RIWA-Meuse

Annual Report 2022
The Meuse

Protect the source of drinking water for 7 million people!

RIWA - Vereniging van Rivierwaterbedrijven

Content

“Protect the source of drinking water for 7 million people by getting a better grip on wastewater discharges.”

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Introduction

High time to be more careful with the water in the Meuse – but how?

In this annual report you can read about the efforts of the members and cooperation partners of RIWA-Meuse in 2022 to protect and improve the quality of the water of the Meuse. This is important, because the Meuse forms a source of drinking water for well over 7 million people in the Netherlands and Belgium.

To protect the Meuse effectively, we first require a good picture of exactly what harmful substances are in the water. Next it is crucial to determine what the source of the impurities is: where exactly do they come from? With this information we can then reduce the quantity of harmful substances in the Meuse.

Quantity and quality are both reducing

Reducing the quantity of harmful substances is, unfortunately, urgently needed. Even more so due to the changing climate, thanks to which we can expect more extreme weather conditions in the coming years: more frequent heavy rainstorms and floods, longer periods of drought and strongly redused river flows, caused by low water levels.

We have already seen all this in recent years. The year 2022 was the fourth dry year in a five-year period, the driest year measured this century in the Netherlands and the next to driest year in the last 30 years in Belgium.

Little rain doesn’t only mean that less water flows down the Meuse and water shortages can arise, but it also means harmful contaminants are diluted less, and are present in higher concentrations. In other words, not only the quantity is dropping, but also the quality. This has consequences for the drinking water supply, as well as for the other users of the water: agriculture, industry, recreation and not to forget the flora and fauna.

What is needed to protect the Meuse as source of drinking water for 7 million people?

Transparent and complete licensing

The quality of drinking water sources is threatened by harmful substances. Insight into which harmful substances end up in the water and where they end up is essential to protect the quality of our water.

- Create a full overview of all direct and indirect wastewater discharge permits.
- Include substances that may harm the production of drinking water in permits. Use the RIVM PMT-screening Tool to estimate the harmfulness of substances.
- Carry out a baseline measurement for new permits or revisions to obtain a complete picture of the harmfulness of wastewater discharges.

Strict control & enforcement on wastewater discharges

Active protection of the sources for the drinking water requires proper licensing, which is essential for supervision and enforcement.

- Review permits regularly using the latest insights into the harmfulness of substances.
- Publish the information from wastewater discharge controls.
- Ensure that what is not permitted will not be discharged. Enforce the law in the event of violations of the permit.

Low river runoff and water shortages

Due to lower availability, and increasing demand for water, parts of the river basin experience water shortages.

- Start an international dialogue on water availability.
- Make international agreements about priority use and the division of water.

Better decisions about permits

What substances pose a risk to the production of drinking water? These are substances that have PMT characteristics. These persistent, mobile and toxic substances only break down a little or not at all, are distributed rapidly and are toxic. Moreover, they are difficult to purify out of the water. These substances must therefore be kept out of the water environment as much as possible.

Therefore the PMT tool recently developed by RIVM is very valuable. Permit issuers can use this tool to gain a convenient insight into what substances have these properties and better decide whether a company obtains a permit or not.

Forever and everywhere chemicals

A well-known example of substances that meet PMT criteria is PFAS. There was a lot of attention to these in 2022, and they feature frequently in this report. This group of man-made chemical substances turns up widely in products and the environment and is proving to be harmful to health in much smaller quantities than previously thought. It emerges from research by RIVM and others that some PFAS have a negative effect on the immune system and can cause certain types of cancer.

In short, and for good reason, RIWA-Meuse has been pleading for years to drive PFAS discharges down to zero. Five European countries including the Netherlands want a complete prohibition of PFAS. We also hope that more and more businesses will realise that the use of PFAS substances is on its way out and that they develop alternatives for them.

Appeal cases, medication residues and algae

In the past year we have noted how important it is to remain constantly alert for new contamination incidents. For example, an appeal case was brought against the discharge permits of the chemicals company Chemours in Dordrecht. An objection was raised to the plan to deposit soil from Flanders with possible PFAS contamination into some Meuse ponds.

Much attention was also paid to the complex problem of harmful medication residues that end up in our drinking water via the sewerage system. Purifying these out is frequently costly and non-sustainable – this is a difficult consideration. More on this can also be read in this report. Furthermore, newly developed substances are continually coming on to the market. It is important from now on to first have clarity about whether a substance is harmful before it is licensed and used.

Another striking development in 2022 was the heavy growth of algae, due to which the abstraction of Meuse water in Limburg was suspended for a long time. While this is indeed a 'natural' contamination, it ultimately has a human cause. The growth increases for example due to excessive fertilisation or discharges of wastewater. As is often the case, much detective work was needed to find out where the contamination came from.

Up-to-date summary of permits

For a long time, the issue of permits has been the poor relation in the Netherlands, according to one of the people interviewed in this report. Many permits are indeed now out of date and incomplete. Unfortunately, no comprehensive overview of permits exists and due to this, we do not know where all the harmful substances in the Meuse originate from.

Rijkswaterstaat is currently busy updating the discharge permits for the main water system, the rivers and major canals. It is important that this also happens for permits or discharges into the sewer system, as well as the regional waters, these being the smaller rivers, streams and canals. As these water streams end up in the Meuse. The Atlas for a Clean Meuse lists the permits of Rijkswaterstaat and the water boards. Entering the permits that the regional enforcement agencies (environmental agencies) issue for discharges via the sewerage system into the Atlas is an appropriate next step to gain more insight into wastewater streams.

Measuring substances jointly

The Atlas is an initiative of the Schone Maaswaterketen (Clean Meuse Water Chain), an partnership of the drinking water companies, water boards along the Meuse, Rijkswaterstaat, the Ministry of Infrastructure and Water Management and RIWA-Meuse. In 2022, we also set up a joint substances monitoring network.

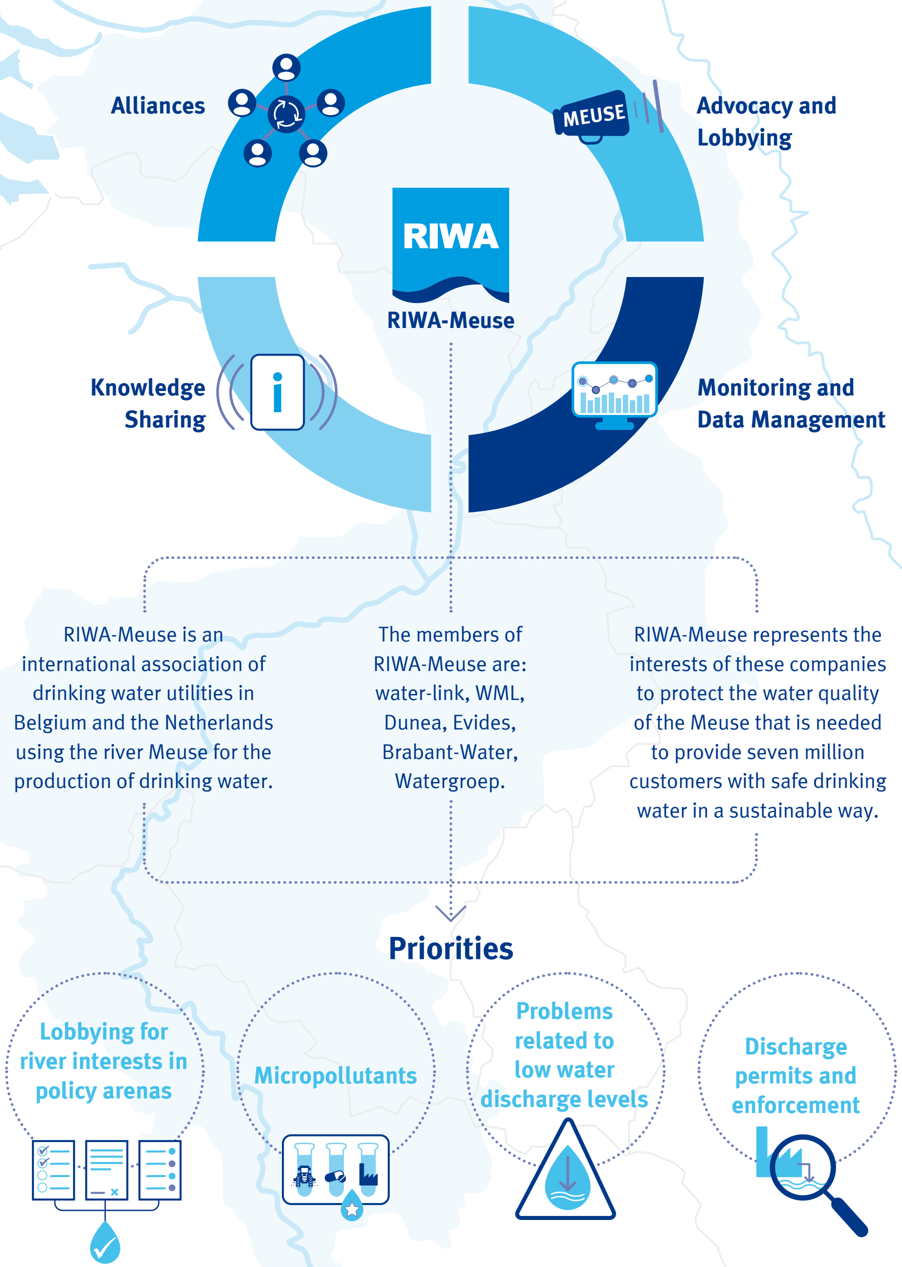
In 2023, we will start measuring substances that form a risk to the drinking water supply in the Meuse, the tributaries and major sewage treatment plants. This will give us a much more complete picture of where these substances are present in the water in the Meuse river basin. This is important to determine where harmful contaminations come from.

Last year an interesting and comprehensive investigation was done by the French newspaper Le Monde with 17 media organisations, including the NRC, into PFAS discharges in Europe. On the Forever Pollution Map, the shocking amount of locations PFAS was measured, where PFAS possibly ends up in the water or in the soil, and where PFAS producers are located and which companies use PFAS can be seen. This information also contributes to our investigation into where harmful discharges possibly come from in the Meuse river basin.

Reducing harmful discharges

As soon as it is clear who is discharging what and where into the Meuse, it is crucial to reduce the discharge of harmful substances as quickly as possible.

Mission RIWA-Meuse



The monitoring results from the Clean Meuse Water Chain will form a good basis for a joint approach, in combination with more insight into the permits – closer supervision and stricter enforcement are needed too.

RIWA is a major proponent for the competent authority to analyse wastewater streams from businesses for harmful substances when permits are issued and during the supervision of the compliance with these. Rijkswaterstaat is already doing this on a small scale. We argue that this method should be applied more widely in the issuing of permits and their supervision. In this way we can get a better grasp of the emissions of harmful substances.

Cooperating on cleaner drinking water

All these themes and more are considered in this RIWA-Meuse annual report. Together, their purpose is to protect and improve the quality of the Meuse water. To solve this complex issue successfully, cooperation is essential. This is because jointly you can achieve more, having more knowledge and power.

In 2022, we also significantly increased the cooperation in the Clean Meuse Water Chain. In the future, we fully intend to cooperate more with the provinces, environmental agencies and businesses. After all, we all benefit from good Meuse water quality.

To summarise, it is high time to become more careful with the water in the Meuse, because, as is observed later in this report: 'We must no longer see our surface water as a kind of waste pit: the quality deserves just as much attention as flooding and drought.' Now that we are frequently confronted with the consequences of drought, the protection of the Meuse is even more urgent.

Maarten van der Ploeg, Director of RIWA-Meuse

A

The Meuse as a source of drinking water

How did things go in 2022 for the Meuse as a source of drinking water? What events affected the water quality?

The facts listed out

In order to monitor the water quality of the Meuse, drinking water companies together with Rijkswaterstaat conducted a total of 74,540 measurements of 1,059 parameters in 2022. Of these 1,059 parameters, 713 were testable, and of these 713, 79 (11.1%) exceeded the European River Memorandum (ERM) target value once or more at at least one measurement point. That 346 parameters were not testable has to do with the fact that there is no ERM target value for them. Preparing drinking water in a sustainable way with natural purification methods that also meets the ERM target values is a viable way of preparing drinking water.

Of the 79 exceeded parameters, 40.5% (32) belong to the category industrial pollutants and consumer products and 21.7% (23) to the category pharmaceuticals and endocrine-disrupting chemicals. These two categories mainly include non-standardised ('upcoming' or new) substances. There was a total of 62 abstraction stops and restrictions at the joint drinking water companies as a result of water pollution in 2022. Due to these, normal operations were interrupted or disrupted for a total of 5,585 hours (233 days, cumulative for the seven abstraction points).

A

A1 More drought and more cooperation among Flemish drinking water companies

Flanders suffers even more from the drought than the Netherlands. After a wet 2021, a dry 2022 followed. The water quality and particularly PFAS were also hot topics. Bert Rousseau of water-link and Tom Diez of De Watergroep report how this was dealt with. "The Flemish drinking water companies are cooperating on a climate-robust system."

In Flanders, there are fewer rivers, lakes and water buffers than in the Netherlands. "This is why it pinches a little more," says Tom Diez. "We are more vulnerable and more quickly see a reaction to drought. We therefore need to arm ourselves well against the extreme consequences of climate change."

As Strategic Planning Manager at De WaterGroep, Diez is responsible for guaranteeing a safe and reliable water supply in both the short and long term. He analyses what sources the company can use in the future and how these can be managed as sustainably as possible. Are additional sources and infrastructure needed and how much water needs to be stored?

Low water in the winter

Both summer and autumn in 2022 were very dry in Flanders, which caused very low water levels lasting until early 2023. "We always assume that we will see a low water level in the summer," says Diez. "But remarkably enough the rivers also had an absolute minimum level in February 2023. It seems that the issue of low water might no longer be limited only to the summer."

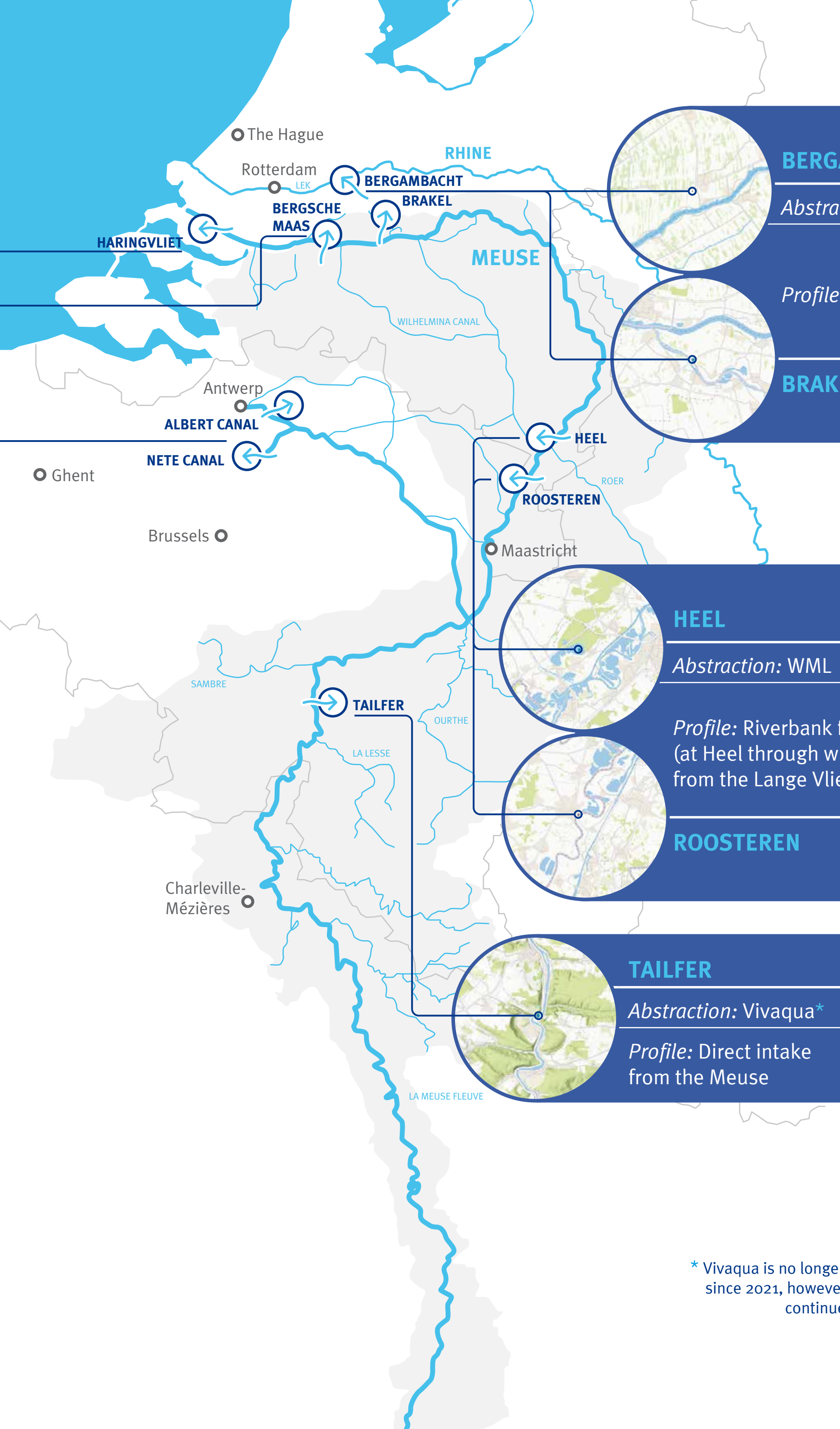
Due to this, Diez remarks, you have an ever-greater risk of conflicts with other water users. "We are beginning to see and feel this seriously, because others like farmers and industrial companies need the water as well. It's rather difficult to decide who gets first go."

Drought committee

One of the themes that stands out for Bert Rousseau in 2022 is the fact that, in this year, the Drought Commission took concrete decisions for the first time to ensure that enough drinking water was available. He is the head of the laboratory at water-link. As process technologist, he is also responsible for the database of results from samples from the Meuse for monitoring the water quality and for research to produce drinking water. Together with his colleagues, he also watches out for threats such as new chemicals.

The Flemish government set up the Drought Commission in 2018; it is a collaboration including water managers and drinking water companies. The Commission maps out threatening problems. The members can provide advice and take measures to save water and to employ the remaining water stocks optimally. "In 2021, for the first time, we made clear agreements with the Drought Commission, but these were not necessary that year because it was a very wet summer," says Rousseau. "However, the summer of 2022 was exceptionally dry, just as in 2018 and 2019."

The Meuse as source of drinking water



HARINGVLIET

Abstraction: Evides

Profile: Dune infiltration

BERGSCHE MAAS

Abstraction: Evides/WBB

Profile: Reservoirs in the Biesbosch

ALBERT CANAL

Abstraction: water-link

Profile: Supplies 40% of Flander's drinking water as well as other drinking water utilities (such as Watergroep, Farys and PIDPA)

NETE CANAL

BERGAMBACHT

Abstraction: Dunea

Profile: Dune infiltration

BRAKEL

HEEL

Abstraction: WML

Profile: Riverbank filtration (at Heel through withdrawals from the Lange Vlieter)

ROOSTEREN

TAILFER

Abstraction: Vivaqua*

Profile: Direct intake from the Meuse

SURFACE WATER AS SOURCE FOR DRINKING WATER

RIWA-Meuse member utilities	*Surface water extraction (%)*	*Surface water extraction (10^6 m³/year)*	*Customers supplied with surface water*
Evides (+WBB)	80%	209,8	2,0 million
water-link	100%	153,4	2,5 million
Dunea	100%	75,0	1,5 million
Vivaqua*	30%	34,6	750.000
WML	25%	9,0	280.000
Total		**481,8**	**7,0 million**

* Vivaqua is no longer a member of RIWA since 2021, however water quality data continues to be exchanged.

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WATER-LINK EN WATERGROEP

All the Flemish drinking water companies support the Drought Commission and cooperate well in it, emphasises Diez. "We are dependent on each other as regards water availability, so it's critical there are clear agreements and that we speak with a single voice."

Water-saving measures

Companies and inhabitants in Flanders for example received the advice to be sparing with water in the summer of 2022. This advice was well taken: the consumption in this period was less than that in the summers of 2018 and 2019.

There was also a hosepipe ban for part of the year in certain areas; no water could be extracted from channels, streams or rivers for agricultural land, to fill ponds, or to water gardens or sports fields. The water sector was not convinced such a prohibition would help. "You often see that after the prohibition is announced and before it enters into force, everyone rapidly starts watering," says Rousseau. "Meaning that we can end up in trouble even quicker."

Another example of a water-saving measure in 2022 was the decision to have vessels that need to go through a lock with a height difference between two canals go through with multiple vessels simultaneously. This way, less water is lost on the way towards port.

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Collecting rainwater

A continual water-saving measure from the Flemish government is the obligation to collect rainwater from newly built houses. This has advantages, Rousseau considers. "Only, this storage runs dry after long periods of drought. To span longer periods of drought, I think more infiltration is a better measure."

So, to use the subsoil as a buffer: try to get the groundwater levels as high as possible during wetter periods by not letting all the surface water just run away into the sea. In Belgium, perhaps more than in the Netherlands, the focus has historically been on the drainage of excess rainwater to prevent flooding. Rousseau: "We now have to transition and try to retain that water as much as possible."

The Albert Canal management also took water-saving measures in the summer of 2022, reports Rousseau. "This was the first time we had really low water levels. We feared a shortage, and made agreements about the use of buffers, so that we had to extract less water from the canal." Water-link gave the situation a 'code yellow', which means raised alertness, and this had a direct impact on all the other water companies.

No competitors

Diez of De Watergroep endorses this. He has the impression that the Flemish drinking water companies cooperate more than those in the Netherlands. "We want to jointly make our drinking water system more robust," he states. "We in Flanders have indeed made this change of course in recent years." Rousseau adds: "In the past, we only entered into consultation once there was a problem; now we do this in advance."

WATER-LINK EN WATERGROEP

The drinking water companies make agreements with each other and use each other's sources if necessary. For this, a number of major connections have been constructed between the water distribution systems and various others are still in construction. Drinking water systems are also built and operated jointly. Diez: "While there is sufficient surface water, we all try together to use it maximally. And in the interim, we save all that groundwater and supplement it for dry periods." This cooperation is possibly necessary in Flanders due to the drought, but he also notes: "This is of course also the most efficient way of working, for your customers as well. Everyone gains improvement in this way."

Buffers, legislation and unconventional sources

Flanders has fewer water buffers than the Netherlands and is constructing more buffers, states Rousseau, because the expectation is that they will become more necessary due to drought. "Previously, the buffers were only needed in case of quality issues, not for water shortages."

The Flemish government is also drafting policy to better protect the surface water against harmful discharges, Diez states. He is optimistic that good legislation will emerge from this in the short term, because the Flemish government is behind it and the drinking water companies are involved in the discussions.

A number of Flemish drinking water companies are currently jointly investigating several possibilities to use less conventional sources, continues Diez. For example, water from the sea is being looked at. However, it costs a great deal of energy to make drinking water from this.

"For this reason, a drinking water production centre is being built where fresh water, brine and also salt water can be treated. So that fresh water can be used if there is enough of it. In extreme emergency you can then use seawater and in this way as few water streams as possible are lost." Other investigations of Flemish drinking water companies are looking at the possibilities to make drinking water from wastewater.

PFAS scandals

Apart from the water quantity, the water quality also featured heavily in the news in Flanders in 2022. Rousseau cites the environmental scandal around the Oosterweel project to extend the Antwerp Ring that came to light in 2021 and has received a lot of attention in the press. Large quantities of PFOS, a toxic substance in the PFAS family (poly and perfluoroalkyl substances) were discovered in the soil; these had been discharged into the Port of Antwerp by the 3M factory in Zwijndrecht.

"PFAS is a similar story as asbestos has been in the past," says Rousseau. "It has been used for years in very many applications, and its harmfulness was not properly studied. Thanks to this dossier, PFAS in Flanders has become a hot topic and that has rapidly increased attention to the problem all over Europe."

Difficult discussion

The PFAS issue is enormously involved – no one is entirely sure how we should deal with it, emphasises Diez. In the issuing of permits for new projects for example, because he says: "PFAS is so widely distributed, it’s present everywhere. They are not called forever chemicals for nothing. So, how for example do we ensure that all projects and the entire economy don’t come to a standstill? Do we insist everywhere that you have to remove it, but with what tech-

WATER-LINK EN WATERGROEP

nique and where do we leave it then?" he asks himself. "Flanders will need to be introspective in its permits policy. These are very difficult discussions and they are something that everyone in Europe will be wrestling with soon. All the Member States are looking into this."

He also mentions the fact that PFAS standards appeared in the revised European Drinking Water Directive for the first time in 2020. "These standards impose very low limits, which we will also have to comply with in 2026. And given the fact that PFAS is widely distributed and very difficult to remove, it's a big challenge for us to remove these substances."

Dealing with new substances

Both emphasise that the precautionary principle must be better applied for new substances. In other words, it must first be clear how harmful newly developed substances are before they are allowed to be discharged. Diez: "It's important to already take account of these new substances right from their development." Besides discharges from businesses, he also mentions medication residues that get into the water via the sewerage system, and suggests for example starting to use more green or sustainable medicines. "So it doesn't prove afterwards that you are confronted with a big problem, as we now are with PFAS."

Rousseau adds: "We must know how hazardous such a substance is, and also how our drinking water production centres should deal with it. Are these substances that are very easy to remove or not? Before they are produced and sold, we need to know this."

Better enforcement

In case of illegal discharges, insufficient action is taken in Flanders, Diez considers. "Sometimes it takes ages, or matters are just left to slide. Certainly in dry periods, enforcement must be stricter, although the legal context doesn't always make that possible currently. I have the impression that this is dealt with more strictly in the Netherlands." Rousseau shakes his head: "The drinking water companies in the Netherlands also ask for quicker intervention, I understand; the government there too is considered too lax sometimes."

"Certainly in dry periods, enforcement must be stricter, although the legal context doesn't always make that possible currently"

The Flemish drinking water companies, in comparison to those in the Netherlands, are indeed more involved in the permits policy, both agree. Rousseau: "So if new discharges are introduced in protected areas for drinking water, drinking water companies are contacted for advice. This is very important."

In Flanders, the supervisory authority, the Flanders Environmental Agency, also looks more closely at what effect a substance has on the drinking water rather than at the source, the quality of the water before it is purified into drinking water. "If there are substances present that they know our water production centres can remove easily, less attention is paid to this than if it's clear these substances will present a problem. We don't have the procedure with exemptions that the Dutch work with."

WATER-LINK EN WATERGROEP

Cooperation across the borders

Both the interviewees emphasize that more international cooperation is needed to better protect the water of the Meuse as a source of drinking water. Rousseau considers that water treaties among the various European Member States will become much more important, to ensure that the region continues to have enough water. "Such a treaty already exists between Flanders and the Netherlands, but we don't have one yet with Wallonia or France. And if only a little amount of water comes from the upstream part in the basin, both Flanders and the Netherlands will increasingly face shortages."

The European Directives are well formulated, Diez considers, but in practice how the Member States and regions deal with these differs. "When defining policy, the reasoning is still too much from the perspective of each Member State separately rather than at the level of river basins. If the Meuse or another water source is not used for drinking water in a certain Member State there is often less attention to it." This is why the protection of the Meuse is dealt with more consciously in the Netherlands and Flanders than in France, where less use is made of this river as a drinking water source.

The cooperation between the Flemish and Dutch drinking water companies, as in the RIWA-Meuse context, is in any event extremely important, they both emphasise. Joint research into new and upcoming substances for example. "It's good that we are doing this jointly so we can share the efforts." Tracking down contaminations jointly also proves highly beneficial. "For example, we have discovered where certain discharges come from in recent months."

A2 Unknown substance in Limburg due to blue-green algae and plants?

In mid-May 2022, WML (Waterleiding Maatschappij Limburg) observed high concentrations of an until-then unknown substance in the Border Meuse, a 47 km long stretch of the Meuse between Belgium and the Netherlands. For this reason, WML had already suspended abstraction of Meuse water briefly several times. From the 24th of June, this was necessary for an extended period of time, and WML started to employ alternative sources.

The substance was given the codename GC-Aqua 0092. Initially, it was suspected that this was phytyl acetate, but tests later revealed that it was a different substance. Because, due to the abstraction stop, the levels of the basins at De Lange Vlieter fell, the normal extraction was reduced, and a switch was made to use the satellite pumping stations and deep extraction. This meant that harder water was supplied in the supply area, which drinking water customers could notice. This is why the stop and the use of other sources was publicised, which was picked up by media including the regional station L1, the NOS broadcaster (the Netherlands) and Het Laatste Nieuws (Belgium).

Source tracing

To determine the identity of the unknown substance, efforts were made to track down the source. WML had requested Rijkswaterstaat to put the Meuse source tracing protocol into action. Following this, on July 5th, Rijkswaterstaat had samples taken at 19 locations between Eijsden and Heel for further GCxGC screening. Additionally, on July 7th, samples were taken by water-link at two monitoring points on the Meuse, namely Liège-Monsin and Namêche.

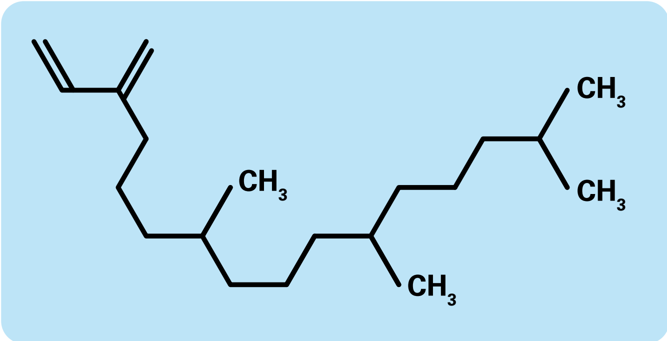
In the meantime, Evides investigated which substances have the molecular formula $C_{22}H_{42}O_2$, as phytyl acetate does: there proved to be 927[1]. RIWA-Meuse investigated the properties persistence (BioWin3) and mobility (log Kow) of these 927 substances using the computer program EPI Suite™[2].

1 Source: https://pubchem.ncbi.nlm.nih.gov/
2 Source: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface

This information was found for 872 substances, and although these all emerged as fairly to moderately persistent substances, they could not be qualified as mobile (being poorly soluble in water, log Kow › 6). This gives a high chance of removal in a purification plant based on natural processes.

The International Meuse Commission reported the results of the source tracing to date on July 21st. It emerged from sampling that a source is present in the tributary of the Geul near the town of Kelmis. On 25 July, extra samples were taken from this tributary of the Geul.

Of natural origin



On July 29th, Aqualab Zuid identified the substance in the samples of July 25th as neophytadiene with a high degree of certainty (CAS RN 504-96-1, molecular formula $C_{20}H_{38}$ [see structural formula alongside], log Kow 9.7, BioWin3 2.58). This is a natural substance most probably originating from plants or algae. After this, WML resumed the abstraction of Meuse water from the Lateral Canal at Heel.

Both KWR and the RIVM concluded that at that time there were no concrete indications that neophytadiene formed a health hazard to humans. Given that there is currently little known about this substance, this could not, however, be excluded[3].

