factor 50)
PNEC freshwater (intermittent release) 8.6 µg/L
PNEC aqua (marine water) 0.174 µg/L (assessment factor 500)
PNEC WWTP 10 mg/L (assessment factor 10)
PNEC sediment (freshwater) 24.4 mg/kg sediment dw
PNEC sediment (marine water) 2.44 mg/kg sediment dw

(https://echa.europa.eu/registration-dossier/-/registered-dossier/12524/6/1)

The UV filter Undecenyl crylene was not found in any of the sample, but the structurally similar UV filter Octocrylene was analysed simultaneously was found in both effluents from HIAS and VEAS at average concentrations of 715 ng/L and 1079 ng/L respectively. Surface water and sediment from Lake Mjøsa contained levels of 56 ng/L and 144 ng/g respectively. Both concentrations are well below the PNEC values for Octocrylene given in Table 23.

Table 23: Octocrylene[3]
PNEC aqua (freshwater) 0.023 mg/L
PNEC freshwater (intermittent release) 0.023 mg/L
PNEC aqua (marine water) 0.023 mg/L
PNEC WWTP 10 mg/L (assessment factor 100)
PNEC sediment (freshwater) 4110 mg/kg sediment dw
PNEC sediment (marine water) 411 mg/kg sediment dw

(https://echa.europa.eu/registration-dossier/-/registered-dossier/14858/6/1)

4. Conclusions

The *linear siloxanes* were found in all emission-related sample types including indoor environment. However, it is expected that the exposure via environmental pathways is much lower compared to the exposure via use of personal care products. ECHA estimated the same dissemination tonnage for both L3 and L4 and a lower tonnage for L5. However, all studied matrices showed higher concentrations for L5 than for L3 and L4. These findings do not support ECHA estimations, suggesting that either L3 and L4 are overestimated or more likely there are additional unidentified sources for L5.

The *volatile aromatic compounds* di-isopropylbenzenes and 4-Isopropyl-1,1'-biphenyl were found both in WWTP sludge and indoor environmental samples, establishing their widespread use and emissions. However, only one finding above LoD in brown trout is not enough evidence for persistence and bioaccumulation.

With exception of DIBALD and Dec 601 all selected *dechlorane compounds* were found regularly and at high concentrations in nearly all studied sample types including house dust. Their occurrence in biota show clear evidence for persistence and bioaccumulation. This compound group should be prioritised for further and profounder studies.

The *prioritized bisphenols* BPAF and BPM were rarely/occasionally found in emission/house dust samples. BPAP was not found at all. On the other hand, the single finding of BPAF in house dust was at a high concentration in the house showing the highest concentration of the other bisphenols. The measured “reference” bisphenols BPA, BPS, and BPF were found in nearly all emission related samples and clearly qualify to be included in regularly monitoring programmes. For the bisphenols the estimated daily intake of house dust by ingestion may be as important as food intake, when calculating the total human exposure to bisphenols. A risk assessment based on comparison of the measured freshwater concentration of Lake Mjøsa with the PNEC for BPA showed a MEC/PNEC ratio just below 1, which still can be characterized as low, however, close to moderate environmental risk.

House dust was the only sample type where it was possible to detect *BAGDE-related compounds*. These compounds were found in all house dust samples and the measured concentrations were in the same range as BPA.

Triphenyl phosphorothioate (TPPT) was only found in influent and sewage sludge from HIAS.

The phosphor flame retardant bisphenol A bis(diphenylphosphate) (BPA-BDPP) was only found in 3 of the house hold dust samples, however, at relative high concentrations. In other studies, this compound is linked to electronic equipment.

The plasticizer n-butylbenzene sulphonamide (NBBsulfone) was only detected in effluent from the landfill site Lindum.

The organotin compound Di-n-octyltin used in water based paints, was found in all house dust samples at concentrations ranging from 7 - 165 ng/g.

The synthetic musk compound methyl-cedryl-ketone was found at relatively high concentration in all influent, effluent and sludge samples. The daily release for VEAS and HIAS were about 70 and 15 g. This compound were also detected in some sediment samples from Lake Mjøsa. It was also found in nearly all dust samples at concentrations from 6 – 14 000 ng/g as well as in air samples.

The UV filter octocrylene was found in all emission related samples and in the recipient samples, surface water and sediment. It was also found at concentrations from 6-14 000 ng/g in all dust samples.

The following substances were not or only rarely detected in this study: Dibromoaldrin, Dec 601, TTBP, DTEB, BPAF, BPAP, BFDGE, BFDGE-2HCL, BFDGE-2H20, Propargite, TPPT, NFacrylat, BCPS, and Undecenyl crylene. Since the compounds selected for this study were of quite different chemical nature, it was not possible to fine-tune the analytical method to optimal performance for every single compound, resulting in sub-optimal LoD and higher numbers of non-detects. Other compounds like Propargite, BCPS, BPA-BDPP, and NBBSulfone are readily biodegraded or biotransformed in fish resulting in low levels in the studied sample types.

The following substances were occasionally detected (or frequently detected in only one sample type) in this study: HPP, BBM, BPM, BADGE-2HCL, BADGE-H20, BADGE-2H2O, OTP, and BPA-BDPP. All other compounds were detected frequently in two or more different matrices or in all samples of one sample type. Further investigation of the following compounds should therefore be considered: L3, L4, L5, diisopropylbenzenes, 4-isopropyl-1,1'-biphenyl, dechloranes, BPS, BPF, BPA, BADGE-group, NBBsulfone, di-noctyltin, methyl-cedryl-ketone, and octocrylene.

