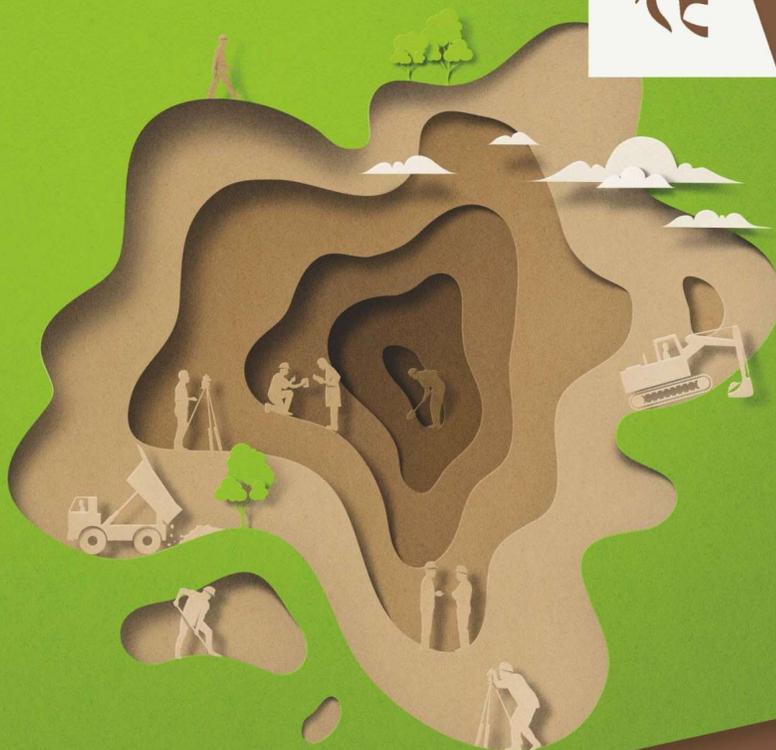




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**STUDY OF THE PRESENCE OF PFAS IN
GROUNDWATER, SOIL AND SEDIMENT
AROUND RISK ACTIVITIES IN
FLANDERS
- PHASE 2**

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1 INTRODUCTION

Flanders has decades of experience in tackling soil and groundwater pollution. The approach developed via the soil remediation policy has proven to be very successful in recent years. This mainly concerns heavy metals and the most common organic pollutants associated with activities in the past. It is becoming increasingly clear that all kinds of new contaminants (also known as Emerging Contaminants) are present in the environment. The occurrence and the risks in soil, groundwater and sediment are insufficiently known for several of these substances.

PFAS compounds have many applications in industry and in households. The expected spread in the environment (in soil, groundwater, surface water, etc.) is therefore large. Due to the complex and varied properties and the low assessment criteria, correct sampling and analysis without cross contamination is also complicated. It requires thorough practical knowledge to conduct investigations (fieldwork, chemical analyses, research strategy, etc.) in the correct manner.

With this in mind, an exploratory study into the presence of PFAS (per- and polyfluoroalkyl substances) at risk locations in Flanders was conducted.

In the first phase of the study, the aim of the project was to conduct a randomized measurement campaign at risk locations to ascertain the presence of PFAS (including PFOS and PFOA) in groundwater, soil and sediment in Flanders. Based on this initial inventory, it was possible to establish that PFAS is present at a large number of measurement locations, both in soil and in groundwater. Fire-related activities in particular (calamities, training grounds, fire extinguishing foam storage, etc.) have a high risk of soil contamination with fluorinated components (<https://www.ovam.be/rapport-onderzoek-naar-aanwezigheid-van-pfas-in-Vlaanderen>).

Based on these findings, the following objectives were formulated for this second phase of the study:

- collect additional data to better estimate the size and distribution at two sites
- policy advice and guidelines for experts, firefighting activities and earthmoving.

In the Netherlands, an extensive measurement program is currently being implemented through the PFAS Expertise Center (set up by Witteveen + Bos, TTE and Arcadis) to gain clarity about the presence or absence of worrying situations. This study is started from this expertise and insight.

2 SITE SELECTION

Based on the results of the first phase of the study, it appeared that the majority of the locations where fire extinguishing activities have taken place or are still taking place are contaminated with PFAS in the soil and/or groundwater.

In order to try to get a better understanding of the distribution pattern as a result of these extinguishing activities and with a view to drawing up a memorandum for the firefighting sector and the earth-moving sector, additional fieldwork was carried out at 2 sites.

2.1 SITE 3

Site 3 is a fire station. Due to its location in the vicinity of large industrial petrochemical companies, the facilities of this fire station are more extensive than the facilities at the average local fire station.

On the basis of the results of the first phase, contamination with substances from the PFAS group in the soil and groundwater was determined.

The following fieldwork was proposed for this site:

- At a considerable distance (approx. 40 m) from the source zones (= training locations and a storage tank), some surface samples will be taken from the soil to investigate the extent of PFAS on this scale. For this purpose, approximately 7 drillings to 0.5 m-gl will be made.
- A boring of up to 0.5 m-gl will also be drilled at a distance of 10 and 30 meters from the source zone.
- Downstream (southerly to south-westerly groundwater flow direction, see previous studies), 2 bore holes will be converted into monitoring wells to determine the extent to which the contamination is spread through the groundwater. In order to obtain a non-intersecting monitoring well, the monitoring wells will have a depth of approximately 4 m-gl.
- A groundwater sample will also be taken upstream of the source zone in order to check the incoming groundwater for PFAS. Industrial activities are present along the upstream side.
- A vertical delimitation will be carried out in soil and groundwater. In order to obtain a sufficient vertical delimitation in the groundwater, the monitoring wells are placed to a depth of 6 m-gl. These monitoring wells are expected to be pulsed to ensure proper monitoring well placement.

Table 1 summary table fieldwork overview

Description	Total	Remarks
Site 3		
Drilling <3 m-gl	3 m	
Monitoring well 3-5 m-gl	12 m	
Monitoring well 5-7 m-gl	6 m	

Description	Total	Remarks
soil samples	11 samples	
Groundwater samples	4 samples	

2.2 SITE 10

Site 10 is a fire training practice site at a small airport. At this site, firefighting exercises with extinguishing foam are carried out on a training aircraft on a regular basis as part of the training of their own fire service.

Based on the results of the first phase, a soil contamination with PFAS components was present at this site, but no groundwater contamination was detected (based on limited sampling).

The following fieldwork was proposed for this site:

- A drilling of 0.5 m-gl will be placed in different directions around the 1st phase drilling. A top sample will be used for analysis. The drillings are placed at a distance of approximately 40 metres from the presumed source zone. On the windward side, a drilling to 0.5 m-gl is also placed at a distance of 10, 20, 30 m. In this way the distribution contour for contamination in the soil can be evaluated.
- In addition, a boring (0.5 m-gl) will be drilled at a greater distance (approx. 100 m) in order to check whether concentrations above the background are still found at that distance.
- Downstream, 1 bore hole will be converted into a monitoring well in order to know the possible presence of PFAS in the groundwater on this site. The bore hole will be placed to a depth of 4 m-gl (non-cutting monitoring well).

To know the vertical distribution in the soil, a bore hole will be drilled in the source zone up to 3 m-gl in which 2 samples will be taken (at groundwater level and at the base of the bore hole), from which a first indication of the distribution between the ground and groundwater can then be obtained.

Table 2 summary table fieldwork overview

Description	Total	Remarks
Site 10		
Bore hole <3 m-gl	7.5 m	
Monitoring well 3-5 m-gl	4 m	
Soil samples	12 samples	
Groundwater samples	1 sample	

3 FIELDWORK AND ANALYSES

3.1 SAMPLING PROTOCOL

Accurate and careful sampling is crucial when studying PFAS compounds in the environment. Because PFAS compounds have/had very many applications and must be determined at very low concentrations (in view of persistence, bio-accumulation, etc.) the chance of cross contamination by sampling material is real. The use of sample material (gloves, drilling material, pumps, containers) with, for example, Teflon components should absolutely be avoided. Glass containers are also not suitable because PFAS compounds adsorb to glass, therefore fully plastic containers (polypropylene) were used.

The measurement campaign per location was carried out in accordance with the applicable CMA procedures for the sampling of soil and groundwater (CMA/1/A.2) supplemented with the PFAS protocol for sampling PFAS components (not included in the CMA yet). The sampling was carried out by the fieldwork team in-house at Witteveen + Bos Belgium NV.