3 RIVM Report no. 2022-0038, Advisory Report on Neophytadiene (CAS no. 504-96-1) in the Meuse

Because the substance has a natural origin, its presence at measurable concentrations in the Meuse could be the result of growth of blue-green or other algae, plant growth or the breakdown of plant material in the river basin. The summer heat, the presence of lots of nutrients, much sunlight and the low water flow, which in some places led to stagnant water, ensured abundant growth of algae and water plants.

That a vegetable origin is highly probable also emerges from other information that may be found on the internet. It is known that Spirulina platensis, a microalgae that belongs to the Cyanobacteria group, is a source of substances including volatile components with an antimicrobial activity such as neophytadiene. It is also known that neophytadiene arises in seaweed extracts, as a byproduct of wastewater purification with MaB-floc reactors[4] and as a metabolite of ginger, but these do not seem probable causes of this incident.

How natural is the growth of blue-green algae?

In the summer, a rapid development of phytoplankton occurred in the entire Meuse (and so also in the Lateral Canal). This was a good deal more than had been measured in the past. The proportion of cyanobacteria was also high in the Lateral Canal, an 8.9 km-long canal in Limburg between the places Heel and Buggenum opened in 1972. In early August, cyanobacteria were observed visually in the Lateral Canal and the storage basins at De Lange Vlieter. Based on the samples taken from De Lange Vlieter it could be established that the levels of both Cyanobacteria and microcystine (a toxin from blue-green algae) were low there[5]. The dephosphatisation of water that is pumped into the storage basins at De Lange Vlieter has proceeded successfully in recent years. It emerged from observations that a reduced productivity of phytoplankton had led after some years to a reduction in themussel population in the storage basins.

4 *Microalgal bacterial floc*

5 *The limnological condition of De Lange Vlieter 2022. Significant reduction of the biomass in quagga mussels. Report from Arco Wagenvoort and Bert Pex*

The abundant growth of algae, including Cyanobacteria, in the Meuse and the Lateral Canal has a number of causes:

- the presence of high levels of nutrients, phosphorus and nitrogen,
- high water temperatures,
- periods with a low flow and the ever-increasing retention of water in the Meuse river basin, due to which the water stagnates or almost stagnates for long intervals.

Humans affect all these causes, sometimes directly (for example the water level and discharges of water including wastewater) and sometimes indirectly (for example nitrogen emissions and climate change). That blue-green algae growth happened in the Meuse river basin in the summer of 2022 is clear. To what extent this contributed to the measured levels of neophytadiene can no longer be reconstructed. A certain contribution would seem probable, but other plants could also have given off this substance, for example after they died. That humans affect blue-green algae blooms is clear, so it cannot be exclusively called a natural phenomenon.

A3 Insight into abstraction restrictions

There were a total of 62 abstraction stops and restrictions at the joint drinking water companies as a result of water pollution in 2022. Due to these, normal operations were interrupted or disrupted for 5,585 hours (233 days, cumulatively for the seven abstraction points). A summary of the numbers of abstraction restrictions and their duration in the period from 2007 to 2022 appears in Figure 1.

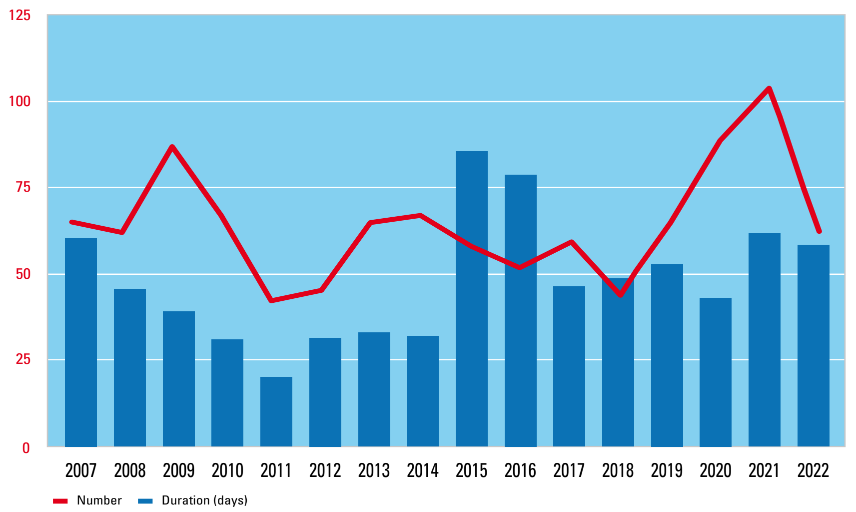


Figure 1: duration and numbers of abstraction restrictions (cumulative) on the Meuse in 2007-2022

Whether and how often drinking water companies shut off their water abstraction (abstraction stop) differs for each location. The furthest upstream abstraction point at Tailfer in Wallonia is never shut off. Further on in Flanders, the Belgian drinking water company water-link prefers to shut off the abstraction from the Albert Canal as little as possible, because clean fresh water is scarce there. Across the Dutch border, at the Heel abstraction point, drinking water company WML frequently closes the gate.

In 2022 there were once again no abstraction stops at the Brakel abstraction point. This is due to the new abstraction concept, in which different water sources are used. To be less dependent on the availability of Meuse water, water from the Afgedamde Maas and the Lek (Rhine water) are mixed.

The Evides abstraction points at Keizersveer[6] (until 2021) and the Bergsche Maas (from 2021) would seem to be the best gauge for the condition of the river, because only Meuse water is available there. The water abstraction from the Haringvliet mostly consists of Rhine water.

6 *The actual abstraction point was situated at Gat van de Kerksloot; the Keizersveer measurement point was representative for this abstraction point*

B

Monitoring and measurement results

Every three years, RIWA-Meuse evaluates the substances in the Meuse that are relevant to the drinking water sector. We do this based on a broad monitoring programme. This evaluation was also conducted in 2021. In 2022, monitoring was done according to the results of this evaluation for the first time.

Since 2007, along with a series of legally-stipulated parameters, RIWA-Meuse has worked with a priority system. This system is intended to allow substances to be monitored in a more targeted way and to be able to take proper advantage of new developments. Every three years, the system is evaluated, with the last evaluation taking place in 2021. The report 'Drinking water relevant substances in the Meuse 2021. An update of the lists with substances that are relevant for the production of drinking water from the river Meuse' describes how we did this. For this monitoring, RIWA-Meuse has since 2015 applied a classification into three categories of substance:

- Drinking water-relevant substances. These are the substances on which RIWA-Meuse focuses its advocacy
- Candidate drinking water-relevant substances (substances that have not yet been measured, or not sufficiently)
- Substances that are no longer relevant to the drinking water

The results from the monitoring in 2022 can be found in this Part B. Because the substance properties persistence, mobility and toxicity can have negative effects on the production of drinking water, we will first elaborate these substances. Then we will consider PFAS, substances that are difficult to remove and yet are widely present. After this, we discover which substances were detected in the Meuse in 2022 in concentrations above the target value in the European River Memorandum (ERM target value).

RIVM

B1 Screening PMT properties with RIVM method

Substances that are persistent, mobile and toxic (PMT substances) are listed for the first time in the European CLP Regulation. It will take some time before manufacturers have this information on the labels, but RIVM has in the interim developed a method for screening potential PMT substances. "We hope that this will help to identify harmful substances as early as possible," says Julia Hartmann.

Drinking water provision is one of the subjects that occupies the Netherlands National Institute for Public Health and the Environment (RIVM). As a scientific staff member in the drinking water team, Julia Hartmann works on diverse subjects concerned with the quality and quantity of drinking water in the Netherlands. She conducts research for the Dutch government for example, as well as internationally. "Water flows freely and does not stop at countries' borders, so it's very important that we also collaborate and exchange knowledge internationally," she says.

For example, on substances with PMT properties. Persistent means that a substance does not break down (or only does so a little) in the environment and remains present there for a long time. Mobile designates substances that are highly soluble in water and are therefore easily distributed. Toxic substances are poisonous to humans and ecosystems. Plants and animals become sick because of these or even die. "It's the combination of these properties in substances about which we are most concerned," says Hartmann.

Difficult to purify

The Dutch and European governments aim to keep these substances out of the environment and to keep the concentrations already present as low as possible. "Substances that are both persistent and mobile cannot be purified out of the water by the drinking water companies using current purification techniques, or can only be purified out with great difficulty," explains Hartmann. Some poly and perfluoroalkyl substances, i.e. PFAS, have PMT properties. PFAS are man-made chemical substances. They do not arise in the environment naturally. Examples of PFAS are GenX and PFOA (perfluorooctanic acid). PFAS are used in applications including nonstick coatings on cooking utensils (Teflon). Some substances are non-toxic and yet very persistent and very mobile (vPvM) and their concentrations in the environment can increase rapidly. "This category is formally non-toxic, but if you are exposed to them for long enough, these substances can still lead to undesirable effects in humans and ecosystems," says Hartmann.

Hazardous properties

Recently, PMT substances have been included as a hazard category in the European CLP Regulation (Classification, Labelling and Packaging) that has existed since 2008 and was updated on 20 April 2023. These rules oblige businesses in the European Union to state on product labels what chemical substances they contain. And also in which hazard category they come, so we know whether we should be concerned about them.

Hartmann: "This ensures that everyone in a substance's production chain knows that it has hazardous properties, and this includes consumers." This could be a manufacturer of clothing who knows exactly what substances are in the dye or the textile, or a consumer who knows what is in the bottle of cleaning product in the kitchen cabinet.

Effects of PMT substances on the production of drinking water

PMT and vPvM substances can accumulate in the environment because they break down very slowly. The use and emission of these substances should be limited as far as possible.

RIVM screening Tool PMT

P Persistent	M Mobile	T Toxic		
Not or hardly degradable in the environment	Well soluble in water + easily transported through the environment	Toxic to humans and/or ecosystem		
X		X		
	X			
X	X	X	≥ 0,33	PMT
X				
	X	X		
X	X		> 0,5	vPvM
	etc.			

Selection of a large set of substances

Screening

The RIVM method scores substances between 0 and 1 based on modelled data:

low to moderate P/M/T	< 0,33	green
high P/M/T	0,33-0,5	orange
very high P/M/T	> 0,5	red

6.000 substances

Source: https://rvs.rivm.nl/en/onderwerpen/gevaarsindeling/PMTvPvM

Effect on drinking water!

Due to their properties, these substances cannot be removed or are very difficult to purify from water with current technologies. Therefore, they can pose a major problem for the production of drinking water.

PMT

or

vPvM

very Persistent and very Mobile

Currently, about 6,000 substances have been screened using the RIVM screening Tool.

https://rvszoeksysteem.rivm.nl/PmtTool

The goal of the European and Dutch authorities is to keep these substances out of the environment, or to keep the concentrations in the environment as low as possible.

European legislation:
CLP regulation obliges companies to state on the label when substances meet the PMT/vPvM criteria (or the other hazard classifications).

Recommendation by RIWA:
- Stimulate the replacement of harmful substances
- Stop the authorisation of harmful and dangerous substances

Milestone

In 2023, the hazard categories endocrine-disrupting chemicals, PBT/vPvB and PMT/vPvM were added to the Regulation. PBT stands for persistent, bio-accumulating and toxic, and the substances with bio-accumulating properties accumulate in the food chain.

Hartmann calls the fact that the PMT substances are now also in the Regulation "a real milestone." "Until this update, there was still a lot of discussion about what a PMT substance formally is. To include this in legislation, you must of course have criteria. And now the first step has been taken for this."

Transition period

The information will however not appear immediately on the labels this year, because businesses get the opportunity to modify their production process during a transition period. From 1 May 2025, businesses must comply with the CLP Regulation for substances that are new on the European market. For substances that are already on the European market, the obligation applies from 1 November2026. Until these dates, businesses may state the information voluntarily.

To nonetheless start making some progress here, RIVM has developed a method to screen substances for PMT or vPvM using automated means. This research, which Hartmann collaborated in, originates from the PMT thematic group, an association that comes under the working group 'Approach to Upcoming Substances.'

In this, experts from the Ministry of Infrastructure and Water Management, the RIVM, Rijkswaterstaat, the Provinces, Vewin, drinking water companies and RIWA have discussed the approach to and possible harmfulness of new and unknown substances since 2015.

Assessment of permits

The RIVM translated the results of the research into the PMT screening tool that has been on the Institute's website since 1 July 2023. Here, permit issuers can in an accessible way look up to what extent a substance is possibly persistent, mobile and toxic. "We hope that this will help in the assessment of the permits for wastewater discharges, so that PMT substances can be identified as early as possible," says Hartmann.

At this time, the RIVM has screened around 6000 substances: there PMT scores may be looked up on the website. Each substance receives a score between 0 and 1: 0 means a substance probably has no PMT properties, while 1 means the probability is very high that the substance does have these properties. The intention is to screen and even more substances.

The point therefore is to estimate the properties of the substance. "The screening is based on models and not on experimental data," explains Hartmann. "We try to make a prediction based on substances with similar structures." The exact PMT properties have in fact only been measured and recorded for a limited number of substances, so the screening is therefore a first step. After this, the exact properties of suspect substances can be investigated in a laboratory. This is a lot of work and so was not mandatory until recently.

RIVM

Looking up PMT score

Hartmann opens the RIVM website and enters as an example 1,4-dioxane, a substance that has applications including a solvent in the paper, cotton and textile industry, and which is now categorised in Europe as a Substance of Very High Concern due to its PMT properties. The substance has a PMT score of 0.38. You can also see that the substance is expected to be 0.09 persistent, 0.73 mobile and 0.84 toxic. Below 0.33, the PMT score is low to average, between 0.33 and 0.5 it is high, and the researchers consider a score exceeding 0.5 to be very high.

“1,4-dioxane is a good example of the fact that alongside general PMT score, the user of the screening method also has to look carefully at the separate scores for P, M and T," says Hartmann. "Once experimental data is available, this overrules the scores in the screening method. This is the case for 1,4-dioxane. We know that this substance is very persistent; the score of 0.09 for persistence is this an underestimate."

Considering alternatives

If the PMT score of a substance in a permit application emerges as high, the permit issuer could for example ask for more information about the substance before a discharge permit is issued, explains Hartmann. Or an alternative to the use of the substance could perhaps be considered. Discussion is still underway in the European Union, she reports, about exactly what experimental data companies should have to supply about how mobile a substance is.

Besides the CLP Regulation about the classification, labelling and packaging of substances, the European REACH Regulation about the registration, assessment, authorisation and restriction of chemical substances exists. REACH contains a list of substances of very high concern which is a different classification from CLP. "If a substance is classified as hazardous in the CLP Regulation this can be a warning to look at it in more detail in REACH," explains Hartmann. "So is this a substance of very high concern, yes or no?"

Confronting PMT in Europe and worldwide

There is currently a lot of attention to PMT substances in the Netherlands and Europe. Various European research projects are working on the issue, states Hartmann. The PROMISCES project for example, which the RIVM is also involved with, concerns preventing PMT substances in the groundwater system. "This study revolves around the questions: will the circular economy be held back by the presence of PMT substances, and if so, what solutions can we come up with for this?"

ZeroPM is another European Union-financed project about PMT substances that RIWA is also involved with. Hartmann: "The aim of this project is no more pollution by PMT substances. And what you can do if they are present in the environment and what substances then have priority."

Ultimately of course PMT substances are a worldwide problem emphasises Hartmann. This is why the European Union will chair a new United Nations workgroup with the aim of developing worldwide criteria for PMT and vPvM substances. Hartmann: "It is very important to keep these substances out of the environment as far as possible, and for this worldwide attention is crucial."

B

B2 PFAS: harmful and present everywhere

PFAS turns up everywhere: in drinking water, food and all kinds of consumer goods. The substances are difficult to purify out of the water and they are harmful even in small quantities. Five European countries are therefore arguing for a prohibition. RIWA-Meuse supports this initiative. André Bannink: "The unfortunate consequences are becoming ever clearer, so we must stop using them."

Poly- and perfluoroalkyl substances (PFAS) are man-made, repel water, oil, dirt and dust and are heat-resistant. Due to these useful properties they have been used for decades in many industrial processes and products. They are present in foodstuff packaging such as pizza boxes, and also in nonstick coatings of cooking utensils, extinguisher foam, mobile phones, raincoats, cosmetics, biocides, lubricants and solar panels.

Unfortunately, many PFAS prove to be harmful even at very low concentrations. According to the Dutch government, these substances may damage the immune system and cause cancer. Meanwhile, we are absorbing PFAS daily via our food[7], the products we use and also to a small extent via drinking water.

Drinking water companies call PFAS ‘a problematic substance group’ in the category 'Industrial substances and consumer products.' "They are persistent, i.e. non-degradable, and are therefore also referred to as 'forever chemicals'," explains senior policy advisor André Bannink of RIWA-Meuse. “They are also mobile, which means they dissolve well in water and are further toxic and so come into the new hazard class PMT.”

Six million PFAS

Theoretically, over six million different PFAS are possible, according to the definition of the Organisation for Economic Cooperation and Development (OECD). Two substances whose production started shortly after the end of the Second World War have already been prohibited: PFOS and PFOA. These substances and also the PFAS substances that are used in the GenX process belong to the RIVM Substances of Very High Concern (SVHC): substances that are hazardous to humans and the environment and that must not be discharged. There are presently 95 PFAS substances in the RIVM list of Substances of Very High Concern.

All drinking water companies in the Netherlands that produce drinking water from surface water have until now applied the target values in the European River Memorandum (ERM). If the water meets these drinking water can be made from it with natural purification techniques. For PFAS, the ERM target value is 0.1 micrograms or 100 nanograms per litre. "There was never more PFAS in the surface water than this amount, so we never discussed it,” says Bannink. "Recently it became clear that this value could very well be much too high."

Strict enough?

On 16 December 2020, the European Parliament adopted the revised European Drinking Water Directive. Standards are included here for PFAS for the first time: a maximum of 500 nanograms per litre for all PFAS or a maximum of 100 nanograms per litre each for 20 specific PFAS substances. The Directive is now implemented everywhere. No later than 12 January 2026, the drinking water in all Member States must meet these standards.

Bannink: "At the same time, a discussion is now underway about whether these standards are indeed strict enough because otherwise you do not meet the health and hygiene values of the European Food Safety Authority (EFSA)." In 2020, the EFSA in fact recommended going to a maximum of only 4.4 nanograms per litre, quite a difference from the 100 nanograms in the European Drinking Water Directive. RIVM recommends, based on the EFSA advice, a maximum of 4.4 ng/l in PFOA equivalents.

7 *https://www.rivm.nl/nieuws/nieuw-onderzoek-bevestigt-mensen-in-nederland-krijgen-te-veel-pfas-binnen*

B

Ins & outs of **PFAS**

What is it being used for?

PFAS are often found in:

- **Food packaging**
- **Textiles, clothing and footwear**
- **Extinguishing foam**
- **Nonstick cookware**
- **(Water repellent) cosmetics**

Why is it harmful?

General characteristics of PFAS:

- **PMT** – **Indestructible forever chemical**
- **Toxic & bio-accumulative**
- **Removal is extremely complex and environmentally harmful**

Advancing toxicological insight

Quality standard of PFOA over time:

year	*µg/l*	*institute*
2006	**10**	RIVM
2009	**0,4**	US EPA
2015	**0,3**	DK EPA
2016	**0,087**	RIVM
2017	**0,014**	DEP (New Jersey)
2020	**0,0044** (4,4 ng/l) (PFOA equivalents)	EFSA
2022	**0,000004** (0,004 ng/l)	US EPA

What is needed?

To protect sources for the production of drinking water and the environment:

- **Total ban**
- **Gaining insight in wastewater streams**
- **Analyze wastewater for PFAS and other harmful substances**
- **Reverse wastewater discharges of harmful substances**

Purify more

The standard of 4.4 nanograms per litre is exceeded everywhere in the Meuse, Bannink is aware. "It will be very difficult to meet the standard of 4.4 nanograms per litre. This means additional purification will be needed: either intensify the existing water purification or build new purification plants to deal with PFAS. And yet Water Framework Directive envisages the purification treatment effort diminishing for drinking water production. While due to the presence of PFAS, the purification effort will in fact increase. This is mutually contradictory."

Purifying PFAS substances out of the water is moreover anything but easy, emphasises Bannink: "Membrane filtration, in which water is pressed through straws, can be used to remove PFAS. However, this requires a lot of energy and a residual flow contaminated with PFAS remains. In this way, the problem is actually shifted and not solved."

RIWA is more in favour of the PFAS at the source approach and that the polluter-pays principle should be applied structurally. "To what extent can it be justified that, for the production of drinking water, hundreds of millions of euros to be invested to purify out waste products of third parties? Is it not smarter to stop the production of PFAS?"

New insights

How harmful PFAS are, is becoming clearer from scientific studies in recent years. Also it is becoming clear that PFAS are detected everywhere. For example, the German research Institute TZW (DVGW-Technologiezentrum Wasser) detected trifluoroacetic acid in precipitation, mountain lakes and beer. The members of RIWA-Meuse also frequently find this substance in the Meuse. This is also a PFAS according to the OECD definition, states Bannink, and it gets into the environment via air conditioners in vehicles and heat pumps.

It emerges from another study that a non-measurable PFAS that went through a wastewater treatment plant emerged in a different PFAS form that can be measured. "At times more PFAS appear to emerge from the plant than went in," he says. "It is certainly very complex and there is still much to discover."

Five European countries are arguing due to these new insights for a European prohibition on the production, use, sale and import of PFAS. In early 2023, the European chemicals agency ECHA published the proposal from the Netherlands, Denmark, Sweden, Norway and Germany. The European Commission is expected to make a decision in 2025. "It is indeed only five countries, but these are five influential countries," says Bannink. The members of RIWA-Meuse have already been arguing for a PFAS prohibition for some years.

Forever and everywhere chemicals

Even if a prohibition is imposed, PFAS will remain in the environment for a very long time. This is because the substances have been used on a large scale since the Second World War. Bannink: "They are not called 'forever chemicals' for nothing – they don't break down and so they are also 'everywhere chemicals'. So it is time to stop producing these substances."

In some countries, for example the United States, the standards for PFAS in drinking water are much stricter than those in Europe, states Bannink. "Countries do indeed agree that these are substances very serious consequences. This is no longer disputed."

Commotion in Flanders

In Flanders, there have recently been a number of incidents concerning PFAS, and a lot of research is being done. For example, during work to extend the Antwerp ring road, soil contaminated with PFAS was found. This originated from the 3M factory situated nearby (known for Post-its) and just as DuPont/Chemours in Dordrecht is, a major PFAS producer.

Bannink reports: "The idea was to dump the contaminated soil in a pond near the town of Kinrooi. This pond turned out to be connected to the Meuse, from which drinking water is being produced. This attracted much political attention in Belgium, and the plan has now been scrapped. The Flemish government is occupied energetically on PFAS – hopefully this will inspire the other countries in the Meuse river basin, including the Netherlands."

Which sectors and companies?

Around half of the PFAS concentrations in the Meuse originate from the Netherlands, and the rest therefore from Belgium, France and Germany. This emerged from research by the knowledge institute for water management KWR, contracted by Vewin, the Association of Water Companies in the Netherlands, in which RIWA-Meuse also collaborated. Rijkswaterstaat Zuid-Nederland is currently investigating from which companies or activities precisely the PFAS in the Netherlands originate.

Rijkswaterstaat WVL on behalf of the Ministry of Infrastructrure and Water management investigated which sectors discharge large quantities of PFAS and is currently consulting these sectors how to reduce the discharge of PFAS. The fire services that use foam extinguishing agents containing PFAS is an example. Bannink: "For 80% of fires, PFAS-containing extinguishing foam proves to be unnecessary, so you can use a substitute agent. This avoids a large amount of PFAS emission."

Recycled paper

The paper industry is another sector which WVL consulted. Bannink: "When the greaseproof wrappers around your hamburger or the pizza box that you deposit in the paper container are being recycled, this can result in PFAS ending up in toilet paper or in different kinds of packaging you find in the supermarket. It's therefore important that companies gain more knowledge about this."

RIWA-Meuse for example compared those sectors that possibly discharge PFAS with large companies on the Meuse that are subject to permits under the European IPPC Directive (the purpose of the Integrated Pollution Prevention and Control Directive is to minimise pollution from industrial sources in the EU).

Looking for alternatives

There are currently no PFAS standards or PFAS requirements in the majority of the discharge permits, because this was never really looked in to, adds Bannink. To his astonishment, PFAS producers are still not obliged to make known to whom they supply. "Some companies don't even know that they are using PFAS – paper companies that recycle paper with PFAS for example. A factory in Helmond that dried Teflon powder was unaware of its misdemeanour. The PFAS only came to light thanks to investigation of wastewater discharges."

Bannink observes that many companies are in the meantime assuming that PFAS substances are on the way out. "So they are busy developing alternatives." He himself in any event has recently replaced all his cooking utensils with PFAS-free ones.

B3 Monitoring results from 2022

Table 1 Summary of substances that exceeded the ERM target value in 2022 (maximum concentrations)

Parameter	CASRN	ERM-tv		TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Industrial pollutants and consumer products																790	2416	32,7%
Ethylenediaminetetraacetic acid (EDTA)	60-00-4	1	µg/l		9,6	10	9,4	12		9,6	335,67			42,22	11,6	83	83	100,0%
Sulfamic acid	5329-14-6	0,1	µg/l					28		42	52			77	120	54	54	100,0%
Cyanuric acid	108-80-5	0,1	µg/l				2,36	2,9		2,5	1		1,78	1,5	1,3	56	63	88,9%
Sucralose	56038-13-2	1	µg/l				1,73				7,32	6,36	8,61	7,56	2,30	46	52	88,5%
Trifluoroacetic acid	76-05-1	0,1	µg/l				<1				1,4		1,2	1,2	1,4	43	49	87,8%
Dichloro-methanesulfonic acid	53638-45-2	0,1	µg/l					0,69		0,36	0,24			0,34	0,23	45	54	83,3%
Cyanoguanidine	461-58-5	0,1	µg/l				0,16						0,51			7	9	77,8%
8-Hydroxypenillic acid	3053-85-8	0,1	µg/l							<0.05				2,9	0,11	20	33	60,6%
Trichloroacetic acid	76-03-9	0,1	µg/l								0,16	0,25		0,29	0,13	29	50	58,0%
Melamine	108-78-1	0,1	µg/l		0,46	1,33	0,35	9,9		4,1	2,36	3,41	2,67	2,8	1,76	202	378	53,4%
1,4-Dioxane	123-91-1	0,1	µg/l				<0.5	0,56		0,62	0,24			0,41	0,7	37	74	50,0%
Ethylene glycol dimethyl ether	110-71-4	0,1	µg/l											<0.05	0,36	12	26	46,2%
Methenamine	100-97-0	1	µg/l		6	3,54	5,51	4,2		3,1	0,98		0,85	7,2	1,5	34	88	38,6%
Aspartame	22839-47-0	0,1	µg/l											<0.1	0,111	1	3	33,3%
Nitriloacetic acid (NTA)	139-13-9	1	µg/l		1,6	1	3,9	2,9		<1	3,63			1,01	<1	17	83	20,5%
Monobromoacetic acid	79-08-3	0,1	µg/l								0,20	0,35		0,14	0,11	9	48	18,8%
Dibromomethanesulfonate	859073-88-4	0,1	µg/l					<0.1		<0.1	0,54			0,33	0,26	9	54	16,7%
Diisopropyl ether	108-20-3	1	µg/l		<0.1	25,8	13	5,1	2,1	2,1	0,02	0,99	0,35	0,93	0,08	26	158	16,5%
Dibromoacetic acid	631-64-1	0,1	µg/l								0,99	2,10		0,35	0,2	8	50	16,0%
Tolyltriazole	29385-43-1	1	µg/l		0,31	3,81					0,68					6	39	15,4%
Tetrahydrofuran	109-99-9	0,1	µg/l					0,34		0,08				0,22	0,13	7	53	13,2%
Theobromine	83-67-0	0,1	µg/l					0,13		0,15				0,1	0,07	5	42	11,9%
Diethylenetriaminepentaacetic acid (DTPA)	67-43-6	1	µg/l		<1	<1	8,4	<1		<1	<1			3,44	1,58	9	82	11,0%
1,2,3-Benzotriazole	95-14-7	1	µg/l		1,72	1,44		0,68		0,82	0,81	1,70		1,13	0,72	10	93	10,8%
Trifluoromethanesulfonic acid	1493-13-6	0,1	µg/l				<0.2	0,56		0,12	0,07		<0.2	0,1	0,07	3	63	4,8%
Tributyl phosphate	126-73-8	1	µg/l		0,05	1,64	1,5		0,42	0,46	0,11	0,65	0,18	0,21	<0.1	2	54	3,7%
1,3-Diphenylguanidine	102-06-7	0,1	µg/l					0,09		<0.05				0,18	0,05	1	42	2,4%
Methyl tert-butyl ether (MTBE)	1634-04-4	1	µg/l	0,39	0,67	0,11	0,3	0,17	0,83	0,46	1,1	1,55	0,89	1,1	0,05	4	186	2,2%
Carbon disulfide	75-15-0	0,1	µg/l	<0.3	0,9	1,4										1	52	1,9%
Ethyl hydrogen sulphate	540-82-9	0,1	µg/l					0,1		<0.1	<0.1			<0.1	<0.1	1	54	1,9%
Vinyl chloride	75-01-4	0,1	µg/l	<0.1	0,36	<0.1	0,15	<0.05	<0.37	<0.04	<0.04		<0.04	<0.04	<0.04	2	157	1,3%
Allyl chloride	107-05-1	0,1	µg/l				<0.1		<0.12	<0.1	<0.1		1,6	<0.1	<0.1	1	90	1,1%

ERM-tv = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Liège, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, BRA = Brakel, HEU = Heusden, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.

In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of measurements

Parameter	CASRN	ERM-tv		TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Residues of pharmaceuticals and endocrine-disrupting chemicals																232	1308	17,7%
Oxypurinol	2465-59-0	0,1	µg/l								1,62					13	13	100,0%
Valsartan acid	164265-78-5	0,1	µg/l					0,22		0,36	0,41			0,55	0,38	36	55	65,5%
Vigabatrin	60643-86-9	0,1	µg/l					1,4		0,8				0,69	0,59	21	42	50,0%
Lamotrigine	84057-84-1	0,1	µg/l		0,11	0,12		0,14		0,13	0,14			0,18	0,15	32	73	43,8%
Guanylurea	141-83-3	1	µg/l				1,04	2		1,5	0,54		1,82	3	1,8	24	72	33,3%
(anti)AR-CALUX® (in flutamide-equivalents)		4,8	µg/l							18,21	53,28	3,43				6	18	33,3%
2-Hydroxyibuprofen	51146-55-5	0,1	µg/l				0,19						0,11			3	9	33,3%
Metformin	657-24-9	1	µg/l		1,75	1,85	1,85	2,7		1,4	0,56		1,02	0,85	0,88	26	88	29,5%
4-Formylaminoantipyrine	1672-58-8	0,1	µg/l					0,01		0,02	0,09			0,11	0,26	14	55	25,5%
Candesartan	139481-59-7	0,1	µg/l					0,01		0,02	0,09			0,12	0,2	10	55	18,2%
Tributyltin cation	36643-28-4	0,1	µg/l				0,04		0,09	0,15	0,19		0,15	0,10	0,07	15	90	16,7%
4-Acetamidoantipyrine	83-15-8	0,1	µg/l					0,02		0,05	0,07			0,08	0,19	8	55	14,5%
Tramadol	27203-92-5	0,1	µg/l		0,16	0,20		0,11		0,09	0,05			0,09	0,03	10	73	13,7%
Sitagliptin	486460-32-6	0,1	µg/l					0,03		0,03	0,04			0,08	0,12	2	55	3,6%
Diclofenac	15307-86-5	0,1	µg/l		0,34	0,40		0,02		0,03	0,01			0,06	0,07	2	69	2,9%
Ibuprofen	15687-27-1	0,1	µg/l		0,18	0,30		<0.1		<0.1	<0.02			<0.1	<0.1	2	69	2,9%
Naproxen	22204-53-1	0,1	µg/l		0,3	0,35		0,02		0,02	<0.01			0,02	0,01	2	69	2,9%
Metoprolol acid	56392-14-4	0,1	µg/l					0,04		0,06				0,10	0,06	1	42	2,4%
Fexofenadine	83799-24-0	0,1	µg/l					0,03		0,06				0,12	0,04	1	42	2,4%
Furosemide	54-31-9	0,1	µg/l					0,012		0,02	<0.01			0,21	0,01	1	55	1,8%
Irbesartan	138402-11-6	0,1	µg/l					0,05		0,11	0,02			0,08	0,04	1	55	1,8%
Telmisartan	144701-48-4	0,1	µg/l		0,07	0,06		0,05		0,05	0,04			0,11	0,05	1	73	1,4%
Metoprolol	37350-58-6	0,1	µg/l		<0.03	<0.03		0,01		0,04	0,04			0,1	0,07	1	81	1,2%

ERM-tv = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Liège, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, BRA = Brakel, HEU = Heusden, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.

