

ANALYTICAL RESULTS OF POPs SAMPLES FOR LEBANON

The data presented are the analytical results from the sampling conducted in Lebanon during 2023, analyzed by the Institut de Diagnòstic Ambiental i Estudis de l'Aigua – CSIC (Idaea-CSIC) in Barcelona in 2024.



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October 2024

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ACRONYMS

Acronym	Definition
11Cl-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid
4:2FTS	4:2 Fluorotelomer sulfonic acid
6:2diPAP	6:2 Fluorotelomer phosphate diester
6:2FTS	6:2 Fluorotelomer sulfonic acid
8:2diPAP	8:2 Fluorotelomer phosphate diester
8:2FTS	8:2 Fluorotelomer sulfonic acid
9Cl-PF3ONS	Perfluoro(2-((6-chlorohexyl)oxy)ethanesulfonic acid)
ADONA	3H-perfluoro-3-[(3-methoxy-propoxy)propanoic acid]
AFFF	Aqueous Film forming Foam
ECHA	European Chemicals Agency
EPS	Expanded polystyrene
FOET	1,1,2,2-Tetrahydroperfluoro-1-decanol
FOSA	Perfluorooctanesulfonamide
GenX	Perfluoro-2-propoxypropanoic Acid
HBCD	Hexabromocyclododecane
L-PFBS	Linear-perfluorobutane sulfonate
L-PFDoS	Linear-perfluorododecane sulfonate
L-PFDS	Linear-perfluorodecane sulfonate
L-PFHpS	Linear-perfluoroheptane sulfonate
L-PFHxS	Linear-perfluorohexane sulfonate
L-PFNS	Linear-perfluorononane sulfonate
L-PFOS	Linear-perfluorooctane sulfonate
L-PFPeS	Linear-perfluoropentane sulfonate
LOD	Limit Of Detection
N-EtFOSAA	N-ethyl perfluorooctane sulfonamido acetic acid
N-EtFOSA	N-ethyl perfluorooctane sulfonamide
N-MeFOSAA	N-methyl perfluorooctanesulfonamido acetic acid
OECD	Organisation for Economic Co-operation and Development
PF3Prop	3,3,3-trifluoroprop-1-ene
PFAS	Per- and polyfluoroalkylated substances
PFBA	Perfluorobutanoic acid
PFDA	Perfluorodecanoic acid
PFDaA	Perfluorododecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFMOAA	Perfluoro-2-methoxyacetic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctane sulfonate
PFOS-F	Perfluorooctane sulfonyl fluoride
PFPeA	Perfluoropentanoic acid
PFTeDA	Perfluorotetradecanoic acid
PFTTrDA	Perfluorotridecanoic acid
PFUdA	Perfluoroundecanoic acid
POPs	Persistent organic pollutants
ppm	Parts per million (mg/L)
PVC	Polyvinyl chloride
Ramboll	RAMBOLL IBERIA, S.L.
SCCPs	Short-chained chlorinated paraffins
XPS	Extruded polystyrene

TABLE OF UNITS

MAGNITUDE	UNITS	DESCRIPTION
Concentration	ng/ml	Nanograms per millilitre
Concentration	mg/kg	Milligrams per kilogram
Concentration	ng/g	Nanograms per gram
Concentration	µg/g	Micrograms per gram

1. INTRODUCTION AND OBJECTIVES

This report was produced to fulfill MedWaves' obligations for the MedProgramme Child Project 1.1 (GEF ID 9684). MedWaves is involved in the execution of the Mediterranean Sea Program (MedProgramme): Enhancing Environmental Security, funded by the Global Environment Facility Trust Fund (GEF), Reference: ID 9607, in collaboration with UNEP/MAP (as one of the executing agencies) and UNEP (as the implementing agency).

Under Component 1, MedWaves is involved in Child Project 1.1, which aims to improve human health and coastal habitats by reducing pollution from harmful chemicals (POPs and mercury) and waste in Mediterranean hotspots, while also measuring progress toward achieving impacts.

The data presented are the analytical results from the sampling conducted in Lebanon during 2023, analyzed by the Institut de Diagnòstic Ambiental i Estudis de l'Aigua – CSIC (Idaea-CSIC) in Barcelona in 2024.

The aim of this report is to make the **assessment of the analytical quantities detected on samples taken in Lebanon**.

Finally, this report plans to clarify what would be the **necessary actions to be taken by Lebanon for the mitigation of environmental impacts caused by the analysed persistent organic pollutants (POPs)**, based on the results obtained from the performed analyses. It is noted that this assessment is necessarily limited given the limited available data, and that the conclusions and recommendations should be revised and updated as additional information becomes available.

2. ASSESSMENT OF SAMPLING RESULTS ON LEBANON

2.1 PFOS assessment

2.1.1 Introduction and methodology

Perfluorooctane sulphonate (PFOS) is a fully fluorinated anion, the related compounds of which are members of the large family of perfluoroalkyl sulphonate substances (PFAS). The majority of PFOS related substances are polymers of high molecular weights in which PFOS is only a fraction of the polymer and final product. Detailed nomenclature of PFAS compounds and categories can be found¹. It must be taken into account the complexity of PFAS classification and nomenclature, e.g. OECD defines PFAS as any compound containing a fully fluorinated methyl or methylene group on an alkane functional group; in contrast, the US EPA requires a PFAS compound to contain at least two adjacent, saturated carbons with one carbon fully fluorinated and the other at least partially fluorinated.

A summary of PFAS classification according to OECD shows:

- Perfluoroalkyl carbonyl compounds
- Perfluoroalkane sulfonyl compounds
- Perfluoroalkyl phosphate compounds
- Fluorotelomer-related compounds
- Per- and polyfluoroalkyl ether-based compounds
- Other PFAA precursors and related compounds - perfluoroalkyl ones
- Other PFAA precursors or related compounds – semifluorinated
- Fluoropolymers

The objective of the campaign performed in Lebanon was the analysis of PFOA, PFHxS and PFOS, as well as 14 other perfluorinated compounds, in firefighting foam samples (AFFF – aqueous film forming foams), as well as sediments or groundwater samples. The analytical methods included liquid chromatography coupled with a QExactive high-resolution analyzer (HPLC-QExactive). Quantification of each isomer was carried out by isotopic dilution.