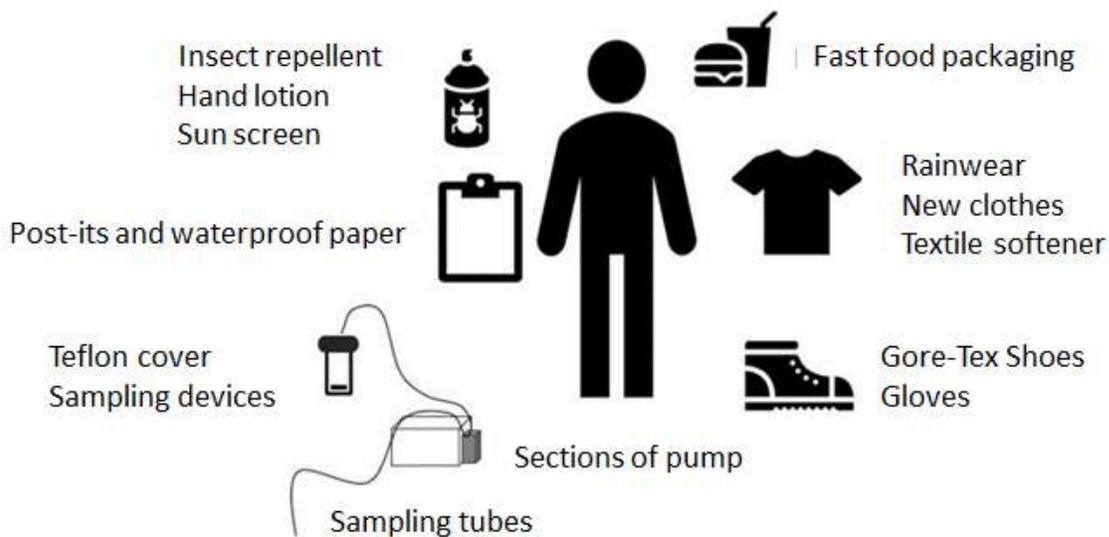


Figure 3.1 Schematic representation of points for attention when avoiding cross-contamination (source: PFAS Expertise Center)

The drilled soil is not collected on LDPE foil, but jute is used. The protective clothing consists of natural untreated cotton overalls as dirt and water-repellent clothing (e.g. Tyvek®, Gore-Tex®, waterproof sprays, etc.) must be avoided to the maximum.

Based on recent research (see Project PFAS Sampling Contamination research, Peter de Vries Sweco Nederland B.V., 2018), it has been found that the influence of the silicone tubes used in the peristaltic pumps can also have a negative influence on the sampling for PFAS. Silicone tubes were used in this study. Significant adsorption of PFAS components can take place in the silicone tubes, so that the analysis result can be an underestimation. A reduction of approximately 25% could occur. As an alternative to silicone tubes, after pre-pumping, a ball valve can be used for the actual sampling of the groundwater.

3.2 SITE 3

The drillings and monitoring wells at the site were installed on 15/10/2018 and on 23/10/2018 (B8104 and B8105). The installed monitoring wells were sampled on 23/10/2018.

The samples were mainly taken at a depth of 0.0-0.20 m-gl. This is because mainly the top layer of the soil was relevant for this study in the context of dispersal through blow-through of the fire-fighting foam used. Annex 5 contains a map with the location of the drillings and monitoring wells.

3.3 SITE 10

The drillings and monitoring wells at the site were installed on 16/10/2018. The installed monitoring wells were sampled on 23/10/2018.

The samples were mainly taken at a depth of 0.0-0.20 m-gl. This is because mainly the top layer of the soil was relevant for this study in the context of dispersal through blow-through of the fire-fighting foam used.

Annex 6 contains a map with the location of the drillings and monitoring wells.

3.4 ANALYSES

The PFAS analyses of soil and groundwater were performed according to CMA method CMA/3/D for the analysis of perfluorinated compounds. The analyses were performed by the OVAM accredited laboratory, SGS Belgium, Polderdijkweg 16, 2030 Antwerp (IAC department - Institute of Applied Chromatography).

The analysis technique applied for soil samples involves high pressure liquid chromatography with electrospray ionization tandem mass spectroscopy (LC-ESI-MS-MS). The analysis technique applied for groundwater samples concerns the LC-MS-MS technique after a fixed phase extraction.

In table 3 the PFAS components and reporting limits are summarized that were routinely analyzed via a target type technique.

Table 3: Overview of analysis parameters and reporting limits

Parameter	Reporting limit soil	Reporting limit groundwater
<u>Perfluorinated carboxylic acids</u>		
Perfluorbutanoic acid (PFBA)	0.5 - 1 µg/kg dm	0.005 – 1.0 µg/l
Perfluorpentanoic acid (PFPA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluorhexanoic acid (PFHxA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluorheptanoic acid (PFHpA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluoroctanoic acid (PFOA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluoronanoic acid (PFNA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluordecanoic acid (PFDA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluorundecanoic acid (PFUnDA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluordodecanoic acid (PFDoDA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluortridecanoic acid (PFTrDA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluortetradecanoic acid (PFTeDA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluorhexadecanoic acid (PFHxDA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l

Parameter	Reporting limit soil	Reporting limit groundwater
Perfluorooctadecanoic acid (PFODA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
<u>Perfluoralkane sulfonamides</u>		
Perfluorooctanoic sulfonamide (PFOSA)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
<u>Perfluorinated sulfonic acids</u>		
Perfluorobutanoic sulfonate (PFBS)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluorohexanoic sulfonate (PFHxS)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
Perfluorooctanoic sulfonate (PFOS)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
(PFDS)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
<u>Fluortelomer sulfonates</u>		
6:2 Fluorotelomer sulfonate (6:2 FTS)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
8:2 Fluorotelomer sulfonate (8:2 FTS)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l
10:2 Fluorotelomer sulfonate (10:2 FTS)	0.5 - 1 µg/kg dm	0.005 - 1.0 µg/l

The reporting limit (0.5 - 1 µg / kg dm for soil or 0.005 - 1.0 µg / l for groundwater) in this study was determined based on the measured concentration in the analysis sample. A lower reporting limit was applied at a lower concentration. The reporting limit is stated in the analysis certificate.

The analysis results are shown in the tables in Annexes 3 and 4.

4 DISCUSSION OF THE RESULTS

4.1 SOIL

4.1.1 Site 3

In phase 1, three monitoring wells were installed at this site:

- P7011
- P7012
- P7013

A soil and groundwater sample from each of these monitoring wells was analyzed for the presence of PFAS. Contamination with PFAS components was found in both the groundwater and the soil. The results of phase 1 can be found in Annexes 1 and 2.

Vertical distribution

At P7101, an attempt was made to achieve a vertical delimitation of the contamination in the soil. At a depth of 5.5 -6.0 m-gl, no delimitation could be obtained below the background value (the background value is understood to mean the PFAS that is naturally present in a nature destination. Since PFAS is not naturally occurring, the background value is considered the detection limit for PFAS in this study) but a strong reduction of the concentration compared to the top sample.

Based on the results of the deep sample, it can be stated that the composition of the components differs slightly from the composition of the top sample (P7101 (0-0.20)).

The composition of the analysis is presented visually in the diagrams below. Here the difference between the composition of a top sample and a deeper sample is clearly visible.

Figure 4.1 PFAS concentrations at the source area in P7101 (0-0.20)