In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of measurements

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Crop protection products, biocides and their metabolites																252	1520	16,6%
Aminomethylphosphonic acid (AMPA)	1066-51-9	0,1	µg/l	0,23	0,73	0,62	0,77	7,8	6	3,4	1,09	1,77	1,22	1,4	0,52	111	119	93,3%
Chloridazone-desphenyl	6339-19-1	0,1	µg/l		0,18	0,19		0,22		0,23	0,33	0,51		0,23	0,13	75	84	89,3%
S-Metolachlor	87392-12-9	0,1	µg/l								0,17	0,18				17	24	70,8%
Propamocarb	24579-73-5	0,1	µg/l					0,55		0,27		0,05		0,09	<0.05	29	268	10,8%
Metolachloor OA	152019-73-3	0,1	µg/l		<0.01	<0.01				<0.05	0,1	0,11		0,11	0,06	6	73	8,2%
Glyphosate	1071-83-6	0,1	µg/l	<0.05	0,15	0,15	<0.2	0,1	0,12	0,13	0,03	0,07	<0.2	0,08	0,03	5	119	4,2%
Fluopyram	658066-35-4	0,1	µg/l								0,16	0,04				1	26	3,8%
Dimethenamid-P	163515-14-8	0,1	µg/l				0,02	0,02		0,05	0,04		0,07	0,10	0,03	1	74	1,4%
2-(Methylthio)benzothiazole	615-22-5	0,1	µg/l		<0.02	0,02		0,03		<0.03	0,03	0,19		0,04	<0.03	1	75	1,3%
1,2-Dibromo-3-chloropropane	96-12-8	0,1	µg/l		<0.11	0,13		<0.05		<0.05				<0.05	<0.05	1	79	1,3%
N,N-Dimethylsulfamide (DMS)	3984-14-3	0,1	µg/l		<0.02	<0.02		<0.05		<0.05	0,07	0,07		0,05	0,32	1	84	1,2%
Thiabendazole	148-79-8	0,1	µg/l		1,46	0,06		<0.05		<0.05	<0.01	0,01		<0.05	<0.05	1	87	1,1%
Dimethenamid	87674-68-8	0,1	µg/l	0,03	<0.02	0,13					0,04	0,06				1	90	1,1%
2,4-Dichlorophenoxyacetic acid	94-75-7	0,1	µg/l	0,01	<0.03	<0.03	0,26	0,02	<0.05	0,03	0,02	0,03	<0.05	0,02	<0.02	1	153	0,7%
Metolachlor	51218-45-2	0,1	µg/l	0,02	0,05	0,12	0,01	0,03	0,06	0,07	0,06	0,03	0,02	0,02	0,02	1	165	0,6%

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
General parameters and nutrients																328	1911	17,2%
Perchlorate	14797-73-0	0,1	µg/l					0,86		0,55	0,67					28	28	100,0%
Adenosine triphosphate (ATP)	56-65-5	100	ng/l												1582	9	12	75,0%
Dissolved organic carbon (DOC)		3	mg/l	8,4			4,4		7,3	4,3	4,58	4,69	5	5,48	5,87	171	263	65,0%
Total organic carbon (TOC)		4	mg/l		6,6	6,2	10	9,2		5,5	4,77		5,7	5,93	4,63	101	222	45,5%
Ammonium as NH4		0,3	mg/l			0,3				0,35	0,16					6	114	5,3%
Electrical conductivity (EC)		70	mS/m	46,8	69,5	67,5	73,3	64	66,3	60	55		59	67,9	75,3	5	380	1,3%
Acidity		7-9	pH		8,54	9,05										1	76	1,3%
Chloride	16887-00-6	100	mg/l	24	86	77	150	75	67	68	62,48	66,45	69	69,87	122,38	5	442	1,1%
Temperature		25	°C	23,9	23,2	24,7	23,6		23,9	24,2	24,7	24	24,3	25,7	23,4	2	374	0,5%

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In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of measurements

Number of measurements

In 2022, the members of RIWA-Meuse and Rijkswaterstaat conducted a total of 74,540 measurements on 1,059 parameters (see Table 2). The substances monitored were tested against the target values in the European River Memorandum (ERM). These target values are mainly used to test upcoming substances that do not have (or do not yet have) a legal standard in the context of drinking water legislation.

B

Table 2: summary of numbers of water quality measurements on the Meuse in 2022

Monitoring point	Number of measurements	Number of parameters	Number of testable measurements	Number of testable parameters
Tailfer (M520)	4,207	179	3,018	136
Namêche (M540)	3,945	368	2,750	315
Liège (M600)	6,747	453	4,425	358
Eijsden (M615)	7,288	373	3,111	280
Roosteren (M660)	4,117	596	4,027	576
Stevensweert (M675)	3,060	260	2,419	203
Heel (M690)	9,533	751	7,969	642
Brakel (M845)	7,361	627	5,979	527
Heusden (M845)	4,645	314	4,200	300
Keizersveer (M865)	4,516	344	3,304	270
Bergsche Maas (M868)	9,714	736	8,094	624
Haringvliet (M870)	9,407	712	8,102	605
Total	74,540	1,059	57,398	713

Drinking water relevant substances

screening

200.482 measurements

1.356 substances

literature review

30 substances

Selection on

- Concentration
- Frequency of Detection
- Toxicity
- Purification Requirement
- Expert judgement

Evaluation + Recommendations

Evaluated every **3** years

LIST 1 — DRINKING WATER RELEVANT SUBSTANCES

ERM

Substance	% > ERM target values
Industrial compounds and consumer products	
1,4-Dioxane	50
Melamine	53
Cyanuric acid	89
Diethylenetriaminepentaacetic acid (DTPA)	11
Ethylenediaminetetraacetic acid (EDTA)	100
Nitriloacetic acid (NTA)	20
Benzothiazole	0
Bromate	0
Di-N-butyltin	0
Aminomethylphosphonic acid (AMPA)	93
Diisopropyl ether (DIPE)	16
Trifluoroacetic acid	88
Sulfamic acid	100
Fluoride	0
PFAS (20 substances)	0
Pharmaceuticals and endocrine disrupting chemicals (EDC's)	
Valsartan	0
└ Valsartanic acid	64
Metformin	30
Guanylurea	33
Lamotrigine	44
Hydrochlorothiazide	0
Tramadol	14
N-Formyl-4-aminoantipyrine	25
Ketoprofen	0
Naproxen	3
Pesticides, biocides and their metabolites	
Dibromoacetic acid	16
Metolachlor	1
Terbuthylazine	0
Monobromoacetic acid	19
Prosulfocarb	0
Glyphosate	4
└ Aminomethylphosphonic acid (AMPA)	93
Chloridazone-desphenyl	89

% > ERM target values

Percentage of measurements exceeding the ERM target values in 2022

for 5 years **13x** a year

Testing against ERM

To test the measured substances, the drinking water companies use the ERM target values, the benchmark of the European River Memorandum (ERM). Drinking water companies in the river basins of the Meuse, Rhine, Danube, Elbe, Ruhr and Scheldt drafted the ERM for surface water. It is possible to prepare drinking water in a sustainable way with natural purification methods from water that meets the ERM target values.

Crop protection products, biocides and their metabolites are also tested against the ERM target values. For active substances and their metabolites toxicologically relevant to humans, the ERM target value is equal to the legal standard (0.1 µg/L).

It is stated in the ERM that toxicologically 'well assessed substances' must be tested against 1 µg/L, while for a number of these substances, testing is still done against a value of 0.1 µg/L. In 2021, the drinking water companies that use Meuse water therefore decided to use a different ERM target value from before for a number of parameters.

Of the 1,059 parameters monitored in 2022, 713 were testable, and of these, 79 (11.1%) exceeded the ERM target value one or more times at at least one monitoring point (see Table 1). That 346 parameters were not testable is to do with the fact that there is no ERM target value for them. In total, a breach of the ERM target value was observed 1,602 times; this is 2.8% of the testable measurements (57,398).

Substances with an indicative drinking water target value over 10 µg/L have been tested against 1 µg/L since 2021. This concerns the substances listed in Annex 4.

Result: number of ERM breaches

Table 3 presents the numbers and percentages of breaches of the ERM target value for each substance category.

Table 3: Summary of breaches of ERM target values by substance category

	Industrial pollutants and consumer products	Pharmaceutical residues and endocrine-disrupting chemicals (EDCs)	Plant protection products, biocides and their metabolites
Permanent 100%	2 (6.3%)	1 (4.3%)	0 (0%)
Structural 50-99%	9 (28.1%)	2 (8.7%)	3 (20.0%)
Frequent 10-49%	13 (40.6%)	10 (43.5%)	1 (6.67%)
Incidental 0-9%	8 (25.0%)	10 (43.5%)	11 (73.3%)
Total	32 (100%)	23 (100%)	15 (100%)

In 2022, EDTA, sulfamic acid and oxypurinol continuously exceeded the ERM target value.

Not every breach of the ERM is equally relevant. Broadly, there are three types of breaches:

- chronic breaches: substances that breach the ERM target value once again every year
- 'flashing light' breaches: substances that do breach the ERM target value one year and not the next year
- new breaches: substances that we now see for the first time because analysis methods are available

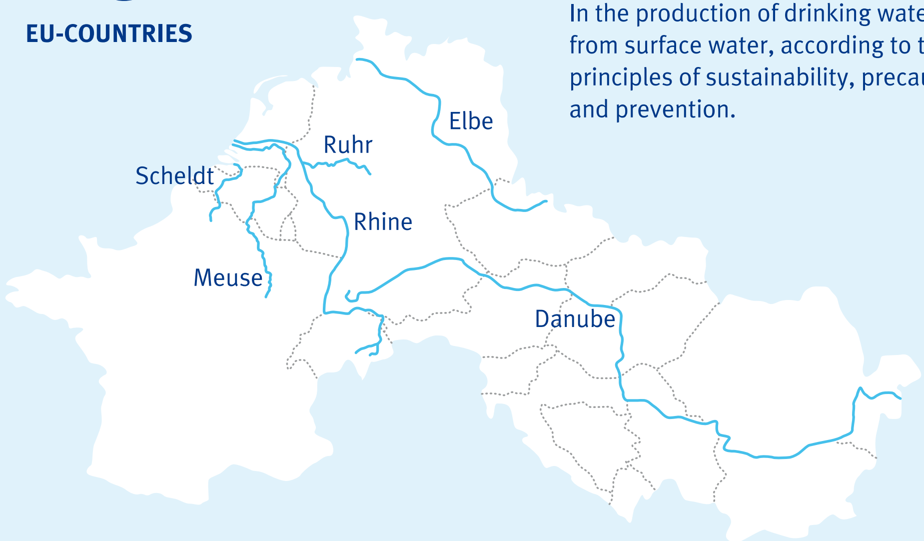
Target Values of the European River Memorandum

Drinking water companies from the river basins of the Meuse, Rhine, Danube, Elbe, Ruhr and Scheldt have the European River Memorandum (ERM) drawn up in order to safeguard the quality of surface water that is used for the production drinking water. Surface water that meets the ERM Target Values can be used sustainably to produce drinking water, making use of natural purification technologies.

EUROPEAN RIVER MEMORANDUM

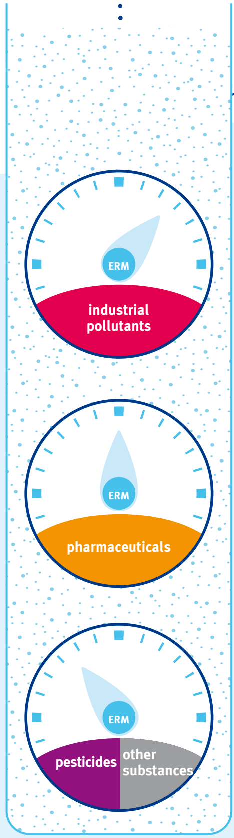
18

EU-COUNTRIES



COMMON STRATEGY AND VISION

In the production of drinking water from surface water, according to the principles of sustainability, precaution, and prevention.



Important ERM principles

- Drinking water supply has a priority above other uses
- Sustainable management of water resources
- Emphasis on the prevention and protection of water bodies
- Enforcing responsibility for the discharge of substances
- Provide insight into (potentially) harmful substances

TARGET VALUES

- Anthropogenic non-natural substances
- Organic substances
- General parameters

RIWA
RIWA-Meuse
WATER QUALITY ASSESSMENT

Water quality indicators for

170

DRINKING WATER COMPANIES

188

MILLION CUSTOMERS

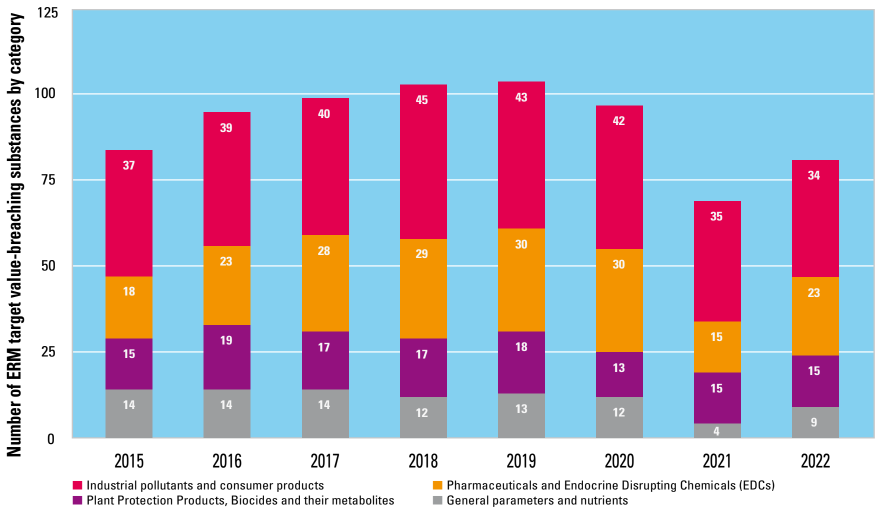


Figure 2 Number of ERM target value-breaching substances by category, 2015-2022

A summary of the number of breaching substances since 2015 is presented in Figure 2.

Because different substance categories were sometimes used in previous reports, the breaches were determined again based on the choices in 2020 and 2021. This presentation may therefore sometimes deviate from what was stated in previous reports. It may also concern new substances compared to before. This is due to the assignment of ERM target values to substances that were not included in the testing in the past, because they already had a (legal) drinking water standard.

After testing against the ERM, it emerges that the number of breaching substances in the categories 'Industrial pollutants and consumer products' is the highest. The number of breaching substances in the category 'Pharmaceutical residues and endocrine-disrupting chemicals (EDCs)' in 2022 proves to be back to the level from before 2021.

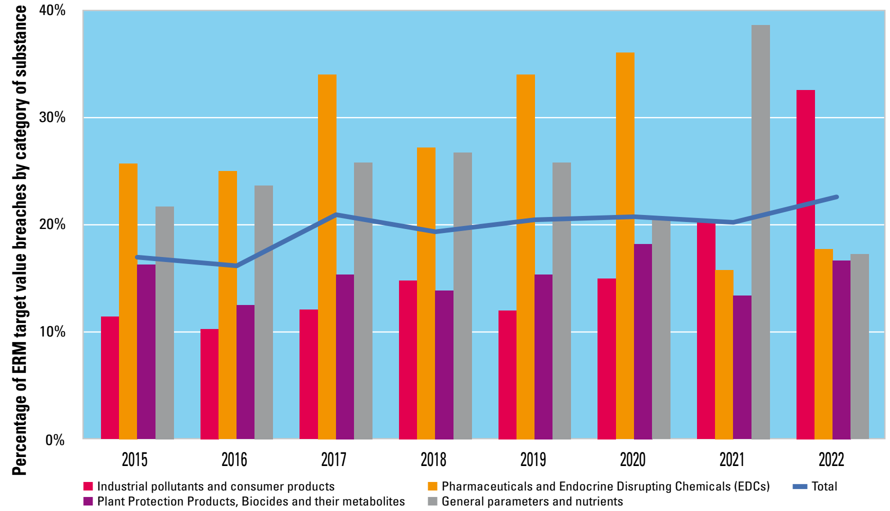


Figure 3 Percentage of ERM target value breaches by category of substance 2015-2022

It further emerges that the number of breaching substances in the categories 'Plant protection products, biocides and their metabolites' and 'General parameters and nutrients' is relatively small.

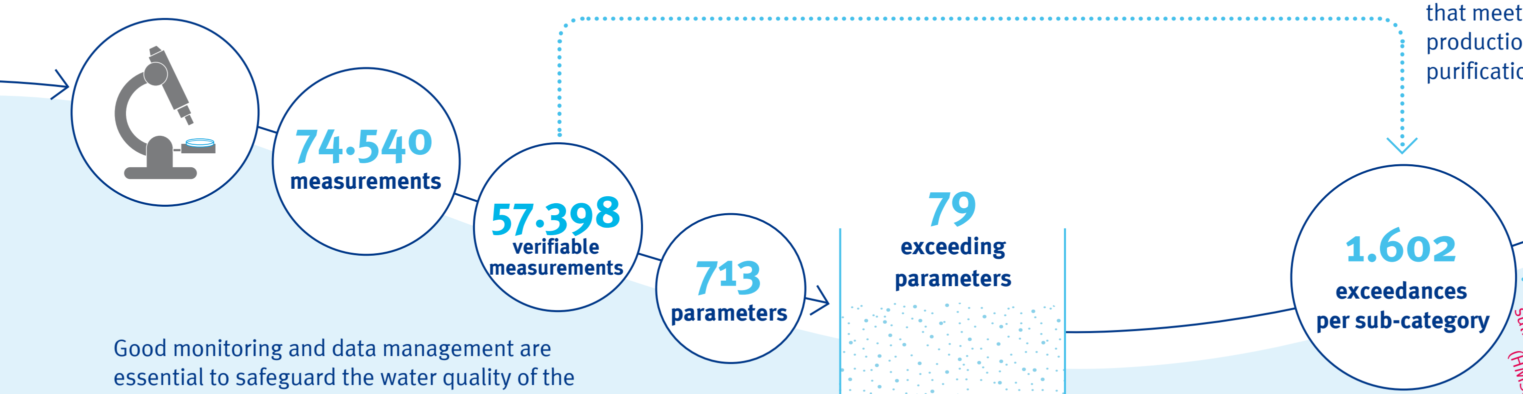
Analysis: seriousness of breach

Besides the number and the type of breach of the ERM, it is relevant to investigate how far above the ERM target values the drinking water-relevant substances are. The percentage of breaches are listed in the infographic about drinking water relevant substances. RIWA-Meuse focuses its lobby and advocacy on drinking water-relevant substances. Figure 3. shows a summary of the percentages of the breaches of ERM target values since 2015. This listed per category of substances.

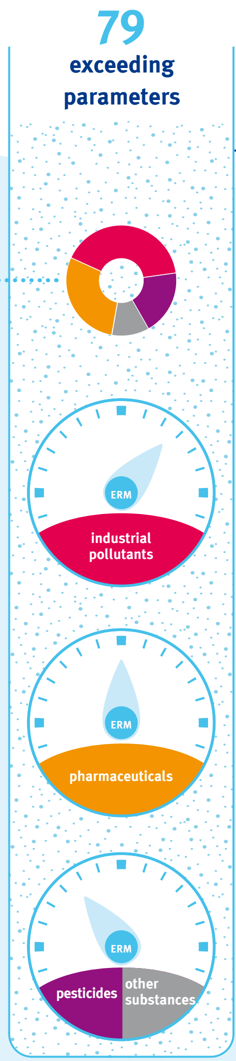
The percentage of breaching measurements is no longer the highest in the category 'Pharmaceutical residues and endocrine-disrupting chemicals.' This was mainly caused by opting to test against a different ERM target value.

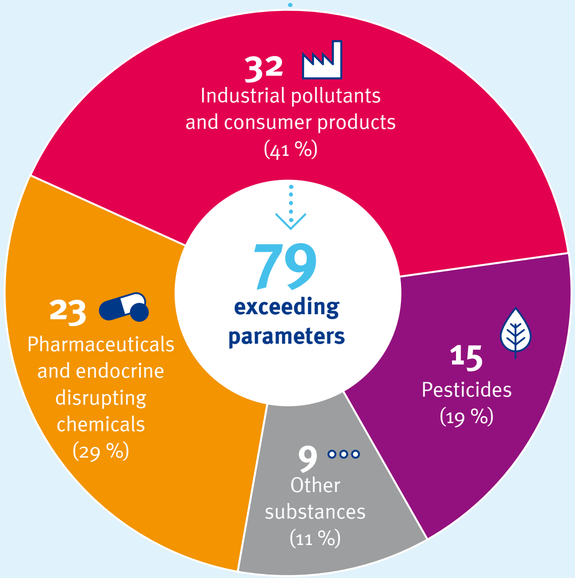
Monitoring the water quality of the Meuse

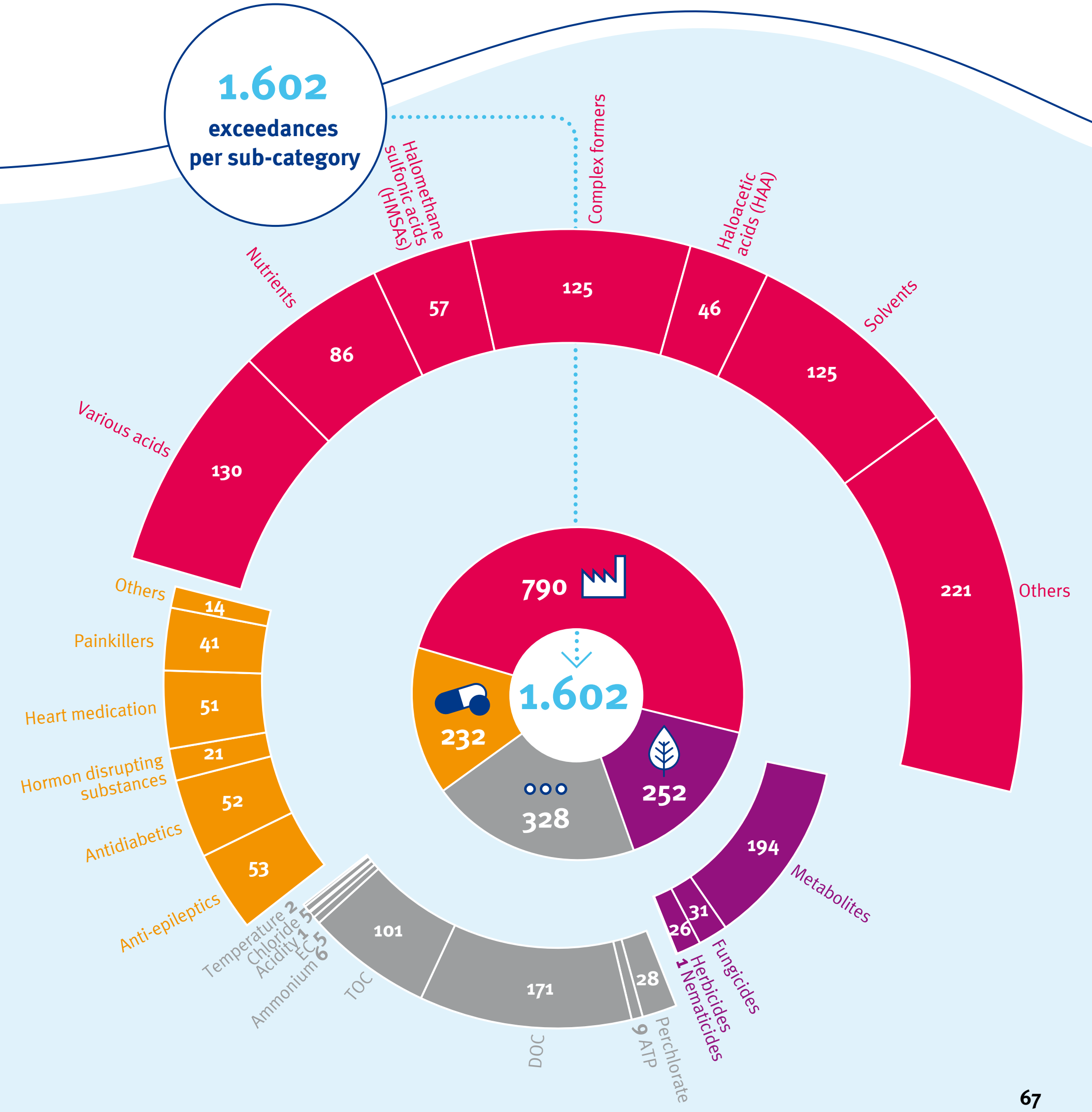
RIWA-Meuse assesses the water quality of the Meuse according to the target values of the European River Memorandum. Surface water that meets the ERM Target Values can be used sustainably for the production of drinking water, which can be prepared by using natural purification methods.



Good monitoring and data management are essential to safeguard the water quality of the Meuse as a source to produce drinking water.







Testing against legal requirements in WFD

In 2022, Rijkswaterstaat tested the surface water abstraction locations in its management area based on the legal requirements, as stipulated in the Water Quality Requirements and Monitoring Decree 2009 and the associated 'Water Framework Directive Protocol for Monitoring and Testing Drinking Water Sources' of 2015. These test results are based on monitoring data from 2019 to 2021 and are compared to the test results from 2020, that were based on monitoring results from 2017 to 2019. Besides this, it was checked whether there are new substances showing a breach of the environmental quality standards (EQS) or warning threshold. An adapted table with test results from the report titled ‘Toestand rijkswateren als bron voor drinkwatervoorziening 2022’ (Condition of Dutch Waters as Source for Drinking Water Supply 2022) is included in Annex 2. The condition assessment for substances in the priority areas for surface water abstraction for Flanders, based on monitoring data from 2018, is also included in Annex 2.

C

Climate change and water availability

The weather in 2022: dry with record precipitation deficit on one day

With a national average of 729 millimetres of precipitation in the Netherlands, 2022 was a dry year (source: KNMI, the Royal Netherlands Meteorological Institute). Normally, the average in the Netherlands is 795 millimetres. The summer was strikingly dry. September 5th, the national average precipitation deficit, a measure of the drought in the Netherlands, had increased to 318 millimetres. The precipitation deficit on a single day had previously never been so high. Despite a wet September, the precipitation deficit by the end of that month was still over 220 millimetres, 2022 is therefore statistically not one the driest 5% of years.

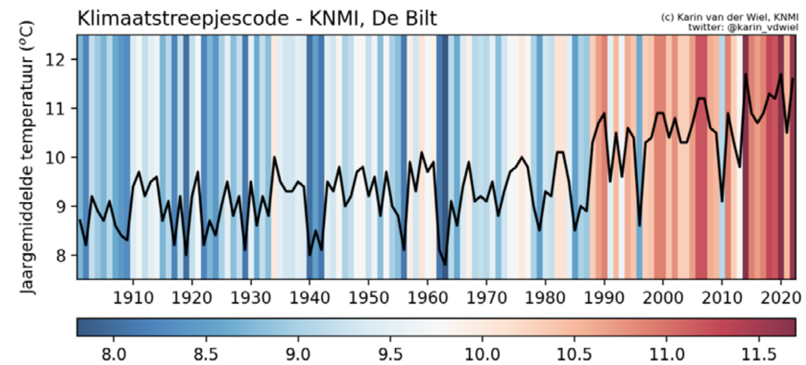
In Ukkel in Belgium, a total of only 701.4 mm of precipitation was measured in 2022 (normally: 837.1 mm) (source: KMI, the Royal Meteorological Institute of Belgium). This amount fell during 148 days (normally: 189.8 days). This means that 2022 was the fourth driest year in Belgium in the current reference period, after 2018 (651.1 mm), 2003 (670.5 mm) and 1997 (700.7 mm).

Extremely hot and record amount of sun

According to the World Meteorological Organization, on a planetary scale, 2022 will be the fifth or sixth hottest year (observations from the 1860s onwards). In Ukkel, 2022, together with the year 2020 was the hottest year since records began in 1833. With an average temperature of 11.6°C, 2022 was the third hottest year since 1901 in the Netherlands (see also the climate barcode from the KNMI). The norm is 10.5°C. With a national average of 2233 hours of sun, 2022 was the sunniest year since records began in the Netherlands. The norm is 1774 hours. All the months apart from January were sunnier than normal. The old record had already been reached by October. On 31 December, it reached over 17°C in the south-east of the Netherlands, the highest temperature since records began.

How is the weather of 2022 related to climate change?

The Netherlands has heated up by 2.3°C since the start of the last century. That is around twice as much as the worldwide average heating of 1.1°C. The relative humidity (the amount of water vapour the air can contain at a given temperature) is decreasing. 2022 was the year with the most solar radiation since monitoring of solar radiation started in 1965. The risk of drought also increases with this increase in solar radiation. In the summer, the nationally-averaged amount of precipitation was 40% less than normal. Together with the powerful evaporation due to the large amount of solar radiation, the restricted precipitation led to a severe precipitation deficit in the period of six months that encompasses the summer.



C

The last eight years were the hottest eight years ever

In 2018, climate researcher Karin van der Wiel of the KNMI created the first climate barcodes for the Netherlands (source: KNMI). With this barcode, you can see the heating of the earth at a glance. Each stripe represents the average temperature for one year. The colours run from dark blue (cooler with respect to the average of the measurement series) to dark red (warmer). The white stripes are four years with a temperature between the coldest year (7.8°C in 1963) and the hottest year (11.7°C in 2014 and 2020). The barcode has been updated for 2022 (average temperature: 11.6°C) and shows clearly that the Earth is continuing to heat up.

EVIDES

C1 Sufficient water in the Meuse, but is it clean enough?

Can we expect increasing water shortages in the future? Drinking water utility Evides asked Deltares to investigate the situation in the Meuse. For Evides, the quantity does not appear to be the problem, but Jeroen Daniëls, source protection consultant states: "Dry periods and therefore less water in the Meuse do affect the water quality."

For the work of Jeroen Daniëls, source protection consultant at Evides, sufficient water of good quality is essential. "My colleagues and I conduct research, provide advice and check whether our water sources are indeed future-proof," he says.