¹ Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance, OECD Series on Risk Management of Chemicals, OECD Publishing, Paris, OECD 2021. Available at: <https://doi.org/10.1787/e458e796-en>.

Table 1 presents the summary of the sampling procedure applied in Lebanon. This included 5 locations overall, from which 4 samples are properly firefighting foams, divided on aqueous film forming foams (AFFF)² and Gel Foams³, the other 3 samples are for sediments on the different locations where a fire had occurred, and where firefighting foams were presumably used.

Table 1. Summary of the sampling on PFAS in Lebanon.

	Company, address	Foam type description	GPS	Quantity	Sampling protocol	Sampling date
1	Beirut Fire Brigade-Karantina	Foam storage / Foam Class A	https://goo.gl/maps/z6AwfrmxZRB9N9eLA	500 ml	A	10/04/2023
	Beirut Fire Brigade-Martyrs Adel Saade and Mohammad Mawla Station	Foam storage / Foam AFFF	https://goo.gl/maps/qAeyN8CbBeShWN5J6	500 ml	A	10/04/2023
		Foam storage / Gel Foam	https://goo.gl/maps/z6AwfrmxZRB9N9eLA	500 ml	A	10/04/2023
2	Airport Fire Department Or Civil Defense. (Note: same supplier and same types of foam used as in Beirut fire brigade: FAAA, gel, and standard foam, hence samples not collected)	Foam storage	https://goo.gl/maps/MQAnVfFdbJsPpZj49	1	A	N/A
		Foam storage		1	A	
3	Fire Incident Site - Location: Safra	Nearby sediments	https://goo.gl/maps/5zW2oErk844rMzdT9	136 g	B	10/04/2023
4	Fire Incident Site - Location: Ain El Remmane*	Paint and rock samples	https://goo.gl/maps/eoyb8vrnR5an9wwU9	100 g	B	10/04/2023
5	Fire Incident Site - Location: Mazraat Yachou 3	Nearby sediments	https://goo.gl/maps/jTi4uU8ipgiGHDP29	90 g	B	10/04/2023
		Nearby sediments		1	B	

* Note: No sediments found, paint and rock samples where fire traces were still evident.

2.1.2 Results

Table 2 shows the results of samples taken at Martyrs Adel Saade and Mohammad Mawla Station and Karantina on AFFF and Gel Foam samples.

Table 2. PFAS sampling results in AFFF and Gel samples on Lebanon. Concentration in ng/ml.

	Martyrs Adel Saade and Mohammad Mawla Station				Karantina Foam Class A	
	AFFF		Gel Foam		Mean	SD
	Mean	SD	Mean	SD		
PFBA	467	93.4	Nd		Nd	
PFPeA	186	27.9	Nd		Nd	
PFHxA	1431	243	5.76	0.75	5.16	0.51
PFHpA	10.9	0.98	Nd		Nd	
PFOA	215	23.4	Nd		Nd	

² Information provided indicates that as an example AFFF was "Chemguard 3% AFFF C-303" that according to its Safety Data Sheet contains a mixture of fluorosurfactant but it doesn't disclosure the concentration.

³ Information provided indicates that a "Gel Foam" is the commercial name of a product from the company Mountain Grout, it does not include any ingredient containing fluoralkylated substances.

	Martyrs Adel Saade and Mohammad Mawla Station				Karantina Foam Class A	
	AFFF		Gel Foam		Mean	SD
	Mean	SD	Mean	SD		
PFNA	Nd		Nd		Nd	
PFDA	Nd		Nd		Nd	
PFUdA	Nd		Nd		Nd	
PFDoA	145	36.2	Nd		Nd	
PRTTrDA	Nd		Nd		Nd	
PFTeDA	54.5	2.18	Nd		Nd	
FOSA	Nd		Nd		Nd	
N-MeFOSAAA	Nd		Nd		Nd	
N-EtFOSAA	Nd		Nd		Nd	
L-PFBS	Nd		Nd		Nd	
L-PFPeS	Nd		Nd		Nd	
L-PFHxS	Nd		Nd		Nd	
L-PFHpS	Nd		Nd		Nd	
L-PFOS	Nd		3.20	0.38	Nd	
L-PFNS	Nd		Nd		Nd	
L-PFDS	Nd		Nd		11.4	1.48
L-PFDoS	Nd		Nd		Nd	
4:2FTS	659	98.8	Nd		Nd	
6:2FTS	3152	315	53.6	8.58	Nd	
8:2FTS	1988	358	19.8	2.98	Nd	
9CI-PF3ONS	Nd		Nd		Nd	
11CI-PF3OUdS	Nd		Nd		Nd	
6:2diPAP	Nd		Nd		Nd	
FOET	Nd		Nd		Nd	
PFMOAA	Nd		Nd		Nd	
PF3Prop	Nd		Nd		Nd	
ADONA	Nd		Nd		Nd	
Gen X	Nd		Nd		Nd	
N-MeFOSA	Nd		Nd		Nd	
N-EtFOSA	Nd		Nd		Nd	

Nd: Not detected peak.

LOQ: Limit of Quantification.

Figure 1 shows the PFAS sampling results on AFFF and Gel Foam samples.

