

Executive Summary - Biomonitoring research on dioxins (PCDD/F and DL-PCB), PFAS and PAH

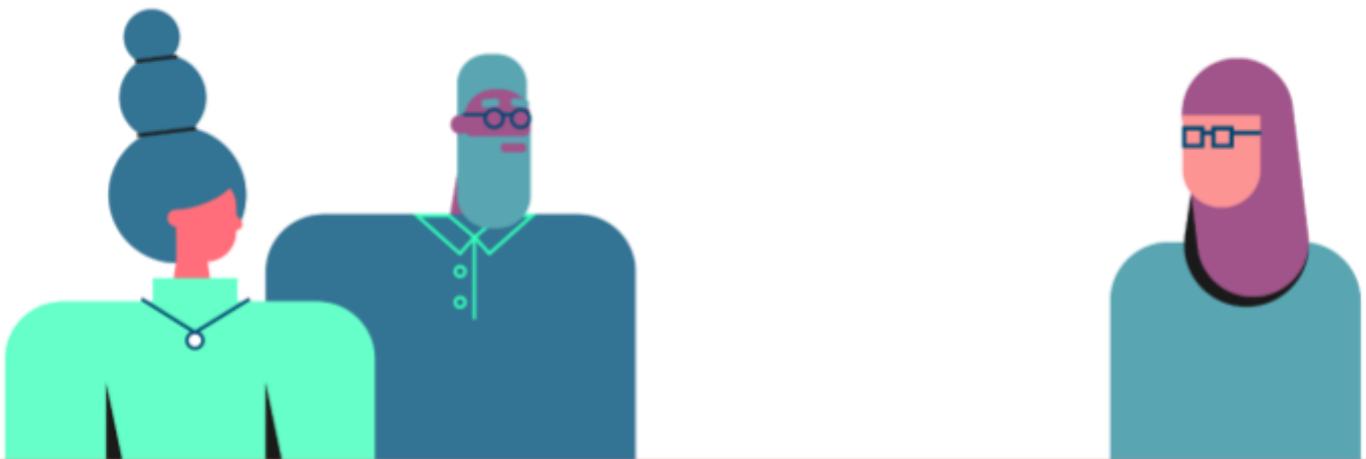
Kaunas, Madrid and Pilsen | 2022



Indicators

Chicken eggs | Moss | Pine needles





Acknowledgements

and credits

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AUTHORS

A. ARKENBOUT - Head of research at ToxicoWatch foundation

K. BOUMAN - Research assistant at ToxicoWatch foundation

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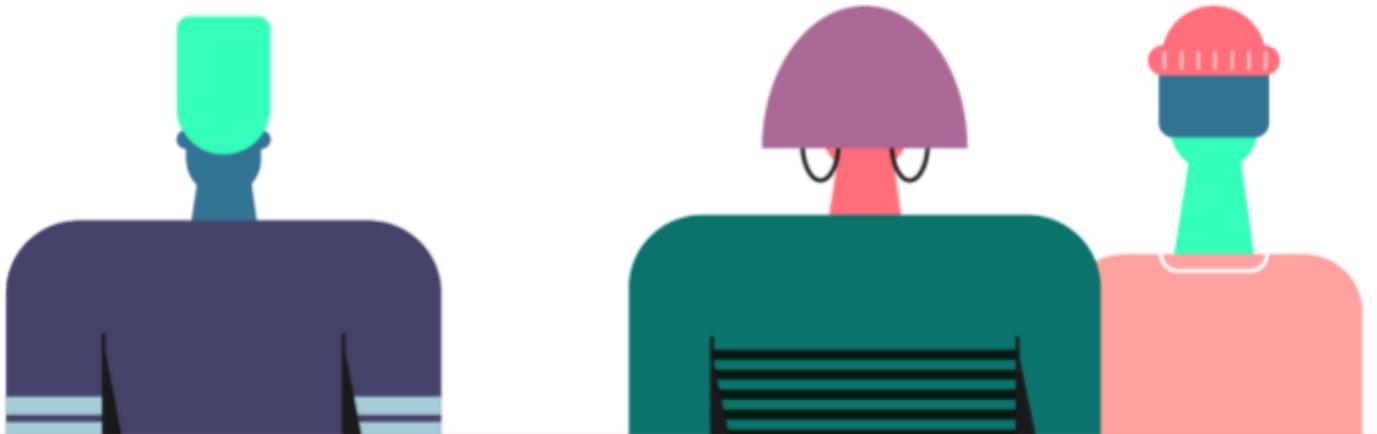