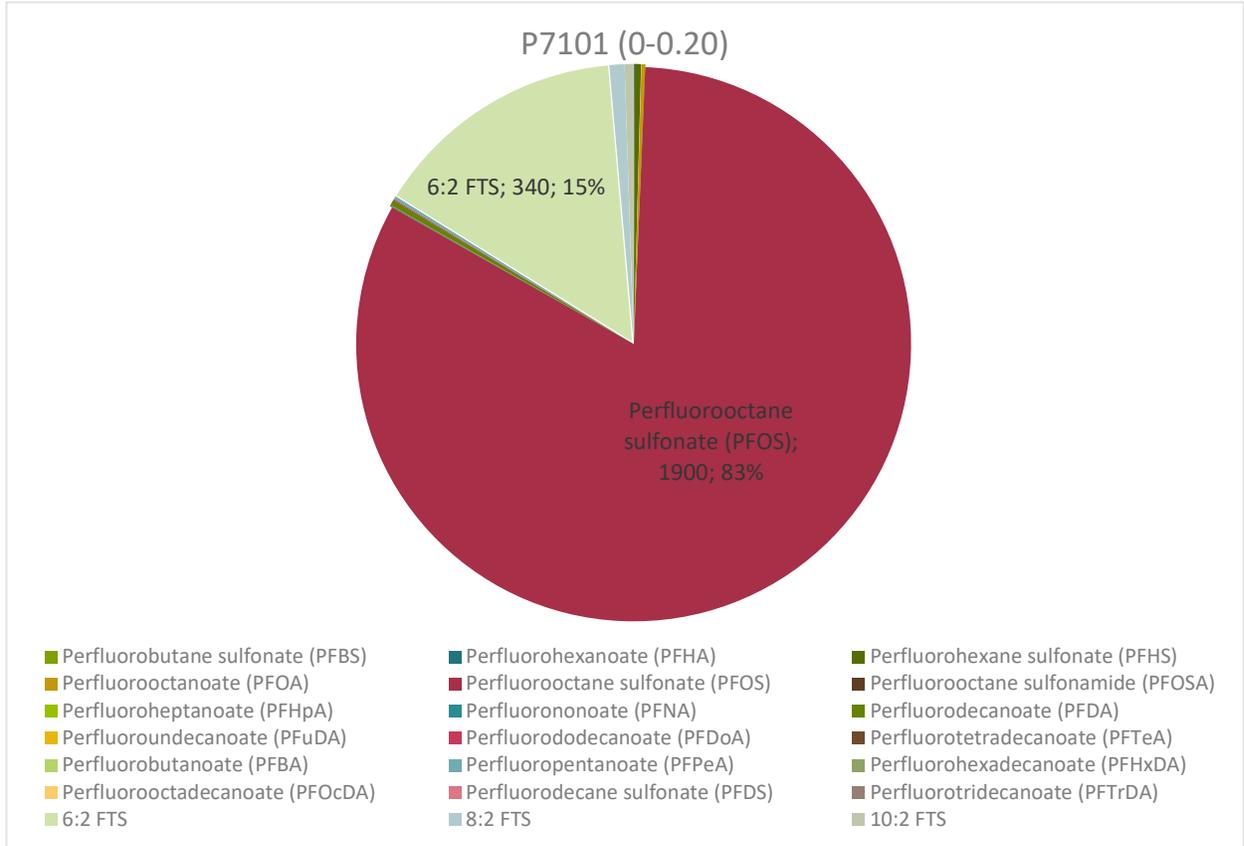
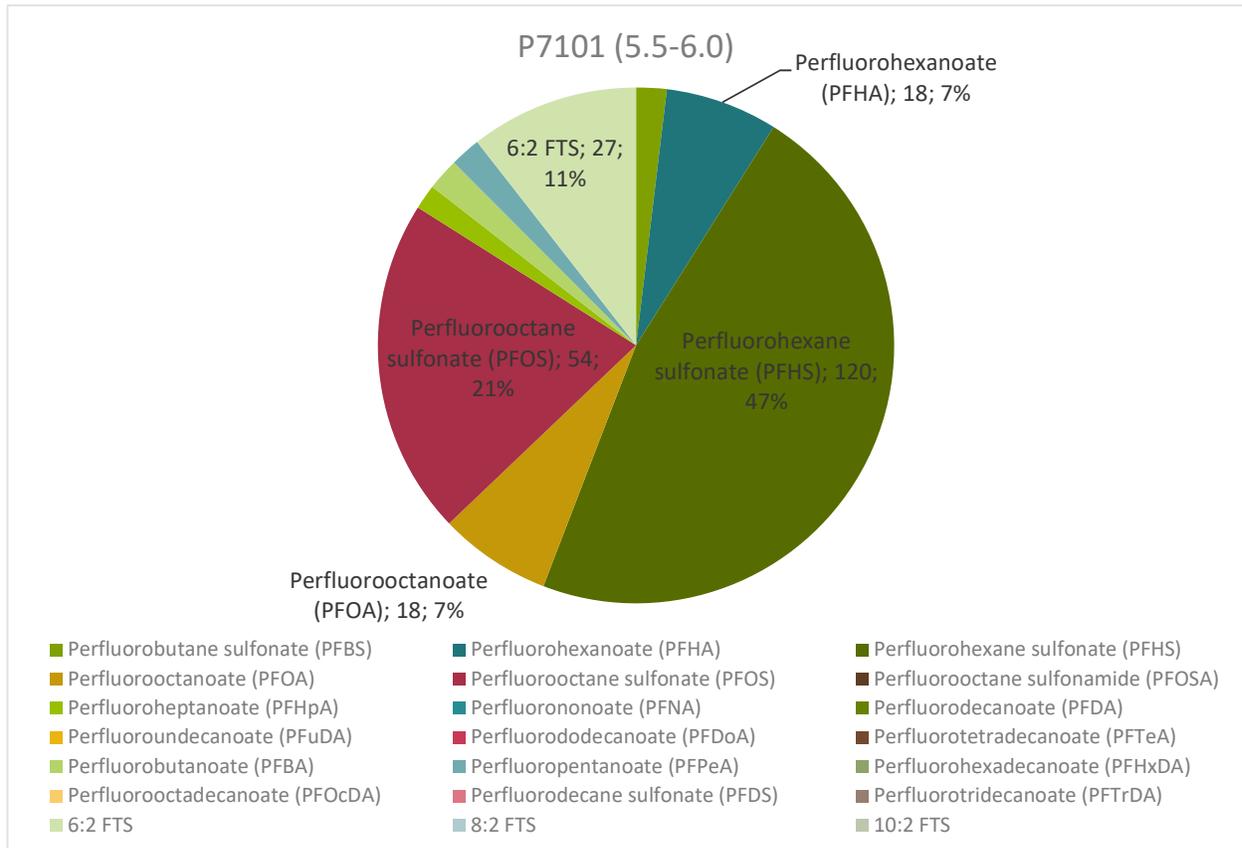


Figure 4.2 PFAS concentration composition at the source zone in P7101 (5.5-6.0)



The proportion of shorter chains is higher at depth than in the surface sample. For example, a relatively large amount of PFOS is found in the top samples compared to the deeper samples where the concentration is many times lower.

In the deep sample, PFHS and PFHA are found in higher concentrations. The 6: 2 FTS proportion remains practically the same between a deep and a surface sample. 6: 2 FTS is added to extinguishing foam to replace PFOS since the ban in 2001. These fluorotelomer sulfonates fall under the so-called precursors and can be converted under certain conditions into persistent fluor components (e.g. PFOA).

Horizontal distribution

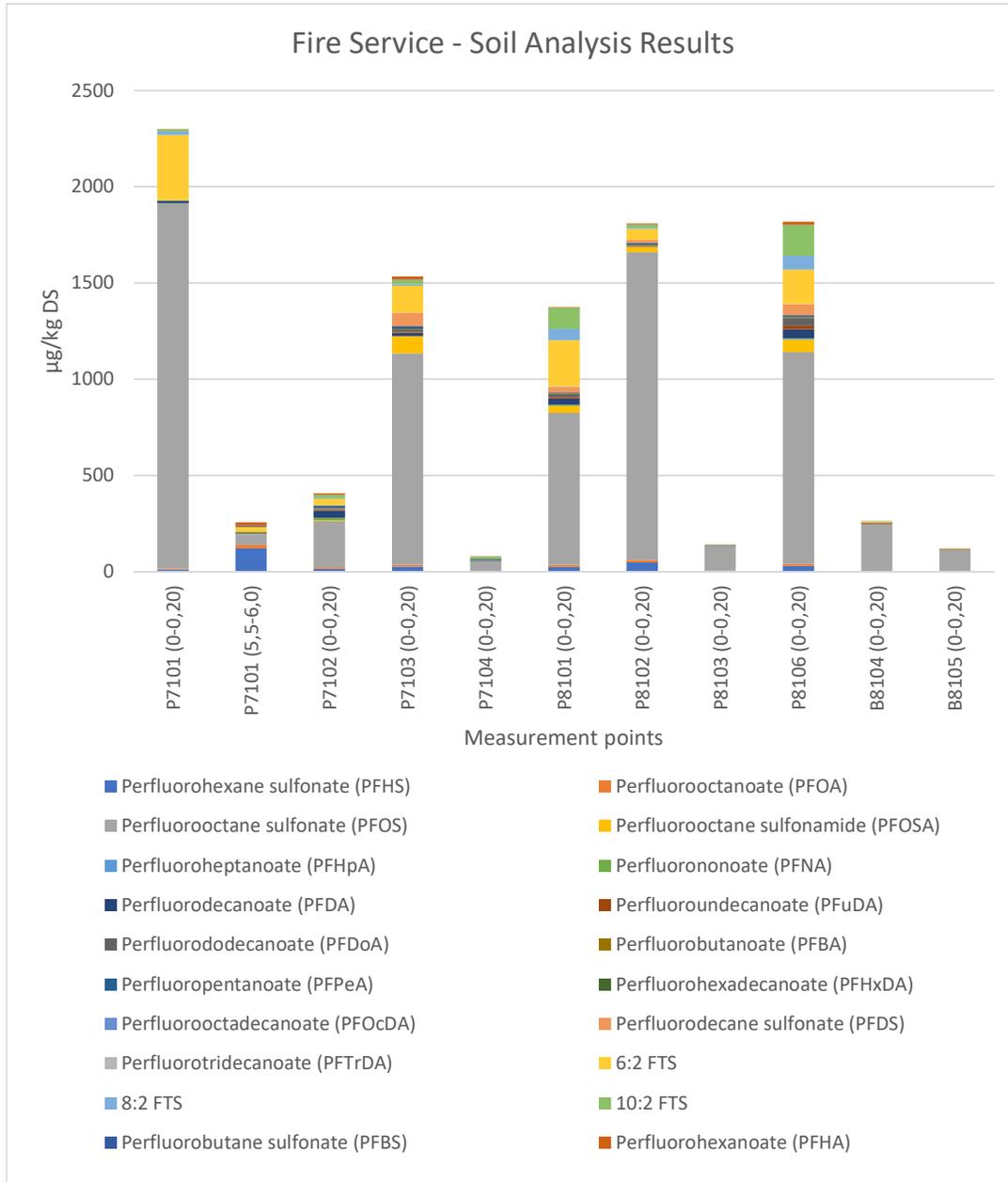
A reduction in the concentration in the horizontal direction is observed, but there is no reduction to the background value (the background value in this study is understood to mean the PFAS that are naturally present in a nature destination. Since PFAS does not occur naturally, the background value is the detection limit for PFAS) possible at a distance of 30-40 meters or at a distance of 50-60 meters from the source zone.

In the first instance, it was assumed that the spread of the contamination in the top layer of the soil had mainly taken place in a northerly/westerly direction (B8102 and B8101) as a result of the wind blowing in a downward direction. After evaluation with the captain of the fire service, however, it turned out that the exercises might have been carried out even more spread over the site than initially assumed, so that the conclusion regarding blow-through could not be maintained.

The P7104 sample was taken in the context of determining a possible background value in the soil for this area. An increased concentration (78.9 µg / kg dm) of PFAS_{sum} was found in this sample. This can be due to the surrounding industrial activities or due to an influence from the fire-fighting exercises at the site. To be able to determine this in more detail, more samples would have to be taken in a wider environment.

The graph below shows the distribution of the PFAS components at each measuring point in the soil.