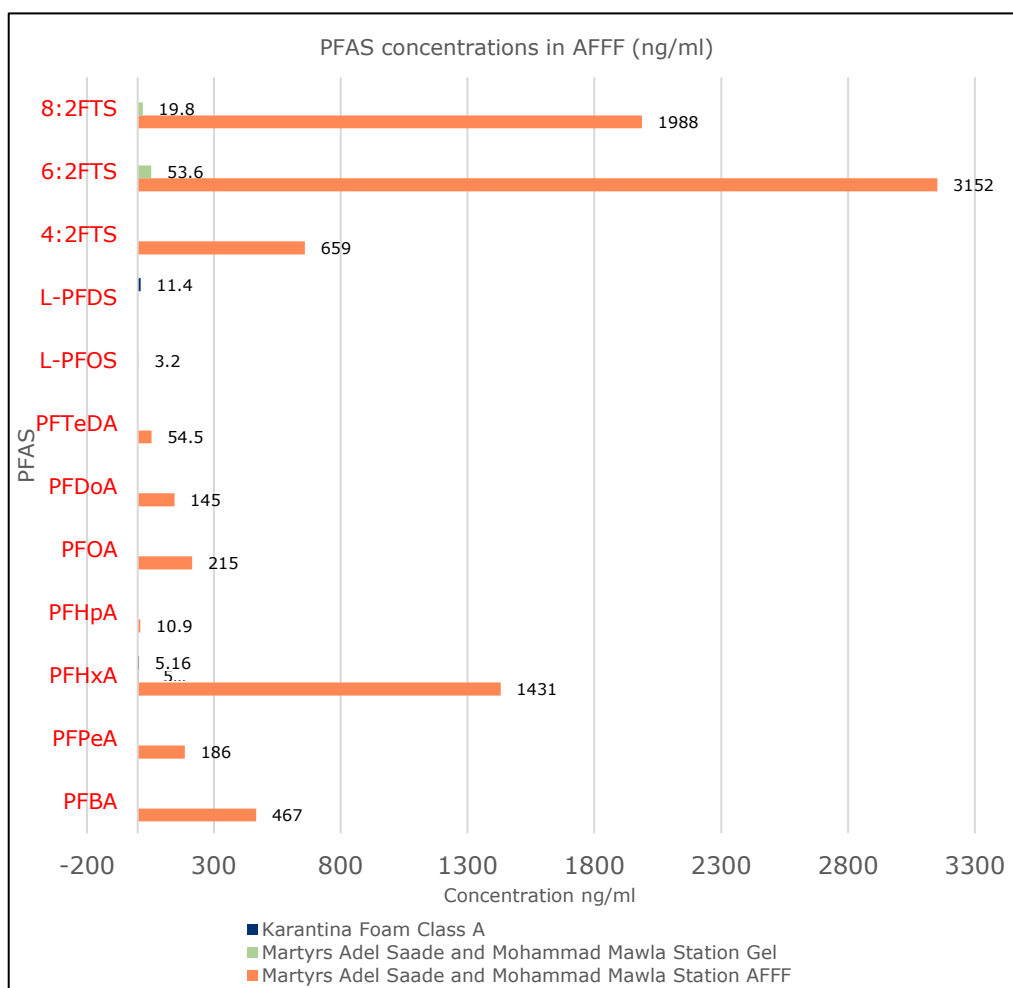


Figure 1. PFAS sampling results in AFFF and Gel samples from Lebanon. Concentration (ng/ml).

2.1.3 Data assessment

PFAS were detected above the LOD in 29 % of the studied samples. The highest concentration was detected in AFFF from Martyrs Adel Saade and Mohammad Mawla Station, with the highest concentrations corresponding to fluorotelomers showing the following concentration sequence: 6:2 FTS > 8:2 FTS > 4:2 FTS, concentrations detected were 3152 > 1988 > 659 ng/ml, respectively.

It is also noted that PFHxA, the alternative to PFOS in AFFF since 2009, was detected at 1431 ng/ml. PFOA was also present in these samples at 215 ng/ml, whereas PFOS was not found on AFFF but was positively found in Gel samples in 3.2 ng/ml. Other PFAS compounds as longer perfluorinated chains were also found as PFTeDA 54.5 ng/ml and PFDaA 145 ng/ml, shorter perfluorinated chains compounds were found in even bigger amounts comparing to the longer ones, e.g. PFBA 467 ng/ml, PFPeA 186 ng/ml and PFHpA 10.9 ng/ml. The sampling results show that Gel Foam samples did not present other PFAS compounds although the already mentioned 6:2FTS. And regarding the Karantina samples it is observed that small traces of PFHxA are present (5.16 ng/ml), and L-PFDS is also present as 11.4 ng/ml.

It is noted that according to the Stockholm Convention the maximum allowed quantities are presented in Table 3:

Table 3. Maximum allowed levels according to Stockholm Convention for perfluorinated substances.

	Threshold in mg/kg	Threshold in ng/ml
PFOA, its salts and compounds related to PFOA	≤1 mg/kg	≤1 ng/ml
Sum of related compounds to PFOA	≤40 mg/kg	≤40 ng/ml
PFHxS and its salts	≤0,025 mg/kg	≤0,025 ng/ml
Sum of related compounds to PFHxS	≤1 mg/kg	≤1 ng/ml
PFHxS and its salts present in mixtures concentrated foam	≤0,1 mg/kg	≤0,1 ng/ml
Perfluorocarboxylic acids with a content of 9 to 14 atoms of carbon in the chain (C9-C14 PFCA), its salts and related substances with the C9-C14 PFCA, sum of C9-C14 PFCAs and it salts	<0,025 mg/kg	<0,025 ng/ml
Sum of substances related to C9-C14 PFCA	<0,260 mg/kg	<0,260 ng/ml

Note: to avoid density considerations the OECD report "Emission scenario document on the use of aqueous film forming foams in firefighting" has been considered, a default value of 1 kg/l permits to compare mg/kg with ng/ml⁴.

It is noted that those **fluorotelomers with a six-carbon perfluorohexyl chain**, including 6:2 fluorotelomer-based compounds are not banned in AFFF formulations.