Table of abbreviations

Abbreviation	Meaning
APCD	Air Pollution Control Devices
BAT	Best Available Techniques
BEP	Best Environmental Practice
BEQ	Biological Equivalents
BMI	Body Mass Index
DL-PCB	Dioxin-Like Polychlorinated Biphenyls
DR CALUX®	Dioxin Responsive Chemical-Activated LUCiferase gene eXpression
dw	Dry Weight
EFSA	European Food and Safety Authority
FITC-T4	Fluorescein Isothiocyanate L-Thyroxine (T4)
GC-MS	Gas Chromatography Mass Spectrometry GC-MS
GenX	Group of fluorochemicals related to hexafluoropropylene oxide dimer acid (HFPO-DA)

i-PCB	Indicator Polychlorinated Biphenyl
LB	Lower Bound; results under detection limit are set to zero
LOD	Limit of Detection
LOQ	Limit of Quantification
MB	Middle Bound; values are set as half the detection limit values
MWI	Municipal Waste Incineration
NDL-PCB	Non-Dioxin-Like Polychlorinated Biphenyl (Non-Dioxin-Like PCB)
ng	Nanogram; 10 ⁻⁹ gram
OTNOC	Other Than Normal Operating Conditions
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzodioxins
PCDF	Polychlorinated Dibenzofurans

PFAS	Per- and PolyFluoroAlkyl Substances
pg	Picogram; 10 ⁻¹² gram
POP	Persistent Organic Pollutants
RPF	Relative Potency Factors
RvA	Dutch Accreditation Council
SVHC	Substances of Very High Concern
SWI	Solid Waste Incineration
TCDD	2,3,7,8-tetrachloordibenzo- <i>p</i> -dioxin
TDI	Tolerable Daily Intake
TEF	Toxic Equivalency Factor
TEQ	Toxic Equivalents
TOF	Total Organic Fluorine
TW	ToxicoWatch

TWI	Tolerable Weekly Intake
UB	Upper Bound (ub), results under detection limit are set as detection limit values.
µg	Microgram 10 ⁻³ gram
WtE	Waste to Energy (waste incinerator)

Abbreviation	Dioxins, furans (PCDD/F) and dioxin-like PCBs	Toxic equivalency factor
	Congeners	TEF
Dioxins (n=7)		
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1
PCDD	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1
HxCDD1	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0,1
HxCDD2	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0,1
HxCDD3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0,1

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HpCDD	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0,01
OCDD	Octachlorodibenzo-p-dioxin	0,0003
Furans (n=10)		
TCDF	2,3,7,8-Tetrachlorodibenzofuran	0,1
PCDF1	1,2,3,7,8-Pentachlorodibenzofuran	0,03
PCDF2	2,3,4,7,8-Pentachlorodibenzofuran	0,3
HxCDF1	1,2,3,4,7,8-Hexachlorodibenzofuran	0,1
HxCDF2	1,2,3,6,7,8-Hexachlorodibenzofuran	0,1
HxCDF3	1,2,3,7,8,9-Hexachlorodibenzofuran	0,1
HxCDF4	2,3,4,6,7,8-Hexachlorodibenzofuran	0,1
HPCDF1	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0,01
HPCDF2	1,2,3,4,7,8,9-Heptachlorodibenzofuran	0,01
OCDF	Octachlorodibenzofuran	0,0003