Figure 4.3 Distribution of the different PFAS components in the soil samples at site 3



This graph shows that mainly PFOS is strongly represented in the soil. This is a direct consequence of the fire-fighting foam extinguishing exercises that have taken place at this site. However, a considerable percentage of 6: 2 FTS and other short chains have also been found. These components are added to the extinguishing foam in the period after 2001 in view of the ban on PFOS. However, some of the short chain components are precursors (such as, for example, 6:2 FTS).

4.1.2 Site 10

In monitoring phase 1, one monitoring well was placed at this site:

- P7006

A soil and groundwater sample from this monitoring well was analyzed for the presence of PFAS. Substantial contamination with PFAS components was found in the soil. Only a very slight increase in PFAS components was detected in the groundwater, this concentration not appear to be in proportion to the concentrations found in the soil. The results of phase 1 can be found in Annexes 1 and 2.

At this location, an attempt was made to determine the extent of the contamination in the top layer in a north-eastern direction. This direction relates to the downwind direction relative to the prevailing wind direction in Flanders (southwest wind).

Sample B8209 was taken at a distance of approximately 100 meters from the source location. In this sample a concentration of 2 µg/kg.dm (PFAS_{sum}) is found. This is still an increase compared to the background value (the background value in this study means the PFAS that is naturally present in a nature destination. Since PFAS does not occur naturally, the background value is the detection limit for PFAS).

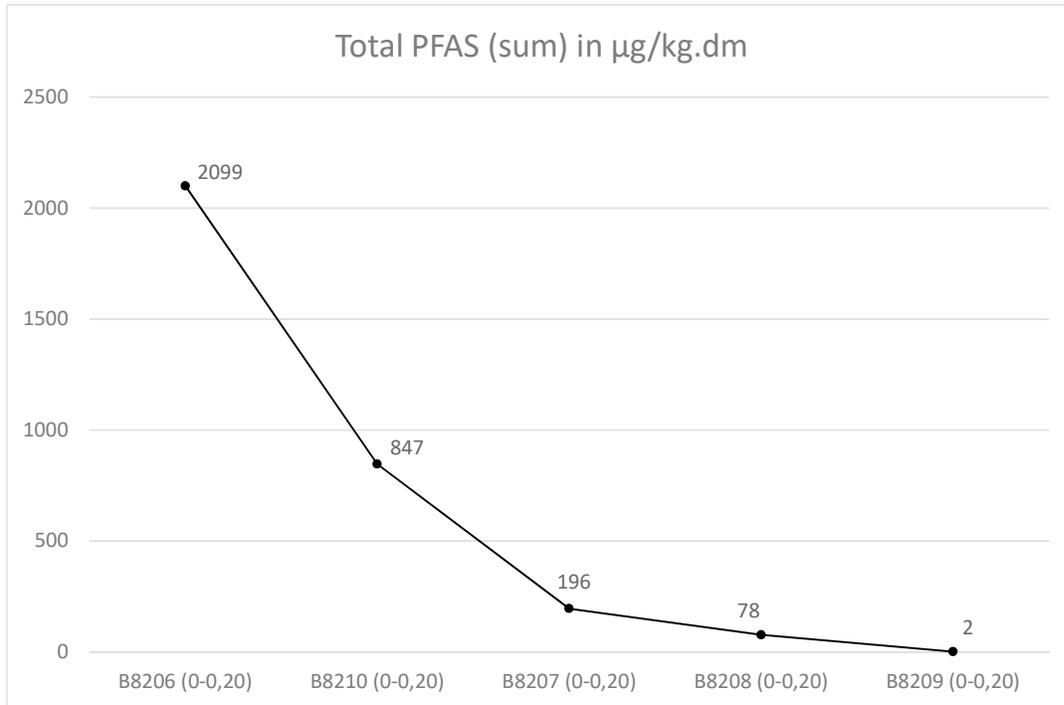
Table 4 below shows the samples with the concentration and the distance to the presumed source zone.

Table 4: concentration trend

	Total PFAS (Tot)	Distance from source (m)
B8206 (0-0.20)	2099	16
B8210 (0-0.20)	847	32
B8207 (0-0.20)	196	43
B8208 (0-0.20)	78	53
B8209 (0-0.20)	2	100

The graph in figure 4.4 shows the concentration gradient.

Figure 4.4 PFAS Concentration gradient at different distances from the source in the soil samples at site 10

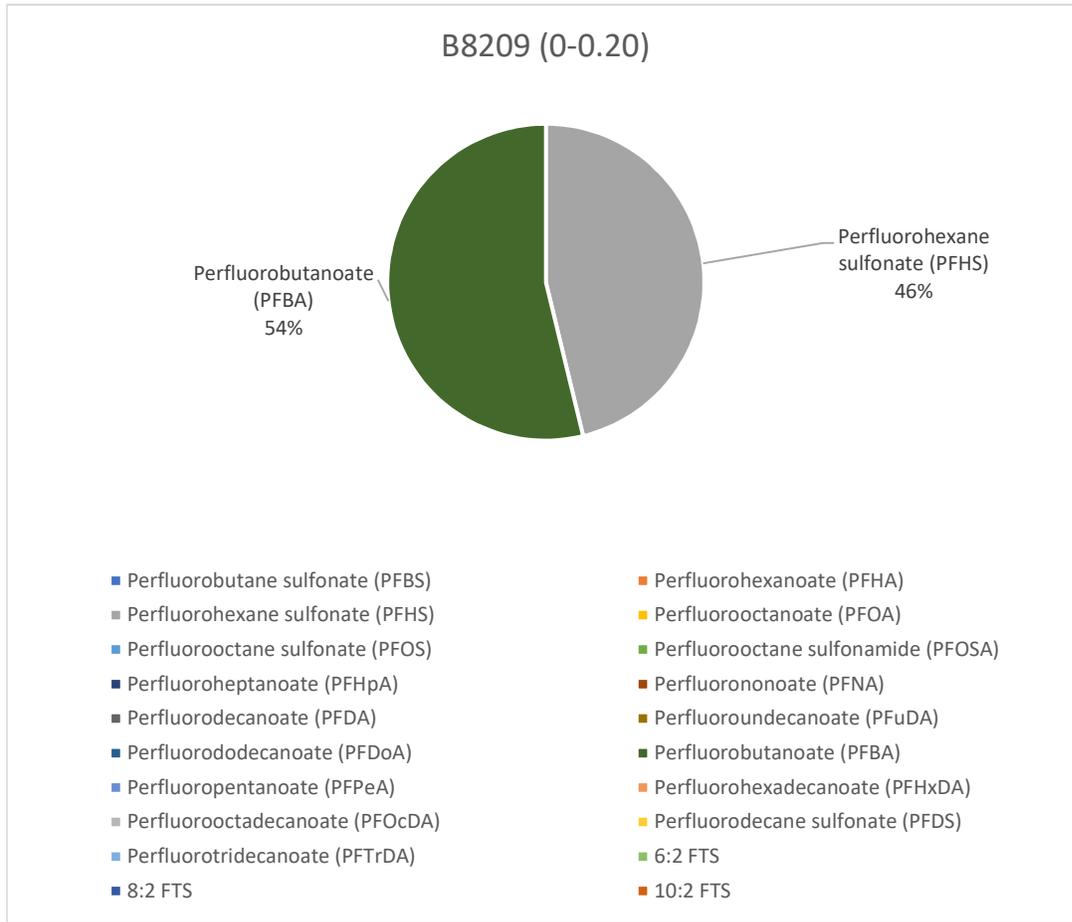


The concentration gradient is clearly decreasing further away from the location of the training. Based on the concentration found in sample B8206, doubts about the exact location of the source zone can be raised. The concentration is higher than the concentration at P7006 (0-0.40) (sampled in the first phase). At B8206 there is also a large pit in which fire fighting exercises are clearly held. However, the fire responsible indicated that they only use the foam on the aircraft. The increased concentration can be both due to an accumulation of foam next to the pavement or that training with foam has taken place at other locations in the past.

The proportion of PFOS in this and the other samples at greater distances (B8210, B8207 and B8208) is large, which can confirm the assumption of the use of old foam, given the ban on PFOS in extinguishing foam after 2001. In these samples, little 6:2 FTS is found, which is the replacement for PFOS in fire-fighting foam.

At the source location, a mixture of older and newer fire extinguishing foam has clearly been found based on the proportional distribution between PFOS and 6:2FTS.

Figure 4.6 PFAS concentration composition at B8209 (0-0.20)



In order to achieve a complete delimitation below the background concentration in the downwind direction, it may be necessary to take into account the distance between 50 and 100 meters away from the source location (in case of the use of fire-fighting foam).

The other samples taken at a distance of approx. 40 m around the source zone are all above the background value (the background value in this study is understood to mean the PFAS that is naturally present in a nature destination. Since PFAS does not occur naturally, the background value is the detection limit for PFAS).

More long chains are found in the top layer at the source zone than in the sample under groundwaterlevel. This can probably be explained by the difference in mobility: short chains are more mobile. 6:2FTS has been added to extinguishing foam to replace PFOS since the ban in 2001. These fluorotelomer sulfonates are

considered as the so-called precursors and can break down under certain conditions into persistent perfluorinated compounds (e.g. PFOA).