For most of the compounds, sufficient knowledge on human and environmental effects is lacking and only a very limited environmental risk assessment could be performed. Based on the PNEC for freshwater biota BPA is the only compound with a low (close to moderate) environmental risk

One of the major objectives in this study was to proof the occurrence or absence of the selected compounds. The sample type with most positive findings was house dust. With the exception of pesticides and some purely industrial chemicals, most of the chemicals either are part of products used in indoor environment or are easily transported into houses. Furthermore, household dust is a comparable easy analysable matrix, where the compounds of interest are not "diluted" or hidden by a lot of interfering biological ballast. In contrast to many other sample types like leachate water, sediment, and biota, household dust is very closely connected to the original product and the composition of the dust is reflecting the composition of relatively new products. Both dust and indoor air can therefore be applied as an early warning tool or watchdog to follow up new developments in the market and to verify reported tonnages.

5. References

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6. Appendix

Sample	L3	L4	L5	1,3-di-isopropylbenzene	1,4-di-isopropylbenzene	4-Isopropyl-1,1'-biphenyl
			ng/g or ng/L or ng/m3			
Influent VEAS	n. d.	<1	<1	<3	<5	<10
Influent VEAS	n. d.	<1	<1	<3	<5	<10
Influent VEAS	n. d.	<1	<1	<3	<5	<10
Influent VEAS	n. d.	<1	<1	<3	<5	<10
Influent VEAS	n. d.	<1	<1	<3	<5	<10
Influent HIAS	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
Influent HIAS	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
Influent HIAS	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
Influent HIAS	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
Influent HIAS	n. d.	n. d.	n. d.	n. d.	n. d.	n. d.
Effluent VEAS						
Effluent VEAS						
Effluent VEAS						
Effluent VEAS						
Effluent VEAS						
Effluent HIAS						
Effluent HIAS						
Effluent HIAS						
Effluent HIAS						
Effluent HIAS						
Sludge VEAS	**2,2**	**16**	**366**	**1,7**	<0,22	**2,0**
Sludge VEAS	**2,5**	**18**	**405**	**2,0**	**2,5**	**2,2**
Sludge VEAS	**2,5**	**17**	**370**	**1,8**	**1,5**	**1,8**
Sludge VEAS	**2,3**	**17**	**373**	**1,7**	<0,24	**1,8**
Sludge VEAS	**3,1**	**17**	**369**	**1,9**	**2,0**	**1,6**
Sludge HIAS	**7,3**	**33**	**389**	<1,97	**1,1**	**0,37**
Sludge HIAS	**6,2**	**31**	**384**	<2,25	<2,02	<0,13
Sludge HIAS	**6,7**	**33**	**402**	**2,1**	**2,1**	<0,13
Sludge HIAS	**5,8**	**30**	**350**	**2,1**	**2,3**	**0,39**
Sludge HIAS	**6,4**	**33**	**392**	**2,1**	**2,0**	**0,36**

Sample	L3	L4	L5	1,3-di-isopropylbenzene	1,4-di-isopropylbenzene	4-Isopropyl-1,1'-biphenyl
			ng/g or ng/L or ng/m3			
Landfill leachate Lindum	n. d.	**2,5**	**4,1**	<5	<10	<10
Landfill leachate Lindum	n. d.	**3,1**	**4,4**	<5	<10	<10
Landfill leachate Lindum	n. d.	**2,4**	**4,3**	<6	<10	<10
Landfill leachate Lindum	n. d.	n.d	n. d.	n. d.	n. d.	n. d.
Landfill leachate Lindum	n. d.	**2,9**	**3,7**	<12	<10	<10
Surface water Mjøsa	n. d.	**3,7**	**5,0**	**4,0**	<7	<10
Surface water Mjøsa	n. d.	**4,0**	**7,4**	**3,4**	<7	<10
Surface water Mjøsa	n. d.	**5,0**	**5,6**	<4.1	<7	<10
Surface water Mjøsa	n. d.	**24**	**9,9**	<3.6	<7	<10
Surface water Mjøsa	n. d.	**6,9**	**9,5**	<5.6	<7	<10
Sediment Mjøsa						
Sediment Mjøsa						
Sediment Mjøsa						
Sediment Mjøsa						
Sediment Mjøsa						
Brown trout (fillet)	<0,04	<0,04	<0,04	<0,05	**0,19**	<0,50
Brown trout (fillet)	<0,04	<0,04	**0,11**	<0,06	<0,05	<0,59
Brown trout (fillet)	**0,05**	<0,02	**0,10**	<0,05	<0,04	<0,45
Brown trout (fillet)	<0,04	<0,04	**0,10**	<0,07	<0,06	<0,49
Brown trout (fillet)	<0,04	<0,03	**0,18**	<0,04	<0,04	<0,35
Brown trout (fillet)	<0,04	<0,03	<0,03	<0,05	<0,04	<0,41
Brown trout (fillet)	<0,04	<0,03	<0,03	<0,04	<0,03	<0,43
Brown trout (fillet)	<0,04	<0,02	**0,09**	<0,04	<0,03	<0,42
Brown trout (fillet)	<0,04	<0,03	**0,07**	<0,05	<0,05	<0,59
Brown trout (fillet)	<0,04	<0,03	**0,11**	<0,04	<0,04	<0,53
Rat liver	<0,06	<0,02	<0,02	<0,04	<0,04	<0,58
Rat liver	<0,06	<0,03	<0,04	<0,06	<0,05	<0,79
Rat liver	<0,06	<0,02	<0,03	<0,06	<0,05	<0,49
Rat liver	<0,06	<0,03	<0,03	<0,05	<0,05	<0,62
Rat liver	<0,06	<0,03	<0,04	<0,05	<0,05	<0,85
Dust, house 1	**0,39**	**0,48**	<10	<0,50	<0,87	**15**
Dust, house 2	**0,49**	**1,6**	**11**	**9,2**	**8,0**	**0,25**
Dust, house 3	**0,30**	**0,59**	<10	<0,58	<1,00	**1,8**
Dust, house 4	**0,36**	**0,96**	**21**	<0,58	<1,00	**0,62**
Dust, house 5	**0,23**	**0,44**	<10	<0,68	<1,17	**0,35**
Dust, house 6	**0,29**	**0,47**	**8,5**	<0,41	<0,71	**0,48**