Polychlorinated biphenyl (n=12)		
PCB77	3,3',4,4'-Tetrachlorobiphenyl (#77)	0,0001
PCB81	3,4,4',5-Tetrachlorobiphenyl (#81)	0,0003
PCB126	3,3',4,4',5-Pentachlorobiphenyl (#126)	0,1
PCB169	3,3',4,4',5,5'-Hexachlorobiphenyl (#169)	0,03
PCB105	2,3,3',4,4'-Pentachlorobiphenyl (#105)	0,00003
PCB114	2,3,4,4',5-Pentachlorobiphenyl (#114)	0,00003
PCB118	2,3',4,4',5-Pentachlorobiphenyl (#118)	0,00003
PCB123	2,3,4,4',5-Pentachlorobiphenyl (#123)	0,00003
PCB156	2,3,3',4,4',5-Hexachlorobiphenyl (#156)	0,00003
PCB157	2,3,3',4,4',5'-Hexachlorobiphenyl (#157)	0,00003
PCB167	2,3',4,4',5,5'-Hexachlorobiphenyl (#167)	0,00003
PCB189	2,3,3',4,4',5,5'-Heptachlorobiphenyl (#189)	0,00003

Background information can be found in the 2021 TW Biomonitoring reports at

- www.toxicowatch.org
- www.zerowasteurope.eu/library/the-true-toxic-toll-biomonitoring-of-incineration-emissions

ToxicoWatch biomonitoring research on backyard chicken eggs and vegetation, such as pine needles and moss, as biomarkers is a European project coordinated by Zero Waste Europe. The project was run simultaneously in Lithuania, Spain and the Czech Republic in 2021 and 2022. The ToxicoWatch (TW) Foundation, based in the Netherlands, participated as a scientific partner together with three environmental organisations: for Spain, Ecologistas en Acción in Madrid, for Lithuania, Žiedinė Ekonomika, and for the Czech Republic, Hnutí DUHA.

The biomarkers were analysed for persistent organic pollutants (POPs), such as dioxins (PCDD/F and DL-PCB), Per- and PolyFluoroAlkyl Substances (PFAS) and Polycyclic Aromatic Hydrocarbons (PAH). The focus of this biomonitoring research is to analyse the deposition of POPs near three (3) WtE incinerators: UAB Kauno Cogeneration Power Plant (Kaunas, Lithuania), Valdemingómez waste-to-energy (WtE) incinerator (Madrid, Spain) and ZEVO Chotíkov (Pilsen, Czech Rep.).

The contamination does not just affect backyard chicken eggs. Increased amounts of hazardous persistent organic pollutants were also found in vegetation in the vicinity of the waste incinerators. To summarise the results for 2022, the second year of biomonitoring, in Kaunas, Pilsen and Madrid:

1. Most backyard chicken eggs in the vicinity of the three (3) incinerators exceeded EU limits for the DR CALUX bioassay and the GC-MS chemical analysis as regulated in EU Regulation 2017/644.
2. Analysis of the vegetation, pine needles and moss shows high concentrations of dioxins in the areas around the waste incinerators in all three (3) countries according to the DR CALUX bioassay.
3. High quantities of PFAS were found in moss, pine needles and backyard chicken eggs in all three (3) areas around the waste incinerators according to FITC-T4 bioassay measurements.
4. High levels of PAH were found in moss and pine needles around all three (3) waste incinerators according to the PAH CALUX bioassay.

An additional consideration is the limitations of chemical analysis (GC-MS) for POPs. It can determine individual congeners but does not, however, measure the total toxicity (of thousands of toxic substances) of dioxins and dioxin-like substances (PCDD/F and DL-PCB), PAH and PFAS. The DR CALUX bioassay does measure the total toxicity of dioxins and dioxin-like substances, while the chemical analysis (GC-MS) is limited to only 17 congeners, with the exclusion of brominated dioxins (PBDD/F). The FITC-T4 bioassay for analysis of total PFAS toxicity demonstrates the huge gap between the current chemical analysis of only four regulated PFAS compounds versus the total toxicity of thousands of other PFAS compounds, which could be present. Therefore, it is strongly recommended that bioassays should also be included as standard in the (EU) regulated monitoring of POPs from emission sources, such as waste incinerators.