Figure 4.7 PFAS concentration at the source zone in P7001 (0-0.40)

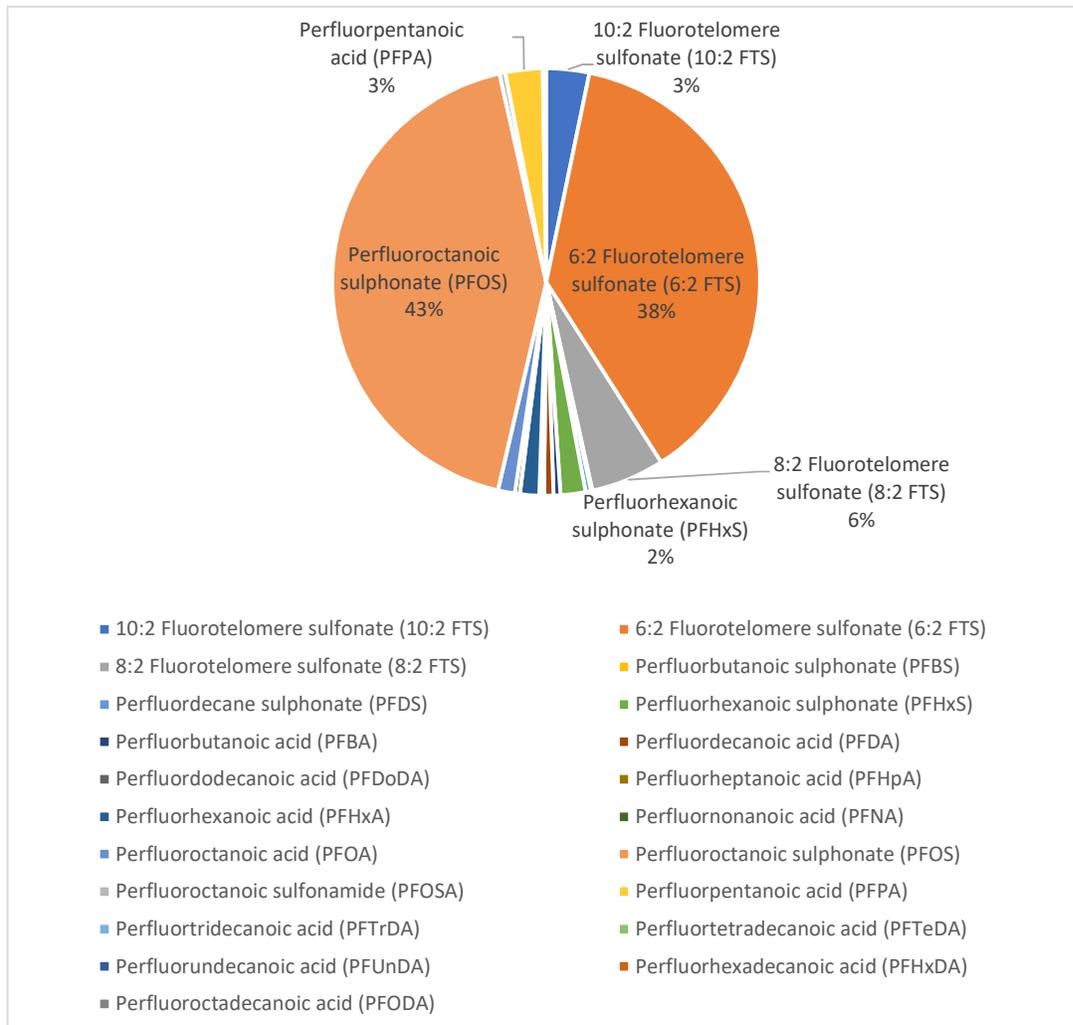
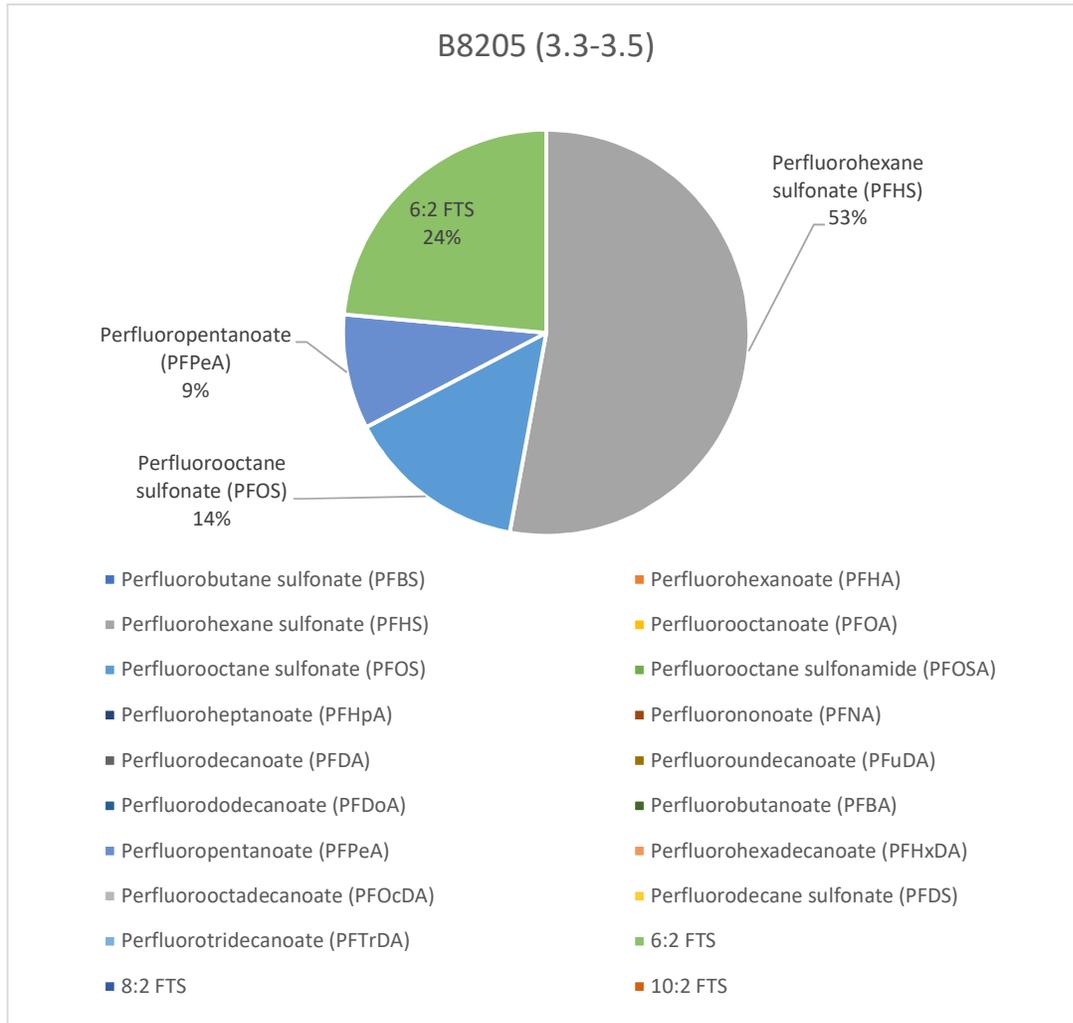


Figure 4.8 PFAS concentration at the source zone in 8205 (3.3-3.5)



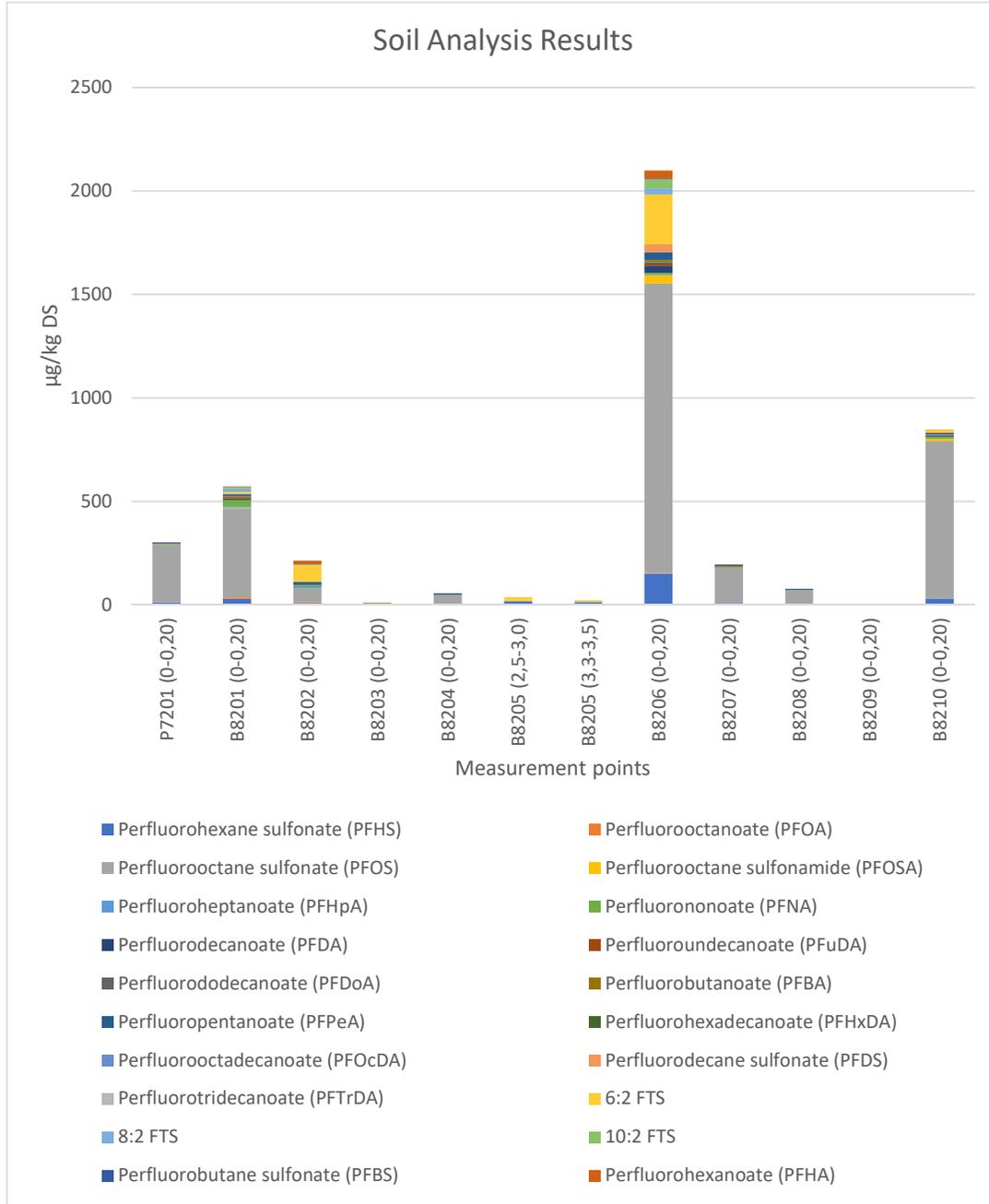
The sample B8205 (2.5-3.0) was taken at groundwater level. The B8205 sample (3.3-3.5) was taken under the groundwater level to determine if significant differences would occur between the air-water interface and under the groundwater table.