Sample	L3	L4	L5	1,3-di-isopropylbenzene	1,4-di-isopropylbenzene	4-Isopropyl-1,1'-biphenyl
	ng/g or ng/L or ng/m3					
Dust, house 7	**0,50**	**0,17**	**464**	<0,36	<0,63	**0,31**
Dust, house 8	**1,3**	<0,2	<10	**0,65**	<1,12	**1,0**
Dust, house 9	**0,30**	**0,95**	**360**	<0,50	<0,77	**0,35**
Air, house 1	**10**	**27**	**56**	**0,45**	**0,51**	<0,17
Air, house 2	**4,5**	**7,6**	**40**	**1,0**	**0,92**	<0,90
Air, house 3	**1,6**	**2,3**	**92**	**3,9**	**3,4**	<0,47
Air, house 4	**3,2**	**37**	**1456**	**1,8**	**1,7**	<0,51
Air, house 5	**4,1**	**3,3**	**5,6**	**1,7**	**1,9**	<1,08
Air, house 6	**73**	**33**	**55**	**1,9**	**1,5**	<0,24
Air, house 7	**32**	**21**	**47**	**4,7**	**3,6**	<0,33
Air, house 8	**743**	**6,8**	**55**	**3,9**	**3,1**	<0,38
Air, house 9	**5,0**	**3,5**	**134**	**0,75**	**0,67**	<0,19
Air, house 10	**3,5**	**1,1**	**6,0**	**1,2**	**0,79**	<0,19

Sample	Dibromoaldrin	Dechlorane 601	Dechlorane 602	Dechlorane 603	Dechlorane 604	Dechlorane plus syn	Dechlorane plus anti	PCB153
	ng/g or ng/L or ng/m3							
Influent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Influent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Influent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	**0,73**	**4,1**	<0,2
Influent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	**0,15**	**2,8**	**0,58**
Influent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	**0,21**	**0,63**	**0,54**
Influent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	**1,1**	**4,2**	**0,77**
Influent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	**0,73**	**2,6**	**0,63**
Influent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	**1,1**	**4,8**	**0,91**
Influent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Influent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	**1,0**	**2,4**	**0,69**
Effluent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	**0,53**	<0,2
Effluent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Effluent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Effluent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Effluent VEAS	<0,1	<0,1	<0,1	<0,1	<0,2	**0,16**	**0,46**	<0,2
Effluent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Effluent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Effluent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Effluent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Effluent HIAS	<0,1	<0,1	<0,1	<0,1	<0,2	<0,10	<0,40	<0,2
Sludge VEAS	<0,1	<0,1	<0,1	<0,1	**0,88**	**0,94**	**3,0**	**3,0**
Sludge VEAS	<0,1	<0,1	<0,1	<0,1	**1,3**	**0,89**	**3,3**	**2,5**
Sludge VEAS	<0,1	<0,1	<0,1	<0,1	**1,5**	**0,96**	**3,5**	**2,2**
Sludge VEAS	<0,1	<0,1	<0,1	<0,1	**1,7**	**0,80**	**2,2**	**2,3**
Sludge VEAS	<0,1	<0,1	<0,1	<0,1	**1,6**	**0,94**	**2,7**	**18**
Sludge HIAS	<0,1	<0,1	<0,1	<0,1	**1,1**	**0,89**	**2,7**	**3,7**
Sludge HIAS	<0,1	<0,1	<0,1	<0,1	**1,1**	**1,0**	**2,3**	**3,3**
Sludge HIAS	<0,1	<0,1	<0,1	<0,1	**1,3**	**0,97**	**3,0**	**3,0**
Sludge HIAS	<400	<0,05	<0,05	<0,05	<0,05	**1,6**	**6,9**	**0,97**
Sludge HIAS	<400	<0,05	<0,05	<0,05	<0,05	**0,90**	**3,3**	**1,1**
Landfill leachate Lindum	<0,1	<0,1	**2,6**	**0,05**	<0,2	**101**	**262**	**194**
Landfill leachate Lindum	<0,1	<0,1	**3,0**	**0,05**	<0,2	**102**	**283**	**158**
Landfill leachate Lindum	<0,1	<0,1	**4,5**	**0,06**	<0,2	**119**	**290**	**218**
Landfill leachate Lindum	<0,1	<0,1	**3,5**	**0,05**	<0,2	**127**	**198**	**137**