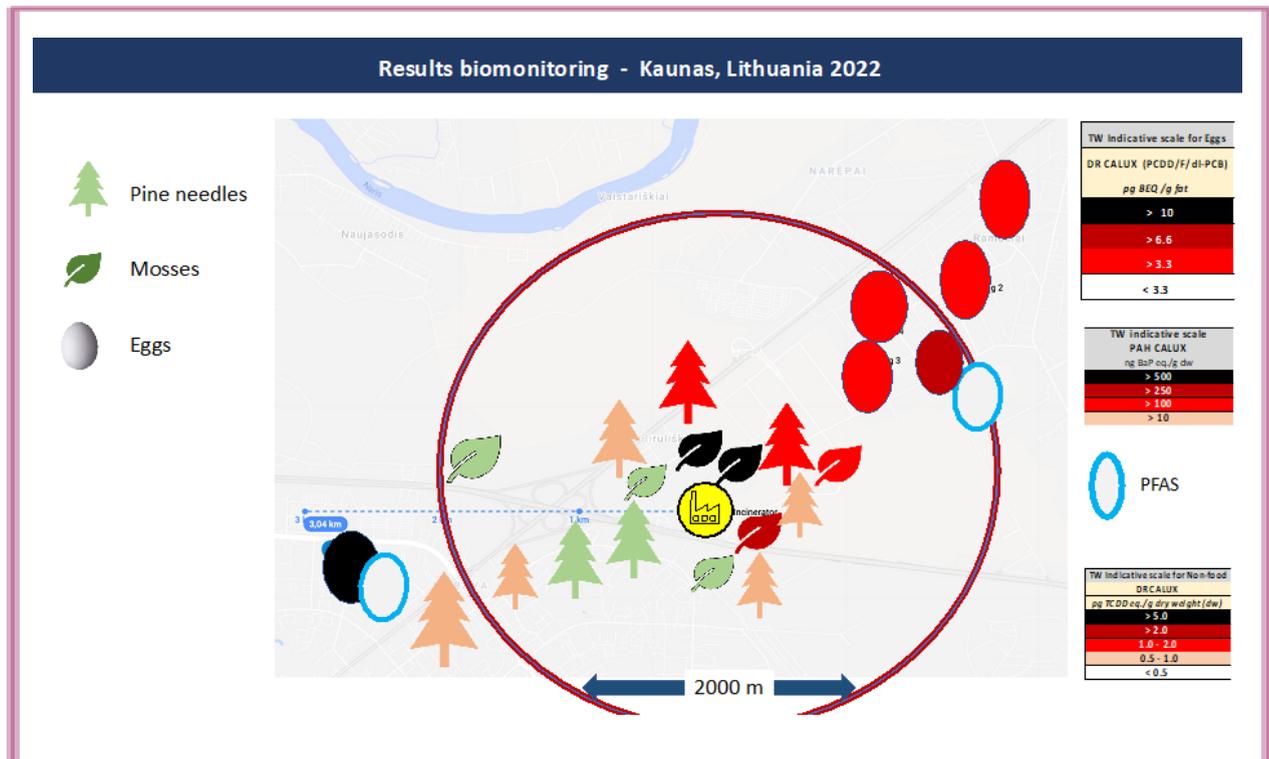
The most polluted area in this biomonitoring research was found to be near Valdemingómez in Madrid, which has one of the oldest waste incinerators in Europe. The Stockholm Convention on Persistent Organic Pollutants aims to protect human health and the

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environment through measures which will reduce and/or eliminate emissions and discharges of persistent organic pollutants.

Biomonitoring results for Kaunas, Lithuania, 2022

The infographic shows dioxin (PCDD/F and DL-PCB), PFAS and PAH contamination in the area around the UAB Kauno Cogeneration Power Plant waste incinerator (WtE).



Eggs

All of the backyard chicken eggs exceeded the EU limit in the bioassay for dioxins (PCDD/F) with dioxin levels increasing considerably in locations near the incinerator. One location was found to have an exceptionally high level of DL-PCB. Egg biomarkers in the northeast and west show elevated levels of dioxins and dioxin-like PCB. PFAS were found in eggs in the bioassay and the limited chemical analysis identified PFOS and GenX.