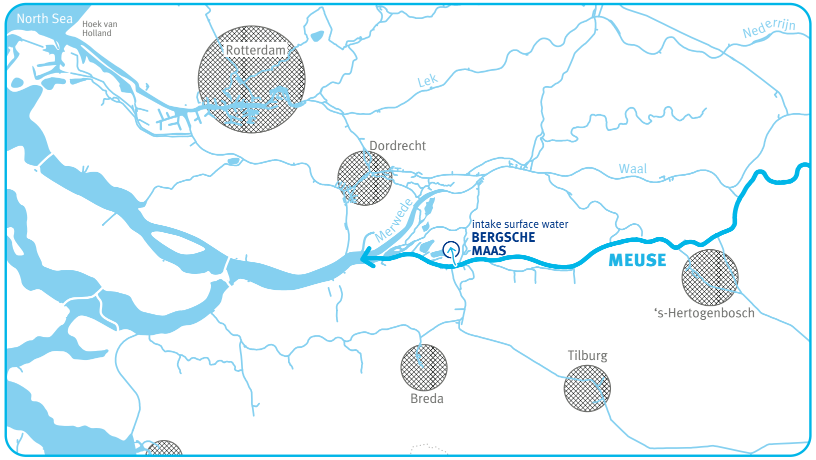
Evides abstracts around 86% of its water from the Meuse, 10% comes from groundwater and 4% from dune water. In total, 2.5 million consumers and businesses make use of our drinking water, in the south-west of Zuid-Holland, the province Zeeland and the south-west of Noord-Brabant.

“Rapid action is needed to prevent a shortage of drinking water in 2030”, this noted the RIVM in a report in April 2023. The research indicates that due to climate change and contamination, the supply of reliable sources for the production of drinking water are under pressure, and regional shortages are already arising.

EVIDES

Initiating the discussion

Evides wanted to know what this means for the Meuse, and particularly for the Bergsche Maas. This is the location of the water company's abstraction pumping station for filling the storage basins in the Biesbosch in Brabant. Evides asked knowledge institute Deltares to investigate this in 2022. Deltares was already working on a study into the 'flow rate', the amount of water running past at a given time, at various locations on the Meuse.



For this, Deltares uses the RIBASIM[8] software developed previously by the Institute. The RIBASIM MAAS model was developed specifically for the Meuse river basin in 2022, commissioned by RIWA-Meuse. The water consumption and water demand of drinking water companies and also industry, the energy sector, shipping and agriculture are included in the model as well. Insofar as the data is known, the amount of water they consume or need is included.

8 *River Basin Simulation Model.*

The models helps in assessing the situation. "In periods of drought, you might have to use less water," explains Daniëls. "Say a business needs 10 cubic metres per second and there is only 5 cubic metres. With this model, we can initiate the discussion about the sticking points and jointly look for solutions." This is exactly what the tool was made for.

Climate scenarios

The model has been used to look at a period of 40 years: from 1980 to 2020. Data from this period has been used to calculate climate projections for 2050 and 2085, explains Daniëls. Based on the climate scenarios from the KNMI, predictions have been made for precipitation, temperature and evaporation, and how much water is expected to flow in the river. "The further ahead you look, the more uncertain it becomes," adds Daniëls. Moreover, the KNMI's climate scenarios date from 2014. "So we have mainly looked at the hot scenarios, because these correlate somewhat better with the latest insights." This year there will be new forecasts, which will probably be more extreme.

Deltares compared how much water actually flowed past the four monitoring points in the Meuse river basin with the estimates from the model. The measured and calculated flows largely corresponded, so the model is usable for forecasts. It emerged from the research that the probability of a low flow in the Meuse increases in all the climate scenarios.

Probability of low Meuse flow rates

Evides has now obtained a better picture of the probability of low flow rates in the Meuse river at the the Bergsche Maas pumping station. This situation naturally arises mainly in the summer, but the model also calculates how often this probability of low flow happens and how much water there is available. Daniëls: "We wanted to know whether the current infrastructural set-up is adequate to have sufficient water in the coming decades."

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EVIDES

Evides also asked Deltares to investigate the impact of very low flow rates in the Meuse. The Bergsche Maas abstraction point lies at a favourable location, Daniëls explains. The abstraction point lies in the delta, guaranteeing a minimum quantity of water: the Haringvliet, the Hollands Diep, the Rhine and the North Sea, at Hoek van Holland, all affect the water level. As a result, Evides basically can always abstract water, based on the amount of water in the river. "The tide causes flow in an inland direction, but the risk that seawater flows past our abstraction point actually proves to be zero with the current sea level."

Enough water for Evides

In case the flow rate of the Meuse becomes very low, water from the Rhine will reach the abstraction point. Thanks to this, the water level at this abstraction point will never be too low. Daniëls: "So even if the Meuse has a low flow rate, enough water will remain available to allow abstraction." The quantity is therefore not a problem at this abstraction station.

The situation is different at other upstream places. Other Evides abstraction points are situated further down the Delta, so closer to the sea, and so other challenges exist here, states Daniëls. Research into the availability of fresh water will be done here at a later time.

Effect on the quality

The challenge of Evides with the Meuse in the coming years will be more about the quality, states Daniëls. The RIBASIM MAAS model can provide insight here too. You can look at where exactly the water comes from, and based on these locations, make an estimate of the water quality risks, explains Daniëls.

If for example, at a certain location, there is a company that uses water and discharges wastewater, there could be contaminants in this. “Or the water is used for cooling and the temperature can possibly increase. If water comes from an urban wastewater treatment plant, it could contain pharmaceutical residues and other contaminants. Pesticides could end up in the water from agricultural businesses. You enter all this information into the model, and in this way, you gain a picture of the risks."

Less diluted

If it has only rained a little for a long period of time, the flow rate of the Meuse will lower. "When the water consumption and wastewater discharges remain the same the Meuse will consist largely of purified wastewater," observes Daniëls. "To put it briefly, low flow rates affect the water quality: contamination will be less diluted. Especially substances with PMT (persistent, mobile and toxic) characteristics will negatively impact the production of drinking water.

It is difficult to predict the water quality, nevertheless, Evides tries to do so, Daniëls adds. "Discharges change over time. Making it difficult to predict incidents in advance. But as a result of climate change, dry periods are likely to increase and therefore the effect on the water quality does seem to be clear."

Using basin stocks during abstraction stops

On average, there are currently around 30 days of abstraction stops annually at the Bergsche Maas, distributed throughout the year. The quality of the Meuse is then too poor to let water into the Biesbosch basins. With a stock of around two months to produce drinking water from, the system can bridge over this kind of abstraction stop, and Evides uses the stock in the basin to produce drinking water.

"An abstraction stop occurs for example when a company discharges substances that we don't want in our tap water," explains Daniëls, "but it could also be due to a fire or a leaking boat. Also, if the water level is very high and the river runs fast and sediment is stirred up, an abstraction stop could be necessary."

Particularly from 2017 onwards, there have been a number of quite dry periods in the Netherlands. Daniëls: "In the case of a low flow situation, meaning little water runs through the Meuse, even a small discharge from a factory can lead to problems. With little water in the system, the effect on the water quality is much greater."

Strict requirements

In the meantime, RIVM health guidelines are becoming ever stricter, Daniëls confirms: the allowed concentrations of harmful substances are steadily being reduced for drinking water. This is of course a good thing for health, but Daniëls observes: "For drinking water companies it is becoming increasingly challenging to have the whole system for water production function properly. Especially when you face more frequent abstraction stops that result from a deteriorating quality of the river." He adds to this: "Discharges of undesirable and harmful substances into the surface water must stop. The governments that issue and must enforce the permits for this play a major role in this matter.

An idea could be to immediately test existing discharge permits against the current, stricter discharge requirements. The enforcement of existing discharge permits must also come higher up the priority list. Its quite simple, substances that do not enter the water system do not have to be removed in order to make drinking water."

“Substances that do not enter the water system do not have to be removed.”

More demand for fresh water

Even if there is enough water in the river Meuse, Daniëls adds: "the general demand for fresh water is increasing. We all want to have drinking water, use products and of course consume food. Industry and agriculture also use fresh water. And at the same time, we can see all kinds of developments on the way: climate change, the rising sea level, more salt water in the coastal areas."

What doesn't help here is the way we have shaped our country, he continues. "Due to the fact that we had abundant water in the past, the Dutch watersystem is more oriented on drainage than it is on storing water, resulting in water shortage starting in spring. We need to organize our water system in such a way that we are able to withstand both drought and flooding, because the latter still occurs of course. He reminds us of the 2021 floods in Limburg, Belgium and Germany. "So it makes sense to allow more space for water in the river basin and retain as much water as possible rather than draining it straight out to sea."

EVIDES

Water footprint

Looking at our water footprint, we are all scarcely aware of how much water we presently consume, emphasises Daniëls. In the Netherlands we use around 120 litres of drinking water per person per day. Whilst our actual water consumption is in fact a great deal more: around 4,000 litres per day. This includes everything we eat and the products we use. For example, to make just 100 grams of chocolate, 1,700 litres of water are needed.

“If you want to save water and keep water available for the future, you need to start acting now.”

"This is often not mentioned, and it's also quite complex to map out our actual consumption in the water chain properly, because a proportion of these products are produced abroad or go abroad." But, he concludes: "If you want to save water and keep water available for the future, you need to start acting now."

C2 What does the latest IPCC report mean to the Meuse?

Every few years, the IPCC, the UN Intergovernmental Panel on Climate Change, prepares a report on the expected impact of climate change. What is new in the latest report, and what the predictions mean specifically for the Meuse? Thomas Oomen, data analyst at RIWA-Meuse, brings us up to date.

In the most recent, sixth IPCC report that was published in 2022, we can read that, this century, we will be confronted more often and for longer with extreme weather conditions thanks to the heating of the earth. The United Nations' climate organisation does not do any research itself, but it evaluates already-published scientific research about the risks of climate change.

Data analyst Thomas Oomen: "Already in 2022 we had extreme temperatures and long periods of drought in various parts of the world, including Europe, due to which there were historically low groundwater levels and river flow rates. Last year was in fact the driest year in the 21st century in the Netherlands and one of the driest years ever in Belgium."

Indisputable role of humanity

In comparison to the previous report from 2014, the latest IPCC report contains more advanced scientific research, more exact models and more data, Oomen reports. "The report gives a more exact prediction of the expected temperature increase. The expected temperature rise has a direct influence on the periods of drought and flooding, which are expected to become more severe."

The emphasis on humanity's role in this edition is also greater, for example due to the use of land and water. "It is stated that humanity's role in the heating of the atmosphere, the ocean and the land is 'indisputable'. In the previous report, the term used was 'extremely probable'."

The latest IPCC report goes further into the socio-economic consequences of climate change worldwide, such as the reducing availability of fresh water, heat waves and long-term drought with failed harvests and famine as a result. "This provides policymakers with the right information to make decisions about how to deal with the consequences of climate change," says Oomen. "It calls for more intensive cooperation and emphasises the importance of developing nature-based solutions: measures featuring nature and water centrally in order to adapt ourselves to the changing climate."

Regional impact

More than the previous one, the sixth edition of the report goes further into the impact of climate change on certain regions, Oomen adds. For example, it contains expectations for North West Europe.

But he also says: "The IPCC report does not zoom in on river basins. It is important to translate the consequences for the Meuse river basin and to obtain more detailed information about the risks of climate change."

Consequences for the Meuse

He mentions the RIBASIM MAAS model from Deltares, which was developed specifically for the Meuse river basin in 2022, commissioned by RIWA-Meuse. And also the climate scenarios from the KNMI and the KMI, the weather institutes of the Netherlands and Belgium. "If the KNMI combines all this data with the new IPCC climate models in the autumn, a good picture will be created of the impact of climate change on the Meuse. In this way, we will know with more certainty what we are going to be faced with."

More focused models and research therefore help to gain insight into the impact of climate change on the Meuse. In order then to go into axction, it is important that this type of model becomes more mainstream, emphasises Oomen, so that staff from different organisations in the water sector understand the models and can make use of them. "Better understanding leads to better decisions. To this end, a bridge needs to be built between science and policy."

Less quantity and quality

Reports such as this one from the IPCC and also the Deltares model make it clear that we will have less water in rivers such as the Meuse in future. In addition, it is good to realise, explains Oomen, that: "More periods of drought don't only mean that the quality of the water drops, but also that the quality reduces. The concentration of harmful substances can in fact increase if less water flows down the river."

In recent years, we have often been confronted with periods of drought and low river flows in the Meuse river basin. Oomen: "But floods also arose, as in 2021 in parts of Germany, Wallonia and Limburg in the Netherlands."

Reducing the impact

To deal with low river flows and worsening water quality, drinking water companies have reservoirs, buffers or alternative sources, Oomen says. In dry periods, these serve as backup if drinking water companies can extract no or only limited water from the Meuse to produce drinking water from.

For this, much cooperation is needed between all the different parties in the water sector, emphasises Oomen. The drinking water companies, water authorities, central government and commerce, also across the borders.

Agreements about water usage

More international cooperation and dialogue about the Meuse is essential in any event, he considers. "It's important for example to know what is happening in France, because this could have consequences for the users of the water in Belgium and the Netherlands."

It is also important that clear agreements are made about the use of the Meuse water in the entire river basin, adds the data analyst. "This goes further than just drinking water: it's also about water usage by the energy sector, industry, agriculture, shipping and recreation. And not to forget nature."

The United Nations has already been arguing for a while to include the consequences of climate change in agreements about water usage and allocation, concludes Oomen. "The latest scientific knowledge, such as that in this IPCC report, provides a good basis for this."

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How can the Meuse become cleaner?

RIWA
RIWA-Meuse

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D1 Water boards and drinking water companies are cooperating

The priorities of water boards and drinking water companies come together in the De Schone Maaswaterketen (Clean Meuse Water Chain, SMWK). Janneke Snijders of the Aa and Maas Water Board tells us about the advantages of this collaboration and what this collaboration has already provided us so far. "Due to the pharmaceutical residues issue, we are now casting our net wider than just our legal responsibilities."

The Aa and Maas Water Board in the province of Noord-Brabant purifies 300 million litres of water from wastewater every day. Via the wastewater treatment plants, the water returns clean into the ditches in the area and finally into the Meuse.

As clean water coordinator, Janneke Snijders is occupied with the substances in the wastewater and the techniques the water board uses for the purification. She mainly looks at the strategic aspect of this: "Matters such as: what must we do due to legislation, shall we do extra things, and what direction should we take? I also enter into discussion with businesses, citizens and action groups that discharge substances into the water to see how this can be reduced."

Three monitoring networks

Within the De Schone Maaswaterketen (Clean Meuse Water Chain), Snijders coordinates the monitoring efforts of all the collaborative partners. These are twelve organisations that collaborate on cleaner water in the Meuse: water boards, drinking water companies, Rijkswaterstaat, the Ministry of Infrastructure and Water Management and RIWA-Meuse. She states that the cooperative association is busy setting up three monitoring networks. "We're going to follow the water quality in the Meuse river basin with the goal of reducing the amount of chemical substances in the water."

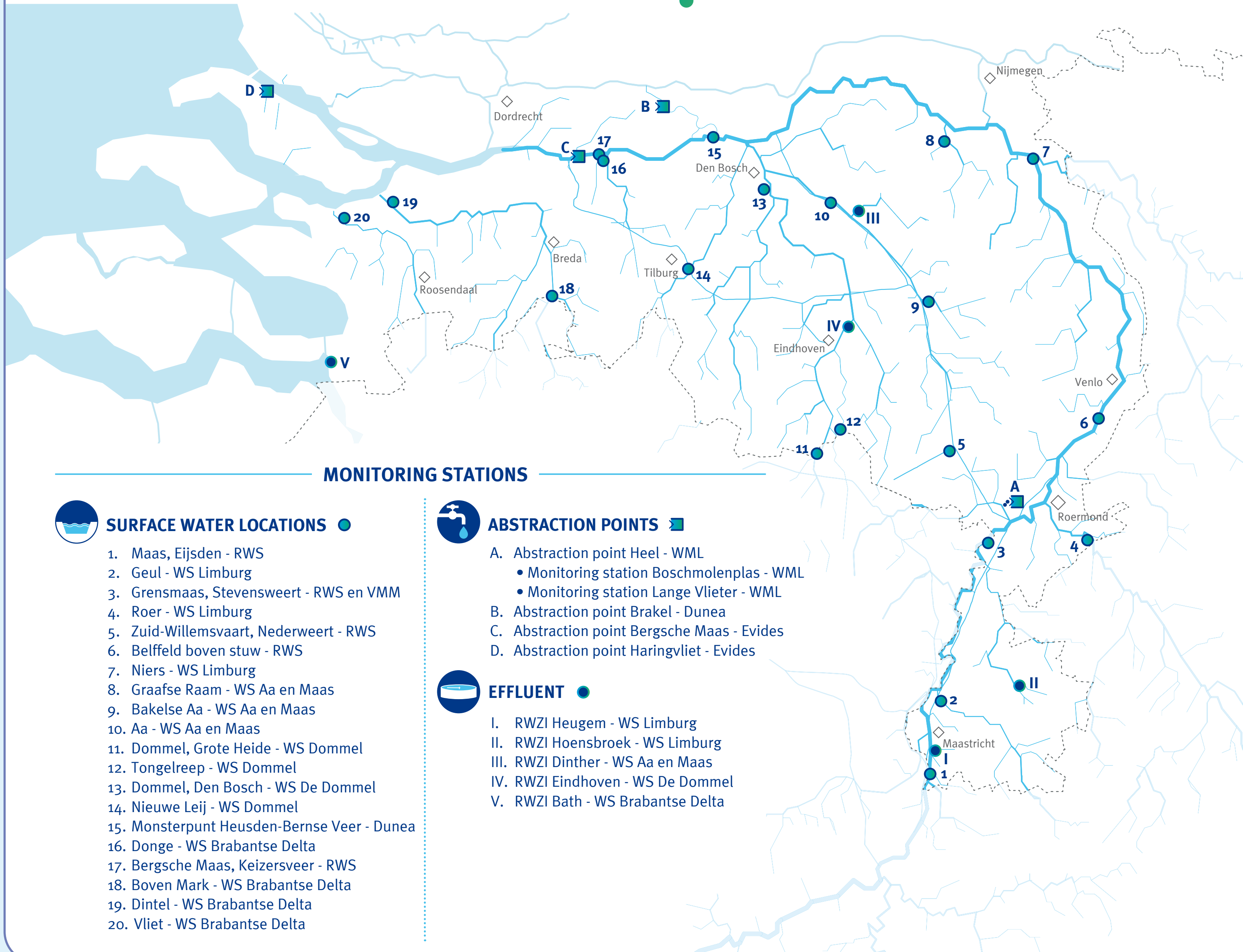
The first is the substance monitoring method, in which 38 substances will be measured at 31 monitoring points. The focus is on pharmaceutical residues and industrial substances. "There are thousands of substances and we can't monitor them all, because it would cost too much money," explains Snijders. "This is why we have selected 38 substances: substances that appear frequently and that we are concerned about. Because they are not good for the ecology, for our drinking water, or both."

The second and third monitoring method consists of new monitoring techniques that the partners in the Clean Meuse Water Chain want to test. The second monitoring method is a screening technique to obtain a picture in one go of 2,000 or more substances that are in the water.

How harmful

The third monitoring method must indicate the effect of the substances by looking at the reaction of certain organisms, like for instance water fleas or fish, on the water sample. Snijders: "Because you can measure these substances, it becomes clear which are above the norm. Finally of course you want to know whether animals or plants are killed, thus how harmful they are."

Joint monitoring programme SCHONEMAAS WATERKETEN



MONITORING STATIONS

SURFACE WATER LOCATIONS

1. Maas, Eijsden - RWS
2. Geul - WS Limburg
3. Grensmaas, Stevensweert - RWS en VMM
4. Roer - WS Limburg
5. Zuid-Willemsvaart, Nederweert - RWS
6. Belfeld boven stuw - RWS
7. Niers - WS Limburg
8. Graafse Raam - WS Aa en Maas
9. Bakelse Aa - WS Aa en Maas
10. Aa - WS Aa en Maas
11. Dommel, Grote Heide - WS Dommel
12. Tongelreep - WS Dommel
13. Dommel, Den Bosch - WS De Dommel
14. Nieuwe Leij - WS Dommel
15. Monsterpunt Heusden-Bernse Veer - Dunea
16. Donge - WS Brabantse Delta
17. Bergsche Maas, Keizersveer - RWS
18. Boven Mark - WS Brabantse Delta
19. Dintel - WS Brabantse Delta
20. Vliet - WS Brabantse Delta

ABSTRACTION POINTS

A. Abstraction point Heel - WML
   - Monitoring station Boschmolenplas - WML
   - Monitoring station Lange Vlieter - WML
B. Abstraction point Brakel - Dunea
C. Abstraction point Bergsche Maas - Evides
D. Abstraction point Haringvliet - Evides

EFFLUENT

I. RWZI Heugem - WS Limburg
II. RWZI Hoensbroek - WS Limburg
III. RWZI Dinther - WS Aa en Maas
IV. RWZI Eindhoven - WS De Dommel
V. RWZI Bath - WS Brabantse Delta

CHECK FOR SUBSTANCES

Pesticides, biocides and their metabolites

Aminomethylphosphonic acid (AMPA)
Azoxystrobin
Carbendazim
Dimethomorph
Diuron
Glyphosate
Imidacloprid
Piperonylbutoxide
Prosulfocarb
Terbutryn
Thiacloprid

Industrial compounds and consumer products

1,4-Dioxane
Aminomethylphosphonic acid (AMPA)
Benzotriazole
Ethylenediaminetetraacetic acid (EDTA)
Melamine
Diethylenetriaminepentaacetic acid (DTPA)
Perfluorooctanoic acid (PFOA)
Perfluorooctane sulfonic acid (PFOS)
Tolyltriazole

Pharmaceuticals and endocrine disrupting chemicals (EDC's)

Azithromycin
Benzotriazole
Carbamazepine
Clarithromycin
Diclofenac
Gabapentin
Guanylurea
Hydrochlorothiazide
Irbesartan
Lamotrigine
Metformin
Metoprolol
N-formyl-4-aminoantipyrine
Oxipurinol
Tolyltriazole
Sotalol
Sulfamethoxazole
Tramadol
Trimethoprim
Valsartan
Venlafaxine

RIWA
RIWA-Meuse

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These three monitoring methods are implemented after the summer of 2023. These monitoring methods are applied simultaneously, so that the results can be compared. The monitoring will last for a year, so the measurements can take place during different seasons. Over the course of five years, it will be monitored whether the amount of chemical substances in the water has actually fallen and also what the effect of this is.

What substances, how and where

All participating organisations also have their own monitoring systems, Snijders reports. They monitor partly the same substances and other ones. "We'd like to look at the entire Meuse river basin: which substances come from abroad and which from the Netherlands?" says Snijders. This is already happening, but it will be done more intensively in the future. "Then it's very useful that we have agreed within the De Schone Maaswaterketen (Clean Meuse Water Chain) which substances we monitor, with what methods, where and how often. We've coordinated this with each other."

Snijders helps to resolve this kind of impasse, which is not always easy with so many cooperative partners. "But if you all agree, you can do much more than separately. We have put a great deal of money together to learn from this so we're not all inventing the same wheel." Testing new techniques out in different places for example, because the situation in a wastewater treatment plant is very different from in a stream or in the Meuse.

A big puzzle

The cooperative partners each have different priorities and tasks and legislation to comply with. Besides purifying wastewater, the water boards also have tasks such as dike monitoring, controlling the water level, nature management in and on the water and checking the water quality for swimming. Snijders: "We as a water board do not produce drinking water, so we use different lists of substances from drinking water companies – originally we're more interested in the effects on the ecology." For example, some substances are more harmful to humans than to fish.

Water boards only monitor the harmful substances that legally must be measured according to the European Water Framework Directive and once a year or every few years a couple of extra substances. "We can't monitor everything we want," explains Snijders, "because that would cost a lot of money, and for some substances there is not yet any norm. There are thousands of substances, so how can you make a good assessment? This is a big puzzle."

Different way of thinking

The substance monitoring network will also monitor harmful substances that fall outside this European Directive. Snijders: "Together with multiple experts, we can now make good choices and monitor substances that are important to both the ecology and the tap water. In this way, we take advantage of the experts at drinking water companies. This is why I'm so pleased with the De Schone Maaswaterketen. Since this collaboration started, we as a water board consider the water as a source of drinking water. This is really a different way of thinking."

Not all 21 of the water boards are involved as the Aa and Maas is. One reason for this is that, in other parts of the Netherlands, there are no initiatives like the De Schone Maaswaterketen in which all these various organisations cooperate.

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Snijders can well imagine that, in the future, water boards will also supply purified wastewater to agriculture and industry, instead of these industries continuing to use drinking water for everything although this is by no means always necessary. There could well be the need for this due to the increasing drought caused by climate change: "Rather than the millions of litres of water that we purify every day going straight back into the channels, we could also reuse it. Then farmers and factories would not have to pump up groundwater, because drinking water companies need that too, especially if it hasn't rained much."

Pharmaceutical residues

The De Schone Maaswaterketen collaboration started in 2015 with two projects. The first was a joint study into pharmaceutical residues. The second project was a pilot with a new technique to remove pharmaceutical residues from the water. "Pharmaceutical residues formed a new group of substances that we suddenly realised could be harmful," says Snijders. "The bacteria in wastewater treatment plants also remove part of the pharmaceutical residues from the water, but not all of them. This residues problem also prompted us to look more widely than only at our own legal tasks."

The pilot proved to be a success and, in March 2023, Minister Harbers of Infrastructure and Water Management opened the new Pacas (powder activated carbon in active sludge) plant of the water board at the wastewater treatment plant in Oijen. This new plant, the second in the Netherlands, removes pharmaceutical residues from the water using powdered activated carbon, a kind of pulverised Norit. The pharmaceutical residues adhere to the powder, which clumps together into a kind of sludge that is then incinerated.

Aa and Maas opted for this location because the wastewater is discharged here into a relatively small stream with vulnerable ecology. "The plant did cost millions, so we couldn't immediately implement one at all our seven purification plants," explains Snijders.

Difficult considerations

Pacas is a very good technique to remove pharmaceutical residues from the water, she says, but because the powder can't be reused, it's not the most sustainable solution. Another method is ozonisation, disinfection by treatment with ozone, but this unfortunately costs a lot of energy. This is why the water board is now investigating other techniques. Snijders: "It comes down to a choice between better water quality, but a not very sustainable method, or sustainable, with poorer water quality. These are difficult considerations."

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The complex thing about pharmaceutical residues in the wastewater, she adds, is that they end up in the sewer via our urine and faeces. So, in contrast to companies that discharge harmful residues, you cannot easily prevent pharmaceutical residues ending up in the water. And due to the ageing population and increasing lifespan, steadily greater amounts of medicines are being used.

Pharmaceuticals in legislation

There is however a proposal to include pharmaceuticals in the Water Framework Directive in 2023 for the first time. This will concern diclofenac, a painkiller, and oestrogens. Snijders: "We're becoming concerned when we find these substances in the water."

It's taken a while before pharmaceuticals appeared in the proposal, and there are only a few, explains Snijders, because: "It is a European Directive, so monitoring has to be done throughout Europe of what pharmaceuticals end up in the water, and there is of course a big lobby of pharmaceuticals manufacturers that doesn't want them on this list." She adds: "Europe has now finally taken notice of pharmaceuticals by including them in the legislation, although it has not yet been formally adopted. After this, all the countries will have to amend their own legislation and by then another two years will have passed."

As many pharmaceutical residues as possible

At that point, water boards will have the obligation to ensure that the water that comes out of the purification plants meets the new requirements, so there must not be too much of these pharmaceutical residues in the water. Snijders also mentions a proposal which states that, in the new European Urban Wastewater Directive, water boards must remove 80% of the pharmaceutical residues from the water. By this means, still more pharmaceutical residues will be looked at.

"This means we will have to start building plants to specifically remove these, and preferably as many pharmaceutical residues as possible," says Snijders. These techniques are however not yet sufficiently developed for application rapidly and at large scale, she adds. "This is quite challenging."

Purifying or tracking down discharges

Water boards are investing millions in advanced purification plants – why is there less money for tracking down the sources of pollution, in other words the source approach? "Both are important, but the source approach is a very complicated puzzle," Snijders responds. "In recent years, research has made clear how alarmingly many substances are present in the wastewater and how harmful they are. Our measurement techniques have made huge progress, but in the meantime, we are not fully aware of all the substances that are discharged."

She mentions the substance group PFAS as an example. There is only one company in the Netherlands that produces PFAS, but it proves to be present in a great many products. If companies use these products, they discharge PFAS unawares. Many companies have no idea that they are using PFAS and therefore have not applied for a permit to do so. Besides this, more PFAS is released through domestic use of these products.

Not enough attention to the issue of permits

For a long time, the issue of permits has not received enough attention in the Netherlands, Snijders considers. "Our enforcement was inadequate and permits such as that of Tata Steel in IJmuiden ought to have been stricter in

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retrospect. In the places where the permits are issued, there are not always people with enough chemical knowledge to be able to assess how toxic it is."

Tracking down substances by measuring them in the water is therefore costly and time-consuming. "Fortunately, with the De Schone Maaswaterketen, we now have the opportunity to monitor many more substances than we could as a water board alone," says Snijders. "Besides issuing strict permits and tracking down contaminations, we must try to remove the substances that nonetheless end up in the drinking water."

The polluter pays

Currently there is not any stimulus for companies to reduce their pollution. To change this, recently the proposal has been made at the European Commission to make companies, that discharge harmful substances or pharmaceutical companies that produce medicines, pay – in other words, the polluter pays principle.

Snijders considers this a good idea, because: "In this way, you put the responsibility on the company that develops a particular product. To ensure that the harmful substances are removed from the environment again, or by developing products that do not contain this substance."

She adds to this: "It's actually madness and unsustainable that anything may be discharged into the sewage system and that we then have to remove it afterwards. This is really somewhat back-to-front."

D2 Who discharges what? A better picture of permits

A lot of contaminating substances end up in the Meuse. A selection of wastewater discharge permits in the the Meuse basin can be consulted, but unfortunately there is no complete overview. Director Maarten van der Ploeg and senior policy advisor André Bannink of RIWA-Meuse explain what they consider should be improved. "The grip on wastewater discharges must be firmer".

RIWA-Meuse advocates for a complete and up to date overview of the industrial discharges in the Meuse basin. This information should be clear, transparent and publicly accessible. This is important in order to track down contaminating substances and stop harmful emissions more quickly. When a drinking water company monitors an excessive concentration of a harmful substance, the abstraction of water from the Meuse is usually temporarily stopped. "If that continues for too long, this might threaten the production of drinking water," explains Maarten van der Ploeg. "It's therefore essential to know what companies produce and what substances are being discharged into the Meuse basin. This will enable us to easier find out where the problem comes from and so save time too."

Direct and indirect discharges

Companies that want to discharge wastewater into rivers in the Netherlands must apply for a permit. In some cases, a notification suffices, depending on the types of substance and the quantities a company discharges. Permits for direct discharges into the surface water, which means into a river, channel, stream, canal or the sea, must be applied for to Rijkswaterstaat or the water boards.

Besides this there are indirect discharges via the sewer system, that finally end up in the river via the urban wastewater treatment plants, and also impact the water quality. These permits are issued by one of the 29 regional environmental agencies in the Netherlands that carry out tasks for municipalities and provinces.