Sample	Dibromoaldrin	Dechlorane 601	Dechlorane 602	Dechlorane 603	Dechlorane 604	Dechlorane plus syn	Dechlorane plus anti	PCB153
				ng/g or ng/L or ng/m3				
Landfill leachate Lindum	<0,1	<0,1	**5,2**	**0,06**	<0,2	**117**	**272**	**167**
Surface water Mjøsa	-	-	-	-	-			
Surface water Mjøsa	-	-	-	-	-			
Surface water Mjøsa	-	-	-	-	-			
Surface water Mjøsa	-	-	-	-	-			
Surface water Mjøsa	-	-	-	-	-			
Sediment Mjøsa	<0,1	<0,1	<0,1	<0,1	<0,2	<1	<6	**0,54**
Sediment Mjøsa	<0,1	<0,1	<0,1	<0,1	<0,2	<1	<6	<0,1
Sediment Mjøsa	<0,1	<0,1	<0,1	<0,1	<0,2	<1	<6	**0,32**
Sediment Mjøsa	<0,1	<0,1	<0,1	<0,1	<0,2	<1	<6	**1,0**
Sediment Mjøsa	<0,1	<0,1	<0,1	<0,1	<0,2	<1	<6	**0,79**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	<0,03	<0,14	**4,6**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	<0,03	<0,14	**2,3**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	<0,03	<0,14	**1,6**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	<0,03	<0,14	**3,1**
Brown trout (fillet)	<0,005	<0,005	**0,02**	<0,005	<0,02	<0,03	<0,14	**6,5**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	<0,03	<0,14	**6,3**
Brown trout (fillet)	<0,005	<0,005	**0,02**	<0,005	<0,02	<0,03	<0,14	**7,5**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	<0,03	<0,14	**2,6**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	<0,03	<0,14	**3,9**
Brown trout (fillet)	<0,005	<0,005	**0,01**	<0,005	<0,02	**0,03**	<0,14	**2,9**
Rat liver	<0,1	<0,02	<0,02	<0,02	<0,02	**0,12**	**0,20**	**0,66**
Rat liver	<0,1	<0,02	<0,02	<0,02	<0,02	**0,08**	**0,14**	**2,4**
Rat liver	<0,1	<0,02	<0,02	<0,02	<0,02	**0,06**	<0,14	**4,0**
Rat liver	<0,1	<0,02	<0,02	<0,02	<0,02	**0,11**	**0,25**	**14**
Rat liver	<0,1	<0,02	<0,02	<0,02	<0,02	**0,12**	**0,27**	**3,6**
Dust, house 1	<0,05	<0,05	<0,05	<0,05	**1,1**	**1,5**	<6	**0,29**
Dust, house 2	<0,05	<0,05	<0,05	<0,05	**1,2**	<1	<6	**0,06**
Dust, house 3	<0,05	<0,05	<0,05	**0,00**	**1,0**	**20**	**56**	**1,0**
Dust, house 4	<0,05	<0,05	<0,05	**0,06**	**0,20**	<1	<6	**10**
Dust, house 5	<0,05	<0,05	<0,05	<0,05	**4,6**	**77**	**49**	**0,32**
Dust, house 6	<0,05	<0,05	<0,05	<0,05	**2,5**	**1,6**	**6,9**	**0,07**
Dust, house 7	<0,05	<0,05	<0,05	<0,05	**0,62**	**1,2**	<6	**0,16**
Dust, house 8	<0,05	<0,05	<0,05	<0,05	<0,1	<1	<6	**0,47**
Dust, house 9	<0,05	<0,05	<0,05	<0,05	<0,1	**1,2**	<6	**1,4**

Sample	HPP	TTBP	BBM	DTEB
	ng/g or ng/L or ng/m3			
Influent VEAS	<25	<30	<60	<30
Influent VEAS	<25	<30	<60	<30
Influent VEAS	<25	<30	<60	<30
Influent VEAS	<25	<30	<60	<30
Influent VEAS	<25	<30	<60	<30
Influent HIAS	<25	<30	<60	<30
Influent HIAS	<25	<30	<60	<30
Influent HIAS	<25	<30	<60	<30
Influent HIAS	<25	<30	<60	<30
Influent HIAS	<25	<30	<60	<30
Effluent VEAS	<3	<2	<9	<2
Effluent VEAS	<3	<2	<9	<2
Effluent VEAS	<3	<2	<9	<2
Effluent VEAS	<3	<2	<9	<2
Effluent VEAS	<3	<2	<9	<2
Effluent HIAS	<10	<3	<10	<5
Effluent HIAS	<10	<3	<10	<5
Effluent HIAS	<10	<3	<10	<5
Effluent HIAS	<10	**6,0**	**368**	<5
Effluent HIAS	<10	<3	<10	<5
Sludge VEAS	**12**	<10	**58**	<10
Sludge VEAS	<10	<10	<15	<10
Sludge VEAS	<10	<10	<15	<10
Sludge VEAS	<10	<10	<15	<10
Sludge VEAS	<10	<10	<15	<10
Sludge HIAS	**46**	<10	**221**	<10
Sludge HIAS	**61**	<10	<15	<10
Sludge HIAS	**60**	<10	<15	<10
Sludge HIAS	<10	<10	<15	<10
Sludge HIAS	**78**	<10	<15	<10
Landfill leachate Lindum	<70	<50	<100	<50
Landfill leachate Lindum	<70	<50	<100	<50
Landfill leachate Lindum	<70	<50	<100	<50
Landfill leachate Lindum	<70	<50	<100	<50
Landfill leachate Lindum	<70	<50	<100	<50
Surface water Mjøsa	<6	<4	<14	<6
Surface water Mjøsa	<6	<4	<14	<6
Surface water Mjøsa	<6	<4	<14	<6
Surface water Mjøsa	<6	<4	<14	<6
Surface water Mjøsa	<6	<4	<14	<6
Sediment Mjøsa	<0,4	<0,2	<0,8	<0,3
Sediment Mjøsa	<0,4	<0,2	<0,8	<0,3