Moss

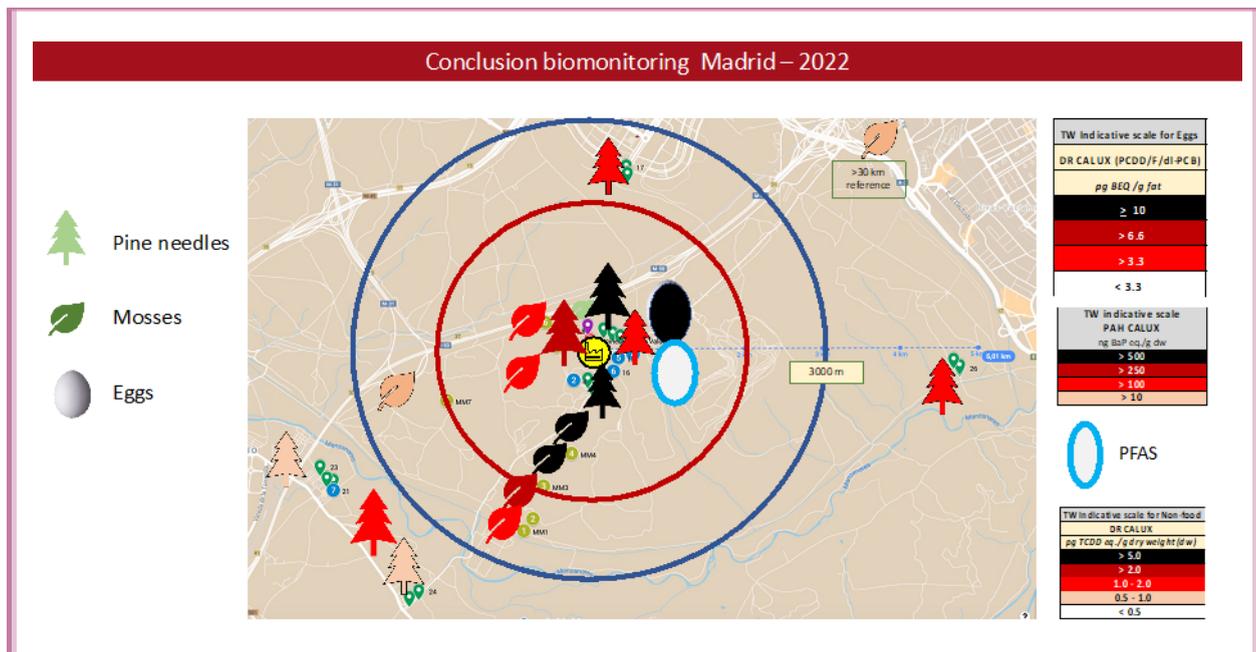
High levels of dioxins and furans (PCDD/F) were measured in moss in the area directly around the incinerator. The difference between the results of the bioassay and the chemical analysis indicates the contribution of substances not covered by the limited GC-MS analyses, such as brominated dioxins or other mixed halogenated substances. Dioxins in moss and pine needles were elevated in the area directly around the incinerator, in the northwest and west. In 2022, PAH were 20 times higher in moss northwest of the incinerator.

Pine needles

The DR CALUX bioassay analyses predominantly demonstrated an increase in dioxins (PCDD/F) in the vicinity of the waste incinerator. PAH were also detected in pine needles located in the east.

Biomonitoring results for Madrid, Spain, 2022

The infographic shows dioxins (PCDD/F and DL-PCB), PFAS and PAH contamination in the area around the Valdemingómez waste incinerator.



Eggs

In the second year of this biomonitoring research, levels of dioxins (PCDD/F and DL-PCB) were elevated, especially for dioxin-like PCB (DL-PCB) activity. PFAS exceeded the EFSA safety limit. The bioassay for PFAS (FITC-T4) found 500x PFAS activity in these eggs.

Moss

The pattern of elevated dioxins (PCDD/F and DL-PCB) in moss, most elevated 1500-2000 metres southwest, was found again in this research. The highest values for dioxins ever measured in a TW European biomonitoring survey were measured in the moss around Valdemingómez.