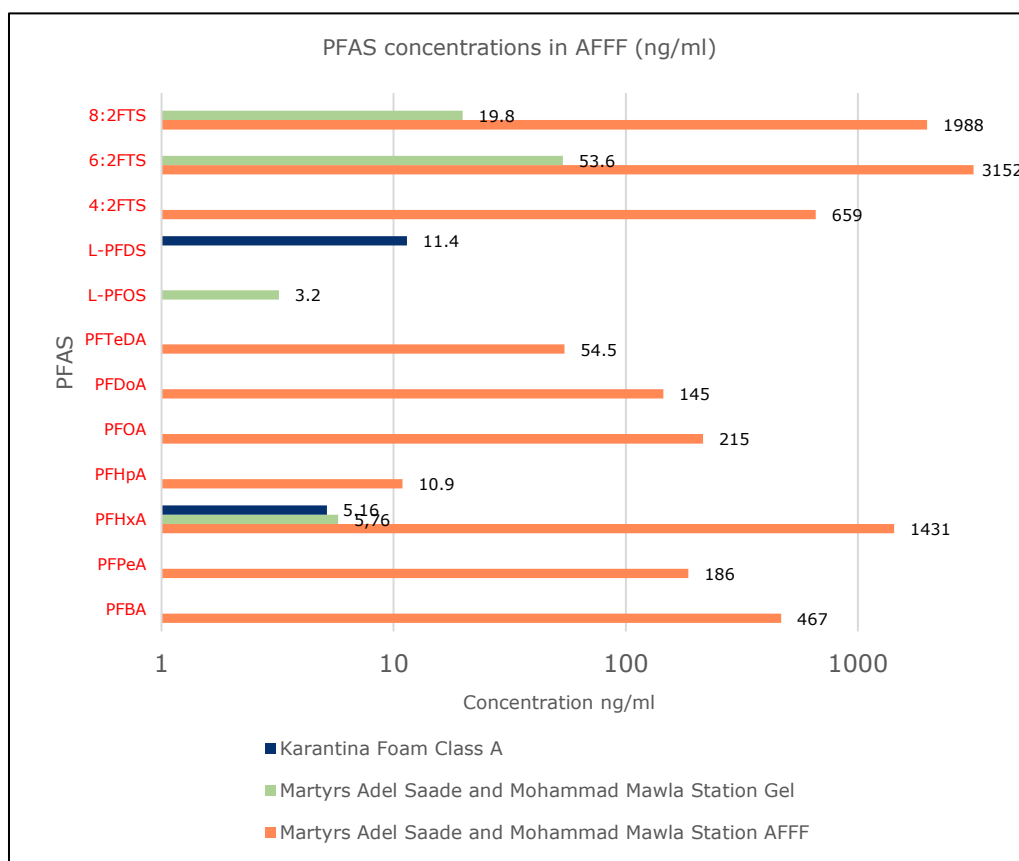


Figure 2. PFAS sampling results in AFFF and Gel samples from Lebanon expanded. Concentration (ng/ml).

⁴ Based on the OECD recommendation on PFOS in the document default value is taken 1 kg/L. *Emission scenario document on the use of aqueous film forming foams in firefighting*. Series on Emission Scenario Documents. ENV/CBC/MONO(2021)5. Environment Directorate Organisation for Economic Cooperation and Development. Paris. February 2021. Available at: [pdf \(oecd.org\)](https://www.oecd.org/)

Comparing with Table 3 and Figure 2, it is possible to check that all compounds were detected above the maximum permitted levels, e. g. PFHxS is exceeded more than 10,000 times in Martys Adel Saade and Mohammad Mawla Station in the sample taken of AFFF, and long-chained (C9-C4): PFTeDA and PFDoA sum, exceed the limits 1,000 times. In Karantina, PFHxA was detected in 5.16 mg/ml, exceeding 100 times the limits, and L-PFDS is almost the same, exceeding the threshold in approximately a 100 times.

Table 4 shows the results of samples taken at Maraat Uachou 3, Safra and Ain El Remmane in sediments samples corresponding to fire sites where AFFF have been used.

Table 4. PFAS sampling results in sediments from Lebanon. Concentrations in ng/g.

	Mazraat Yachou 3			Safra		Ain El Remmane	
	Mean	SD		Mean	SD	Mean	SD
PFBA	< MLOQ			0.026	0.01	4.30	1.81
PFPeA	< MLOQ			Nd		18.3	7.85
PFHxA	Nd			Nd		40.6	9.07
PFHpA	Nd			0.052	0.004	11.7	2.93
PFOA	Nd			Nd		2.63	0.19
PFNA	0.035	0.01		0.069	0.006	4.59	0.54
PFDA	0.264	0.04		0.092	0.001	0.148	0.02
PFUdA	0.265	0.04		0.036	0.003	0.034	0.002
PFDoA	0.224	0.01		0.058	0.012	0.041	0.01
PRTTrDA	0.084	0.02		Nd		0.009	0.002
PFTeDA	9524	1358		Nd		3635	746
FOSA	Nd			Nd		Nd	
N-MeFOSAAA	Nd			Nd		Nd	
N-EtFOSAA	Nd			Nd		Nd	
L-PFBS	Nd			Nd		Nd	
L-PFPeS	Nd			Nd		Nd	
L-PFHxS	Nd			Nd		Nd	
L-PFHpS	Nd			Nd		Nd	
L-PFOS	Nd			Nd		Nd	
L-PFNS	Nd			Nd		Nd	
L-PFDS	Nd			Nd		Nd	
L-PFDoS	Nd			Nd		Nd	
4:2FTS	Nd			Nd		3.05	1.99
6:2FTS	Nd			Nd		90.3	1.13
8:2FTS	Nd			0.065	0.003	0.70	0.08
9CI-PF3ONS	Nd			Nd		Nd	
11CI-PF3OUdS	Nd			Nd		Nd	
6:2diPAP	Nd			Nd		Nd	
FOET	Nd			Nd		Nd	
PFMOAA	Nd			Nd		Nd	
PF3Prop	Nd			Nd		Nd	

	Mazraat Yachou 3			Safra		Ain El Remmane	
	Mean	SD		Mean	SD	Mean	SD
ADONA	Nd			Nd		Nd	
Gen X	45.7	7.84		21.9	5.41	13.2	1.59
N-MeFOSA	3.54	0.084		0.523	0.078	1.93	0.408
N-EtFOSA	Nd					2.11	0.151

Nd: Not detected peak.

LOQ: Limit of Quantification.

Figures 3 and 4 show the PFAS sampling results in sediment samples.