Database of permits

The Atlas for a Clean Meuse has been launched in 2020, and it includes a database of permits for wastewater discharges. This is an initiative of the Clean Meuse Water Chain, an association of the Dutch drinking water companies and water boards along the Meuse, Rijkswaterstaat, the Ministry of Infrastructure and Water Management and RIWA-Meuse. In it, you can search on company, type of substance and permit issue, among other things. "A large proportion of the direct permits are already in it," states Van der Ploeg. "From Rijkswaterstaat and recently also from the water boards."

The indirect permits are not yet present. "It would be good to know which companies discharge streams of wastewater into the sewer system, to which sector these companies belong in and exactly what they discharge," emphasises Van der Ploeg. "This information is not easily accessible, but I suspect the number will be a multiple of the direct wastewater discharges. This should be readily available at the press of a button."

Companies' permits to discharge substances should be publicly available. "It was in fact agreed in the Aarhus Convention, a European Convention that entered into force in 2001, that all environmental information should be open and publicly accessible," says André Bannink.

Underground

There should be paid more attention to the indirect discharges, Van der Ploeg considers. "Discharges into the sewers take place under the ground – you don't see them. Citizens don't complain about wastewater, while if a company makes a lot of noise or causes a stench they raise the alarm straight away. But at a given point these harmful substances come to light and then everyone is bothered by them." Various parties are involved with regards to indirect permits, namely the environmental agencies, municipalities and provinces and this makes it complicated. After investigation of the environmental agencies in March 2021, the Van Aartsen Commission made 10 recommendations to improve the issue, supervision and enforcement of permits by environmental agencies.

Updating permits

Wastewater permits may not be older than ten years, and sometimes they must be updated within five years, depending on how environmentally impacting or how hazardous the discharged substances are. In 2019, Rijkswaterstaat conducted a random check to see how up to date the issued permits were. Three quarters of the permits proved to require updating. “Up to date also means that all substances that are being discharged including the quantities are in the permit," explains Van der Ploeg. "If something in the production process changes, this may affect the waste stream."

Rijkswaterstaat decided to inspect all the permits – around 800 – and revise them when necessary. According to the organisation this will take quite a while. Bannink: "Now that Rijkswaterstaat is busy on this update, you see that the water boards want to do this as well. Hopefully the environmental agencies will follow thereafter."

Van der Ploeg points out that recently, thanks to the Clean Meuse Water Chain, all kinds of exchanges are taking place between Rijkswaterstaat and the water boards on technical matters with regard to permit issuance. "Matters such as: what are you coming across? How will you deal with this? This is of course very valuable." Bannink: “Rijkswaterstaat now even has an ambassador for indirect wastewater permits. There wasn't one previously."

Belgium, France and Germany

The Meuse doesn't only flow through the Netherlands, the river first flows through Belgium and France and receives water from tributaries including some in Germany. It would therefore be good, according to RIWA-Meuse, to have a combined overview of permits in these four countries. The Atlas for a Clean Meuse is a first step. "We are therefore taking steps in the Netherlands," says Van der Ploeg. "The permits in Flanders and Wallonia have also been mapped out partly and made digitally available by the water authorities. So there are opportunities to do this."

Why would it be good to have this information available? In case a drinking water company encounters a certain substance in the water, it will contribute to identifying which companies have obtained a permit for this substance, he explains. "As permit issuer you can look at the greater entirety of permits: if for example a large amount of a certain substance is being discharged in Belgium, that provides information that should impact the issuing of a permit in the Netherlands to make sure that the quality of the water does not deteriorate further in the Netherlands."

Who best could organise such an overview? The International Meuse Commission or the European Commission perhaps? It would be even better to have a summary for the whole of Europe, so including the Rhine and the other rivers.

European Directives

Besides this, it would be good if European legislation is better coordinated, emphasises Bannink. "The European Industrial Emissions Directive is presently being tightened up. It would be good in this if an immission test could take place in Member States, in other words a check of what substances enter the water, an important step in the Dutch water policy for determining the effects of a residual discharge on the environment. The Netherlands have been doing since 2011. The section for the test at water abstraction locations has been significantly tightened up in 2019. RIWA proposed this together with Vewin at the time."

The European Commission is also busy on a revision of the Urban Waste Water Directive. Water boards hope this will give them more authority over who is allowed to discharge what into the sewer system.

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Further, there are proposals to expand and refine the European Pollutant Release and Transfer Register (E-PRTR) into the European Emissions Portal. This is a European Union portal within which large businesses must declare what substances they discharge. "But if you currently search in that, you find few substances that we actually encounter in the Meuse," says Bannink. Now it contains only discharges exceeding 1,000 kg and from businesses that are subject to permits under the EU IPPC (Integrated Pollution Prevention and Control) Directive. According to RIWA-Meuse, it is important that smaller discharges and smaller businesses appear here too.

New insights

And once there is a picture of all these permits? "Then we'll see that there are many out-of-date permits and that not all substances that companies emit are included in the permits," says Van der Ploeg. "In other words, permits are not up to date and incomplete. In many cases exactly those substances that threaten the production of drinking water are absent: the persistent, mobile and toxic substances. Thanks to new research there has been recently much attention to the fact that these substances are hazardous to health. This is another example why it is good to review permits regularly: you can include new insights about existing substances."

Bannink cites PFAS substances as an example. "We've known about these for over 50 years, but are only now discovering what problematic substances they are. This could also happen with other substances. So where at first no necessity was seen to impose discharge requirements on PFAS, now the strictest requirements are imposed. As long as we don't know how harmful substances are, they better should not be discharged."

In Flanders, much research has been done in recent years into PFAS discharges: how much is there and where does it come from? "One of the actions arising from this," reports Bannink, "is that baseline measurements are being conducted. In these baseline measurements one examines which harmful substances are there in the wastewater stream. When this is compared with the measurement results of the receiving water one can see how do these concentrations add up? Is it in order to allow the discharge, or is there already too much present in the water? Based on what we find in the water, discharge restrictions should be imposed.

Commercial secret

In the current situation a company must report to the permitting authority what it plans to discharge. Companies are not always transparent about this, or don't know exactly what substances are released in a particular production process. Bannink: "It might be that a company applies for a permit to discharge cooling water for example, but doesn't know exactly what substances are in it, because the supplier of the cooling water treatment agent doesn't want to tell them as it is a commercial secret. Also, if different substances are discharged from what is in the permit, the permit issuer does not find this out."

A few years ago the Dutch Council of State pronounced that the permit applicant may only discharge substances present in the permit application. Bannink: "This was always the intention of the law, but now the Court has made it explicit that you must interpret it in this way. So now companies can get into trouble if they discharge substances that are not in the permit."

Know what you discharge

RIWA-Meuse would like to advocate that baseline measurements for wastewater streams are conducted in the Netherlands as well. "It would be good to look at PFAS," the Director of RIWA-Meuse considers. "But it would be even better to do thorough research into all harmful substances in wastewater streams and consequently amend the permit requirements to this."

Drinking water companies' expertise can also be used to assess which permits should and should not be granted. "The drinking water companies possess a great deal of knowledge about the substances, about what is harmful and less harmful, what is difficult to purify, and they have developed many advanced measurement technologies in their laboratories," says Van der Ploeg, who concludes: "To put it briefly, it would be very desirable, from our perspective, for companies to know exactly what they discharge. And a permit issuer should make every effort to know what is being discharged by companies. Incorporating this practice hopefully helps in getting better grip on harmful wastewater discharges."

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EVIDES

D3 Water quality deserves just as much attention as flooding and drought

An appeal case against the discharge permit of Chemours, a lawsuit against the Flemish government (which ultimately proved unnecessary) and an investigation into how the emmission test can be improved. Manager Rona Vink of Evides: “Our surface water must not be used as a kind of sewer.”

Rona Vink manages the Technology & Sources Department, which employs 32 enthusiastic technologists, hydrogeologists and microbiologists. "You can see us as the water quality conscience within Evides. We monitor and supervise the water quality from the source to the tap." Evides abstracts the water from the Meuse, Haringvliet and groundwater sources.

To keep the water quality as high as possible and, where necessary, to improve it, the employees work on influencing policy and representing interests, conducting research and developing knowledge in the field of purification technology and water quality. They analyse the water quality, supervise the abstraction areas and advise their own organisation about future modifications in the drinking water production process.

Appeal case against Chemours

In 2022, together with the drinking water company Oasen, Evides brought an appeal case against the discharge permits of the chemicals company Chemours in Dordrecht. The province of Zuid-Holland and Rijkswaterstaat revised the old permits and issued new ones in 2022. Vink: "The company therefore has permission to continue discharging wastewater with PFAS substances into the sewers and the surface water."

All the drinking water companies in the Netherlands are arguing for a total ban on PFAS, both for the production and for their application in products. “Every discharge of PFAS is one too many," says Vink. Chemours’ previous permit was issued in 2013. If substances of very high concern (VHC) are released then, since 2016, the permit must be reviewed every five years and then revised, if necessary, she states.

Oasen had already brought an appeal case in 2018 due to an industrial discharge of GenX. "An appeal case is quite a big step," says Vink. "It demands much preparation and of course you'd rather the practice of permit issuance protected drinking water sources adequately."

Latest insights

Vink was closely involved in the preparation of the appeal case against Chemours. The permit is extremely complex and comprises over 300 pages, but she says regardless: "In regard to the carefulness with which the consideration was made, we see points of improvement.”

In October 2022, Minister of Infrastructure and Water Management Mark Harbers decided that every permit with PFAS must be checked against the RIVM-recommended drinking water target, namely a maximum of 4.4 nanograms[9] per litre. "This decision has not yet been included in these permits," says Vink,

9 *PFOA equivalents (PEQ).*

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"and neither have the latest insights about PFAS. We also refer to this in the appeal case. Insufficient attention was paid to this in the assessment of the permit application. Moreover, the RIVM previously issued advice about the harmfulness of PFAS to public health."

Too much PFAS already

It is important that no more PFAS are discharged, because, Vink states: “The concentrations currently present in the surface water in the Netherlands, and in the Meuse as well, are already higher than 4.4 nanograms per litre and the levels are still increasing. The harmful concentrations of PFAS get into the water of the Meuse via various direct and indirect sources and from our own country and abroad.

The appeal case writ against Chemours was sent to the court in February and the court is currently preparing the lawsuit. It is not yet known when the case will be heard. Vink expects that due to the complexity this could take a while. "It is encouraging that several countries in Europe are getting up steam for a PFAS prohibition, though it does cost a great deal of time to get it all together."

Contaminated or uncontaminated soil

In 2022, Evides, together with the drinking water companies Dunea and WML, brought a lawsuit against an environmental permit that the Flemish government had issued in December 2021. The gravel consortium Rekin was allowed to deposit over 7 million cubic metres of soil into a pond that is connected to the Meuse in the vicinity of the Belgian town of Kinrooi near the Dutch border.

Amendment of the Water Framework Directive and standards for PFAS

Until now, the Water Framework Directive (WFD) has contained environmental quality standards (EQS) for only one of the PFAS, namely PFOS. On 26 October 2022, the European Commission published a proposal for an amendment to the WFD. This WFD standard is based on risks from the perspective of drinking water production. This WFD proposal includes a standard for the sum 24 PFAS of 4.4 nanograms of PFOA equivalents (PEQ) per litre. Although at the time of writing this, not all these 24 PFAS are monitored, it is already clear that for example at the monitoring point Bergsche Maas, this proposed standard was not met at any single moment in 2022 (see Figure 4). In order to meet the proposed standard, appropriate measures will need to be taken in the Meuse river basin.

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Figure 4 Sum of 24 PFAS at Bergsche Maas in 2022

EVIDES

Too little was known about the origin and contamination of the soil and its consequences on the environment. "Uncontaminated soil was mentioned, but what criteria were used for this? This was absent from the permit," explains Vink.

In the permit it was not clearly described whether the soil that would be deposited would also be tested against PFAS limit values, which meant it was unclear whether there would be a risk to the drinking water supply. This was the reason for the drinking water companies to go to appeal. Finally, no lawsuit arose from this. Zuhal Demir, the Flemish Minister of The Environment, Justice, Tourism and Energy decided in late 2022 to withdraw the environmental permit: the soil is therefore not allowed to be deposited.

Better imission-emmission test

Furthermore, in the past year, Evides together with a consultancy bureau has conducted research into what can be improved in the mission-immission test inregard to protecting drinking water sources.

The National Government imposes this testing framework task on Rijkswaterstaat, the waterboards, the provinces and the environmental agencies. These competent authorities use this to assess permits as to whether a certain discharge is permitted.

Using a step-by-step plan in the associated manual, both the discharge and the receiving surface water are looked at. Could the substances be discharged with an eye to the water quality requirements and standards in force, such as the Water Framework Directive objectives, or would the maximum permissible impact be exceeded? "The emission-immission test is a sound instrument," Vink considers. "But it stands or falls depending on how you use it."

Unjust permit

Investigation that was completed in 2022 showed that it is not always sufficiently clear what the quality of the surface water is, that will be discharged into, even in the case of substances of very high concern. This is because Rijkswaterstaat and the water boards do not monitor many of these substances everywhere and for extended periods of time. Vink: "Therefore they cannot be included in the test and, thus, a background concentration of zero is entered, the concentration that is already present in the water before the discharge. This can lead to a discharge being permitted unjustly." This often concerns substances that are difficult to remove and are harmful to the quality of the drinking water.

The conclusion was discussed with the association partners in the Clean Meuse Water Chain, Vink reports. After the summer of 2023, this organisation is going to monitor many more substances that are harmful to the drinking water and the ecology in the Meuse over the course of a year. For the emission-immission test, monitoring must continue for at least three years. Afterwards, these substances can be included in the testing toolbox (for more about the Clean Meuse Water Chain, please see section D1).

What is in the discharge?

The competent authorities and the companies themselves must also describe and establish much better what exactly is in the discharge, it has emerged from the investigation on the emission-immission test. Vink: "This regards the questions; how much will be discharged? Whwhat substances will be discharged?, When will they be discharged? And, are these substances harmful to the drinking water?" Currently, health risks often cannot be assessed systematically because there is no complete picture. Because the company is not transparent or does not have enough information itself.

"This means you can miss substances, because they have not been investigated, for example, " says Vink. "A safety netneeds to be included in the permit on how to deal with these situations. Additional investigation must be done as to whether there is a complete picture of all drinking water-relevant substances in the discharge and to what extent these are discharged."

The firm Sitech in Geleen forms an example for other companies in this regard, reports Vink. Sitech screens the discharge continuously, since it became known in 2015 that the company discharged the harmful substance pyrazole, after which various drinking water companies had to suspend water abstraction. After this, the entire discharge was mapped out step-by-step and jointly with all parties, and the company has frequent consultation on the matter with Evides and others.

Protecting citizens better

In April 2023, the Dutch Safety Board (in Dutch, OVV) published a report in which the organisation stated that citizens should be better protected against the harmful emissions or discharge from industrial companies. The investigators specifically mentioned Tata Steel, Asfalt Productie Nijmegen and Chemours.

These three companies do little more than what is legally mandatory to reduce the harmful emissions, the OVV wrote. They only go into action if people nearby keep complaining. And due to the lack of knowledge, capacity and sense of urgency, the government frequently responds only reactively. Previous reports too, for example from the Van Aartsen Commission, draw attention to the gaps in the permit issuance, the supervision and enforcement of these permits.

Lack of knowledge and expertise

"Unfortunately, I recognise this picture," Vink responds. According to her, this happens due to, among other reasons, a lack of sufficient, sound knowledge and expertise at the competent authorities. "The permits of these companies and industrial processes are really complex. The assessment and consideration often fall short, due to which those living near polluters are often not well protected."

Moreover, the knowledge about PFAS compounds is developing continuously, Vink emphasises. "Ten years ago, the views on the harmfulness of certain substances were different from today, so as a competent authority you must follow these developments closely. For example the tightening up regarding PFAS."

Distrustful citizens

Complaints received by businesses and government bodies from the surrounding area often receive a procedural answer along the lines of 'it's allowed according to the permit,' is Vink's experience. "While in these cases there is often a valid reason to do additional investigation. This can of course lead to distrust from the citizens."

A permit should in fact be a safety net for the citizens and the environment, she considers. In order to be able to check immediately whether the company that receives the permit can further reduce discharge through measures in the industrial processes. "We want the precautionary principle to weigh very heavily," says Vink. "To only grant permits once you know exactly what the company is going to discharge and that the company is not discharging harmful substances, rather than realising this afterwards. This is useful to prevent these harmful substances from ending up in the surface water and living environment."

Money and labour

In recent years, various investigations have been done and advisory reports have been published to make improvements to this situation and the water quality. Does Vink expect something to be done with this? "The government has released money for various measures to improve the water quality more quickly, and also improvement of permit issuance, supervision and enforcement is being worked on, so I am hopeful that things will improve."

But, she adds: "This requires you also obtain the labour force needed to carry this out." And finding specialised staff is of course difficult given the current tight labour market. Besides this, she indicates the recent conclusion of the Council for the Environment and Infrastructure that the objectives of the Water Framework Directive must be translated more explicitly and bindingly into national legislation. "The rules for fertilisers, crop protection products and the discharge of hazardous substances need to be tightened up."

Vink is positive about all these reports having led to the insight that many discharge permits, and standards in use, are out of date and that the safety net needs to be improved. Because it is not known exactly what substances are present in a discharge, and due to amended target levels and insights about the harmfulness of substances. "Rijkswaterstaat has therefore started to update the permits, starting with the discharges of substances of very high concern. The fact that this will take quite a while still is due to it being so difficult to get sufficiently skilled staff, and sometimes due to the complexity of the permit as well," she says.

More attention to water quality

There needs to be more attention paid to the quality of our water, Vink states in conclusion. "We have recently had the nitrogen crisis, but the next crisis is already on its way: the water crisis. And then we won't just have to worry about the quantity, but also the quality. If this is the case, doing our best in the Netherlands will have to get even better than it is now."

The complexity of this,, she adds, arises from the fact that in the meantime millions of chemical substances have been approved worldwide, of which many are relevant to the drinking water sector. Besides this, the quantity of chemical substances that are being produced is rising rapidly and the safety assessments of these substances always lags behind.

One silver lining, she considers, is the revision of REACH, the Regulation of the European Agency for Chemical substances, that is planned for 2023. This system for the registration, evaluation and authorisation of chemical substances that are produced in or imported into the European Union has existed since 2007.

"It is high time that we no longer see our surface water as a sort of sewer," emphasises Vink, "but as a valuable water system necessary to our protection that is the basis for healthy drinking water. The water quality deserves just as much attention as flooding and drought."

Annexes

Annex 1

Substances that exceeded the ERM target value in 2022

Many anthropogenic (human-caused) pollutants were detected in the Meuse water. In 2022, 79 substances exceeded the target value in the European River Memorandum (ERM target value) in target substance analyses. This happened 1,602 times in 7,155 measurements that were conducted for these 79 substances, so in 22.4% of the cases. It is possible to produce drinking water in a sustainable way with natural purification methods from river water that meets the ERM target values.

To gain an impression of the types of substance that drinking water companies had to deal with in 2022, a 'mugbook' for substances in the Meuse that exceeded the ERM target value in this year is presented below. RIVM's PMT screening tool was used to look up the PMT scores of these substances, insofar as they are available.

This concerned the following substance groups:

- Industrial pollutants and consumer products
- Residues of pharmaceuticals and endocrine-disrupting chemicals
- Crop protection products, biocides and their metabolites

Industrial pollutants and consumer products

In 2022, 79 parameters exceeded the ERM target values one or more times. Industrial pollutants were the culprit in 40.5% of cases (32). Of the 2,416 measurements that were done for these 32 substances, 790 (32.7%) exceeded the ERM target value.

Table 4: Industrial pollutants and consumer products that exceeded the ERM target value in 2022 (maximum concentrations)

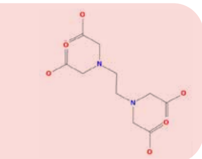
Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Industrial pollutants and consumer products																790	2416	32,7%
Ethylenediaminetetraacetic acid (EDTA)	60-00-4	1	µg/l		9,6	10	9,4	12		9,6	335,67			42,22	11,6	83	83	100,0%
Sulfamic acid	5329-14-6	0,1	µg/l					28		42	52			77	120	54	54	100,0%
Cyanuric acid	108-80-5	0,1	µg/l				2,36	2,9		2,5	1		1,78	1,5	1,3	56	63	88,9%
Sucralose	56038-13-2	1	µg/l				1,73				7,32	6,36	8,61	7,56	2,30	46	52	88,5%
Trifluoroacetic acid	76-05-1	0,1	µg/l				<1				1,4		1,2	1,2	1,4	43	49	87,8%
Dichloro-methanesulfonic acid	53638-45-2	0,1	µg/l					0,69		0,36	0,24			0,34	0,23	45	54	83,3%
Cyanoguanidine	461-58-5	0,1	µg/l				0,16						0,51			7	9	77,8%
8-Hydroxypenillic acid	3053-85-8	0,1	µg/l							<0.05				2,9	0,11	20	33	60,6%
Trichloroacetic acid	76-03-9	0,1	µg/l								0,16	0,25		0,29	0,13	29	50	58,0%
Melamine	108-78-1	0,1	µg/l		0,46	1,33	0,35	9,9		4,1	2,36	3,41	2,67	2,8	1,76	202	378	53,4%
1,4-Dioxane	123-91-1	0,1	µg/l				<0.5	0,56		0,62	0,24			0,41	0,7	37	74	50,0%
Ethylene glycol dimethyl ether	110-71-4	0,1	µg/l											<0.05	0,36	12	26	46,2%
Methenamine	100-97-0	1	µg/l		6	3,54	5,51	4,2		3,1	0,98		0,85	7,2	1,5	34	88	38,6%
Aspartame	22839-47-0	0,1	µg/l											<0.1	0,111	1	3	33,3%
Nitriloacetic acid (NTA)	139-13-9	1	µg/l		1,6	1	3,9	2,9		<1	3,63			1,01	<1	17	83	20,5%
Monobromoacetic acid	79-08-3	0,1	µg/l								0,20	0,35		0,14	0,11	9	48	18,8%
Dibromomethanesulfonate	859073-88-4	0,1	µg/l					<0.1		<0.1	0,54			0,33	0,26	9	54	16,7%
Diisopropyl ether	108-20-3	1	µg/l		<0.1	25,8	13	5,1	2,1	2,1	0,02	0,99	0,35	0,93	0,08	26	158	16,5%
Dibromoacetic acid	631-64-1	0,1	µg/l								0,99	2,10		0,35	0,2	8	50	16,0%
Tolyltriazole	29385-43-1	1	µg/l		0,31	3,81					0,68					6	39	15,4%
Tetrahydrofuran	109-99-9	0,1	µg/l					0,34		0,08				0,22	0,13	7	53	13,2%
Theobromine	83-67-0	0,1	µg/l					0,13		0,15				0,1	0,07	5	42	11,9%
Diethylenetriaminepentaacetic acid (DTPA)	67-43-6	1	µg/l		<1	<1	8,4	<1		<1	<1			3,44	1,58	9	82	11,0%
1,2,3-Benzotriazole	95-14-7	1	µg/l		1,72	1,44		0,68		0,82	0,81	1,70		1,13	0,72	10	93	10,8%
Trifluoromethanesulfonic acid	1493-13-6	0,1	µg/l				<0.2	0,56		0,12	0,07		<0.2	0,1	0,07	3	63	4,8%
Tributyl phosphate	126-73-8	1	µg/l		0,05	1,64	1,5		0,42	0,46	0,11	0,65	0,18	0,21	<0.1	2	54	3,7%
1,3-Diphenylguanidine	102-06-7	0,1	µg/l					0,09		<0.05				0,18	0,05	1	42	2,4%
Methyl tert-butyl ether (MTBE)	1634-04-4	1	µg/l	0,39	0,67	0,11	0,3	0,17	0,83	0,46	1,1	1,55	0,89	1,1	0,05	4	186	2,2%
Carbon disulfide	75-15-0	0,1	µg/l	<0.3	0,9	1,4										1	52	1,9%
Ethyl hydrogen sulphate	540-82-9	0,1	µg/l					0,1		<0.1	<0.1			<0.1	<0.1	1	54	1,9%
Vinyl chloride	75-01-4	0,1	µg/l	<0.1	0,36	<0.1	0,15	<0.05	<0.37	<0.04	<0.04		<0.04	<0.04	<0.04	2	157	1,3%
Allyl chloride	107-05-1	0,1	µg/l				<0.1		<0.12	<0.1	<0.1		1,6	<0.1	<0.1	1	90	1,1%

ERM-tv = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Liège, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, BRA = Brakel, HEU = Heusden, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.

In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of measurements

Complex formers

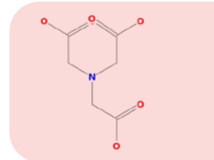
Complex formers (chelates) are chemical substances that form complex, soluble molecules with certain metal irons, thanks to which these metal irons are inactivated such that they cannot react in a normal way with other elements or ions in order to form a precipitate or deposit. They are used as ingredients in cleaning agents such as limescale removers and strippers and as stabilisers in bleaches and soap products.



EDTA (CASRN 60-00-4)

PMT-score 0,23
(P=0,02 | M=0,95 | T=0,68)

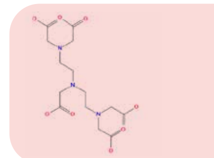
Application: EDTA is a complex former that is used in detergents and in medicine to trap and remove calcium and other metals, including heavy metals such as arsenic, copper and mercury.
Origin: This substance mainly ends up in surface water via wastewater treatment plants.
Distribution of contamination: EDTA (ethylenediaminetetraacetic acid) was detected at far above the ERM target value of 1 µg/L in all measurements at all measurement points. The indicative drinking water target value for EDTA is 600 µg/L.
Notable: Since 1990, this substance has been detected at concentrations between 0 and 30 µg/L in drinking and surface water. A concentration of 335 µg/l was measured in the Afgedamde Maas near Brakel in 2022. This is more than half of the indicative drinking water target value. EDTA as a compound is not very toxic to humans, but it is difficult to purify and it has the property of releasing heavy metals from sludge and keeping them dissolved in water.



NTA (CASRN 139-13-9)

PMT-score 0,13
(P=0,01 | M=0,94 | T=0,18)

Application: NTA (nitrilotriacetic acid) is suitable for softening water and for preventing or removing limescale deposits. It is therefore frequently added to water in boilers. NTA was used increasingly from the late 1960s as a replacement for phosphates in detergents.
Origin: This substance mainly ends up in surface water via cooling water discharges and wastewater treatment plants.
Distribution of contamination: NTA was detected at above the ERM target value in measurements at Namêche, Liège, Eijsden, Roosteren, Brakel and Bergsche Maas. The indicative drinking water target value for NTA is 400 µg/L.
Notable: NTA is effectively biologically degradable, better than the similar EDTA. It is mainly the water-soluble trisodium salt of NTA that is used in soaps and detergents. The WHO IARC considers NTA as possibly carcinogenic to humans (IARC class 2B).



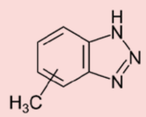
DTPA (CASRN 67-43-6)

PMT-score 0,26
(P=0,03 | M= 0,96 | T=0,68)

Application: From the 1960s onwards, DTPA (pentetic acid or diethylenetriaminepentaacetic acid) has been used to combat internal contamination with radioactive material. DTPA and its derivatives are used to form complexes with gadolinium, which in their turn are used as contrast agents in MRI[10] scans. DTPA is also used in the extraction of soil samples.
Origin: This substance mainly ends up in surface water via wastewater treatment plants.

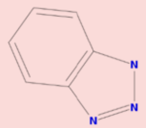
10 *Magnetic Resonance Imaging*

Distribution of contamination: DTPA was detected above the ERM target value at Eijsden, Bergsche Maas and Haringvliet. Since July 2022, DTPA has been on the Dutch list of substances of very high concern [source:]. The indicative drinking water target value for DTPA is 700 µg/L.
Notable: In the past (2018), Dunea and Evides had an exemption to allow them to continue to use surface water with DTPA at Brakel and Keizersveer (Gat van de Kerksloot) for the production of drinking water. Similarly to EDTA, DTPA forms stable complexes with many metals.



Tolyltriazole (CASRN 29385-43-1)

PMT-score 0,35
(P=0,15 | M=0,51 | T=0,56)



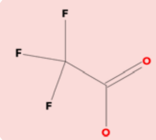
1,2,3-Benzotriazole (CASRN 95-14-7)

PMT-score 0,27
(P=0,11 | M=0,54 | T=0,35)

Application: Tolyltriazole (a mixture of 4- and 5-methyl-1-H benzotriazole) and 1,2,3-benzotriazole are chelating agents[11] that have applications including corrosion inhibitors in cooling water, antifreeze/anti-icing agents (including deicing aircraft) and as protective agents for silverware in washing-up liquid. Benzotriazole is for example a constituent of the cooling water additive Nalco 3D TRASAR 3DT151, a copper corrosion inhibitor.
Origin: This substance mainly ends up in surface water via wastewater treatment plants.
Distribution of contamination: Tolyltriazole was detected above the ERM target value at Liège. Benzotriazole was detected above the ERM target value at Namêche, Liège, Heusden and Bergsche Maas. The indicative drinking water target value for benzotriazole is 700 µg/L. The indicative drinking water target value for tolyltriazole is 350 µg/L.
Notable: In the past, WML (2018) and Evides (2019) had an exemption to allow them to continue to use surface water with benzotriazole from the Meuse for the production of drinking water.

11 From a chemical standpoint, chelation is the same as complex formation, with the understanding that, in chemistry, the concept complex formation is applied to mono-, di- and polydentate ligands, while chelation explicitly excludes the monodentate ligands (source: Wikipedia).

Solvents



Trifluoroacetic acid (TFA, CASRN 76-05-1)

PMT-score 0,34
(P=0,16 | M=0,75 | T=0,34)

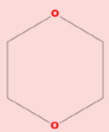
Application: Trifluoroacetic acid (TFA) is used in the production of trifluoroacetic fluoride and 2,2,2-trifluoroethanol. The acid is added to some HPLC analyses in the mobile phase to reduce the occurrence of 'tailing'. The acid is also frequently used as a building block in the synthesis of pharmaceutical substances and agricultural chemicals and as a catalyst in polymerisations and condensation reactions. On the boundary between organic chemistry and biochemistry, trifluoroacetic acid is used during in vitro peptide synthesis to remove the protective tert-butoxycarbonyl group from amino groups. TFA is used in the form of its salts (trifluoroacetates) in the production of ceramic materials. TFA is a much-used solvent in NMR spectroscopy, and it is used in mass spectrometry to calibrate the equipment [source: Wikipedia]. TFA is also a breakdown product of hydrofluorocarbons or HFCs that are used in applications including air conditioners, foam blowing agents and propellant gases in aerosols (source:

UBA report FB000452/ENG). TFA may also be a metabolite of crop protection products based on flurtamone, fluopyram, tembotrione and flufenacet and of the substances fluoxetine, sitagliptin and 4:2 fluorotelomer sulfonate (source: https://www.ncbi.nlm.nih.gov/pub-med/28992593).

Origin: This substance mainly ends up in surface water via industrial wastewater treatment plants. TFA has also been detected in rain-water.

Distribution of contamination: TFA was detected above the ERM target value at Brakel, Keizersveer, Bergsche Maas and Haringvliet. TFA is a potential substance of very high concern[source: RIVM]. According to the OECD definition, TFA is one of the PFAS and has an indicative drinking water target value of 2.2 µg/L.