Sample	HPP	TTBP	BBM	DTEB
	ng/g or ng/L or ng/m3			
Sediment Mjøsa	<0,4	<0,2	<0,8	<0,3
Sediment Mjøsa	<0,4	<0,2	<0,8	<0,3
Sediment Mjøsa	<0,4	<0,2	<0,8	<0,3
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Brown trout (fillet)	<8	<9	<43	<12
Rat liver	<4	<4	<10	<10
Rat liver	<4	<4	<10	<10
Rat liver	<4	<4	<10	<10
Rat liver	<4	<4	<10	<10
Rat liver	<4	<4	<10	<10
Dust, house 1	<10	<7	<30	<10
Dust, house 2	<10	<7	<30	<10
Dust, house 3	<10	<7	<30	<10
Dust, house 4	<10	<7	<30	<10
Dust, house 5	<10	<7	<30	<10
Dust, house 6	<10	<7	<30	<10
Dust, house 7	<10	<7	<30	<10
Dust, house 8	<10	<7	<30	<10
Dust, house 9	<10	<7	<30	<10
Air, house 1	<50	<5	<31	<4
Air, house 2	<50	<5	<31	<4
Air, house 3	<50	<5	<31	<4
Air, house 4	<50	<5	<31	<4
Air, house 5	<50	<5	<31	<4
Air, house 6	<50	<5	<31	<4
Air, house 7	<50	<5	<31	<4
Air, house 8	<50	<5	<31	<4
Air, house 9	<50	<5	<31	<4
Air, house 10	<50	<5	<31	<4

Sample	BPS	BPF	BPA	BPAF	BPAP	BPM
			ng/g or ng/L or ng/m3			
Influent VEAS	**496**	**98**	<450	<1	<2	**8,0**
Influent VEAS	**485**	<90	<450	<1	<2	<2
Influent VEAS	**450**	**111**	<450	<1	<2	<2
Influent VEAS	**400**	<90	**536**	<1	<2	**17**
Influent VEAS	**370**	<90	**377**	<1	<2	<2
Influent HIAS	**526**	**120**	**4080**	<1	<2	<2
Influent HIAS	**523**	**95**	**2600**	<1	<2	<2
Influent HIAS	**481**	**96**	**2220**	<1	<2	<2
Influent HIAS	**581**	**91**	**1480**	<1	<2	<2
Influent HIAS	**602**	<90	**1890**	<1	<2	**4,0**
Effluent VEAS	**221**	<15	<30	<2	<5	<5
Effluent VEAS	**291**	<15	<30	<2	<5	<5
Effluent VEAS	**354**	<15	<30	<2	<5	<5
Effluent VEAS	**222**	<15	<30	<2	<5	<5
Effluent VEAS	**267**	<15	<30	<2	<5	<5
Effluent HIAS	**426**	**27**	**316**	<2	<5	<5
Effluent HIAS	**419**	<20	**485**	<2	<5	<5
Effluent HIAS	**456**	<20	**577**	<2	<5	<5
Effluent HIAS	**429**	**261**	**374**	<2	<5	<5
Effluent HIAS	**499**	<20	**172**	<2	<5	<5
Sludge VEAS	**4,0**	<20	**138**	<0,9	<0,8	<0,5
Sludge VEAS	**10**	<20	**79**	<0,9	<0,8	**193**
Sludge VEAS	**6,0**	<20	**157**	<0,9	<0,8	**1,2**
Sludge VEAS	**3,0**	<20	**128**	<0,9	<0,8	**1,6**
Sludge VEAS	**6,0**	<20	**152**	<0,9	<0,8	**1,9**
Sludge HIAS	**41**	**57**	**1550**	<0,9	<0,8	<0,5
Sludge HIAS	**39**	**27**	**1500**	<0,9	<0,8	<0,5
Sludge HIAS	**34**	**26**	**1610**	<0,9	<0,8	<0,5
Sludge HIAS	**39**	**32**	**1590**	<0,9	<0,8	<0,5
Sludge HIAS	<2	**68**	**1570**	<0,9	<0,8	<0,5
Landfill leachate Lindum	**3600**	**395**	**90400**	<16	<7	<5
Landfill leachate Lindum	**3910**	<200	**317000**	<16	<7	<5
Landfill leachate Lindum	**6320**	**384**	**82600**	<16	<7	<5
Landfill leachate Lindum	**5330**	**345**	**143000**	<16	<7	<5
Landfill leachate Lindum	**3880**	<200	**104000**	<16	<7	<5
Surface water Mjøsa	<13	<40	**951**	<1	<1	<1
Surface water Mjøsa	<13	<40	**1560**	<1	<1	<1
Surface water Mjøsa	<13	<40	<200	<1	<1	<1
Surface water Mjøsa	<13	<40	<200	<1	<1	<1
Surface water Mjøsa	<13	<40	**398**	<1	<1	<1
Sediment Mjøsa	<6	<3000	<200	<0,4	<10	<8

Sample	BPS	BPF	BPA	BPAF	BPAP	BPM
			ng/g or ng/L or ng/m3			
Sediment Mjøsa	<6	<3000	<200	<0,4	<10	<8
Sediment Mjøsa	x	<3000	<200	<0,4	<10	<8
Sediment Mjøsa	x	<3000	<200	<0,4	<10	<8
Sediment Mjøsa	x	<3000	<200	x	<10	<8
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Brown trout (fillet)	<2	<9	<150	<25	-	<15
Rat liver	<6	<150	<250	<2	<7	<10
Rat liver	<6	<150	<250	<2	<7	<10
Rat liver	<6	<153	<250	<2	<7	<10
Rat liver	<6	<153	<250	<2	<7	<10
Rat liver	<6	<153	<250	<2	<7	<10
Dust, house 1	**325**	**209**	**2360**	<10	<10	<10
Dust, house 2	**1230**	**750**	**978**	<10	<10	<10
Dust, house 3	**951**	**133**	**839**	<10	<10	<10
Dust, house 4	**320**	**30**	**1490**	<10	<10	<10
Dust, house 5	**339**	**84**	**2570**	<10	<10	<10
Dust, house 6	**701**	**1740**	**9690**	**409**	<10	<10
Dust, house 7	**186**	**22**	**2300**	<10	<10	<10
Dust, house 8	**23**	**203**	**2860**	<10	<10	<10
Dust, house 9	**318**	**441**	**4360**	<10	<10	<10
Air, house 1						
Air, house 2						
Air, house 3						
Air, house 4						
Air, house 5						
Air, house 6						
Air, house 7						
Air, house 8						
Air, house 9						
Air, house 10						