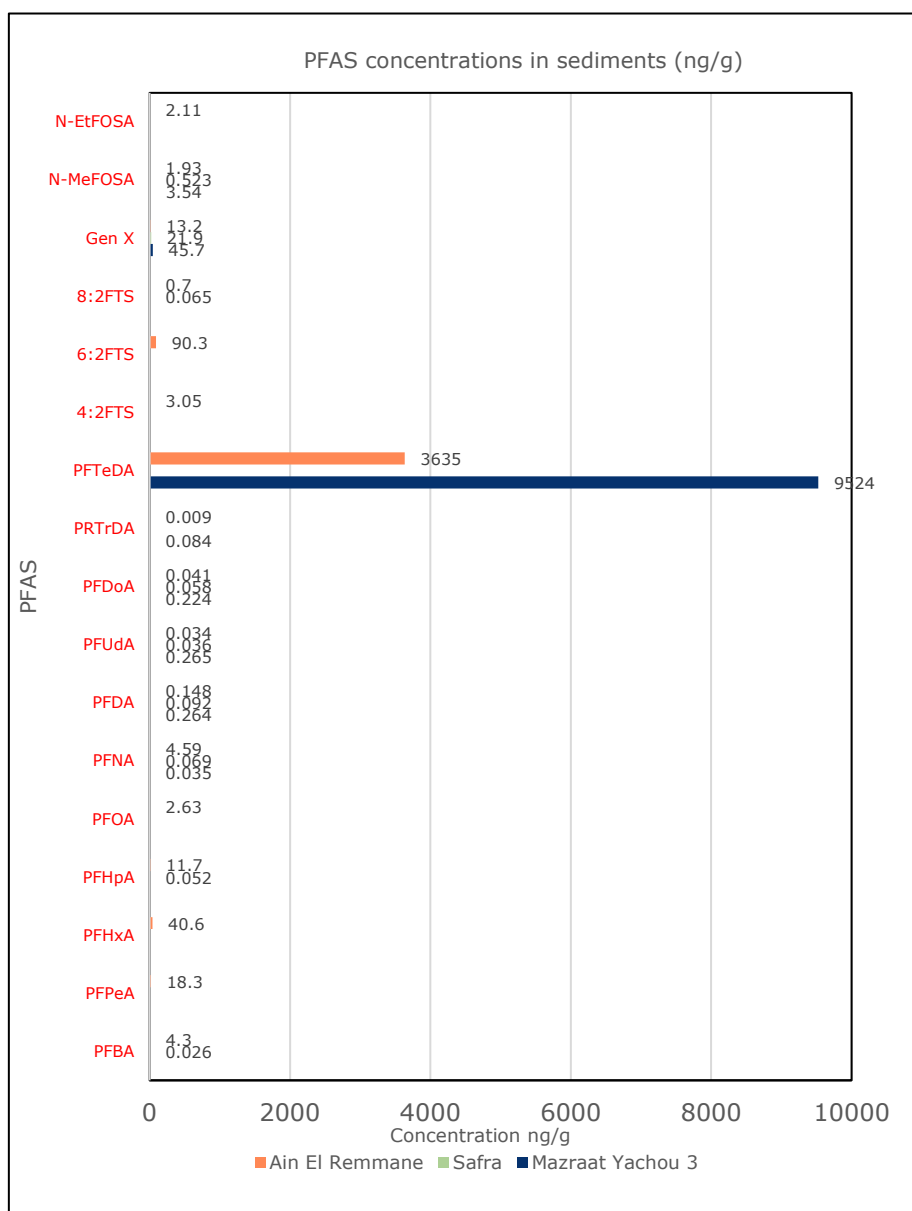


Figure 3. PFAS sampling results in sediment from Lebanon. Concentration (ng/g).

The Figure 3 provides information in sediment analysis that indicates that in two of the three investigated sites a large proportion of PFTeDA is detected: in Mazraar Tachou at 9,524 ng/g and in Ain

El Rammane at 3,635 ng/g. The concentrations of other detected compounds are in the order of three to four orders of magnitude lower.

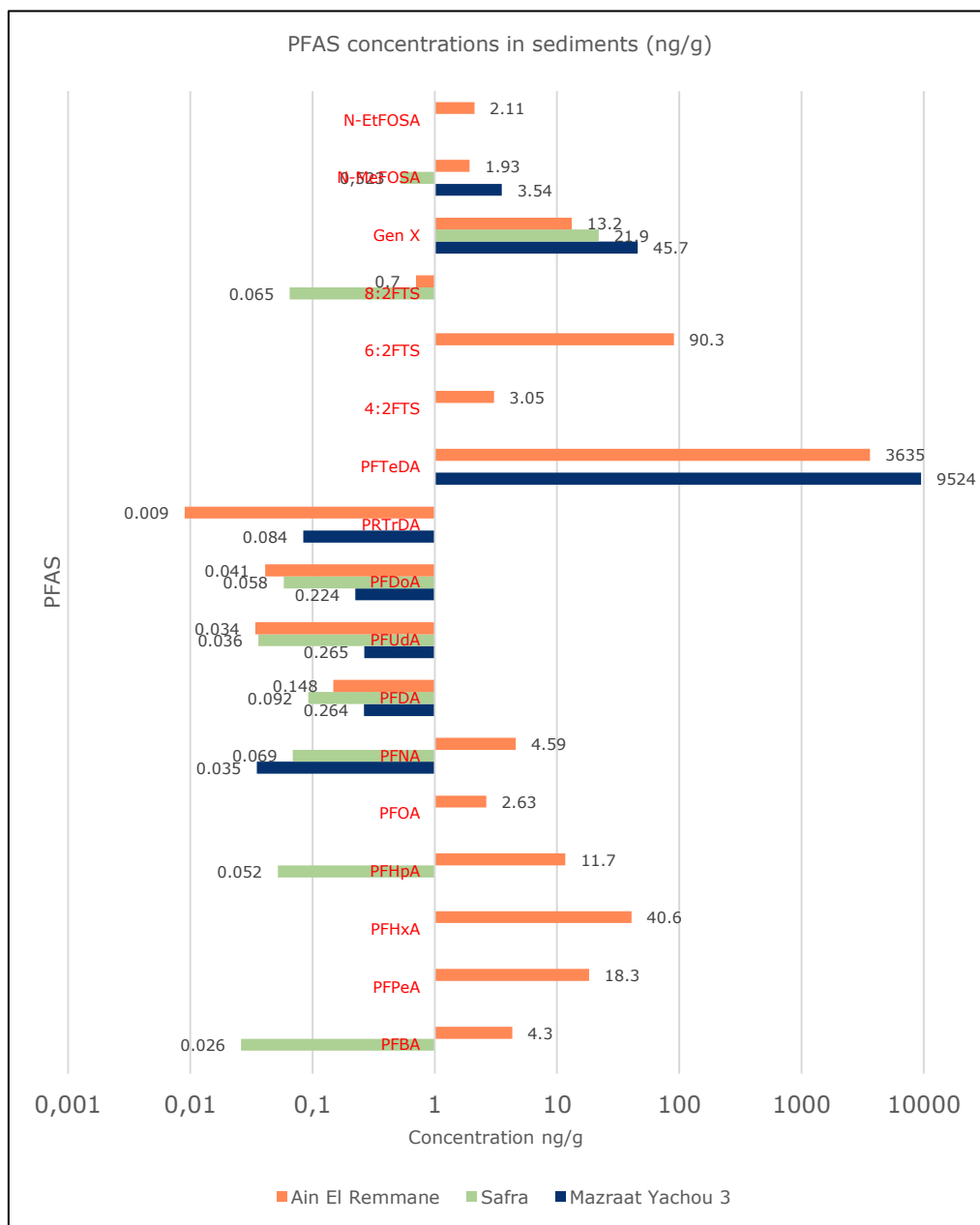


Figure 4. PFAS sampling results in sediment from Lebanon expanded. Concentration (ng/g).