Notable: In September 2016, at the LUBW (Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg), there were indications of an industrial contamination of the Neckar tributary with TFA. For this reason, monitoring was started. In the Neckar, high concentrations above 10 µg/L were detected; in the Netherlands part of the Rhine, the concentrations in the surface water are around 1.5 µg/L (source: fact sheet from Het Waterlaboratorium).



1,4-Dioxane (CASRN 123-91-1)

PMT-score 0,38

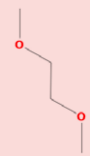
(P=0,09 | M=0,73 | T=0,84)

Application: 1,4-Dioxane is an ether that is mainly used as a solvent in the paper, cotton and textile industry, in vehicle coolants, as initial substance for the synthesis of other substances, as foaming agent in the polymer industry, and in the production of cosmetics and shampoos. On 12 July 2021, 1,4-dioxane was added to REACH Annex XIV (Substance of Very High Concern, SVHC). In the Netherlands, the substance was added to the list of Substances of Very High Concern (ZZS). 1,4-Dioxane may be formed in the production and processing of ethylene oxide, a major raw material in the chemicals industry. Two cases are known in which the production of ethylene oxide led to emissions of 1,4-dioxane: at INEOS in Dormagen (Rhine) and at KLK Kolb Specialties in Delden (Twente Canal). Ethylene oxide is used as an intermediate product in processes including the pro-duction of ethylene glycols. It is also used as a disinfecting agent for heat-sensitive materials in hospitals.

Origin: It emerges from the REACH dossier that at least one ethylene oxide factory is situated on the Meuse [source: ECHA]. There are also at least two manufacturers on the Albert Canal.

Distribution of contamination: 1,4-Dioxane was detected above the ERM target value at Roosteren, Heel, Brakel, Heusden, Bergsche Maas and Haringvliet. The indicative drinking water target value for 1,4-dioxane is 3 µg/L.

Notable: Because the WHO IARC states that this ether could possibly be carcinogenic to humans (IARC class 2B), 0.1 µg/L is kept to as ERM target value.



1,2-Dimethoxyethane (CASRN 110-71-4)

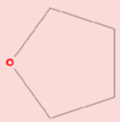
PMT-score 0,38

(P=0,09 | M=0,72 | T=0,81)

Application: 1,2-Dimethoxyethane, often abbreviated to DME or EGD-ME, and also known under the names glyme and ethylene glycol dimethyl ether, is a solvent. It is often used in chemical reactions in which an aprotic, coordinating solvent is needed. Examples of this are organometallic reactions or reductions with hydrides. It can also act as a ligand in metal complexes (source: Wikipedia). DME is a substance of very high concern (https://rvszoeksysteem.rivm.nl/stof/

detail/1418): on 15 July 2012, DME was added to the candidate list for REACH Annex XIV (Substance of Very High Concern, SVHC).

Distribution of contamination/Origin: DMA was only detected above the ERM target value in the Haringvliet. The water in the Haringvliet mainly originates from the Rhine river basin, from where the discharges of this substance presumably also come.



Tetrahydrofuran (THF, CASRN 109-99-9)

PMT-score 0,35

(P=0,08 | M=0,65 | T=0,80)

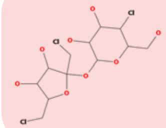
Application: Tetrahydrofuran (THF) is a solvent that is used in the chemicals industry. It can be polymerised by strong acids or electrophiles (such as trityl tetrafluoroborate) into a linear polymer, poly(tetramethylene ether) glycol or PTMEG (also known as poly (tetramethylene) glycol or polytetramethylene oxide). This glycol is mainly used for the production of elastomer polyurethanes, in particular polyurethane fibres such as elastane (Spandex, Lycra).

Origin: This substance mainly ends up in surface water via wastewater treatment plants.

Distribution of contamination: THF was detected above the ERM target value at Roosteren, Bergsche Maas and Haringvliet.

Notable: No clear trend is observable.

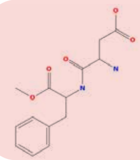
Foodstuffs



Sucralose (E955, CASRN 56038-13-2)

PMT-score 0,62

(P=0,45 | M=0,87 | T=0,61)



Aspartame (E951, CASRN 22839-47-0)

PMT-score 0,00

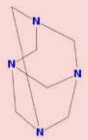
(P=0,10 | M=0,79 | T=0,00)

Application: Sucralose (E955) and aspartame (E951) are artificial sweeteners that are used as sugar replacements in various foodstuff products and soft drinks.

Origin: These substances mainly end up in surface water via wastewater treatment plants.

Distribution of contamination: Sucralose was detected at concentrations above the ERM target value at Eijsden, Heusden, Brakel, Keizersveer, Bergsche Maas and Haringvliet. It is stable and is not broken down or absorbed in the body. This property means that it is also not (well) broken down in the environment, a wastewater purification plant or a simple drinking water purification plant. The indicative drinking water target value for sucralose is 5,000 µg/L. Aspartame was detected at a concentration above the ERM target value at Haringvliet.

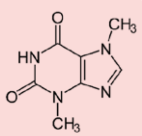
Notable: Sucralose is in Annex III of the REACH Regulation due to the suspicion of carcinogenicity, hazard to the aquatic living environment, mutagenicity and persistence [source: ECHA].



Methenamine (E239, CASRN 100-97-0)

PMT-score 0,63
(P=0,81 | M=0,93 | T=0,34)

Application: Methenamine (urotropine, hexamine) is one of the trivial names for a compound that is much used in phenol resin and many other industrial applications, and also as a preservative against mould (E239 in products including caviar, rollmop herring, tinned fish and pickled herring). Methenamine is also the main constituent of solid fuel tablets, known by the name Esbit, much used for example in stoves for campers, mountain climbers and the military, and in miniature steam engines. Methenamine may also be used as a corrosion inhibitor and antibiotic.
Origin: This substance mainly ends up in surface water via wastewater treatment plants.
Distribution of contamination: Methenamine was detected above the ERM target value at Namêche, Liège, Eijsden, Roosteren, Heel, Bergsche Maas and Haringvliet. The indicative drinking water target value for methenamine is 500 µg/L.
Notable: Since 2010, methenamine has been monitored in the water abstracted at Brakel and it is also detected regularly at over the ERM target value. From 2012 this substance has also been detected systematically at Keizersveer and Haringvliet at above the ERM target value.

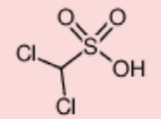


Theobromine (CASRN 83-67-0)

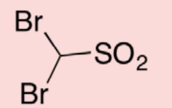
Application: Theobromine is the substance that gives dark chocolate its bitter taste. It has a stimulating effect on the nervous system and heart muscle; it causes relaxation of the smooth muscles, it dilates blood vessels and promotes the excretion of urine. Theobromine is taken up very rapidly in the oral cavity and stomach and so has a very rapid effect on the body. The liver breaks the substance down, and it then travels to the kidneys via the blood where is excreted as waste. Theobromine is poisonous to dogs.
Origin: unknown
Distribution of contamination: Theobromine was detected at levels above the ERM target value at Roosteren, Heel, Keizersveer, and Bergsche Maas.

Halomethane sulfonic acids (HMSAs)

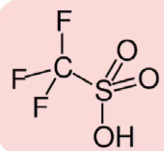
Dichloro-methanesulfonic acid (CASRN 53638-45-2)



Dibromomethane sulfonic acid (CASRN 859073-88-4)



Trifluoromethanesulfonic acid (CASRN 1493-13-6)



Application: Halomethane sulfonic acids (HMSAs) are recently discovered polar disinfectant byproducts. Due to its acid strength, trifluoromethanesulfonic acid is mainly applied in chemical reactions as a catalyst or a source for the triflate group. Trifluoromethanesulfonic acid is one of the strongest known acids and is therefore counted as a super acid as they are known.
Origin: HMSAs arise frequently and at high levels in drinking water and could potentially be very persistent and very mobile (vPvM)[12].

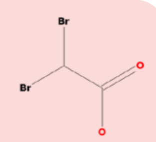
12 *https://www.ufz.de/promote/index.php?en=33621*

Distribution of contamination: Dichloro-methanesulfonic acid was detected above the ERM target value at Roosteren, Heel, Brakel, Bergsche Maas and Haringvliet. Dibromomethane sulfonic acid was detected above the ERM target value at Brakel, Bergsche Maas and Haringvliet. Trifluoromethanesulfonic acid was detected at concentrations above the ERM target value at Roosteren, Heel and Bergsche Maas.

Halogenated acetic acids (HAA)

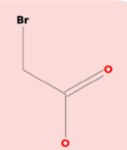
Trichloroacetic acid (TCA, CASRN 76-03-9)

PMT-score 0,54
(P=0,36 | M=0,68 | T=0,62)



Dibromoacetic acid (DBA, CASRN 631-64-1)

PMT-score 0,33
(P=0,06 | M=0,73 | T=0,81)



Monobromoacetic acid (MBA, CASRN 79-08-3)

PMT-score 0,28
(P=0,04 | M=0,75 | T=0,82)

Application: These substances are known byproducts that arise from the chlorination of water. TCA has many applications, including solvent in the plastics industry, production of sodium trichloroacetic acid (a herbicide), etchant in metal processing, additive in mineral lubricant oils and catalyst for polymerisation reactions [source: Wikipedia]. In biochemistry, TCA is used to precipitate out proteins and other macromolecules. Other applications are to be found in the medical (treatment of skin conditions and removal of warts) and cosmetic spheres (chemical peeling). TCA has been detected in the Meuse since 1986 [see H2O article from Versteegh, J.F.M., Peters, R.J.B. & De Leer, E.W.B. (1990)].
Origin: Chlorination of water in industrial processes is probably the source of HAA in the Meuse.
Distribution of contamination: TCA, DBA and MBA were detected above the ERM target value at Heusden, Brakel, Bergsche Maas and Haringvliet.
Notable: TCA has been detected above the reporting limit for years in Meuse water at Heusden and Brakel.

Substances that are used in the Prayon process

DIPE (CASRN 108-20-3)

PMT-score 0,35
(P=0,10 | M=0,56 | T=0,75)

Tributyl phosphate (CASRN 126-73-8)

PMT-score 0,14
(P=0,01 | M=0,30 | T=0,80)

Application: There is a known industrial discharge in the Wallonian part of the river basin that for decades has been responsible for the presence of the substances fluoride, DIPE and tributyl phosphate in the Meuse. The company Société de Prayon developed and patented an extraction process that uses the solvents di-isopropyl ether (DIPE, 85-95%) and tributyl phosphate (5-15%) with which technical grade phosphoric acid can be upgraded to phosphoric acid of food quality [Gilmour, 2013]. Since 1983, this process has been used in the factory at Engis and there is presently a plant with which 120,000 tonnes per year (expressed as P2O5) can be processed with the Prayon process as it is known.

In the first step of the pre-treatment in the Prayon process, the impurities sulfate and fluoride in industrial grade phosphoric acid are reduced to 0.3% and 0.1% respectively. Part of the fluoride is recovered from the process and sold in the form of hexafluorosilicic acid (H2SiF6).

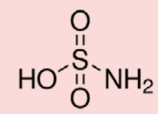
Origin: Société de Prayon in Engis.

Distribution of contamination: DIPE was detected above the ERM target value at Liège, Eijsden, Roosteren, Stevensweert and Heel. Tributyl phosphate was detected above the ERM target value at Liège and Eijsden. The indicative drinking water target value for tributyl phosphate is 350 µg/L. The indicative drinking water target value for DIPE is 1,400 µg/L.

Notable: Société de Prayon further optimised the fluoride recovery process in their factory at Engis by installing a vapour separator and air scrubber in October 2014. This ought to deliver an extra yield of around 250 tonnes of fluoride per year, which would no longer be discharged. In the past years, a single breach of fluoride arose; the last time fluoride regularly exceeded the ERM target value was in 2011: then, this applied to 34% of the measurements at Liège. The drinking water companies are delighted that the contaminations have been reduced, partly through reuse of the substances. They hope that this positive trend continues and that all emissions finally come below the ERM target value. Société de Prayon has made known that, in the future, it plans to reduce the discharges of DIPE and TBP by means of an additional purification step.

Other industrial substances and consumer products

Sulfamic acid (CASRN 5329-14-6)

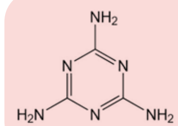


Application: Sulfamic acid is an ingredient of many acidic cleaning agents for the removal of deposits: limescale deposit in coffee machines and on chrome or stainless steel in places such as milking sheds and breweries, in steam boilers, cement residue on tiles and urine scale on sanitary ware. Sulfamic acid is also used in the synthesis of artificial sweeteners (cyclamic acid and sodium cyclamate).

Origin: The use of cleaning agents in both industry and households probably leads to the concentrations observed.

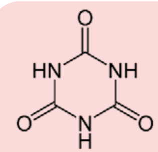
Distribution of contamination: Sulfamic acid was detected far above the ERM target value in all measurements at Roosteren, Heel, Brakel, Bergsche Maas and Haringvliet.

Melamine (CASRN 108-78-1)



PMT-score 0,64
(P=0,53 | M=0,80 | T=0,61)

Cyanuric acid (CASRN 108-80-5)



Application: Melamine is a synthetic substance mainly used in the production of plastics [source: RIVM]. Under high pressure (>7 MPa) and a temperature over 370°C, isocyanic acid is formed, yielding cyanuric acid via an exothermic reaction. The cyanuric acid condenses with ammonia into melamine and water. Finally, the liquid melamine cools into the intended end product: a white crystalline powder.

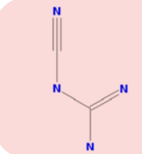
Melamine is formed from urea, with ammonia and carbon dioxide as byproducts [source: Melamine and cyanuric acid. Potential commercial discharges in the Netherlands, Arcadis 2019]. Melamine plastics are strong, hard, light and resistant to strong acids among other things. Consumer products into which melamine is processed include plastic plates, cups, dishes and cutlery, and also miracle sponges as they are known. The Dutch Food and Consumer Product Safety Authority (NVWA) recommends no longer using crockery made from bamboo with melamine plastic, such as coffee cups and bowls (source: NOS).

Origin: In 1964, DSM built the first melamine factory on the site that is now known as Chemelot, a large industrial complex for the chemicals industry between Stein and Geleen, in the Dutch province of Limburg. OCI Nitrogen has a melamine factory on the Chemelot Industrial Park. It is the only production location of melamine in the Netherlands and it makes products with names such as Melamine-byOCI™ and Melafine®. OCI Nitrogen is by far the largest production site for melamine in the world.

Distribution of contamination: Melamine was detected above the ERM target value at Liège, Roosteren, Heel, Brakel, Heusden, Keizersveer, Bergsche Maas and Haringvliet. Cyanuric acid was detected above the ERM target value at Eijsden, Roosteren, Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet. Melamine has an indicative drinking water target value of 0.28 µM. This value applies to the sum of melamine, melem and melam. This value takes account of the simultaneous presence of cyanuric acid. If it has been demonstrated that the concentration of cyanuric acid is below 10 µg/L (0.08 µM), a drinking water target value of 2.0 µM applies for the sum of melamine, melem and melam. The values stated only apply if the concentration of cyanuric acid is lower than the sum of melamine, melem and melam.

Notable: To apparently elevate the protein percentage, melamine was added to baby milk powder in China, which attracted much media attention in 2008. The milk products were diluted with water and this can be masked by adding melamine. After ingestion into the body, melamine can be converted to compounds including isocyanic acid via hydrolysis. Melamine and isocyanic acid can then form insoluble complexes, leading to the formation of crystals and finally kidney stones, possible obstruction and damage to the renal tissue as a result. Kidney problems arose in the cases of illness and even death in China, probably due to the formation of kidney stones.

Cyanoguanidine (CASRN 461-58-5)



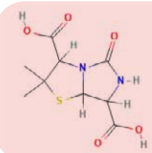
PMT-score 0,30
(P=0,09 | M=0,94 | T=0,33

Application: There are various known applications of cyanoguanidine or dicyandiamide. For example, it is a building block in the synthesis of plastics, fertilisers, pharmaceuticals and other technical chemicals. There are also applications known such as fertiliser, explosive and as substitute for fire extinguisher systems based on halon.

Origin: Unknown.

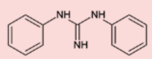
Distribution of contamination: Cyanoguanidine was detected above the ERM target value at Eijsden and Keizersveer.

8-Hydroxypenillic acid (CASRN 3053-85-8)



Application/Origin: 8-Hydroxypenillic acid was used in the past as an additive in the purification process of Sitech's IAZI (industrial wastewater treatment plant) in Sittard/Geleen (source: RIVM-VSP advisory report 14623A00). The RIVM categorises this substance as a medication or veterinary medication (source: https://rvszoeksysteem.rivm.nl/stof/detail/5206].

Distribution of contamination: 8-Hydroxypenillic acid was detected above the ERM target value at Bergsche Maas and Haringvliet. The indicative drinking water target value for this substance is 10 µg/L.



1,3-Diphenylguanidine (CASRN 102-06-7)

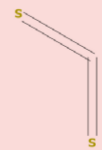
Application: 1,3-Diphenylguanidine is used as primary and secondary catalyst in the vulcanisation of rubber. It also serves as catalyst in the synthesis of sulphur-containing compounds, such as thiols, thiazoles, sulphonamides and thiurams.
Origin: Unknown
Distribution of contamination: 1,3-diphenylguanidine was detected above the ERM target value at Bergsche Maas.

MTBE (CASRN 1634-04-4)

PMT-score 0,42
(P=0,17 | M=0,61 | T=0,74)

Application: MTBE (methyl tert-butyl ether) is added to petrol as a lead substitute and to improve the combustion. The Netherlands is the largest producer of MTBE in Europe.
Origin: Container ships that do not keep to the guideline for MTBE/ ETBE transport on inland waterways, leaks from and during filling of petrol vehicles and vessels.
Distribution of contamination: MTBE was detected above the ERM target value at Heusden and Brakel. The indicative drinking water target value for MTBE is 9,420 µg/L. The odour threshold is around 10-15 µg/L.
Notable: Years ago, peaks of MTBE arose frequently in the Meuse. The reduction in the peaks in the years after 2008 is due to:

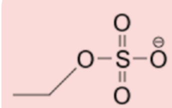
- the remediation of the MTBE contamination in Limburg that resulted from leakage from an underground pipe belonging to Sabic on the port site in Stein, and
- the publication of the guideline for MTBE/ETBE transport on inland waterways from the European Fuel Oxygenates Association (EFOA). The EFOA is the European sector organisation of producers of MTBE and ETBE. The purpose of this Code of Best Practice is to minimise the residual amount of vapour and liquid that arises during the transport of MTBE and ETBE to reduce the risk of release into the water.



Carbon disulfide (CASRN 75-15-0)

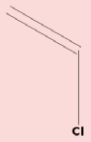
PMT-score 0,29
(P=0,08 | M=0,55 | T=0,56)

Application: Carbon disulfide is mainly used in the synthesis of organosulfur compounds and in the production of viscose.
Origin: Unknown.
Distribution of contamination: Carbon disulfide was detected above the ERM target value at Namêche and Liège.



Ethyl hydrogen sulfate (CASRN 540-82-9)

Application: Ethyl hydrogen sulfate, also known as sulfovinic acid and ethyl sulfate, is an organic chemical compound that is used as intermediate product in the production of ethanol from ethylene. It is the ethyl ester of sulfuric acid.
Origin: Unknown.
Distribution of contamination: Ethyl hydrogen sulfate was detected at a concentration equal to the ERM target value at Roosteren.



Chloroethene (CASRN 75-01-4)

PMT-score 0,40

(P=0,13 | M=0,60 | T=0,86)

Application: Chloroethene or vinyl chloride is the monomer of polyvinyl chloride (PVC), a widely used thermoplastic polymer.
Origin: Unknown.
Distribution of contamination: Chloroethene was detected above the ERM target value at Namêche and Eijsden.

3-Chloropropene (CASRN 107-05-1)

PMT-score 0,40

(P=0,14 | M=0,56 | T=0,86)

Application: 3-Chloropropene or allyl chloride is almost exclusively used as an intermediate product in chemistry, including for the production of epichlorohydrin (an important raw material for epoxy resins), and in the synthesis of pesticides and pharmaceutical products.
Origin: Unknown.
Distribution of contamination: 3-Chloropropene was detected above the ERM target value at Keizersveer.

Substances with a drinking water standard

There are a number of substances that have an ERM target value, and also a drinking water standard. In the past, we did not report about these substances, because the ERM target value is intended for substances without a drinking water standard. An exception is the category of crop protection products, biocides and their metabolites. These substances are tested against the ERM target value, which is equal to the standard for drinking water, and in the Netherlands also equal to the standard for surface water from which drinking water is made. From now on, all substances will be tested against their ERM target value, even if they have a drinking water standard. In 2022, breaches of the ERM target values took place for:

- chlorinated hydrocarbons: 1,2-dichloroethane, trichloroethene (TRI), sum of tetra- and trichloroethene
- trihalomethanes: dibromochloromethane, tribromomethane
- methyl benzene.

Residues of pharmaceuticals and endocrine-disrupting chemicals

In 2022, 79 parameters exceeded the ERM target values one or more times. Of these cases, 21.7% concerned pharmaceuticals and endocrine-disrupting chemicals (23). Of the 1,308 measurements that were done for these 23 substances, 232 (17.7%) exceeded the ERM target value.

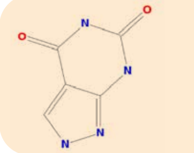
Table 5: Residues of pharmaceuticals and endocrine-disrupting chemicals that exceeded the ERM target value in 2022 (maximum concentrations)

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Residues of pharmaceuticals and endocrine-disrupting chemicals																232	1308	17,7%
Oxypurinol	2465-59-0	0,1	µg/l								1,62					13	13	100,0%
Valsartan acid	164265-78-5	0,1	µg/l					0,22		0,36	0,41			0,55	0,38	36	55	65,5%
Vigabatrin	60643-86-9	0,1	µg/l					1,4		0,8				0,69	0,59	21	42	50,0%
Lamotrigine	84057-84-1	0,1	µg/l		0,11	0,12		0,14		0,13	0,14			0,18	0,15	32	73	43,8%
Guanylurea	141-83-3	1	µg/l				1,04	2		1,5	0,54		1,82	3	1,8	24	72	33,3%
(anti)AR-CALUX® (in flutamide-equivalents)		4,8	µg/l							18,21	53,28	3,43				6	18	33,3%
2-Hydroxyibuprofen	51146-55-5	0,1	µg/l				0,19						0,11			3	9	33,3%
Metformin	657-24-9	1	µg/l		1,75	1,85	1,85	2,7		1,4	0,56		1,02	0,85	0,88	26	88	29,5%
4-Formylaminoantipyrine	1672-58-8	0,1	µg/l					0,01		0,02	0,09			0,11	0,26	14	55	25,5%
Candesartan	139481-59-7	0,1	µg/l					0,01		0,02	0,09			0,12	0,2	10	55	18,2%
Tributyltin cation	36643-28-4	0,1	µg/l				0,04		0,09	0,15	0,19		0,15	0,10	0,07	15	90	16,7%
4-Acetamidoantipyrine	83-15-8	0,1	µg/l					0,02		0,05	0,07			0,08	0,19	8	55	14,5%
Tramadol	27203-92-5	0,1	µg/l		0,16	0,20		0,11		0,09	0,05			0,09	0,03	10	73	13,7%
Sitagliptin	486460-32-6	0,1	µg/l					0,03		0,03	0,04			0,08	0,12	2	55	3,6%
Diclofenac	15307-86-5	0,1	µg/l		0,34	0,40		0,02		0,03	0,01			0,06	0,07	2	69	2,9%
Ibuprofen	15687-27-1	0,1	µg/l		0,18	0,30		<0.1		<0.1	<0.02			<0.1	<0.1	2	69	2,9%
Naproxen	22204-53-1	0,1	µg/l		0,3	0,35		0,02		0,02	<0.01			0,02	0,01	2	69	2,9%
Metoprolol acid	56392-14-4	0,1	µg/l					0,04		0,06				0,10	0,06	1	42	2,4%
Fexofenadine	83799-24-0	0,1	µg/l					0,03		0,06				0,12	0,04	1	42	2,4%
Furosemide	54-31-9	0,1	µg/l					0,012		0,02	<0.01			0,21	0,01	1	55	1,8%
Irbesartan	138402-11-6	0,1	µg/l					0,05		0,11	0,02			0,08	0,04	1	55	1,8%
Telmisartan	144701-48-4	0,1	µg/l		0,07	0,06		0,05		0,05	0,04			0,11	0,05	1	73	1,4%
Metoprolol	37350-58-6	0,1	µg/l		<0.03	<0.03		0,01		0,04	0,04			0,1	0,07	1	81	1,2%

ERM-tv = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Liège, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, BRA = Brakel, HEU = Heusden, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.

In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of measurements

Oxypurinol (CASRN 2465-59-0)



PMT-score 0,26

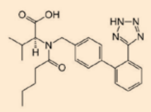
(P=0,10 | M=0,52 | T=0,33)

Application: Oxypurinol is a metabolite of allopurinol, which inhibits the formation of uric acid by inhibiting the enzyme xanthine oxidase. Allopurinol prevents the body converting purine into uric acid. Purine arises in certain foodstuffs, and the body produces it as well. In this way, allopurinol reduces the amount of uric acid in the blood. Doctors prescribe allopurinol for gout, kidney stones, kidney diseases and cancer. It is also used for certain metabolic conditions in which too much uric acid is produced. Allopurinol (Zyloric®), with 24,428,800 DDD, was at position 76 in the top 100 of the most prescribed medications in the Netherlands in 2021 [source: gipdatabank.nl].

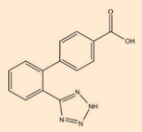
Origin: Allopurinol is converted rapidly (in two hours) into its active metabolite oxypurinol. The half life of this substance is 18 to 30 hours, which means that the effectiveness of allopurinol largely arises via its conversion product. Oxypurinol is excreted by the body and ends up in the surface water via sewerage systems.

Distribution of contamination: Oxypurinol exceeded the ERM target value 13 times in the 13 measurements at Brakel. Oxypurinol has an indicative drinking water target value of 8 µg/L.

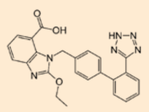
Medications for cardiovascular diseases (AIIRAs and beta blockers)



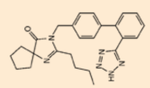
Valsartan (CASRN 137862-53-4)



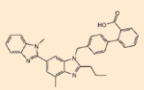
Valsartan acid (CASRN 164265-78-5)



Candesartan (CASRN 139481-59-7)



Irbesartan (CASRN 138402-11-6)



Telmisartan (CASRN 144701-48-4)

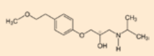
Application: Valsartan, candesartan, irbesartan and telmisartan are medications in the category angiotensin II receptor antagonists (AIIRAs). They inhibit the action of a hormone in the blood that contracts the blood vessels and raises the blood pressure. They are prescribed for high blood pressure, heart failure and after a cardiac infarct. In 2021, valsartan was in positions 70 (Diovan®, 27,029,600 DDD), 168 (Entresto® with sacubitril, 4,440,400 DDD), 188 (Codiovan® with diuretics, 6,050,300 DDD), 289 (Exforge® with amlodipine, 2,647,000 DDD) and 289 (Exforge HCT® with amlodipine and hydrochlorothiazide, 2,460,000 DDD) in the top 500 of the most-prescribed medications in the Netherlands [source: gipdatabank.nl]. In 2021, candesartan appeared twice in the top 500 of the most prescribed medications in the Netherlands: at number 29 with 67,614,500 (Atacand®) and at number 219 with 4,747,100 DDD (Atacand plus® with diuretics). In 2021, irbesartan appeared twice in the top 100 of the most prescribed medications in the Netherlands: at number 31 with 65,138,300 (Aprovel®) and at number 88 with 18,843,300 DDD (Coaprovel® with diuretics). In 2021, telmisartan appeared twice in the top 500 of the most prescribed medications in the Netherlands: at number 78 with 22,099,400 (Micardis®) and at number 203 with 5,378,800 DDD (Micardis plus® with diuretics).

Origin: After being administered, these substances are excreted by the body and end up in the surface water via sewerage systems.

Distribution of contamination: The breakdown product of valsartan, valsartan acid, exceeded the ERM target value in measurements at Roosteren, Heel, Brakel, Bergsche Maas and Haringvliet. Candesartan was detected in amounts above the ERM target value at Bergsche Maas and Haringvliet. Irbesartan equalled the ERM target value once in one measurement at Heel. Telmisartan was detected over the ERM target value once at Bergsche Maas.

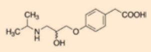
Notable: Valsartan was in the news in 2017 and 2018 thanks to large-scale recalls of medication by pharmacists worldwide. Blood pressure-lowering drugs in the sartans group contained elevated concentrations of carcinogenic nitrosamines, including N-nitrosodimethylamine (NDMA) and N-nitrosodiethylamine (NDEA). After this discovery, a study was initiated immediately to investigate the cause of the presence of this contaminant. This study led to the recommendation to permit no measurable quantity of nitrosamines in sartans.

Metoprolol (CASRN 37350-58-6)



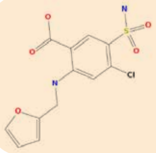
PMT-score 0,48
(P=0,26 | M=0,76 | T=0,56)

Metoprolol acid (CASRN 56392-14-4)



Application: Metoprolol is a beta blocker, a pharmaceutical with a beneficial effect on perfusion, cardiac rhythm disorders and high blood pressure. Metoprolol acid is a metabolite of metoprolol, but may also be an impurity of atenolol. In 2021, metoprolol appeared twice in the top 500 of the most prescribed medications in the Netherlands: at number 12 with 159,881,400 (Selokeen®) and at number 182 with 6,321,000 DDD (Selokomb® with thiazides).
Origin: After being administered, these substances are excreted by the body and end up in the surface water via sewerage systems.
Distribution of contamination: Metoprolol equalled the ERM target value once in one measurement at Haringvliet. Metoprolol acid exceeded the ERM target value once at Bergsche Maas.
Notable: Concentrations of metoprolol exceeded the ERM target value most recently in 2019: this happened four times at Keizersveer with a maximum of 0.2 µg/L. Before this, in 2016 there was only a single breach of the ERM target value, at monitoring points Heel (0.12 µg/L) and Stellendam (2 µg/L).

Furosemide (CASRN 54-31-9)

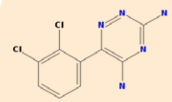


PMT-score 0,52
(P=0,57 | M=0,60 | T=0,42)

Application: Furosemide is a diuretic (a water pill) that has applications including the treatment of oedema in heart failure, liver cirrhosis, kidney failure and nephrotic syndrome. Furosemide is also used as a blood pressure-lowering agent. At a very low dosage, furosemide is also prescribed to control premenstrual syndrome. In 2021, furosemide was at position 26 in the top 100 of the most prescribed medications in the Netherlands with 77,563,800 DDD (Lasix®).
Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: Furosemide just exceeded the ERM target value once at Bergsche Maas.

Medications for epilepsy and depression

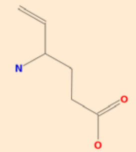
Lamotrigine (CASRN 84057-84-1)



PMT-score 0,64
(P=0,77 | M=0,47 | T=0,74)

Application: Lamotrigine is a substance that brings overstimulated nerves in the brain to rest in epilepsy and manic depression (bipolar disorder). Sometimes also in neuralgia, in post-traumatic stress disorder (PTSD), in complex regional pain syndrome (CPRS, also called post-traumatic dystrophy), singultus (hiccups), muscle cramps and in the treatment of breast cancer to combat hot flushes. In 2021, Lamotrigine was at position 183 in the top 500 of the most prescribed medications in the Netherlands with 6,306,100 DDD (Lamictal®).

Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: Lamotrigine was detected at the ERM target value at Namêche, Liège, Roosteren, Heel, Brakel, Bergsche Maas and Haringvliet.

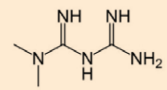


Vigabitrin (CASRN 60643-86-9)

PMT-score 0,18
(P=0,03 | M=0,89 | T=0,18)

Application: Vigabitrin is a substance that brings overstimulated nerves in the brain to rest in epilepsy. It is one of the last therapeutic options, because it is less safe and is less well tolerated than other antiepileptic drugs (source: Farmacotherapeutisch Kompas).
Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: Vigabitrin was detected above the ERM target value at Roosteren, Heel, Bergsche Maas and Haringvliet.

Antidiabetic drugs



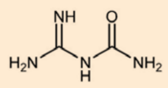
Metformin (CASRN 657-24-9)

PMT-score 0,33
(P=0,12 | M=0,96 | T=0,34)

Application: Metformin is an antidiabetic drug, a medication to lower the blood sugar. It belongs to the most-produced drugs in the world as regards production volume [Scheurer et al., 2009]. Doctors prescribe metformin not only for diabetes mellitus but sometimes also for reduced fertility caused by a deformity of the ovaries (Polycystic Ovary Syndrome, PCOS). In Belgium, 38 medications with this active substance are approved [source: fagg-afmps.be]. In 2021, metformin, with a total of 160,266,000 DDD[13] (Glucient®), stood in the 11th place of most-prescribed medications in the Netherlands [source: gipdatabank.nl]. Metformin is also present at position 344 (Janumet® with sitagliptin, 1,517,100 DDD) and 376 (Eucreas® with vildagliptin, 1,095,000 DDD). Metformin is not available over the counter.
Origin: After being administered, these substances are excreted by the body and end up in the surface water via sewerage systems.
Distribution of contamination: Metformin was detected above the ERM target value in 2022 at the measurement points Namêche, Liège, Roosteren and Heel. The indicative drinking water target value for metformin is 196 µg/L.
Notable: The primary breakdown product of metformin is guanylurea, which is not broken down further by bacteria or under the influence of light in aerobic conditions [Trautwein and Kümmerer, 2011 in Derksen and Ter Laak, 2013].

13 *defined daily dose*

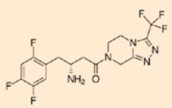
Guanylurea (CASRN 141-83-3)



PMT-score 0,29
(P=0,10 | M=0,78 | T=0,33)

Application: Guanylurea is a breakdown product of metformin.
Origin: Metformin introduced into surface water breaks down into guanylurea, after which no further breakdown happens. Guanylurea is indeed well broken down by passage through soil.
Distribution of contamination: Guanylurea was detected above the ERM target value in 2022 at the monitoring points Roosteren, Stevensweert, Heusden, Keizersveer and Bergsche Maas. Guanylurea has an indicative drinking water target value of 22.5 µg/L.
Notable: The breakdown product guanylurea has a lower indicative drinking water target value than the parent substance metformin.

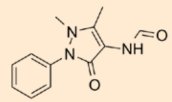
Sitagliptin (CASRN 486460-32-6)



Application: Sitagliptin reduces the blood sugar level. It is one of the DPP-4 inhibitors. These ensure that the level of insulin after a meal is at a better level and that the body produces less sugar. Doctors prescribe it for diabetes mellitus. In 2021, sitagliptin, with a total of 8,079,400 DDD (Januvia®), stood in the 160th place of most-prescribed medications in the Netherlands [source: gipdatabank.nl]. Sitagliptin is also present at position 344 (Janumet® with metformin, 1,517,100 DDD).
Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: Sitagliptin was detected above the ERM target value in 2022 at Haringvliet.

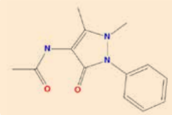
Analgetics

4-Formylaminoantipyrine (FAA, CASRN 1672-58-8)



PMT-score 0,46
(P=0,24 | M=0,68 | T=0,61)

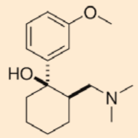
4-Acetamidoantipyrine (AAA, CASRN 83-15-8)



PMT-score 0,48
(P=0,26 | M=0,70 | T=0,61)

Application: 4-Formylaminoantipyrine (FAA) and 4-Acetamidoantipyrine (AAA) are metabolites of antipyrene, a medication with analgesic and antipyretic effects, also known as phenazone. Phenazone was synthesised for the first time by Ludwig Knorr in 1887 and used as an analgetic and fever-reducing medication. Phenazone is now only seldom used for the treatment of pain and fever. It is however frequently used in the testing of the effects of other medications or illnesses in the medication-degrading enzymes in the liver.
Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: FAA exceeded the ERM target value in measurements at Bergsche Maas and Haringvliet, while AAA was only detected in breach at Haringvliet. AAA has an indicative drinking water target value of 10 µg/L.

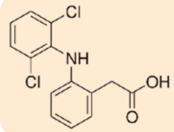
Tramadol (CASRN 27203-92-5)



PMT-score 0,38
(P=0,67 | M=0,51 | T=0,17)

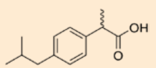
Application: Tramadol is a medium to strong analgesic that is prescribed for sudden or long-term severe pain, such as after injury, surgery or due to cancer, and also for neuralgia and joint pain caused by osteoarthritis. It can also help in premature ejaculation, if other medicines do not work [source: apotheek.nl]. Tramadol is a morphine-like synthetic opioid, but does not come under the Opium Act. In 2021, tramadol appeared twice in the top 200 of the most prescribed medications in the Netherlands: at number 132 with 11,374,000 DDD (Tramagetic®) and at number 177 with 7,195,600 DDD (Zaldiar® with paracetamol).
Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: Tramadol exceeded the ERM target value at Namêche, Liège and Roosteren.
Notable: In recent years, the substance has appeared with some regularity in the sports news, and then mainly in connection with its large-scale use in competitive cycling.

Diclofenac (CASRN 15307-86-5)



PMT-score 0,48
(P=0,52 | M=0,40 | T=0,56)

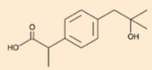
Application: Diclofenac is a non-steroidal inflammation inhibitor and analgetic belonging to the NSAID group of medications which is used to inhibit inflammation for example in arthritis or when pain or fever occurs. Diclofenac is one of the most prescribed painkillers. In 2021, diclofenac appeared twice in the top 500 of the most prescribed medications in the Netherlands: at number 65 with 29,128,600 DDD (Cataflam®) and at number 306 with 2,097,300 DDD (Arthrotec®). The low dose tablets may be obtained over the counter from the chemist in the Netherlands. In Belgium, only the emulgel and spray are available without prescription from the pharmacist; the tablets are only on doctor's prescription. The medicine is available on prescription as an injection and as a topical gel.
Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: Diclofenac exceeded the ERM target value at Namêche and Liège.
Notable: Since diclofenac's market introduction in the Indian subcontinent as a veterinary medicine in the 1990s, there have been many deaths of vultures. This has caused a number of vultures in the Indian subcontinent to reduce by 95% in 2003 and by no less than 99.9% in 2008. Dead cattle are left there on the land for the carrion eaters – Bengali vultures. When these birds eat the cadavers, they are poisoned by the accumulated diclofenac and die of kidney failure. In India there has been a total prohibition of this product since 2010, but since the EU licensed diclofenac as a veterinary medicine in Europe, we see the same consequences here. In Spain, between 2000 and 2010, 2,355 red and black kites, 2,146 griffon vultures, 638 cinereous vultures, 348 Egyptian vultures, 114 Spanish imperial eagles and 40 lammergeiers were found dead.



Ibuprofen (CASRN 15687-27-1)

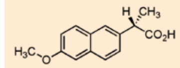
PMT-score 0,20

(P=0,10 | M=0,44 | T=0,17)



2-Hydroxyibuprofen (CASRN 51146-55-5)

Application: Ibuprofen (chemical name: iso-butyl-propanoic-phenylic acid) is an analgetic that belongs to the group of non-steroidal anti-inflammatory drugs (NSAIDs). It acts as an inflammation inhibitor, analgetic and fever reducer; the action is similar to that of acetylsalicylic acid. The medicine was developed by the research department of the pharmaceutical firm Boots in the United Kingdom and was approved in 1969. It is sold under different brand names including Advil, Brufen, Dolofin, Ibruphar, Motrin, Nuprin and Nurofen, as well as the generic name ibuprofen. The patent on the medicine has lapsed in the meantime. In 2021, ibuprofen was at position 145 in the top 500 of the most prescribed medications in the Netherlands with 10,128,500 DDD (Brufen®).
2-Hydroxyibuprofen is a metabolite of ibuprofen.
Origin: After being administered, this substance is excreted by the body and ends up in the surface water via sewerage systems.
Distribution of contamination: Ibuprofen exceeded the ERM target value at Namêche and Liège, while 2-hydroxyibuprofen exceeded this value at Eijsden and Keizersveer.



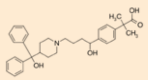
Naproxen (CASRN 22204-53-1)

PMT-score 0,32

(P=0,11 | M=0,51 | T=0,56)

Application: Naproxen is an inflammation-inhibiting painkiller. This type of painkiller is also called the NSAIDs. Its action is analgesic, anti-inflammatory and fever-reducing. It should be used for pain where inflammation is also present, such as in joint pain. Also in inflammations of the joints such as rheumatoid arthritis, Bechterew's disease and gout. And further for colic, headache, migraine and menstruation symptoms, such as abnormal vaginal blood loss. It is also sometimes used for painful, stiff and worn joints (arthrosis), muscle pain and symptoms due to flu or colds [source: apotheek.nl]. Naproxen, with 37,356,000 DDD, was at position 53 in the top 100 of the most prescribed medications in the Netherlands in 2021 [source: gipdatabank.nl]. Naproxen has been on the market internationally since 1973. It is available under the brand name Aleve and as the generic Naproxen, Naproxenum and Naproxennatrium in tablets and suppositories. Small packages of naproxen tablets in the strengths 220 mg and 275 mg (no more than 12 tablets) are available over the counter from the pharmacist or chemist. Larger packages of these strengths and tablets of 550 mg are available over the counter only from the pharmacist [source: apotheek.nl].
Origin: After administration, this substance is excreted by the body, and finds its way into the surface water via sewerage systems.
Distribution of contamination: Naproxen was detected above the ERM target value at Keizersveer and Haringvliet.

Antihistamine



Fexofenadine (CASRN 83799-24-0)

PMT-score 0,56
(P=0,75 | M=0,69 | T=0,33)

Application: Fexofenadine is a medication to combat allergy. Doctors prescribe it for various forms of allergy, such as hay fever, long-term inflammation of the nasal mucosa, inflamed eyes due to allergy, urticaria and itching. In 2021, fexofenadine was at position 81 in the top 100 of the most prescribed medications in the Netherlands with 21,709,900 DDD [source: gipdatabank.nl].
Origin: After administration, this substance is excreted by the body, and finds its way into the surface water via sewerage systems.
Distribution of contamination: Fexofenadine exceeded the ERM target value once at Bergsche Maas.

Endocrine-disrupting chemicals

(anti)AR-CALUX®

Application: None.
Origin: CALUX® assays form a family of bioassays that make use of human or mammalian cells. They are genetically modified such that they produce light as a reaction to exposure to substances that induce a specific effect. A reporter gene (luciferase) is then transcribed into the cell nucleus and translated into an enzyme that produces light after administration of its substrate, luciferin. The amount of light produced is proportional to the activity of the substances to which the cells have been exposed and it is quantified in a luminometer. The AR-CALUX® measures the activation of the androgen[14] receptor. It is known of many substances, particularly PCBs, that they in fact block this receptor (antagonistic binding). This is why this assay is used in the antagonistic mode (anti)AR-CALUX®.
Distribution of contamination: The (anti)AR-CALUX® measurements exceeded the ERM target value at Heel and Brakel.

Tributyltin cation

Application: Tributyltin (TBT) is an overarching term for a class of organotin compounds that contain the $(C_4H_9)_3Sn$ group. Tributyltin compounds are biocides. The antifouling properties of TBT were discovered in the Netherlands in the 1950s. It prevents micro-organisms growing on the hulls of vessels and poisons any organisms that do this. By halfway through the 1960s it had become the most popular antifouling paint in the world. TBT was mixed into paint to extend the service life of antifouling coatings, and vessels could continue with their activities for longer. The paint ensured low fuel consumption and postponed costly ship's repairs. TBT is also an ingredient in wood preservatives, silicone sealant, roof covering membranes and textiles. TBT can also be use as a catalyst and stabiliser in the production of plastics.
Origin: The TBT leaches out slowly in a marine environment, where it is very toxic to non-target organisms. After it led to the collapse of local populations of organisms, TBT was prohibited.
Distribution of contamination: TBT was detected above the ERM target value at Heel, Brakel, Keizersveer and Bergsche Maas.

14 *male sex hormone*

Crop protection products, biocides and their metabolites

In 2022, 79 parameters exceeded the ERM target values one or more times. In 19% of cases (15 times), this concerned crop protection agents, biocides and metabolites. Of the 1,520 measurements that were done for these 15 substances, 252 (16.6%) exceeded the ERM target value.

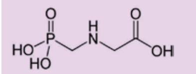
Table 6: Crop protection products, biocides and their metabolites that exceeded the ERM target values in 2022 (maximum concentrations)

Parameter	CASRN	ERM-	tv	TAI	NAM	LUI	EYS	ROO	STV	HEE	BRA	HEU	KEI	BSM	HAR	n/	N	%
Crop protection products, biocides and their metabolites																252	1520	16,6%
Aminomethylphosphonic acid (AMPA)	1066-51-9	0,1	µg/l	0,23	0,73	0,62	0,77	7,8	6	3,4	1,09	1,77	1,22	1,4	0,52	111	119	93,3%
Chloridazone-desphenyl	6339-19-1	0,1	µg/l		0,18	0,19		0,22		0,23	0,33	0,51		0,23	0,13	75	84	89,3%
S-Metolachlor	87392-12-9	0,1	µg/l								0,17	0,18				17	24	70,8%
Propamocarb	24579-73-5	0,1	µg/l					0,55		0,27		0,05		0,09	<0.05	29	268	10,8%
Metolachloor OA	152019-73-3	0,1	µg/l		<0.01	<0.01				<0.05	0,1	0,11		0,11	0,06	6	73	8,2%
Glyphosate	1071-83-6	0,1	µg/l	<0.05	0,15	0,15	<0.2	0,1	0,12	0,13	0,03	0,07	<0.2	0,08	0,03	5	119	4,2%
Fluopyram	658066-35-4	0,1	µg/l								0,16	0,04				1	26	3,8%
Dimethenamid-P	163515-14-8	0,1	µg/l				0,02	0,02		0,05	0,04		0,07	0,10	0,03	1	74	1,4%
2-(Methylthio)benzothiazole	615-22-5	0,1	µg/l		<0.02	0,02		0,03		<0.03	0,03	0,19		0,04	<0.03	1	75	1,3%
1,2-Dibromo-3-chloropropane	96-12-8	0,1	µg/l		<0.11	0,13		<0.05		<0.05				<0.05	<0.05	1	79	1,3%
N,N-Dimethylsulfamide (DMS)	3984-14-3	0,1	µg/l		<0.02	<0.02		<0.05		<0.05	0,07	0,07		0,05	0,32	1	84	1,2%
Thiabendazole	148-79-8	0,1	µg/l		1,46	0,06		<0.05		<0.05	<0.01	0,01		<0.05	<0.05	1	87	1,1%
Dimethenamid	87674-68-8	0,1	µg/l	0,03	<0.02	0,13					0,04	0,06				1	90	1,1%
2,4-Dichlorophenoxyacetic acid	94-75-7	0,1	µg/l	0,01	<0.03	<0.03	0,26	0,02	<0.05	0,03	0,02	0,03	<0.05	0,02	<0.02	1	153	0,7%
Metolachlor	51218-45-2	0,1	µg/l	0,02	0,05	0,12	0,01	0,03	0,06	0,07	0,06	0,03	0,02	0,02	0,02	1	165	0,6%

ERM-tv = ERM target value, TAI = Tailfer, NAM = Namêche, LUI = Liège, EYS = Eijsden, ROO = Roosteren, STV = Stevensweert, HEE = Heel, BRA = Brakel, HEU = Heusden, KEI = Keizersveer, BSM = Bergsche Maas, HAR = Haringvliet.

In the table, the highest-measured value is presented if the parameter exceeded the ERM target value, where n is the number of breaches and N is the number of measurements

Glyphosate (CASRN 1071-83-6)



PMT-score 0,25

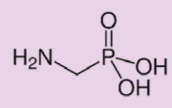
(P=0,05 | M=0,96 | T=0,34)

Application: Glyphosate is a herbicide (weedkiller).

Origin: Although the majority of the quantities sold are applied in agriculture, we know from practical investigations and monitoring programmes in the past that emissions of glyphosate into the Meuse mainly originate from sources outside agriculture, such as site management and in particular application to surfacing. This was confirmed by calculations of burdens of emissions that were conducted in 2010 for the Dutch part of the Meuse river basin: 1.5% of the burden comes from agricultural use and 98.5% via rainwater drains, overflows and effluents from wastewater treatment plants (RWZIs) [source: Klein et al., 2013].

Distribution of contamination: Glyphosate was detected above the ERM target value at the monitoring points Namêche, Liège, Roosteren, Stevensweert and Heel.

Notable: In 1994, the drinking water companies demonstrated the presence of the herbicide glyphosate in the Dutch part of the Meuse for the first time, and from 1996, the ERM target value was exceeded every year. Particularly in the period 2002-2005, the average concentration of glyphosate in the Meuse Rose to above 0.1 µg/L. In 2021, the ERM target value – also the quality requirement in the Dutch Drinking Water Regulation and the Water Quality Requirements and Monitoring Decree (in Dutch, BKMW) – was exceeded in seven of the 126 measurements (5.6%) at the monitoring points along the Meuse. The ERM target value has no longer been exceeded at Tailfer for years, which means that very little glyphosate from France ends up in the Meuse. In 2018, an exemption was granted to WML and Evides to allow them to continue to use surface water containing glyphosate at Heel and Keizersveer (Gat van de Kerksloot) for the production of drinking water.

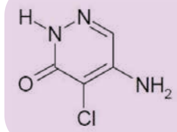


Aminomethylphosphonic acid (CASRN 1066-51-9)

PMT-score 0,30
(P=0,10 | M=0,84 | T=0,33)

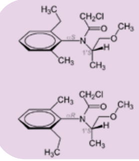
Application: None.
Origin: Aminomethylphosphonic acid (AMPA) is a metabolite of glyphosate or ATMP. In a monitoring programme in 2010, a major source of AMPA was discovered that did not have its source in the use of glyphosate. High concentrations of AMPA were measured in the Ur tributary, which flows into the Grensmaas (Border Meuse) at Stein. The AMPA in the water of the Ur tributary is a breakdown product of ATMP (aminotrismethylenephosphonic acid) which is added to cooling water on the nearby Chemelot chemistry industrial estate. The majority of the AMPA burden increase between Eijsden and Keizersveer in 2010 could however be explained by the use of glyphosate and mainly outside agriculture.
Distribution of contamination: AMPA was detected at above the ERM target value at all monitoring points. The Dutch government considers AMPA to be a metabolite of a crop protection agent toxicologically irrelevant to humans. Since 2011, the Dutch government has applied a standard for metabolites toxicologically irrelevant to humans of 1 µg/L for the raw material for the production of drinking water [Dutch Drinking Water Regulation 2011]. Since 2020, a list of metabolites of crop protection agents toxicologically irrelevant to humans and their standards has been available [source: https://rvszoeksysteem.rivm.nl/Stoffen]. The value of 1 µg/L was exceeded in 2022 at the monitoring points Roosteren, Stevensweert, Heel, Brakel, Heusden, Keizersveer and Bergsche Maas.
Notable: On average in 2010, the Ur tributary accounted for 34% of the AMPA burden increase between Eijsden and Keizersveer [Volz, 2011]. An exemption was temporarily granted to WML (2017), Evides (2017) and Dunea (2018) to allow them to continue to use surface water containing AMPA at Heel, Brakel and Keizersveer (Gat van de Kerksloot) for the production of drinking water.

Chloridazon-desphenyl (CASRN 6339-19-1)



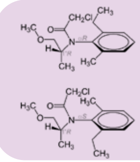
Application: Chloridazon-desphenyl is a metabolite of chloridazon (herbicide).
Origin: Weedkillers based on the active substance chloridazon have recently been prohibited in Belgium and the Netherlands.
Distribution of contamination: The metabolite chloridazon-desphenyl was detected above the ERM target value at Namêche, Liège, Roosteren, Heel, Brakel, Keizersveer, Bergsche Maas and Haringvliet. The Dutch government considers chloridazon desphenyl to be a metabolite of a crop protection agent toxicologically irrelevant to humans. Since 2011, the Dutch government has applied a standard for metabolites toxicologically irrelevant to humans of 1 µg/L for the raw material for the production of drinking water [Dutch Drinking Water Regulation 2011]. Since 2020, a list of metabolites of crop protection agents toxicologically irrelevant to humans and their standards has been available [source: https://rvszoeksysteem.rivm.nl/Stoffen]. The value of 1 µg/L was not exceeded in 2022.
Notable: Chloridazon-desphenyl is detected in groundwater in many North European countries.

Metolachlor (CASRN 51218-45-2)

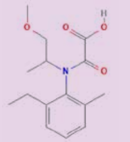


PMT-score 0,58
(P=0,60 | M=0,43 | T=0,74)

S-Metolachlor (CASRN 87392-12-9)



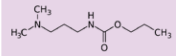
PMT-score 0,58
(P=0,60 | M=0,43 | T=0,74)



Metolachlor-OA (CASRN 152019-73-3)

Application: In both Belgium and the Netherlands, S-metolachlor (CASRN 87392-12-9) is approved as a herbicide in the cultivation of various fruit and vegetables. It is the active substance in the crop protection products Camix (NL, BE), CODAL (BE), Dual Gold 960 EC (NL, BE), EFICA 960 EC (NL, BE), Gardo Gold (NL, BE), GARDOPRIM (BE), LECAR (BE) and PRIMAGRAM GOLD (BE) (source: Ctgb.nl, Fytoweb.be]. Metolachlor OA, also called metolachlor oxanilic acid or metolachlor-C-metabolite, is a metabolite of (S-)metolachlor.
Origin: The drinking water companies' laboratory analysis methods present metolachlor as the racemic mixture of the R- and S-isomers[15]. Measurement results for both S-metolachlor and metolachlor should be considered as representative for S-metolachlor.
Distribution of contamination: (S-)Metolachlor was detected above the ERM target value at Liège, Brakel and Heusden. The concentration of the metabolite metolachlor-OA exceeded the ERM target value at Brakel, Heusden and Bergsche Maas. The Dutch government considers metolachlor-OA to be toxicologically irrelevant to humans. Since 2011, the Dutch government has applied a standard for metabolites toxicologically irrelevant to humans of 1 µg/L for the raw material for the production of drinking water [Dutch Drinking Water Regulation 2011]. Since 2020, a list of metabolites of crop protection products toxicologically irrelevant to humans and their standards has been available [source: https://rvszoeksysteem.rivm.nl/Stoffen]. The value of 1 µg/L was not exceeded.
Notable: Since 30 November 2002, the racemic mixture of metolachlor has been prohibited in the European Union (Regulation No. 2002/2076/EC). The active substance S-metolachlor[16] was added on 1 October 2005 to Annex I of Directive 91/414/EEC pursuant to Directive 2005/5/EC. The active substance was then approved in accordance with Regulation (EC) No. 1107/2009 by Implementing Regulation (EU) 540/2011. The term of the approval of the substance was extended until 31 July 2020 by Implementing Regulation (EU) 2019/707.

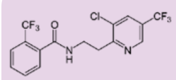
Propamocarb (CASRN 24579-73-5)



PMT-score 0,54
(P=0,36 | M=0,61 | T=0,74)

Application: Propamocarb is a fungicide that is used in agriculture in the cultivation of various vegetables, types of lettuce, tomatoes, potatoes and house plants, to combat false mildew, phytophthora and pythium. In Belgium, many crop protection products based on the active substance propamocarb are approved: AXIDOR, BORESO FLEX, CUROMIL 450 SC, DIPROSPERO, EDIPRO, INFINITO, MATIX, OMIX (DUO), POTAGOLD 687.5 SC, PREVICUR ENERGY, PROFO ENERGY, PROPLANT, PROXANIL (GARDEN), PROXSTORM, RIVAL (DUO), VSM FINITO and WOPRO ENERGY. In the Netherlands, only Budget Propamocarb-Fosetyl is approved.
Origin: See the section 'Example of a successfully detected incident' on page 35-37 of the Annual Report 2012 the Meuse.
Distribution of contamination: Propamocarb exceeded the ERM target value at Haringvliet.

Fluopyram (CASRN 658066-35-4)



Application: Fluopyram is approved in the Netherlands and Belgium in several crop protection products as a fungicide (to combat mould) and a nematicide (to combat roundworms including eelworms) in all kinds of arable crops, vegetables, fruit crops and floriculture crops [source: HWL factsheet]. These crop protection products are sold in Belgium and the Netherlands under the brand names Ascra Xpro

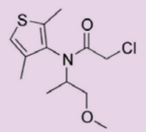
15 *The designations R- and S- are abbreviations of the Latin words rectus (right) and sinister (left).*
16 *The mixture of 80-100% S-metolachlor and 0-20% R-metolachlor*

(NL, BE), Bixazor Extra (BE), Caligula (BE), Exteris Stressgard (NL, BE), Inter Lunar (BE), Keynote Xpro (BE), Luna Care (NL, BE), Luna Experience (NL, BE), Luna Privilege (NL, BE), Luna Sensation (NL, BE), Luna Smart (BE), Moona Duo (BE), Propulse (NL, BE), Propyram 250 Se (BE), Recital (BE), Silvron Xpro (BE), Veldig Xpro (BE), Velum Prime (NL, BE), Verango (NL), Vsm Care (BE), Vsm Fluostrobine (BE) and Yearling (BE) [source: Ctgb.nl, Fytoweb.be].

Origin: It emerges from the monitoring data that fluopyram was mainly detected at high concentrations in the polder water at Brakel Pumping Station. Direct application in agriculture, fruit growing and floriculture is probably the main source of fluopyram in the polder water and indirectly the surface water [source: HWL factsheet].

Distribution of contamination: Fluopyram was detected above the ERM target value at Brakel.

Notable: Trifluoroacetic acid is one of the metabolites of fluopyram. Since 20 December 2022, fluopyram has been considered in the Netherlands as a potential substance of concern, given that it belongs to the PFAS group [source: RIVM].



Dimethenamid(-P) (CASRN 87674-68-8)

PMT-score 0,56

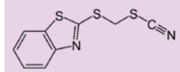
(P=0,58| M=0,50| T=0,61)

Application: Dimethenamid(-P) is a herbicide (weedkiller).

Origin: Based on Implementing Regulation (EU) 2019/1137, dimethenamid-P will remain on the list of approved active substances until 31 August 2034. In Belgium, the following crop protection products based on dimethenamid-P (CASRN 163515-14-8) are approved: Akris, Arundo, Butisan Gold, Frontier Elite, Grometa, Springbok and Tanaris [source: Fytoweb.be]. In the Netherlands, the following crop protection products based on dimethenamid-P are approved: Frontier Optima, Spectrum, Springbok, Tanaris, Wing P and WOPRO Uischoon [source: Ctgb.nl]. These crop protection products may be applied to many arable crops (vegetables, fruit etc.) and in floriculture in both countries. In the Netherlands, Frontier Optima may also be used on field verges and on temporarily uncultivated land.

Distribution of contamination: Dimethenamid was detected above the ERM target value once in 2022 at Liège (in 2021, once at Namêche).

Notable: The drinking water companies' laboratory analysis methods usually present dimethenamid as a mix of stereo-isomers; the S-isomer dimethenamid-P is reported only once.



2-(Methylthio)benzothiazole (CASRN 615-22-5)

PMT-score 0,27

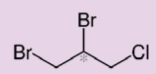
(P=0,16| M=0,38| T=0,33)

Application: None.

Origin: 2-(Methylthio)benzothiazole is a chemical compound in the thiazole group, which is formed as a breakdown product of the fungicide/biocide (benzothiazol-2-ylthio)methyl thiocyanate (TCMTB) or the vulcanisation accelerator mercaptobenzothiazole. 2-(Methylthio) benzothiazole is found in effluent from sewage treatment plants. Every year, several tonnes are released in Germany due to tyre wear. Crumb rubber possibly also plays a role. Field experiments have been conducted in Switzerland, in which test artificial grass fields and athletics tracks were laid down and exposed to the prevalent weather conditions to study the leaching behaviour of the crumb rubber. In this, precursors of 2-(methylthio)benzothiazole were released.

Distribution of contamination: 2-(Methylthio)benzothiazoleethylthio) benzothiazole was detected over the ERM target value once in 2022 at Heusden.

Notable: 2-(Methylthio)benzothiazole was detected at concentrations over the ERM target value in 2018 at Liège. This substance was also seen previously in screenings, including at Brakel (2014), Keizersveer (2012) and Liège (2011, 2010). In the project Broad Screening of Meuse River Basin of 2016, 2-(methylthio)benzothiazole was the most-detected substance in the surface water. This was ascribed to tyre wear.

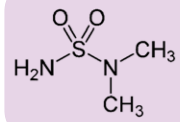


1,2-Dibromo-3-Chloropropane (DBCP, CASRN 96-12-8)

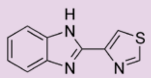
PMT-score 0,49
(P=0,30 | M=0,40| T=0,96)

Application: 1,2-Dibromo-3-Chloropropane or DBCP, put on to the market under the brand name Nemagon, is a pesticide that was applied on a large scale in the 1960s in the cultivation of bananas and sugar cane. Nemagon was developed to eliminate minuscule worms that lodge in the roots of the bananas, damage the plant and discolour the fruit. DBCP is used as an intermediate product in the synthesis of organic chemicals.
Origin: Unknown.
Distribution of contamination: DBCP was detected above the ERM target value once in 2022 at Liège.

N,N-Dimethylsulphamide (DMS, CASRN 3984-14-3)



Application: DMS (N,N-Dimethylsulfamide) is a breakdown product of tolylfluanid (CASRN 731-27-1), the active substance in a biocide against mould, which is used in products for wood preservation. The use of tolylfluanid as an anti-mould product for wood protection increased sharply in the late 1980s, being used to replace the newly-prohibited pentachlorophenol. As of 1 October 2011, tolylfluanid was included in Annex I of the Biocides Directive 98/8/EC (Directive 2009/151/EC). DMS is seen as a relevant metabolite, because when ozonisation is used to prepare drinking water, DMS is converted into the highly toxic NDMA. The toxicity of DMS itself was not the motivation to classify the substance as a relevant metabolite. The conversion of DMS into NDMA is an effect that occurs specifically through the use of ozone; other methods of disinfection and oxidation of drinking water do not show any formation of NDMA.
Origin: In the Netherlands, dichlofluanid is authorised as a dry film preservative (PT07) in Preventol A 4-S from Lanxess.
Distribution of contamination: DMS was detected at levels above the ERM target value at Haringvliet in 2022, probably because it is present in the Rhine. In 2019, DMS was detected above the ERM target value once in the Afgedamde Maas at Brakel.
Notable: Tolylfluanid was introduced in 1964 and was first used mainly as a fungicide in agriculture, the product Eupareen Multi being the best-known example. In April 2007, the authorisation of Eupareen Multi was temporarily withdrawn in the Netherlands, based on a decision of the European Commission (Decision 2007/322/EC). Since 13 April 2008, this authorisation has been definitively withdrawn. Dichlofluanid (CASRN 1085-98-9), an active substance that is used in antifouling paints for boats, has DMSA (CASRN 4710-17-2) as its primary metabolite. DMSA can be converted back into DMS in the soil or seabed.