Sample	BADGE	BADGE-HCl	BADGE-2HCl	BADGE-H2O	BADGE-2H2O	BADGE-HCl-H2O	BFDGE	BFDGE-2HCl	BFDGE-2H2O
	ng/g or ng/L or ng/m3								
Influent VEAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent VEAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent VEAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent VEAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent VEAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent HIAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent HIAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent HIAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent HIAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Influent HIAS	n.d.	<21	<12	<5	<25	<12	<5	<4	<20
Effluent VEAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent VEAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent VEAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent VEAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent VEAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent HIAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent HIAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent HIAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent HIAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Effluent HIAS	n.d.	<15	<15	<14	<20	<15	<5	<10	<10
Sludge VEAS	n.d.	<4	<49	<3	<7	<25	<0	<1	<2
Sludge VEAS	n.d.	<4	<49	<3	<7	<25	<0	<1	<2
Sludge VEAS	n.d.	<4	<49	**5,0**	<7	<25	<0	<1	<2
Sludge VEAS	n.d.	<4	<49	<3	<7	<25	<0	<1	<2
Sludge VEAS	n.d.	<4	<49	<3	**11**	<25	<0	<1	<2
Sludge HIAS	n.d.	<4	<49	<3	<7	<25	<0	<1	<2
Sludge HIAS	n.d.	<4	<49	<3	<7	<25	<0	<1	<2
Sludge HIAS	n.d.	<4	<49	<3	<7	<25	<0	<1	<2
Sludge HIAS	n.d.	<4	<49	<3	<7	<25	<0	<1	<2
Sludge HIAS	n.d.	**16**	<49	<3	<7	<25	<0	<1	<2
Landfill leachate Lindum	n.d.	<160	<170	<220	<140	<100	<50	<35	<110
Landfill leachate Lindum	n.d.	<160	<170	<220	<160	<100	<50	<35	<110
Landfill leachate Lindum	n.d.	<160	<170	<220	<140	<100	<50	<35	<110
Landfill leachate Lindum	n.d.	<160	<170	<220	<180	<100	<50	<35	<110
Landfill leachate Lindum	n.d.	<160	<170	<220	<400	<100	<50	<35	<110
Surface water Mjøsa	n.d.	<15	<10	<15	<20	<12	<2	<3	<8
Surface water Mjøsa	n.d.	<15	<10	<15	<20	<12	<2	<3	<8
Surface water Mjøsa	n.d.	<15	<10	<15	<20	<12	<2	<3	<8
Surface water Mjøsa	n.d.	<15	<10	<15	<20	<12	<2	<3	<8
Surface water Mjøsa	n.d.	<15	<10	<15	<20	<12	<2	<3	<8
Sediment Mjøsa	n.d.	<10	<10	<5	<15	**78**	<2	<4	<8

Sample	BADGE	BADGE-HCl	BADGE-2HCl	BADGE-H2O	BADGE-2H2O	BADGE-HCl-H2O	BFDGE	BFDGE-2HCl	BFDGE-2H2O
	ng/g or ng/L or ng/m3								
Sediment Mjøsa	n.d.	<10	<10	<5	<15	**55**	<2	<4	<8
Sediment Mjøsa	n.d.	**30**	<10	<5	**52**	**63**	<2	<4	<8
Sediment Mjøsa	n.d.	<10	<10	<5	<15	<5	<2	<4	<8
Sediment Mjøsa	n.d.	<10	<10	<5	<15	**96**	<2	<4	<8
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Brown trout (fillet)	n.d.	<16	<47	<11	<28	<18	<8	<20	<34
Rat liver	n.d.	<62	<122	<30	<94	<55	<13	<28	<32
Rat liver	n.d.	<62	<122	<30	<94	<55	<13	<28	<32
Rat liver	n.d.	<62	<122	<30	<94	<55	<13	<28	<32
Rat liver	n.d.	<62	<122	<30	<94	<55	<13	<28	<32
Rat liver	n.d.	<62	<122	<30	<94	<55	<13	<28	<32
Dust, house 1	n.d.	<15	**100**	**9,0**	**1150**	**80**	<7	<11	<30
Dust, house 2	n.d.	<15	**55**	**23**	**2500**	**280**	<7	**44**	<30
Dust, house 3	n.d.	**80**	**180**	<5	**2070**	**220**	<7	<11	<30
Dust, house 4	n.d.	**20**	**65**	<5	**420**	**70**	**45**	<11	<30
Dust, house 5	n.d.	<15	**110**	<5	**2600**	**200**	<7	<11	<30
Dust, house 6	n.d.	**160**	**70**	**145**	**1550**	**35**	<7	<11	<30
Dust, house 7	n.d.	<15	**450**	<5	**470**	**150**	<7	<11	<30
Dust, house 8	n.d.	**375**	<28	**90**	**590**	**55**	<7	<11	<30
Dust, house 9	n.d.	**160**	**900**	<5	<170	**230**	<7	<11	<30
Air, house 1									
Air, house 2									
Air, house 3									
Air, house 4									
Air, house 5									
Air, house 6									
Air, house 7									
Air, house 8									
Air, house 9									
Air, house 10									