The results (concentrations and components) are in line with the exception that Perfluoropentanoate (PFPeA) is also found in the deepest sample.

The concentrations decreased but are still in concentrations above the background concentration.

Figure 4.9 shows the distribution of the PFAS components at each measuring point in the soil

Figure 4.9 distribution of the different PFAS components in the soil samples at site 10



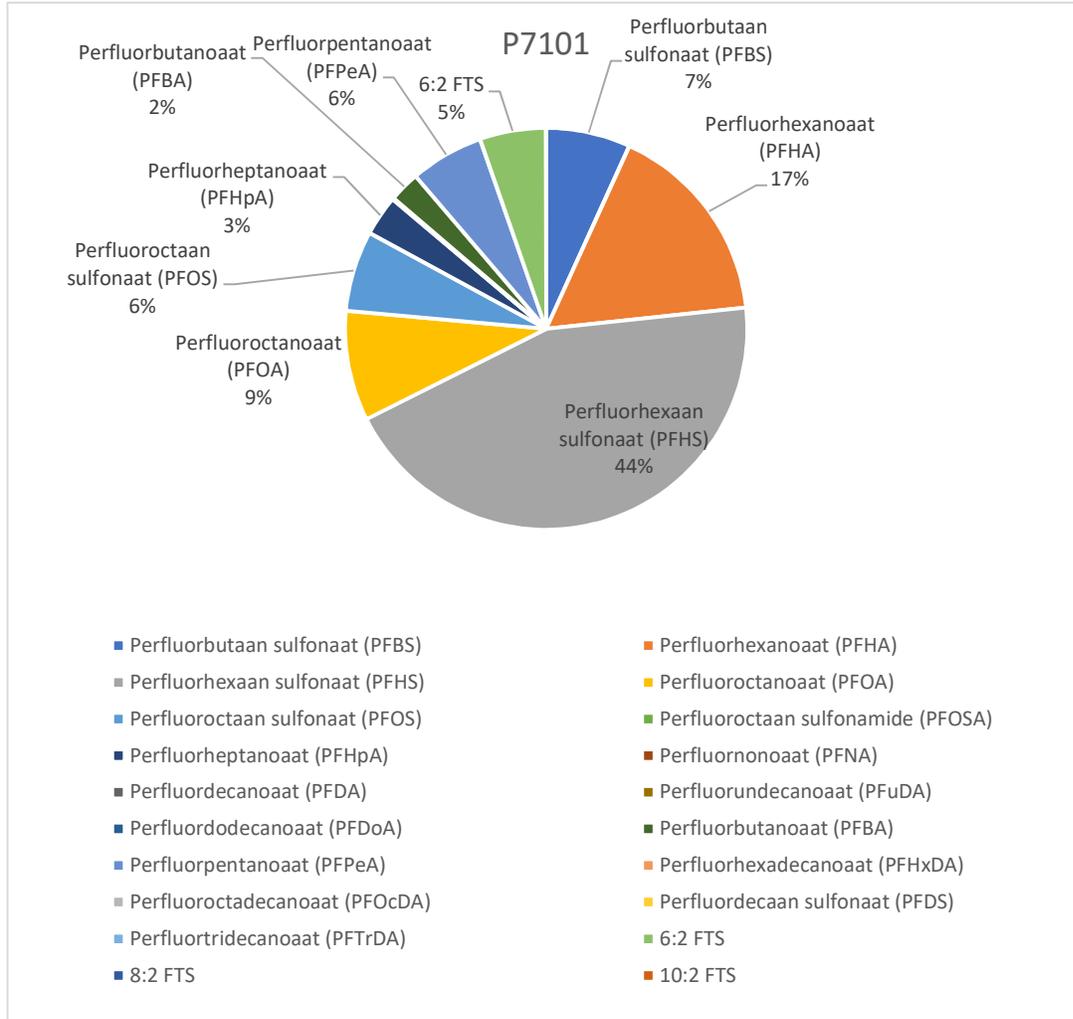
4.2 GROUNDWATER

4.2.1 Site 3

A monitoring well was installed upstream of the training location to check the background value. A total concentration of PFAS of 0.72 µg/l was found in P7104. The slightly increased background value upstream may be due to the industrial activities in the surrounding area.

At P7101, an attempt was made to achieve a vertical delimitation in the groundwater. At a depth of approximately 6 m-gl, no complete delimitation until background value (the background value in this text means the PFAS that is naturally present in a nature destination. Since PFAS does not occur naturally, the background value is the detection limit for PFAS), but a reduction in concentration was obtained. The composition in the groundwater differs at different depths. Especially the short, more mobile components are present at depth.

Figure 4.11 PFAS concentration in P7101 (depth 5.0-6.0 m-gl)



Horizontally no downstream delimitation (in the direction of the surface water (river)) could be obtained at a distance of 30 meters. Here too, the proportion of the most mobile components is the largest further downstream.

It is not clear whether this groundwater contamination has spread to the surface water.

Figure 4.12 shows the distribution of the PFAS components in the groundwater at each measuring point.

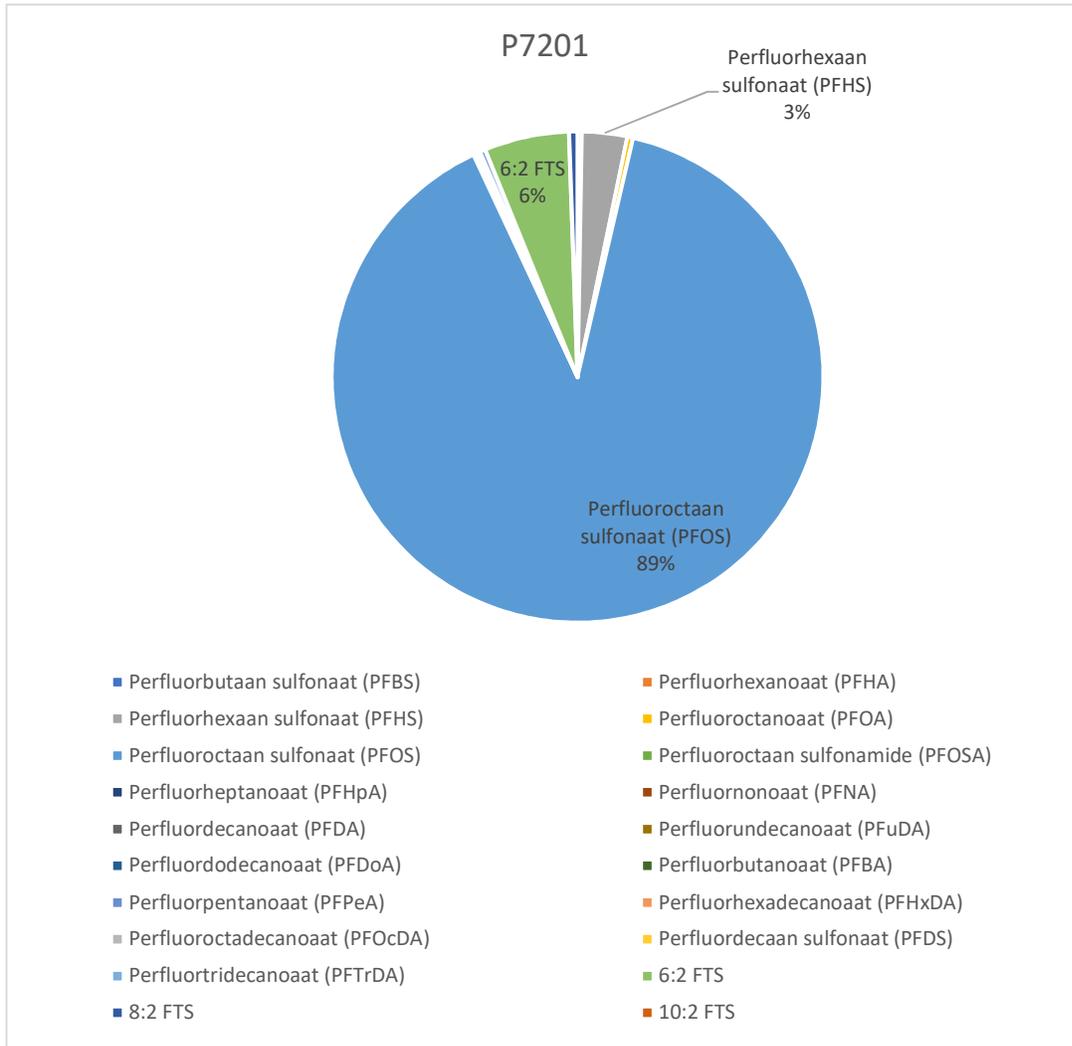
4.2.2 Site 10

In the first phase of the study, only a limited contamination in groundwater was found at this site. A monitoring well was placed downstream (presumed flow direction based on previous studies). The concentration in this monitoring well was twice as high as the concentration found in the first phase. The composition is very different between the two water samples.