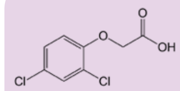
Thiabendazole (CASRN 148-79-8)

PMT-score 0,35

(P=0,18 | M=0,38| T=0,61)

Application: Thiabendazole is a biocide that is used against mould (fungicide) and parasites (parasiticide) and as a preservative (E233). Thiabendazole is used as medication to treat fungal infections and parasitic worms in humans and animals. Brand names include Mintezol and Tresaderm (for use in animals). It is sprayed on to citrus fruit and bananas to combat mould formation on the peel. Thiabendazole is approved in agriculture and horticulture in Belgium and the Netherlands under the brand name Tecto as a systemic fungicide for the protection of chicory and potatoes after harvesting. It is also effective as a biocide in products for wood protection.
Origin: Thiabendazole is probably mainly released during/after use of this substance as a biocide or preservative.
Distribution of contamination: Thiabendazole was detected above the ERM target value at Namêche.
Notable: In 2020 and 2018 (Namêche and Liège), 2017 (Liège), 2016 (Namêche and Liège) and 2014 (Brakel), this substance was also detected above the ERM target value.

2,4-Dichlorophenoxyacetic acid (CASRN 94-75-7)



PMT-score 0,45

(P=0,27 | M=0,54 | T=0,61)

Application: 2,4-Dichlorophenoxyacetic acid (2,4-D) is the active substance in a herbicide that was discovered in 1942 and came on to the market in 1944 (source: Wikipedia). The active substance 2,4-D was extended as of 1 January 2016 pursuant to Regulation (EC) No. 1107/2009 (Implementing Regulation (EU) 2015/2033 dated 13 November 2015). The approval of this active substance expires on 31 December 2030. 2,4-D is permitted in Belgium and the Netherlands as herbicide in the crop protection products Cirran (NL, BE), Compo Gazonmeststof plus onkruidbestrijder (NL), DARBY (BE), DICOPHAR SL (NL), Genoxone ZX (NL), LANDSCAPER PRO WEED CONTROL + FERTILIZER (BE), Mega 2,4-D (NL), Pokon Onkruid Weg! (NL), Roundup Gazon Onkruidvrij (NL), STAPLER (BE), Tri-But Turbo (NL), U 46 D Fluid (NL), U-46-D-500 (BE) and Weedex (NL).
Origin: 2,4-D is mainly used to control broad-leaved weeds in grain crops (such as barley and maize) and on grass fields and lawns.
Distribution of contamination: 2,4-D was detected over the ERM target value once in 2022 at Eijsden.
Notable: In 2021, 2,4-D was detected over the ERM target value once at Stevensweert and Heel. 2,4-D was detected over the ERM target value once in 2019 at Liège. In 2012, 2,4-D was detected above the ERM target value once at Keizersveer. Before that, 2,4-D last exceeded the ERM target value in 2008, namely three times at Keizersveer.

Annex 2

Results from WFD tests on drinking water

Transferred from the report: Condition of national waters as source for drinking water supply 2022 (Rijkswaterstaat).

Summary of the test results from the abstraction points and reference locations on the Meuse. The table presents the parameters that, at one or more abstraction points, exceeded the environmental quality standard (EQS) or taget value (TV) in the WFD Protocol for monitoring and testing drinking water sources. The drinking water target value (DWTV) is listed alongside. For the locations, the 90th percentile value (P90) is stated for each substance over the period 2019-2021 (the test value).

	CAS-nr.	Unit	EQS	TV	DWTV	EIJSDEN	HEEL	BRAKEL	HEUSDEN	BERGSCHE MAAS
Microbiological parameters										
Bacteria of the coli group (incubation at 37 °C) (cfu/100ml)		cfu/ 100ml	2000			48987 ▲	6407 ▲	283▼		3516 ▲
Crop protection products, biocides and their metabolites										
Aminomethylphosphonic acid (AMPA)	1066-51-9	µg/l		0,1		0.95 ▼	3.9 ▼	1.5 ■	2,2	1.6▼
Chloridazon-desphenyl	6339-19-1	µg/l		0,1			0.23 ▼	0.16▼		0.24 ▼
Metazachlor ethane sulfonic acid (ESA)	172960-62-2	µg/l		0,1				0,05		0.14 ■
Sum of crop protection products, biocides and their metabolites toxicologically relevant to humans		µg/l				0.51 ▼	0.27 ▼	0.30 ▼	0.36 ▼	0.38 ▼
Industrial chemicals										
1,4-dioxane	123-91-1	µg/l		0,1	3	0.56 ▼	0.23 ■	0.17 ▲	n.t.	0.23 ▼
Tolyltriazole	29878-31-7	µg/l		0,1	350A		0.43 ▼	0.46 ▼	0.70 ▼	0.62 ▼
5-Methyl-1H-benzotriazole	136-85-6	µg/l		0,1	350A		0.33 ■	0.19 ▲	0.39 ▲	0.36 ▲
1,2,3-Benzotriazole	95-14-7	µg/l		0,1	700		0.69 ▲	0.75 ▼	1,1	1.0 ▲
Bis(2-methoxyethyl) ether	111-96-6	µg/l		0,1	440		0.21 ▲	0.07 ■		0.13 ▼
Chlorate (ion)	14866-68-3	µg/l		0,1			n.t.	9		24
Cyanuric acid[B]	108-80-5	µg/l		0,1			2,1	n.t.		2
Dichlor-methanesulfonic acid	53638-45-2	µg/l		0,1			0,25	n.t.		0,28

	CAS-nr.	Unit	EQS	TV	DWTV	EIJSDEN	HEEL	BRAKEL	HEUSDEN	BERGSCHE MAAS
Industrial chemicals (continuation)										
Diethylenetriaminepentaacetic acid (DTPA)	67-43-6	µg/l		0,1	700	n.t.	n.t	4.9 ▲		2.7 ▼
Diisopropyl ether	108-20-3	µg/l		0,1	1400	5.7 ▼	1.1 ▲	0.022 ▼	0.71 ▼	0.50 ▼
Ethylenediaminetetraacetic acid (EDTA)	60-00-4	µg/l		0,1	600	8.2 ▼	9.6 ▼	18 ▼		28 ▼
2-Ethoxy-2-methylpropane (ETBE)	637-92-3	µg/l		0,1			0.081 ■	0.20 ▼		0.13 ▲
Hexa(methoxymethyl)melamine	68002-20-0	µg/l		0,1			0,081	0,26		0.22 ■
Melamine[B]	108-78-1	µmol/l		0,1	2B		0.017 ▼	0.019 ▼	0.022 ▼	0.022 ▼
Methenamine	100-97-0	µg/l		0,1	500		1.8 ▲	1.0 ▲		1.8 ▲
Methyl tert-butyl ether	1634-04-4	µg/l		0,1	9420	0.20 ▼	0.18 ▼	0.26 ▲	0.35 ■	0.28 ▲
Perchlorate	14797-73-0	µg/l		0,1			0,57			0,6
Sulfamic acid	5329-14-6	µg/l		0,1	1400		22	n.t.		38
Tetrahydrofuran	109-99-9	µg/l		0,1			0,038			0,15
Tributyl phosphate	126-73-8	µg/l		0,1	3500	1.2 ▼	0.30 ▼	0.10 ▼	0.25 ▼	0.21 ▼
Trichloroacetic acid	76-03-9	µg/l		0,1				0.17 ▲	0.35 ▲	0,3
Trifluoroacetic acid	76-05-1	µg/l		0,1				1.1 ▼		1.1 ▲
Trifluoromethanesulfonic acid	1493-13-6	µg/l		0,1			0,16	n.t.		0,19
Residues of pharmaceuticals and metabolites										
8-Hydroxypenillic acid	3053-85-8	µg/l		0,1	10					0,43
10,11-Dihydroxycarbamazepine	35079-97-1	µg/l		0,1				0,16		
Gabapentin	60142-96-3	µg/l		0,1	100		0.26 ▼	0.27 ▲		0.40 ■
Guanylurea	141-83-3	µg/l		0,1	22,5		1.9 ▲	0.61 ▼		n.t.
Metformin	657-24-9	µg/l		0,1	196		1.1 ■	0.61 ▼		0.91 ▲
Oxypurinol	2465-59-0	µg/l		0,1	8			1.2 ▲		
10,11-trans-Dihydroxy-10,11-dihydrocarbamazepine	58955-93-4	µg/l		0,1	50		0.13 ▼			0.22 ▼
Valsartan acid	164265-78-5	µg/l		0,1			0,076	0,38		0,17
Vigabatrin	60643-86-9	µg/l		0,1			0,76			0,55
X-ray contrast media										
Diatrizoic acid	117-96-4	µg/l		0,1	250000		0.033 ▲	00932 ▼		0.11 ▼
Iohexol	66108-95-0	µg/l		0,1	375000		0.19 ▼	0.15 ▲		n.t.
Iomeprol	78649-41-9	µg/l		0,1	1000000		0.27 ▼	0.30 ▼		0.37 ▼
Iopamidol	60166-93-0	µg/l		0,1	415000		<0.005 ▼	0.10 ▼		0.13 ▼
Iopromide	73334-07-3	µg/l		0,1	250000		0.21 ▼	0.15 ▼		0.22 ▼
Ioxitalamic acid	28179-44-4	µg/l		0,1	500000		0.70 ▲	0.0031 ▼		0.63 ▲

	CAS-nr.	Unit	EQS	TV	DWTV	EIJSDEN	HEEL	BRAKEL	HEUSDEN	BERGSCHE MAAS
Food additives										
Acesulfame K	55589-62-3	µg/l		0,1	3200			0.48 ▼	0.76 ▼	0.64 ▼
Caffeine	58-08-2	µg/l		0,1	1500		0.37 ▼			0.27 ■
Cyclamate	100-88-9	µg/l		0,1	2500			0.053 ▼	0.15 ▼	0.18 ▲
Saccharin	81-07-2	µg/l		0,1	1300			0.069 ▼	0.13 ▲	0.14 ▼
Sucralose	56038-13-2	µg/l		0,1	5000			3.6 ▲	3.2 ▼	4.4 ▼
Theobromine	83-67-0	µg/l		0,1			0,16			0,097

Explanation:

▲ *means that P90 has increased compared to 2017-2019 as presented in the River Dossier on Water Abstraction from the Meuse Implementation Programme 2022-2027.*

▼ *means that P90 has decreased compared to 2017-2019 as presented in the River Dossier on Water Abstraction from the Meuse Implementation Programme 2022-2027.*

■ *means that P90 is unchanged compared to 2017-2019 as presented in the River Dossier on Water Abstraction from the Meuse Implementation Programme 2022-2027.*

n.t. means 'not testable'. This assessment is given if many of the measurement values lie below the detection limit and the detection limit is above the warning threshold, or if the substance was measured fewer than 10 times in the past three monitoring years.

A This drinking water target is derived for the sum of 4-methyl-1H-benzotriazole and 5-methyl-1H-benzotriazole.

B At a cyanuric acid concentration of less than 10 µg/L, a drinking water target of 2 µM applies for the sum of melamine, melem and melam. If the concentration of cyanuric acid greater than 10 µg/L, a drinking water target value of 0.28 µM applies for the sum of melamine, melem and melam. At the abstraction points on the Meuse, the cyanuric acid concentration is less than 10 µg/L, so a drinking water target of 2 µM applies for the sum of melamine, melem and melam.

Transferred (amended) from: Background document to the River Basin Management Plan 2022-2027 for Drinking Water Source Protection from the Coordinating Committee for Integral Water Policy.

Table 8: Condition assessment (2018) for other substances in the priority surface water abstraction areas (red = condition poor, green = condition good, orange = at risk (75% of the test value)) (value = 90th percentile; under consideration here are only those substances for which there was a breach of the test value at at least one location) (source: water-link, VMM).

	Priority area Watercourse	Albert Canal
Parameter	Test value	
AMPA	1 µg/L	0.98
1H-benzotriazole	1 µg/L	2.12
5-Methyl-1H-Benzotriazole	1 µg/L	1.16
Bis(2-ethylhexyl) phthalate	1 µg/L	0.33
Chloridazon-desphenyl	1 µg/L	0.14
DIPA	1 µg/L	5.88
EDTA	1 µg/L	72.1
Gabapentin	1 µg/L	0.29
Hydrochlorothiazide	1 µg/L	0.00
Iopromide	1 µg/L	0.42
Metformin	1 µg/L	1.1
Metolachlor-ESA	1 µg/L	0.05
Tributyl phosphate	1 µg/L	0.88
Valsartan	1 µg/L	0.05
VIS-01	1 µg/L	0.00

Annex 3

Abstraction stops and restrictions due to water pollution

There were no abstraction stops or restrictions at Tailfer or Brakel (statements from Vivaqua and Dunea).

Intake point: Water-Link, Broechem (Albertkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
1	di 18/01/22 14:30	do 20/01/22 14:30	2,00	48,00	Oil spill on Albert Canal reported by The Flemish Waterway	Water authority notification
2	zo 26/06/22 09:00	zo 26/06/22 18:00	0,38	9,00	Preventive closure due to water ski competition in Viersel	Other
3	vr 07/10/22 00:00	vr 21/10/22 00:00	14,00	336,00	Intake reduced by 2 m³/sec in connection with excavation of a property of the Meuse in Liège after works	Water authority notification

Intake point: Water-Link, Lier (Netekanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
4	wo 22/06/22 06:00	wo 22/06/22 09:00	0,13	3,00	Physical measurement (pH, EGV, O2, temp.)	Own measurement
5	zo 14/08/22 16:56	zo 14/08/22 19:52	0,12	2,93	Regular measurement	Own measurement
6	ma 10/10/22 12:05	ma 10/10/22 14:05	0,08	2,00	Increased turbidity	Own measurement

Intake point: WML, Heel (Lateraalkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
7	za 01/01/22 00:00	ma 03/01/22 00:00	2,00	48,00	mussel monitor, 52 µg/l Pyrazole, turbidity	Notification other body
8	do 06/01/22 00:00	vr 07/01/22 00:00	1,00	24,00	Meuse discharge > 1000 m3/s	Own observation
9	zo 09/01/22 00:00	ma 10/01/22 00:00	1,00	24,00	mussel monitor	Own observation
10	ma 10/01/22 00:00	do 13/01/22 00:00	3,00	72,00	Meuse discharge > 1000 m3/s	Own observation
11	do 13/01/22 00:00	di 18/01/22 00:00	5,00	120,00	turbidity, Daphnia monitor	Own observation
12	do 20/01/22 00:00	vr 21/01/22 00:00	1,00	24,00	mussel monitor	Own observation
13	vr 21/01/22 00:00	do 27/01/22 00:00	6,00	144,00	H1, LCAqua-114; 1.4 µg/l, turbidity. Cal A1, DIPE; 10.5 µg/l, Propamocarb; 0.27 µg/l, mussel monitor	Water authority notification
14	zo 30/01/22 00:00	di 01/02/22 00:00	2,00	48,00	Daphnia monitor, mussel monitor	Own observation
15	do 03/02/22 00:00	vr 04/02/22 00:00	1,00	24,00	mussel monitor	Own observation

Intake point: WML, Heel (Lateraalkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
16	zo 06/02/22 00:00	ma 07/02/22 00:00	1,00	24,00	turbidity, mussel monitor	Own observation
17	di 08/02/22 00:00	do 10/02/22 00:00	2,00	48,00	H2, Propamocarb 0.11 µg/l, Melamine 350 µg/l	Own measurement
18	za 12/02/22 00:00	wo 02/03/22 00:00	18,00	432,00	Daphnia monitor, turbidity, Cal A2 unknown 4.9 µg/l, Cal A3 TBP 3.8 µg/l, Cal A4; two unknowns 12.5 µg/l and 16.4 µg/l, H3; unknown 3.2 µg/l, mussel monitor	Water authority notification
19	vr 04/03/22 00:00	vr 11/03/22 00:00	7,00	168,00	Cal A5; DIPE 11.2 µg/l TBP 6.4 µg/l, H4; Diethyl phthalate 2.0 µg/l, turbidity, mussel monitor	Water authority notification
20	wo 16/03/22 00:00	do 17/03/22 00:00	1,00	24,00	mussel monitor	Own observation
21	za 19/03/22 00:00	ma 21/03/22 00:00	2,00	48,00	mussel monitor	Own observation
22	ma 21/03/22 00:00	do 24/03/22 00:00	3,00	72,00	H5; Propamocarb 0.25 µg/l	Own measurement
23	ma 28/03/22 00:00	vr 01/04/22 00:00	4,00	96,00	H6; Propamocarb 0.104 µg/l and various other substances	Own measurement
24	do 07/04/22 00:00	vr 08/04/22 00:00	1,00	24,00	H7; Propamocarb 0.16 µg/l	Own measurement
25	di 26/04/22 00:00	do 28/04/22 00:00	2,00	48,00	Turbidity	Own observation
26	vr 29/04/22 00:00	ma 02/05/22 00:00	3,00	72,00	H8, Propamocarb 0.19 µg/l	Own measurement
27	zo 15/05/22 00:00	di 17/05/22 00:00	2,00	48,00	Cal A13 four unknowns 4.6 µg/l, 2.8 µg/l, 2.4 µg/l, 1.7 µg/l	Water authority notification
28	wo 18/05/22 00:00	ma 23/05/22 00:00	5,00	120,00	H9 GCAqua-0092 1.38 µg/l, mussel monitor. 20-5-2022: GCAqua-0092 2.0 µg/l, GCAqua-0093 1.1 µg/l, LCAqua-0160 1.03 µg/l	Own measurement
29	vr 27/05/22 00:00	di 31/05/22 00:00	4,00	96,00	H10 notification > Propamocarb 0.16 ug/l	Own measurement
30	vr 10/06/22 00:00	do 23/06/22 00:00	13,00	312,00	H11 GCAqua-0092: 2 ug/l. GCAqua-0093: 1,2 ug/l	Own measurement
31	vr 24/06/22 00:00	vr 15/07/22 00:00	21,00	504,00	H12 GC Aqua-0092 value of 1.03ug/l	Own measurement

Intake point: WML, Heel (Lateraalkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
32	ma 18/07/22 00:00	ma 18/07/22 00:00	0,00	0,00	Internal assignment	Own measurement
33	do 21/07/22 00:00	za 23/07/22 00:00	2,00	48,00	H13 unknown GCAqua-0025 1.26 µg/l	Own measurement
34	ma 25/07/22 00:00	vr 29/07/22 00:00	4,00	96,00	H14 GCAqua-0092 1,14 µg/l	Own measurement
35	vr 05/08/22 00:00	di 09/08/22 00:00	4,00	96,00	H15 GCAqua-0036 (Hexadecane) 1.12 µg/l, report RWS cyanobacteria Albert Canal, mussel monitor, Melamine 150 µg/l	Own measurement
36	wo 10/08/22 00:00	vr 23/09/22 00:00	44,00	1056,00	H16 three components of which GCAqua-0092 1.1 µg/l, 0036 1.6 µg/l, 0048 1.5 µg/l, mussel monitor	Water authority notification
37	vr 30/09/22 00:00	wo 05/10/22 00:00	5,00	120,00	H17 Propamocarb 0.158 µg/l	Own measurement

Intake point: WML, Heel (Lateraalkanaal)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
38	ma 10/10/22 00:00	wo 12/10/22 00:00	2,00	48,00	H18 4-Methyl-1H-benzotriazole 2.6 µg/l , GCAqua-0092 Neophytadiene 1.2 µg/l	Own measurement
39	wo 19/10/22 00:00	vr 21/10/22 00:00	2,00	48,00	H19 Squalene 37 µg/l, Neophytadiene 1.1 µg/l	Own measurement
40	zo 23/10/22 00:00	do 27/10/22 00:00	4,00	96,00	Cal A20 three unknown substances.	Water authority notification
41	vr 04/11/22 00:00	vr 04/11/22 00:00	0,00	0,00	mussel monitor	Own observation
42	vr 04/11/22 00:00	ma 07/11/22 00:00	3,00	72,00	mussel monitor	Own observation
43	vr 11/11/22 00:00	di 15/11/22 00:00	4,00	96,00	H20 GCAqua-0123 (probably n-Hexadecanoic acid) at a concentration of 1.3 ug/l	Own measurement
44	vr 18/11/22 00:00	vr 18/11/22 00:00	0,00	0,00	Daphnia monitor	Own observation
45	za 26/11/22 00:00	wo 30/11/22 00:00	4,00	96,00	CALA24 PT-GCMS, sample 24-11-2022 1.2 dichloroethane 12.9 ug/l	Water authority notification
46	wo 30/11/22 00:00	do 01/12/22 00:00	1,00	24,00	H21 Propamocarb 0.11 ug/l	Own measurement
47	do 01/12/22 00:00	za 03/12/22 00:00	2,00	48,00	CAL A25 unknown compound 5.2 ug/l	Water authority notification
48	za 03/12/22 00:00	ma 05/12/22 00:00	2,00	48,00	H21 expired intake resumed again	Own measurement
49	za 10/12/22 00:00	vr 23/12/22 00:00	13,00	312,00	CAL A27 SPE-GCMS unknown 3.6 ug/l, H22 Propamocarb 0.36 ug/l	Water authority notification

Intake point: Evides Waterbedrijf, Bergsche Maas (Bergsche Maas)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
50	vr 11/03/22 05:30	vr 11/03/22 11:00	0,23	5,50	Alarm biomonitoring (Daphnia)	Own observation
51	ma 16/05/22 11:45	di 17/05/22 11:45	1,00	24,00	Water authority notification	Notification other body
52	ma 17/10/22 07:30	ma 17/10/22 11:45	0,18	4,25	Alarm biomonitoring (Daphnia)	Own observation

Intake point: Evides Waterbedrijf, Haringvliet (Haringvliet)

No.	Start	End	Duration [d]	Duration [h]	Cause	Explanation
53	di 11/01/22 23:00	wo 12/01/22 07:30	0,35	8,50	Increased turbidity	Own measurement
54	do 13/01/22 01:00	do 13/01/22 11:00	0,42	10,00	Increased turbidity	Own measurement
55	do 13/01/22 16:30	vr 14/01/22 09:00	0,69	16,50	Increased turbidity	Own measurement
56	za 15/01/22 01:30	ma 17/01/22 07:30	2,25	54,00	Increased turbidity	Own measurement
57	ma 17/01/22 23:00	di 18/01/22 08:00	0,38	9,00	Increased turbidity	Own measurement
58	di 18/01/22 20:30	wo 19/01/22 07:30	0,46	11,00	Increased turbidity	Own measurement
59	wo 19/01/22 22:30	do 20/01/22 12:00	0,56	13,50	Increased turbidity	Own measurement
60	ma 31/01/22 07:30	di 01/02/22 14:30	1,29	31,00	Increased turbidity	Own measurement
61	zo 03/07/22 10:00	ma 04/07/22 08:00	0,92	22,00	Alarm biomonitoring (mussel)	Own measurement
62	di 02/08/22 01:00	di 02/08/22 07:30	0,27	6,50	Physical measurement (pH, EGV, O2, temp.)	Own measurement
			232,70	5584,68		

Annex 4

Target values in the European River Memorandum (ERM)

(maximum values, unless stated otherwise)

	Unit	Target value
General parameters		
Oxygen content	mg/L	>8
Electrical conductivity	mS/m	70
Acidity	pH	7–9
Temperature	°C	25
Chloride	mg/L	100
Sulfate	mg/L	100
Nitrate	mg/L	25
Fluoride	mg/L	1.0
Ammonium	mg/L	0.3
Organic group parameters		
Total Organic Carbon (TOC) ***	mg/L	4
Dissolved Organic Carbon (DOC) ***	mg/L	3
Adsorbable organic halogen compounds (AOX)	µg/L	25
Adsorbable organic sulfur compounds	µg/L	80
Anthropogenic substances foreign to nature with effects on biological systems		
Pesticides and their breakdown products, by substance	µg/L	0.1*
Endocrine active substances, by substance	µg/L	0.1*
Pharmaceuticals (incl. antibiotics), by substance	µg/L	0.1*
Biocides by substance	µg/L	0.1*
Other organic halogen compounds, by substance	µg/L	0.1*
Evaluated substances without biological effect		
Microbiologically difficult to degrade substances, by substance	µg/L	1.0
Non-evaluated substances		
(substances that possibly penetrate** into the drinking water, or substances that form uncharacterised breakdown and transformation products) by substance	µg/L	0.1
Health and hygiene/microbiological quality		
The health and hygiene/microbiological quality of the surface water must be improved to such an extent that excellent swimming water quality as stipulated in EU Directive 2006/7/EC is permanently guaranteed.		

* *unless, as a result of advancing toxicological insight, a lower value must be kept to here, for example for genotoxic substances.*

** *substances that are not or are not satisfactorily removed with natural methods for the purification of drinking water.*

*** *unless, due to the geogenic relationships, higher values must be kept to here.*

From 2021, testing is done for the following substances against the ERM target value of 1 µg/L, where previously testing was still done against 0.1 µg/L:

Substance name	CASRN	ERM-tv		IDWT	
1,3,5-Trimethylbenzene	108-67-8	1	µg/L	70	µg/L
10,11-Dihydro-10,11-dihydroxycarbamazepine	58955-93-4	1	µg/L	50	µg/L
2,5-Furandicarboxylic acid	3238-40-2	1	µg/L	1100	µg/L
2-Methoxypropanol	1589-47-5	1	µg/L	10.5	µg/L
2-Methyl-2-propanol	75-65-0	1	µg/L	1.5	mg/L
4-Methyl-1H-benzotriazole	29878-31-7	1	µg/L	350	µg/L
Acesulfame K	55589-62-3	1	µg/L	3200	µg/L
Diatrizoic acid (amidotrizoic acid)	117-96-4	1	µg/L	250	mg/L
1,2,3-Benzotriazole	95-14-7	1	µg/L	700	µg/L
Butanone	78-93-3	1	µg/L	1.3	mg/L
Butoxypolypropylene glycol	9003-13-8	1	µg/L	1400	µg/L
Caffeine	58-08-2	1	µg/L	1500	µg/L
Carbamazepine	298-46-4	1	µg/L	50	µg/L
Cis-4,4-diaminostilbene-2,2-disulfonate disodium salt	7336-20-1	1	µg/L	7	mg/L
Cis-4,4-diaminostilbene-2,2-disulfonic acid	81-11-8	1	µg/L	7	mg/L
Cyclamate	100-88-9	1	µg/L	2500	µg/L
Diethylenetriaminepentaacetic acid	67-43-6	1	µg/L	700	µg/L
Diisopropyl ether	108-20-3	1	µg/L	1400	µg/L
Ethylenediaminetetraacetic acid	60-00-4	1	µg/L	600	µg/L
Ethylene glycol dimethyl ether	111-96-6	1	µg/L	440	µg/L
Ethyl lactate	97-64-3	1	µg/L	500	µg/L
Gabapentin	60142-96-3	1	µg/L	100	µg/L
Guanylurea	141-83-3	1	µg/L	22.5	µg/L
Hexamethylenetetramine	100-97-0	1	µg/L	500	µg/L
Iohexol	66108-95-0	1	µg/L	375	mg/L
Iomeprol	78649-41-9	1	µg/L	1000	mg/L
Iopamidol	60166-93-0	1	µg/L	415	mg/L
Ioxitalamic acid	28179-44-4	1	µg/L	500	mg/L
Metformin	657-24-9	1	µg/L	196	µg/L
Methyl-Tert-Butyl ether	1634-04-4	1	µg/L	9420	µg/L
Naphthalene-1,3,5-Trisulfonic acid	6654-64-4	1	µg/L	0.7	mg/L
Naphthalene-1,3,6-Trisulfonate trisodium salt	5182-30-9	1	µg/L	0.7	mg/L
Naphthalene-1,3,6-Trisulfonic acid	86-66-8	1	µg/L	0.7	mg/L

Substance name	CASRN	ERM-tv		IDWT	
Naphthalene-1,3,6-Trisulfonate sodium salt	19437-42-4	1	µg/L	0.7	mg/L
Naphthalene-1,5-Disulfonate disodium salt	1655-29-4	1	µg/L	0.7	mg/L
Naphthalene-1,5-Disulfonic acid	81-04-9	1	µg/L	0.7	mg/L
Naphthalene-1,7-Disulfonic acid	5724-16-3	1	µg/L	0.7	mg/L
Naphthalene-2,7-Disulfonic acid	92-41-1	1	µg/L	0.7	mg/L
Nitriloacetic acid	139-13-9	1	µg/L	400	µg/L
Polysorbate 60	9005-67-8	1	µg/L	175	mg/L
Saccharine	81-07-2	1	µg/L	1300	µg/L
Sotalol	3930-20-9	1	µg/L	80	µg/L
Sucralose	56038-13-2	1	µg/L	5000	µg/L
Tolyltriazole	29385-43-1	1	µg/L	350	µg/L
Tetraethylene glycol dimethyl ether	143-24-8	1	µg/L	440	µg/L
Tributyl phosphate	126-73-8	1	µg/L	350	µg/L
Trichloromethane	67-66-3	1	µg/L	25	µg/L
Triethyl phosphate	78-40-0	1	µg/L	1400	µg/L
Triglyme	112-49-2	1	µg/L	440	µg/L

CASRN = CAS registry number
ERM-tv = target value in the European River Memorandum
IDWT = Indicative drinking water target

In addition to/in deviation from the above, in this report, the following target values are kept to for Meuse water from which drinking water is prepared:

- PFOA: 4.4 ng of PFOA equivalents/L (= indicative drinking water target)
- HFPO-DA: 4.4 ng of PFOA equivalents/L (= indicative drinking water target)
- NDMA: 12 ng/L (based on the Netherlands Drinking Water Decree)
- Bromate: 1 µg/L (based on https://www.rivm.nl/publicaties/risicogrenzen-voor-bromaat-in-oppervlaktewater-afleiding-volgens-methodiek-van)
- Caffeine: 1 µg/L (based on Opinion of the Scientific Committee on Food on Additional information on “energy” drinks)
- Bromide: 70 µg/L

The target values for bioassays in this report are the effect-based trigger (EBT) values for human health in Been et al., 2021:

- ER-CALUX 17β-estradiol (E2): 0.25 ng E2-eq/L (0.083)
- Anti-AR CALUX Flutamide (Flut): 4800 ng Flut-eq/L (270)
- AR-CALUX Dihydrotestosterone (DHT): 4.5 ng DHT-eq/L (0.51)
- PR-CALUX Progesterone (P4): 15.5 ng P4-eq/L (0.22)
- GR-CALUX Dexamethasone (DEX): 47.9 ng DEX-eq/L (1.7)
- PAH-CALUX Benzo[a]pyrene (BaP): 24.4 ng BaP-eq/L (19)

Colophon

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