Sample	Propargite	NBBSulfone	OTP	BPA-BDPP	TPPT	PFPiA
	ng/g or ng/L or ng/m3					
Influent VEAS	<50	<250	<50	<50	<100	<100
Influent VEAS	<50	<250	<50	<50	<100	<100
Influent VEAS	<50	<250	<50	<50	<100	<100
Influent VEAS	<50	<250	<50	<50	<100	<100
Influent VEAS	<50	<250	<50	<50	<100	<100
Influent HIAS	<50	<250	**74**	<50	<100	<100
Influent HIAS	<50	<250	**107**	<50	<100	<100
Influent HIAS	<50	<250	**57**	<50	<100	<100
Influent HIAS	<50	<250	<50	<50	<100	<100
Influent HIAS	<50	<250	<50	<50	<100	<100
Effluent VEAS	<50	<250	<50	<50	<100	<100
Effluent VEAS	<50	<250	<50	<50	<100	<100
Effluent VEAS	<50	<250	<50	<50	<100	<100
Effluent VEAS	<50	<250	<50	<50	<100	<100
Effluent VEAS	<50	<250	<50	<50	<100	<100
Effluent HIAS	<50	<250	<50	<50	<100	<100
Effluent HIAS	<50	<250	<50	<50	<100	<100
Effluent HIAS	<50	<250	<50	<50	<100	<100
Effluent HIAS	<50	<250	<50	<50	<100	<100
Effluent HIAS	<50	<250	<50	<50	<100	<100
Sludge VEAS	<100	<500	<100	<100	<10	<10
Sludge VEAS	<100	<500	<100	<100	<10	<10
Sludge VEAS	<100	<500	<100	<100	<10	<10
Sludge VEAS	<100	<500	<100	<100	<10	<10
Sludge VEAS	<100	<500	<100	<100	<10	<10
Sludge HIAS	<100	<500	**173**	<100	<10	<10
Sludge HIAS	<100	<500	**322**	<100	<10	<10
Sludge HIAS	<100	<500	**213**	<100	<10	<10
Sludge HIAS	<100	<500	**281**	<100	<10	<10
Sludge HIAS	<100	<500	**138**	<100	<10	<10
Landfill leachate Lindum	<50	**302**	<50	<50	<100	<100
Landfill leachate Lindum	<50	**306**	<50	<50	<100	<100
Landfill leachate Lindum	<50	**362**	<50	<50	<100	<100
Landfill leachate Lindum	<50	**408**	<50	<50	<100	<100
Landfill leachate Lindum	<50	**478**	<50	<50	<100	<100
Surface water Mjøsa	<50	<250	<50	<50	<100	<100
Surface water Mjøsa	<50	<250	<50	<50	<100	<100
Surface water Mjøsa	<50	<250	<50	<50	<100	<100
Surface water Mjøsa	<50	<250	<50	<50	<100	<100
Surface water Mjøsa	<50	<250	<50	<50	<100	<100

Sample	Propargite	NBBSulfone	OTP	BPA-BDPP	TPPT	PFPiA
			ng/g or ng/L or ng/m3			
Sediment Mjøsa	<50	<250	<100	<50	<10	<10
Sediment Mjøsa	<50	<250	<100	<50	<10	<10
Sediment Mjøsa	<50	<250	<100	<50	<10	<10
Sediment Mjøsa	<50	<250	<100	<50	<10	<10
Sediment Mjøsa	<50	<250	<100	<50	<10	<10
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	**23**	<25	<10	<5	NA	NA
Brown trout (fillet)	9 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Brown trout (fillet)	10 > <25	<25	<10	<5	NA	NA
Rat liver	<10	<10	<10	<5	<10	<10
Rat liver	<10	<10	<10	<5	<10	<10
Rat liver	<10	<10	<10	<5	<10	<10
Rat liver	<10	<10	<10	<5	<10	<10
Rat liver	<10	<10	<10	<5	<10	<10
Dust, house 1	<100	<250	<250	<100	<10	<10
Dust, house 2	<100	<250	<250	<100	<10	<10
Dust, house 3	<100	<250	<250	**1123**	<10	<10
Dust, house 4	<100	<250	<250	<100	<10	<10
Dust, house 5	<100	<250	<250	<100	<10	<10
Dust, house 6	<100	<250	<250	<100	<10	<10
Dust, house 7	<100	<250	<250	**248**	<10	<10
Dust, house 8	<100	<250	<250	<100	<10	<10
Dust, house 9	<100	<250	<250	**799**	<10	<10
Air, house 1	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 2	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 3	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 4	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 5	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 6	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 7	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 8	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 9	<0,5	<1	<0,5	<0.2	NA	NA
Air, house 10	<0,5	<1	<0,5	<0.2	NA	NA