Figure 4 shows that the fluorotelomer 6:2FTS is still detected mostly in sediments (90.3 ng/g) but then we would highlight for example, GenX detected in Mazraat Yachou in amounts of 45.7 ng/g. PFOS was not detected in sediments and PFOA only in Ain El Remmane sediments at 2.93 ng/g. Due to the different amount of PFAS found in Ain El Remmane it seems likely that degradation of PFAS has occurred.

In the case of the Safra sediments sample, it seems that the firefighting compounds used were based on GenX (21.9 ng/g) and a number of other products have also been detected (PFDaA 0.058 ng/g, PFUdA 0.036 ng/g, PFDA 0.092 ng/g, PFNA 0.069 ng/g, PFHpA 0.052 and PFBA 0.026 ng/g), not clear where which could be the source.

It is not possible to perform a comparison with any threshold since Stockholm Convention has not established any limit for soil or sediments for these substances.

2.2 HBCD assessment

2.2.1 Introduction and methodology

Hexabromocyclododecane (HBCD) is a brominated flame retardant that has been added to EPS/XPS both pellets and panels. This compound has three different isomers (alpha, beta and gamma) that have been analysed in EPS/XPS samples taken in Lebanon. The quantitative analytical method used includes a detection by liquid chromatography coupled with tandem mass spectrometry (LC-MS-MS) and a subsequent quantification carried out by isotopic dilution.

Table 5 shows the description of samples collected at different companies in Lebanon. The samples were collected both from pellets and from panels EPS.

Table 5. Resume of the sampling on HBCD in Lebanon.

	Company, address	Foam type	GPS	Quantity	Protocol	Collection date
1	CMC XPS insulation board	Pannels EPS	https://goo.gl/maps/hVirsTXCQyrjTk3i6	26 g	D	12/04/2023
		Pannels EPS		1	D	
		Pannels EPS		1	D	
2	Hincra XPS insulation board	Pannels EPS	https://goo.gl/maps/kUgjadvU3bBjwEMSA	28 g	D	13/04/2023
3	Kilzi and Co.	Pellets EPS	https://goo.gl/maps/kNeM9183WDeXPFEQZ	79 g	D	19/04/2023
		Pannels EPS	https://goo.gl/maps/kNeM9183WDeXPFEQZ	39 g	D	19/04/2023
		Pannels EPS		1	D	

2.2.2 Results

Table 6 shows the quantity of HBCD isomers and sum of isomers of samples collected at different companies from Lebanon. The samples were collected both from pellets and from panels EPS.

Table 6. HBCD sampling results on pellets and panels EPS on Lebanon. Concentrations in ng/g.

	α -HBCD	β -HBCD	γ -HBCD	Sum of isomers
Kilzi and Co Pannels EPS	53.3	6.65	16.0	75.95
Kilzi and Co Pellets EPS	< LOD	< LOD	< LOD	0,00
Hincra XPS insulation board	4.33	< LOD	< LOD	4,33
CMC XPS insulation board	221	33.1	87.5	341.60

LOD: Limit of Detection.

Figure 5 shows the HBCD sampling results in pellets and panels EPS from Lebanon.

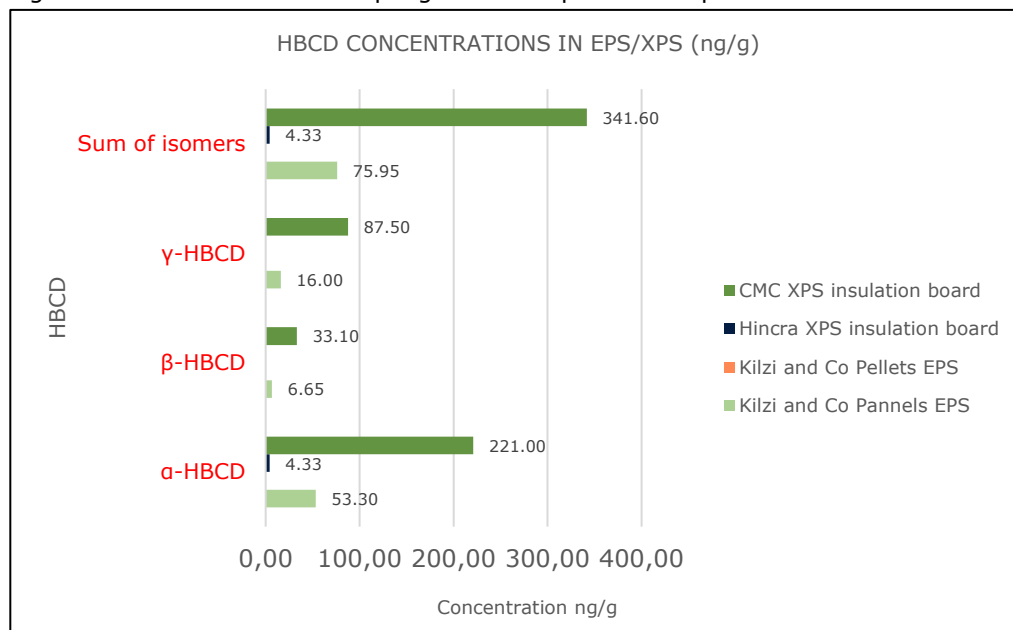


Figure 5. HBCD sampling results on pellets and EPS on Lebanon. Concentration (ng/g).

2.2.3 Data assessment

It is observed that CMC XPS is the company that shows major amounts of HBCD on its panels with 341.60 ng/g. According to the reference level set in the Stockholm Convention that is 100 ng/g, it is exceeded about 3 times.

The second one is Kilzi and Co Panels with 75.95 ng/g. This value it is not above the limits.

For pellets HBCD was not detected during the sampling performed in Lebanon. This may indicate that the new purchases do not contain HBCD in agreement with the international bans.