PFOS was mainly found in the downstream sample and a strong mixture of all kinds of components was found at the source. This may indicate the use of "old" fire-fighting foam (fire-fighting foam before the prohibition of PFOS) at a location other than the training aircraft zone.

This evaluation corresponds to the findings in the soil.

Figure 4.14 PFAS concentration at P7201 (3.0-4.0)



There is no horizontal delimitation in the groundwater below the background value in the downstream direction (presumed flow direction based on previous soil surveys) of what can be regarded as the source zone (training aircraft, fire pit).

In phase 1 only low groundwater concentration were measured. Therefore no attempt was made to achieve a vertical delimitation in the groundwater for this site.

Figure 4.15 shows the distribution of the PFAS components in the groundwater at each measuring point.

5 CONCLUSION

5.1 GENERAL CONCLUSION

Based on the results of the further study at 2 sites where PFAS-containing fire-fighting foam is/was used, it can be concluded that a contamination in soil and groundwater can be observed vertically and horizontally. It is shown that mainly the shorter and more mobile chains are spread horizontally and vertically. Based on the findings at the two sites studied, it can be stated that the soil contamination at fire training practice sites can be more than 40 meters away from the source zone. This of course depends greatly on the scope of the training activities. A complete delimitation until the background value can be > 100 m in the top layer. Also vertically, spreading in the soil far below the groundwater table is possible.

In all samples PFOS as well as 6:2 FTS was found. Since 2001, fire extinguishing foams have been produced using fluorinated surfactants based on fluorinated telomers (given the prohibition on PFOS), such as 6:2 FTS and 8:2 FTS (fluorotelomer sulfonates). These fluorotelomer sulfonates are known as the so-called precursors and can break down under certain conditions into persistent perfluorinated compounds (e.g. PFOA). As a result, the potentially harmless telomers can be converted into harmful components of the PFAS group that will then accumulate further in the subsoil, ...

In the groundwater, the difference in solubility/leachability between the 2 sites is remarkable. Despite the fact that the soil concentrations at both sites have the same order of magnitude, there is - based on the limited study - a strong and extensive groundwater contamination at site 3 and a rather limited groundwater contamination at site 10. A possible explanation for this may be that the groundwater on site 10 has been studied less extensively.

Within the context of prevention of new additional problems arising from the use of fire-fighting foams, a memorandum was drawn up as part of this study that will be used within the fire service sector to train the fire service and prevent the spread of PFAS component contamination during earthmoving at training sites.

As this problem mainly manifests itself in the short term within the earthmoving sector and can occur due to earthmoving, a memorandum has also been drawn up for soil remediation experts, cleaning centers and soil management organizations on how to deal with PFAS.

5.2 RECOMMENDATIONS FOR EXPERTS

Based on the findings of this study, the following recommendations can be made to certified soil remediation experts:

- When conducting soil investigations as part of descriptive soil surveys or earthmoving projects, a potentially significant horizontal and vertical spreading must be taken into account. This distribution will of course depend on the nature and scope of the fire fighting activities.
- In studies that are performed in the immediate vicinity of locations where PFAS-containing products have been used, stored or processed, it is recommended that these components are included as risk parameters.
- In the vicinity of sites where exercises or calamities have taken place and fire-fighting foams have been used, it is advisable to screen for the presence of PFAS within the context of earthmoving due to the potentially distant spreading of these components.
- When studying PFAS, it must be taken into account that a good preliminary study is important as the practice locations often changed over time and often take place/took place in a "forgotten" corner of a site.
- The composition of the PFAS components found in the soil and/or groundwater can be an aid in determining the origin of the contamination. This will not always be conclusive, certainly not in case of a mixture of products.
- With regard to sampling, the following could be recommended:
 - Create a clear framework for the sampling of PFAS components. The preparation of a specific CMA that is specifically aimed at sampling PFAS is recommended. Given the low reporting limit, there is a high risk of cross-contamination, so that the measured value is higher than the actual value, but a reduced concentration due to adsorption of the PFAS components on the materials used is also possible. Figure 3.1 is a first step in this direction. It is therefore advisable to use such an instruction sheet for fieldwork.
 - The most important starting points are:
 - Avoid products containing PFAS:
 - Clothing: Goretex, Tyvek overalls, waterproof sprays, dirt-resistant clothing, etc.
 - Wear pure, untreated cotton overalls
 - Sampling equipment: no Teflon tubing
 - use PE tubing
 - Do not use water-repellent paper (food packaging material, writing paper, Post-ITs, etc.)
 - Do not use mosquito repellent, soaps, sun creams, detergents, day creams containing PFAS
 - Avoid PFAS-adsorbent products:
 - Sampling equipment: no glass or LDPE
 - HDPE, PE, PP are OK
 - No silicone tube when sampling
 - sampling with a ball valve is OK
- Regarding the laboratories, it is important that the samples are analyzed by laboratories that are recognized to perform CMA procedure CMA/3/D so that the risk of cross-contamination is avoided.

PART Annexes

Annex 1: Results phase 1 soil



7011 (0,0-0,30)	170	61	140	1,2	10	6,8	4,6	34	5,1	<1,0	5	1,5	2,3	2100	18	9,9	<1,0	<1,0	2,8	<1,0	<1,0	2572,2
7012 (0,0-0,30)	450	1400	980	<1,0	3,4	13	2,6	160	39	7,7	32	71	48	240	13	12	<1,0	<1,0	13	<1,0	<1,0	3489,8
7013 (0,0-0,50)	2600	76	480	2	12	40	<1,0	16	6,9	2,7	9,8	2,6	16	6100	21	4,7	<1,0	<1,0	2,6	<1,0	<1,0	9392,3
7006 (0,0-0,40)	38	440	65	1	4,8	22	6,1	8,4	1,2	2,9	17	4,3	15	500	5,2	33	<1,0	<1,0	2,8	<1,0	<1,0	1166,7
																						SOM PFAS