Sample	Di-n-octyltin	BCPS	Methyl- cedryl- ketone	Undecenyl crylene	Octocrylene
	ng/g or ng/L or ng/m3				
Influent VEAS	<5	<120	**3100**	<110	**4811**
Influent VEAS	<5	<25	**1500**	<120	**14946**
Influent VEAS	<5	<25	**1600**	<120	**15607**
Influent VEAS	<5	<25	**1800**	<120	**15316**
Influent VEAS	<5	<25	**1300**	<120	**13465**
Influent HIAS	<5	<130	**10800**	<150	**9770**
Influent HIAS	<10	<130	**9800**	<50	**8448**
Influent HIAS	<10	<160	**9500**	<80	**8880**
Influent HIAS	<10	<130	**12900**	<50	**5325**
Influent HIAS	<10	<160	**8800**	<110	**8348**
Effluent VEAS	<2	<10	**252**	<60	**892**
Effluent VEAS	<2	<10	**309**	<60	**934**
Effluent VEAS	<3	<10	**327**	<60	**1309**
Effluent VEAS	<3	<10	**297**	<60	**1253**
Effluent VEAS	<4	<10	**310**	<60	**1006**
Effluent HIAS	<2	<10	**720**	<60	**662**
Effluent HIAS	<3	<10	**700**	<100	**761**
Effluent HIAS	<3	<10	**630**	<80	**831**
Effluent HIAS	<3	<10	**690**	<80	**748**
Effluent HIAS	<2	<10	**780**	<80	**572**
Sludge VEAS	<12	<60	**4200**	<960	**350**
Sludge VEAS	<12	<60	**4900**	<1100	**457**
Sludge VEAS	<12	<60	<2700 *	<840	**366**
Sludge VEAS	<12	<60	**5100**	<940	**778**
Sludge VEAS	<12	<60	**4800**	<1300	**1402**
Sludge HIAS	<12	<70	**3800**	<1500	**2276**
Sludge HIAS	> 12 <30	<70	**3900**	<1800	**3239**
Sludge HIAS	**32**	<70	**4000**	<1900	**3315**
Sludge HIAS	> 12 <30	<70	**4600**	<1400	**6258**
Sludge HIAS	> 12 <30	<90	**4400**	<3000	**5998**
Landfill leachate Lindum	<100	<2600	<2700	<550	**1527**
Landfill leachate Lindum	<70	<1500	<2500	<1900	**1371**
Landfill leachate Lindum	<50	<2200	<3000	<1900	**2114**
Landfill leachate Lindum	<200	<3300	<2200	<4600	**1709**
Landfill leachate Lindum	<130	<3300	<2000	<2700	**1958**
Surface water Mjøsa	<0.5	<10	<15	<10	**102**
Surface water Mjøsa	<0.5	<10	<15	<10	**22**
Surface water Mjøsa	<0.5	<10	<15	<10	**115**
Surface water Mjøsa	<0.5	<10	<15	<10	**22**
Surface water Mjøsa	<0.5	<10	<15	<10	**17**

Sample	Di-n-octyltin	BCPS	Methyl-cedryl-ketone	Undecenyl crylene	Octocrylene
		ng/g or ng/L or ng/m3			
Sediment Mjøsa	<17	<20	<1400	<300	**46**
Sediment Mjøsa	<17	<20	**620**	<300	**397**
Sediment Mjøsa	<17	<20	**730**	<300	**191**
Sediment Mjøsa	<17	<20	<1500	<300	**47**
Sediment Mjøsa	<17	<20	<910	<300	**38**
Brown trout (fillet)	<0,6	<5	<10	<20	<5
Brown trout (fillet)	<0,9	<5	<15	<30	<10
Brown trout (fillet)	<0,9	<5	<15	<30	<5
Brown trout (fillet)	<0,9	<5	<25	<30	<10
Brown trout (fillet)	<0,9	<5	<25	<30	<10
Brown trout (fillet)	<0,9	<5	<25	<20	<5
Brown trout (fillet)	<0,9	<10	<40	<20	<5
Brown trout (fillet)	<0,9	<5	<25	<20	<10
Brown trout (fillet)	<1,4	<10	<50	<30	<10
Brown trout (fillet)	<1,4	<10	<90	<30	<10
Rat liver	<2,5	<15	<90	<10	NA
Rat liver	<2,5	<5	<20	<10	NA
Rat liver	<2,5	<5	<40	<10	NA
Rat liver	<1,5	<5	<20	<10	NA
Rat liver	<1,5	<5	<50	<10	NA
Dust, house 1	**165**	<30	<200	<400	**14000**
Dust, house 2	**43**	<300*)	<210	<400	**9600**
Dust, house 3	**7,1**	<20	**360**	<300	**960**
Dust, house 4	**22**	<25	**470**	<200	**760**
Dust, house 5	**13**	<75	**520**	<400	**110**
Dust, house 6	**19**	<50	**330**	<200	**9400**
Dust, house 7	**10,0**	<60	**1500**	<300	**510**
Dust, house 8	**9,4**	<200	**7200**	**320**	**94**
Dust, house 9	**34**	<50	**2100**	<500	**3300**
Air, house 1	NA	<0,2	**18**	NA	NA
Air, house 2	NA	<0,2	**31**	NA	NA
Air, house 3	NA	<0,2	**60**	NA	NA
Air, house 4	NA	<0,2	**113**	NA	NA
Air, house 5	NA	<0,2	**55**	NA	NA
Air, house 6	NA	<0,2	**36**	NA	NA
Air, house 7	NA	<0,2	**163**	NA	NA
Air, house 8	NA	<0,2	**87**	NA	NA
Air, house 9	NA	<0,2	**42**	NA	NA
Air, house 10	NA	<0,2	<2	NA	NA

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The Norwegian Environment Agency is working for a clean and diverse environment. Our primary tasks are to reduce greenhouse gas emissions, manage Norwegian nature, and prevent pollution.

We are a government agency under the Ministry of Climate and Environment and have 700 employees at our two offices in Trondheim and Oslo and at the Norwegian Nature Inspectorate’s more than sixty local offices.

We implement and give advice on the development of climate and environmental policy. We are professionally independent. This means that we act independently in the individual cases that we decide and when we communicate knowledge and information or give advice.

Our principal functions include collating and communicating environmental information, exercising regulatory authority, supervising and guiding regional and local government level, giving professional and technical advice, and participating in international environmental activities.