According to European Regulation following Stockholm Convention decisions, Regulation (EU) 2019/1021 on persistent organic pollutants, it can not be exceeded concentrations of HBCD equal to or below 100 mg/kg (0,01 % by weight) where it is present in substances, mixtures, articles or as constituents of the flame-retarded articles, **in wastes concentration limit for HBCD is 50 mg/kg.**

Lebanon legislation in wastes, Law N° 444 of 29/07/2002 does not include HBCD yet.

2.3 SCCPs assessment

2.3.1 Introduction and methodology

The Lebanon sampling objective was the analysis of SCCPs in samples of PVC pellets, considering that SCCPs are a group of substances, not an individual one. The identification of these SCCPs in the sample was implemented by gas chromatography coupled to mass spectrometry (GC-MS), using negative chemical ionization. The quantification of these substances was carried out by means of multiple linear regression.

Table 7. Summary of the sampling of SCCPs in Lebanon.

	Company, address	Foam type	GPS	Quantity (g)	Protocol	Sampling date
1	Liban cables - Seven Plast, Antelias, Lebanon	Pellets PVC 86	https://goo.gl/maps/oCd2ygdeqYji3Hgg8	28	C	
2		Pellets PVC (CS Egyplast)	https://goo.gl/maps/oCd2ygdeqYji3Hgg8	51	C	
3		Pellets PVC (Cobopol T1)	https://goo.gl/maps/oCd2ygdeqYji3Hgg8	55	C	

2.3.2 Results

The analytical results are presented below.

Table 8. SCCPs samples from Lebanon. Concentration $\mu\text{g/g}$.

	SCCPs
Cobopol T1	11.2
Egyplast	5.60
86	608

As it can be seen in Figure 6 SCCPs were found in 608.00 $\mu\text{g/g}$ in the 86 company.

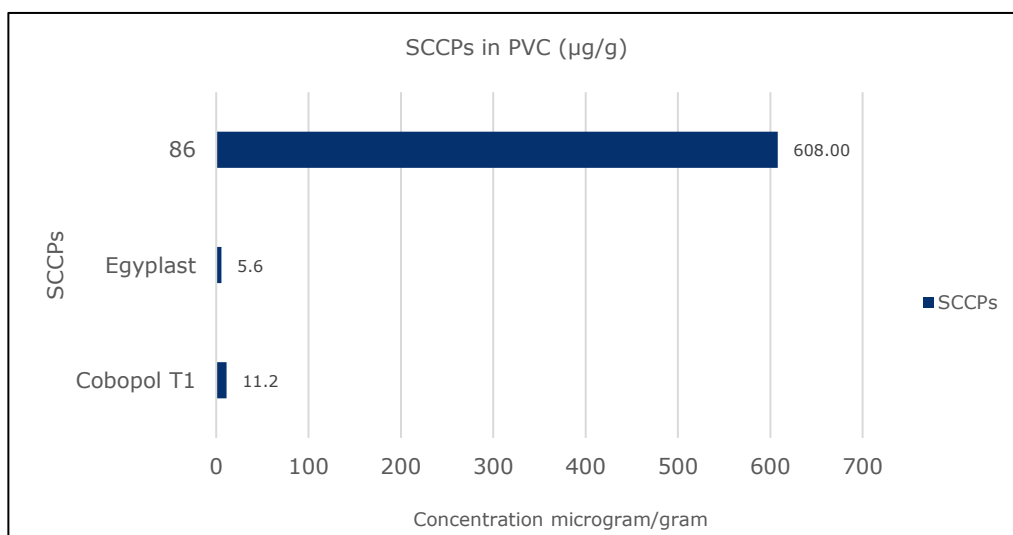


Figure 6. SCCPs sampling results on PVC on Lebanon. Concentration ($\mu\text{g/g}$).

2.3.3 Data assessment

It would be desirable to consider a major number of samples.

The limit of the Stockholm Convention is established in Annex 1:

"It is banned to manufacture, place on the market and use substances or mixtures containing SCCPs in concentrations greater than 1 % by weight,

or articles containing SCCPs in concentrations greater than 0,15 % by weight".

According to the acquired data it is only possible to say that company 86 amply exceeds this limit concentration, and the product from Cobopol T1 is also above the limit of compliance. On the contrary Egyplast pellets do comply with the requirements established in the Stockholm Convention.

3. CONCLUSIONS

According to *Task 1: Mission to Lebanon to advise local experts and established work guidelines and to identify key parties to be contacted* where the expected outcomes of the project were depicted, the major objective was:

- the **“reduction of harmful chemicals and waste of POPs in coastal hotspots and watersheds”**.

As secondary objectives, and as part of the Lebanon Implementation Plan of the Stockholm Convention 2017⁵, strategic objective 2 includes:

- the **“management of the import and export, production, user recycling and disposal of Industrial POPs”**,
- **“to improve the control of import/trade of IPOP**s, enhance the knowledge and capacity of industrialist, distributors and retailers to manage POPs and consider their risk, to identify and manage / residues (current and future) in and environmentally sound and integrated manner”
- and finally, **“to identify, assess and remediate potential contaminated sites including water bodies”**.

It is necessary to conclude, for the three POPs analysed in this project, the state of the Lebanon based in the data acquired by the sampling procedure.

3.1 PFOS conclusions

1. Over 35 different PFAS have been analysed in AFFF and Gel Foam samples on Lebanon.
 2. Fluoropolymers were the compounds detected in higher concentrations 6:2FTS > 8:2FTS > 4:2 FTS (3152 > 1988 > 659 ng/ml). No decisions from Stockholm Convention or legislation in force do specify a limit for these PFAS in products/articles yet.
 3. Regarding PFOA it was also detected in AFFF from Martyrs Adel Saade and Mohammad Mawla Station in 215 ng/ml. The limit established in the Stockholm Convention is **≤ 40 ng/ml**; so, it is exceeded in that sample.
 4. PFHxA, that is the alternative to PFOS in AFFF since 2009, is exceeded more than 10,000 times in Martyrs Adel Saade and Mohammad Mawla Station in the sample taken of AFFF, and long-chained (C9-C4): PFTeDA and PFDoA sum, exceed the limits 1,000 times. In Karantina, PFHxA was detected in 5.16 mg/ml, exceeding 100 times the limits.
1. PFTeDA, PFDoA, PFBA, PFPeA and PFHpA in AFFF stored foams from Martyrs Adel Saade and Mohammad Mawla Station do not exceed the regulation limit.
 2. Sediments taken from a fire incident site located in Mazraat Yachou 3 present an amount of PFTeDA 9524 ng/g (all other concentrations are three to four orders of magnitude lower). Current legislation does not specify a limit for these PFAS in wastes yet.
 3. Fluorotelomer 6:2FTS was detected in sediments in Mazraat Yachou 3 in amounts of 90.3 ng/g. Legislation does not present a limit for these PFAS in wastes yet.
 4. GenX detected in sediments in Mazraat Yachou 3 in amounts of 45.7 ng/g. Legislation does not include a limit for these PFAS in wastes yet.