Annex 2: Results phase 1 groundwater

Annex 3: Results phase 2 soil

	Perfluorbutane sulfonate (PFBS)	Perfluorohexanoate (PFHA)	Perfluorohexane sulfonate (PFHS)	Perfluorooctanoate (PFOA)	Perfluorooctane sulfonate (PFOS)	Perfluorooctane sulfonamide (PFOSA)	Perfluoroheptanoate (PFHpA)	Perfluorononoate (PFNA)	Perfluorodecanoate (PFDA)	Perfluoroundecanoate (PFUDA)	Perfluorododecanoate (PFDoA)	Perfluorotetradecanoate (PFTeA)	Perfluorobutanoate (PFBA)	Perfluoropentanoate (PFPeA)	Perfluorohexadecanoate (PFHxDA)	Perfluorooctadecanoate (PFOcDA)	Perfluorodecane sulfonate (PFDS)	Perfluorotridecanoate (PFTrDA)	6:2 FTS	8:2 FTS	10:2 FTS	Totaal PFAS (som)
P7101 (0-0,20)	<0,50	1,3	8,6	5,5	1900	1,1	<0,50	1,1	7,6	<0,50	1,3	<0,50	<0,50	3,9	<2,0	<2,0	<0,50	<0,50	340	20	12	2302,4
P7101 (5,5-6,0)	4,9	18	120	18	54	<0,50	4	<0,50	<0,50	<0,50	<0,50	5,1	4,9	<2,0	<2,0	<0,50	<0,50	27	<2,0	<2,0	255,9	
P7102 (0-0,20)	<0,50	6,7	15	7,1	240	3,9	<0,50	13	37	4,1	7,5	1,4	3,1	11	<2,0	<2,0	2,9	<0,50	34	5	16	407,7
P7103 (0-0,20)	1,5	16	25	10	1100	87	1,1	0,91	14	7	13	1,9	4,6	12	<2,0	<2,0	69	1,7	140	7,8	23	1535,51
P7104 (0-0,20)	<0,50	1,1	2,9	<0,50	51	<0,50	<0,50	0,54	1,8	0,77	2,6	<0,50	3,1	4,1	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	11	78,91
P8101 (0-0,20)	<0,50	4,1	23	12	790	37	0,87	4,7	30	7,8	18	2,6	2,2	3,8	<2,0	<2,0	32	2,5	240	58	110	1378,57
P8102 (0-0,20)	2,1	4	47	13	1600	28	<0,50	<0,50	4	1,6	1,8	<0,50	4,5	7,7	<2,0	<2,0	16	<0,50	56	4	19	1808,7
P8103 (0-0,20)	<0,50	1	3,5	<0,50	130	<0,50	<0,50	<0,50	0,77	<0,50	<0,50	<0,50	1,3	0,81	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	2,7	140,08
P8106 (0-0,20)	0,98	16	28	12	1100	66	3,1	3,6	46	19	42	5,2	4,1	10	<2,0	<2,0	55	2	180	71	160	1823,98
B8104 (0-0,20)	<1,0	<0,50	1,9	<0,50	240	2,4	<0,50	<0,50	3	2,1	1,1		2,2	2,2	<0,50	<1,0	2,5	<0,50	3,1	<2,0	2,7	263,2
B8105 (0-0,20)	<1,0	1,2	2,5	<0,50	110	0,92	<0,50	<0,50	0,87	<0,50	<0,50		1,9	<0,50	<0,50	<1,0	<0,50	<0,50	<0,50	<2,0	<2,0	117,39
P7201 (0-0,20)	<0,50	<0,50	12	<0,50	280	<0,50	<0,50	2,8	2,7	0,77	0,67	<0,50	<0,50	2,3	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	<2,0	301,24
B8201 (0-0,20)	0,81	0,8	29	6,3	430	2,6	6,8	31	7,5	5,8	2,3	<0,50	4,3	9,9	<2,0	<2,0	4,8	<0,50	6,5	14	8,7	571,11
B8202 (0-0,20)	<0,50	17	8,9	5	65	<0,50	5,7	8,6	<0,50	1,1	<0,50	<0,50	1,9	14	<2,0	<2,0	<0,50	<0,50	82	3,3	<2,0	212,5
B8203 (0-0,20)	<0,50	<0,50	2,7	2,1	3,3	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	2,2	<0,50	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	<2,0	10,3
B8204 (0-0,20)	<0,50	<0,50	4,9	0,58	43	<0,50	<0,50	<0,50	0,65	0,86	<0,50	<0,50	1,1	4,3	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	<2,0	55,39
B8205 (2,5-3,0)	<0,50	<0,50	15	<0,50	4,9	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<2,0	<2,0	<0,50	<0,50	18	<2,0	<2,0	37,9
B8205 (3,3-3,5)	<0,50	<0,50	11	<0,50	3	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	1,9	<2,0	<2,0	<0,50	<0,50	4,9	<2,0	<2,0	20,8
B8206 (0-0,20)	4,5	39	150	2,8	1400	39	2,8	10	34	11	6,3	<0,50	9,7	38	<2,0	<2,0	39	<0,50	240	30	43	2099,1
B8207 (0-0,20)	<0,50	1,9	9,2	<0,50	170	1,3	<0,50	3,6	0,7	0,79	<0,50	<0,50	0,96	7,2	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	<2,0	195,65
B8208 (0-0,20)	<0,50	<0,50	1,2	1,1	65	<0,50	<0,50	3,4	<0,50	<0,50	<0,50	<0,50	1,1	5,7	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	<2,0	77,5
B8209 (0-0,20)	<0,50	<0,50	0,73	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	<0,50	0,85	<0,50	<2,0	<2,0	<0,50	<0,50	<0,50	<2,0	<2,0	1,58
B8210 (0-0,20)	<0,50	2,7	30	<0,50	760	11	3	8,5	5,8	<0,50	1,1	<0,50	2,6	7,6	<2,0	<2,0	5	<0,50	9,7	<2,0	<2,0	847

Annex 4: Results phase 2 groundwater

	Perfluorbutaan sulfonaat (PFBS)	Perfluorhexaanoaat (PFHA)	Perfluorhexaan sulfonaat (PFHS)	Perfluoroctaanoaat (PFOA)	Perfluorocetaan sulfonaat (PFOS)	Perfluorocetaan sulfonamide (PFOSA)	Perfluorheptanoaat (PFHpA)	Perfluornonoaat (PFNA)	Perfluordecanoaat (PFDA)	Perfluorundecanoaat (PFUDA)	Perfluordodecanoaat (PFDoA)	Perfluorbutanoaat (PFBA)	Perfluorpentanoaat (PFPeA)	Perfluorhexadecanoaat (PFHxDA)	Perfluorotadecanoaat (PFOcDA)	Perfluordecaan sulfonaat (PFDS)	Perfluortridecanoaat (PFTrDA)	6:2 FTS	8:2 FTS	10:2 FTS	Totaal PFAS (som)
P7101	23	56	150	30	22	<0,20	11	0,37	<0,0050	<0,005	<0,2	8,4	20	<0,0050	<0,010	<0,005	<0,005	18	0,087	<0,005	338,857
P7102	4,9	16	62	5,5	44	<0,20	3,6	0,059	<0,0050	<0,005	<0,2	4	15	<0,0050	<0,010	<0,005	<0,005	2	<0,0050	<0,005	157,059
P7103	1	27	23	5,9	420	<0,20	5,7	0,85	0,04	<0,005	<0,2	7,2	32	<0,0050	<0,010	<0,20	<0,005	150	0,65	<0,005	673,34
P7104	0,009	0,031	0,025	0,018	0,5	<0,20	0,01	<0,0050	<0,0050	<0,20	<0,2	0,031	0,053	<0,20	<1,0	<0,005	<0,20	0,046	<0,0050	<0,005	0,723
P7201	<0,005	0,051	0,53	0,07	16	<0,20	0,017	0,042	0,009	<0,005	<0,2	0,018	0,062	<0,0050	<0,010	<0,005	<0,005	1	0,1	<0,005	17,899

Annex 5: Map Site 3

Site 3 Brandweeroefenplaats (Regionaal)

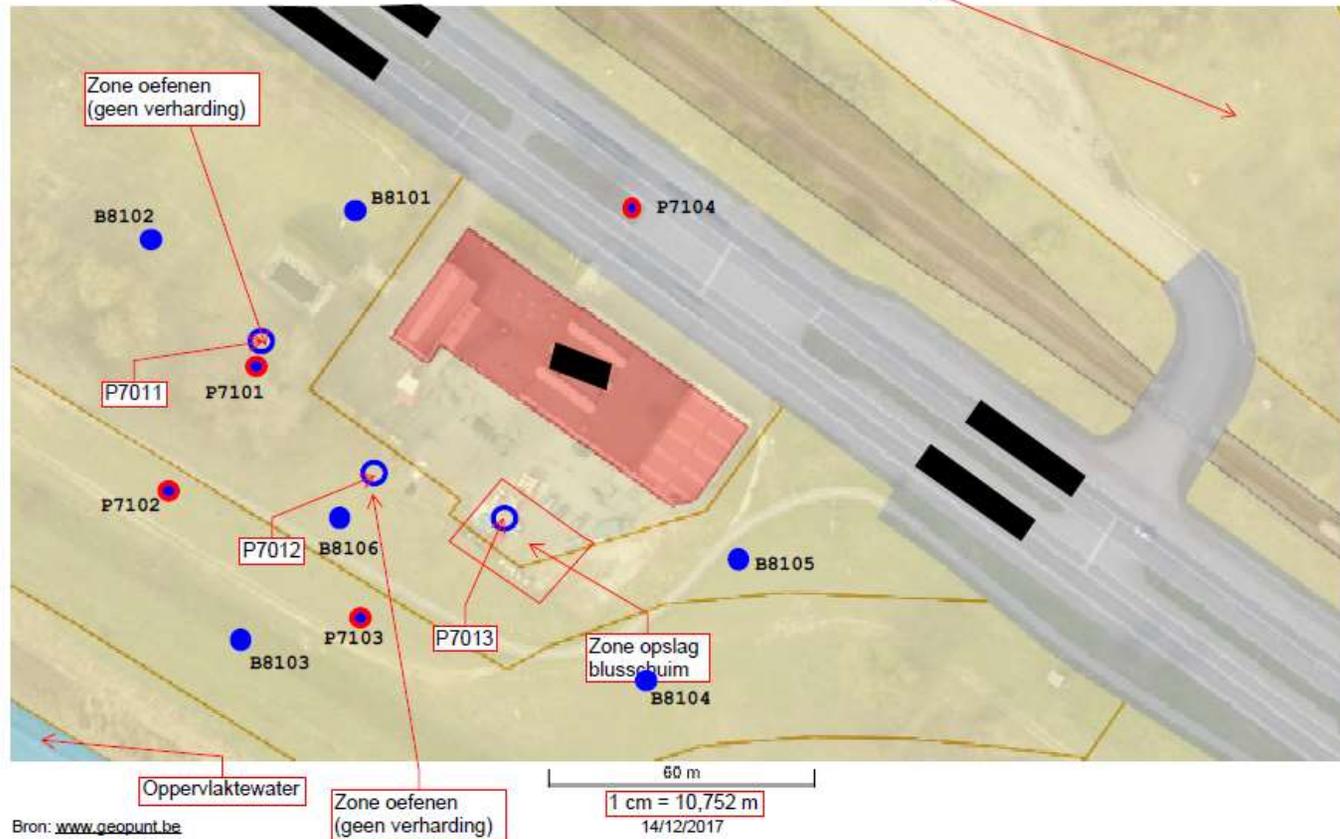
geo

INFORMATIE
VLAANDEREN



Vlaamse
overheid

Industriezone



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Annex 6: Map site 10



60 m

1 cm = 10,66 m

23/02/2018

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