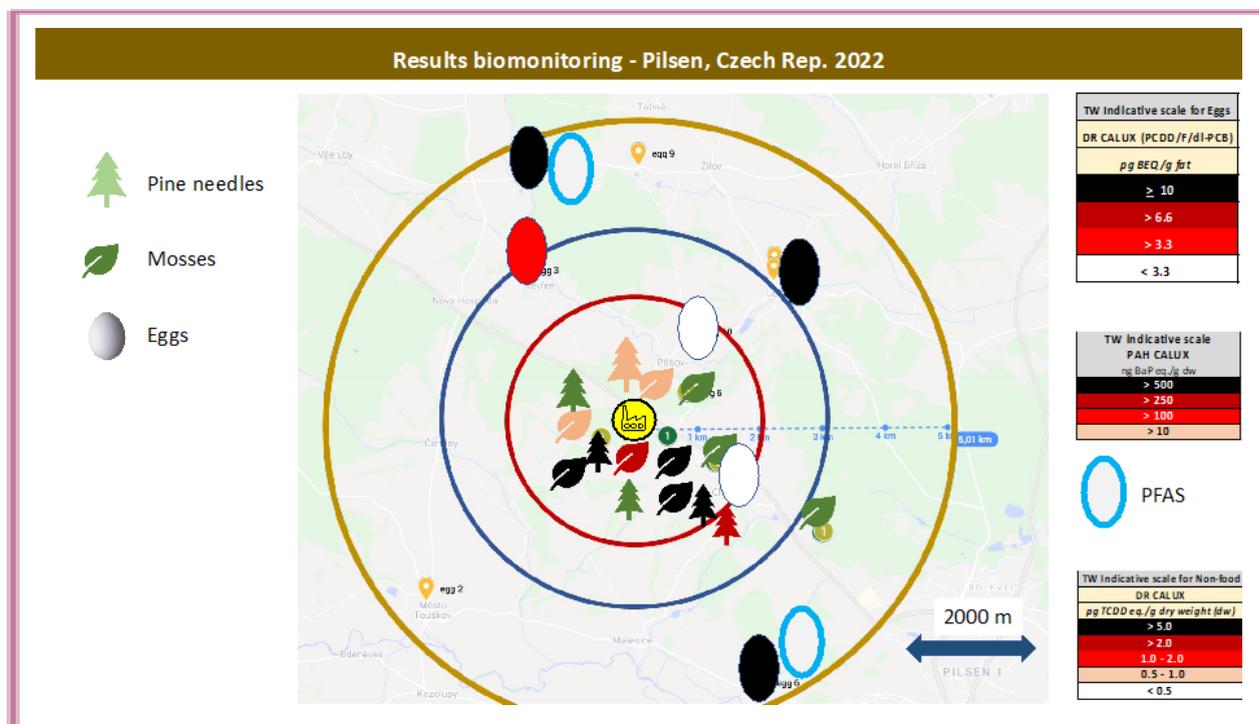
Pine needles

Pine needles and foliage from evergreen trees surrounding the fence around the waste incinerator had the highest levels of dioxins (PCDD/F and DL-PCB) ever measured in TW biomonitoring research, mostly due to the dioxins and furans (PCDD/F), a typical combustion-related emission value. A slight decrease was observed near the incinerator, as well as a considerable increase in dioxins (PCDD/F) in pine needles at a distance of 3000-5000 m. The dioxins and dioxin-like PCB (PCDD/F and DL-PCB) again showed the highest level found in pine needles in this TW biomonitoring research, as was also the case in 2021, the first year of this biomonitoring study.

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Biomonitoring results for Pilsen, Czech Rep., 2022

The infographic shows dioxin (PCDD/F and DL-PCB), PFAS and PAH contamination in the area around the ZEVO Chotíkov waste incinerator.



Eggs

Analyses on locations within 3000-5000 m show high levels of dioxins (PCDD/F), more than three times the EU limit values for bioassays and chemical analyses. Dioxin congener patterns are related to incomplete combustion. There was a significant increase in dioxin-like PCB (DL-PCB) in the eggs, although these substances have been banned for almost 40 years. With FITC-T4, high concentrations of PFAS were found and PFOS and GenX were identified in the chemical analysis.

Moss

Dioxins (PCDD/F and DL-PCB) were found in elevated concentrations northwest of the waste incinerator. Elevated levels of PFAS and PAH were found in moss 2000 m southwest, near the city of Pilsen.

Pine needles

Elevated levels of dioxins (PCDD/F and DL-PCB) were found in pine needles northeast of the incinerator. PFAS were found near the incinerator and in pine needles 2000 m east, near the city of Pilsen.



THE TRUE TOXIC TOLL

To find out more, please visit
www.zerowasteurope.eu



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