⁵ MoE/UNEP/GEF (2017) - National Implementation Plan on Persistent Organic Pollutants. Lebanon. Available at: <http://chm.pops.int/Implementation/NationalImplementationPlans/NIPTransmission/tabid/253/Default.aspx>

5. PFOA was detected in sediments in Ain El Remmane in amounts of 2.93 ng/g.
6. Due to the different amount of PFAS detected in Ain El Remmane it can be concluded that degradation of PFAS may occurred.
7. For sediments in Safra only GenX was detected in a notable amount, 21.9 ng/g.
8. A small number of precursors and potentially degraded products have also been detected in sediments in Safra (PFDoA, PFUdA, PFDA, PFNA, PFNA and PFBA).

3.2 HBCD conclusions

1. 4 samples containing HBCD were analysed from different companies on Lebanon, 1 from EPS pellets and 3 from EPS panels.
2. CMC XPS shows major amounts of HBCD on its panels with 341.60 ng/g. Threshold according to the Stockholm Convention should be below 100 ng/g.
3. The second one is Kilzi and Co Panels with 75.95 ng/g. Threshold according to the Stockholm Convention should be below 100 ng/g so Kilzi and Co Panels does comply with the regulation.
4. Pellets sample have not shown HBCD levels.

3.3 SCCPs conclusions

1. SCCPs have been analysed in 3 samples of PVC pellets.
2. SCCPs were detected in pellets from the 86 company in amounts of 608.00 µg/g. Threshold according to the Stockholm Convention should be below 1 % by weight or in addition shall be allowed articles containing SCCPs in concentrations lower that are 0.15 % by weight. In this case PVC pellets company 86 amply exceeds this limit concentration.
3. In wastes concentration limit according to regulation is 10000 mg/kg, so if pellets are treated as wastes to comply with the regulation company86 and Cobopol pellets should be destroyed.
4. Only pellets from Egyplast could be reused/recycled, it is not necessary to destroy them.

4. NEXT STEPS AND RECOMMENDATIONS FOR LEBANON

It is recommended that the Ministry of Environment of Lebanon considers the following actions.

➤ **According to the regulations, which actions are prioritized due to non-compliance?**

Under the current program a total of 4 samples of AFFFs and Gel Foam and 3 sediment samples were analysed. This number of samples is not representative to make a complete assessment of the country.

For PFOS, the analyses suggest that it is no longer present in AFFFs, other alternatives have been used and, in general, the ones that are being used are fluorotelomers and PFHxS and its related substances (these substances are not banned yet). However, this provisional conclusion should be further substantiated by additional sampling and analysis.

Given that the available analytical data indicates that there are still AFFF in Lebanon that contain PFAS, it is recommended that these are replaced in their entirety with PFAS-free firefighting foams.

➤ **Expired foams and waste management actions**

It should be established how these AFFFs containing PFAS are eliminated. According to that information a detailed evaluation will show which is the most affordable and environmentally friendly method to be applied in Lebanon.

It is recommended that an initial selection is made of sites where a high probability exists that severe subsurface impacts exist due to the use of PFAS containing AFFF, and where environmental resources such as groundwater and surface water are threatened. Additional investigations at these sites should establish the need for corrective actions to safeguard these resources for public use.

➤ **Promotion of information and awareness**

Given that Lebanon's political and socio-economic situation, it is very difficult to successfully implement an **Awareness and Sensibilization Program**, as chemical contamination is no longer a priority. It is recommended that the already prepared awareness material is printed on paper and/or disseminated by digital means to the sectors that work with fire-fighting foams.

5. ANNEX

A. Protocol for water/foam sampling 1. Material and volumes: Groundwater, surface waters or premixed firefighting foam. Containers of 0.5 L polypropylene bottle 2. Cleaning protocol PP bottles must be cleaned before sampling with distilled water and ethanol, twice each. 3. Sampling protocol Bottles will be cleaned with groundwater from the sampling site twice, vigorously, before taking the sample. Samples will be taken wearing nitrile gloves in order to discard contamination and without filling the bottles completely. It is important to put a piece of aluminium foil before putting the lid. <i>*Please remember to record the location, take a photograph of each sample and note these references in the appropriate box*</i> 4. Transport conditions All the samples will be transported to the laboratories at 4 °C and preserved at -20 °C.	C. Protocol for plastic pellets 1. Material and volumes: Approximately 20 grams of pellets in double polypropylene zipper bag 2. Cleaning protocol Not necessary. 3. Sampling protocol Samples will be taken wearing nitrile gloves in order to discard contamination. <i>*Please remember to record the location, take a photograph of each sample and note these references in the appropriate box*</i> 4. Transport conditions All samples will be transported at room temperature.
B. Protocol for sediment sampling 1. Material and volumes: 20 g of sediments containing PFAS. 50 mL centrifuge tubes of polypropylene or urine collection bottles of polypropylene. 2. Cleaning protocol PP bottles must be cleaned before sampling with distilled water and ethanol, twice each. 3. Sampling protocol Samples will be taken wearing nitrile gloves in order to discard contamination and without filling the bottles completely with a shovel or with a Van Veen grab for sediments. <i>*Please remember to record the location, take a photograph of each sample and note these references in the appropriate box*</i> 4. Transport conditions All the samples will be transported to the laboratories at 4 °C and preserved at -20 °C.	D. Protocol for EPS/XPS and PVC samples 1. Material and volumes: Approximately 20 grams of polystyrene in double polypropylene zipper bag. 2. Cleaning protocol Not necessary. 3. Sampling protocol Samples will be taken wearing nitrile gloves in order to discard contamination. In a controlled laboratory environment proceed to milling the pieces into small granules/particulates. <i>*Please remember to record the location, take a photograph of each sample and note these references in the appropriate box*</i> 4. Transport conditions All samples will be transported at room temperature.

