September 24, 2023

Non-confidential comments for Annex XV restriction report: Non-health (environmental) socioeconomic costs linked to PFAS exposure

Dear Madame or Sir,

We welcome the opportunity to provide input on the restriction proposal regarding per- and polyfluoroalkyl substances (PFAS). This submission was prepared by Gretta Goldenman (Milieu Ltd, retired) and Dr. Juliane Glüge (ETH Zürich), with input of other members of the Global PFAS Science Panel (GPSP). The GPSP is a collaborative partnership among academic researchers, regulatory scientists and policy analysts dedicated to enhancing understanding of PFAS and to protecting human and environmental health from potentially adverse effects associated with PFAS through better informed decision-making. The scientific work of the GPSP in the last five years has considerably advanced the understanding of PFAS and the GPSP would like to take the opportunity to also give input to the PFAS restriction proposal.

We see the restriction proposal as a very important initiative and good way forward to counteract the ongoing emissions of PFAS in Europe (and in part even worldwide). Our submissions should therefore be seen as a support of the restriction proposal to make it even stronger and more fully complete.

This submission is on the non-health (environmental) socioeconomic costs linked to exposure to PFAS. A separate submission covers health-related socioeconomic costs. The following topics are covered in the current submission:

1. A general note on costs to society from externalized impacts of PFAS exposure
2. How "The cost of inaction" report estimates for non-health costs linked to PFAS were developed and why we consider them as low
3. The cost of cleaning up Europe's contaminated drinking water
4. Costs of cleaning up other legacy PFAS contamination
5. Not yet quantifiable costs of PFAS
6. Tracking costs to the PFAS industry from settlements and litigation
7. Costs associated with the release of fluorinated greenhouse gases
8. Concluding remarks

1) A general note on costs to society from externalized impacts of PFAS exposure

“The cost of inaction” report is cited in the Annex XV report for its estimates of the costs to society **(EUR 52 - 84 billion a year)** for the health impacts linked to PFAS exposure in the European Economic Area. “The cost of inaction” report also estimated non-health costs related to PFAS contamination, such as monitoring of affected populations and remediation of drinking water and soil. These additional cost estimates **– EUR 821 million to EUR 170.8 billion over a 20 year period** – are not provided in the Annex XV report.

The OECD defines inaction in terms of the lack of regulatory progress, i.e., “no new policies beyond those which currently exist” (OECD 2008). The cost of inaction is therefore the cost that society will pay now and in the future, if timely action is not taken to limit PFAS exposure.

“The cost of inaction" report considered only the socioeconomic costs incurred by society at large. It did not look at possible costs to industry such as costs of substitution due to the phase-out of PFAS.

This note reviews how the quantitative estimates for the non-health or environmental impacts in “The cost of inaction” report were developed. It also looks at other estimates of societal costs from the externalized impacts of PFAS to environmental media. Finally, it considers other categories of costs, such as the loss of use of natural resources, to highlight the potential gains of reducing sources of PFAS exposure.

2) How “The cost of inaction” estimates for non-health (environment-related) costs linked to PFAS were developed and why we consider them as low

As we mentioned in our submission concerning socioeconomic costs linked to health impacts, the section in the Annex XV report on societal costs from PFAS is very short. In contrast, Annex E (the Impact Assessment) goes into considerable detail (400+ pages) concerning potential costs to businesses (company closures, job losses) and consumers (higher prices) if proposed derogations to certain sectors of industry are not granted.

This summary explains how the overlooked non-health cost estimates in “The cost of inaction” report were developed, and why the true costs to society from PFAS exposure are considerably higher. The analysis of environmental costs was separate because it required a different methodology.[1] It looked at six non-health elements:

1. Monitoring to assess PFAS contamination where it may have occurred.
2. Temporary provision of uncontaminated drinking water.
3. Capital costs of upgrading water treatment as well as ongoing costs for maintenance, e.g., replacement and disposal of filters.
4. Soil and other in-situ clean-up measures to reduce exposure from contamination.
5. Management of public health concerns where exposure to contamination has occurred.

[1] The methodology for non-health costs was developed by Dr Michael Holland.

6. Impacts on biodiversity.

The study's terms of reference specified that monetary values were to be based on actual cases, so the research team gathered examples where measures had been taken to address PFAS contamination. The search included news reports and other grey literature in both Europe and the US. For example, costs for upgrading drinking water treatment plants were drawn from 8 European and 10 US case studies. These costs were then translated into cost per person where possible, e.g. by dividing the costs of upgrading a treatment plant by the number of persons served, to enable aggregation of costs at a later point.

Table 1: Summary of per person cost data for non-health expenditures, based on actual case examples

Activity	Unit	Best estimate	Range from studies	Adopted range
Monitoring	Cost/sample	EUR 340	EUR 278-420	EUR 278-420
	Cost/case	EUR 50,000	EUR 4 thousand – 6.1 million	EUR 25 thousand – 500 thousand
Health assessment (inc monitoring)	Cost/person	EUR 50	No range	EUR 5 – 95 (+/- 90%)
	Total biomonitoring & assessment/case	EUR 3.41	EUR 2.5 million – 4.3 million	EUR 1 million – 5 million
Provision of temporary water supply	Cost/person	No appropriate data available		
Provision of new pipeline	Cost/person	EUR 800	EUR 37 – 5,000	EUR 500 – 1,500
Upgrading water treatment works (capital)	Cost/person	EUR 300	EUR 8 – 2,200	EUR 18 -600
Upgrading water treatment works (maintenance)	Cost/person	EUR 19	EUR 8 - 30	EUR 8 – 26
Excavation and treatment of soils	Cost/kg PFAS	EUR 280,000	EUR 100 thousand – 4.3 million	EUR 100 thousand – 1 million
	Cost/case	EUR 5 million	EUR 100 thousand – 3 billion	EUR 100 thousand – 50 million

Source: "The cost of inaction" report

Aggregation of costs was carried out by multiplying the adopted ranges by an estimate of the percentage of people affected, assumed to be between 1% and 10% of Europe's overall population, with a best estimate at 3%. This assumption that around 3% of Europeans were affected by environmental contamination was also used in the scenario for estimating the health-related costs to communities affected by PFAS in their drinking water.

Total aggregated costs covering environmental screening, monitoring where contamination is found, water treatment, soil remediation and health assessment came to a low of EUR 821 million to a high of

EUR 170.8 billion, with a best estimate of EUR 16.9 billion for the European Economic Area, over a 20-year period.

Impacts on biodiversity could not be quantified, given lack of data on the species/stock at risk and other elements, such as exposure response. For these reasons, few studies have ventured to estimate ecological costs. A rare example was a survey estimating anglers' willingness to pay to avoid fishing in contaminated lakes in Minnesota at over USD 90 million over 30 years (Sunding 2017).

The wide range of the estimate – **EUR 821 million to EUR 170.8 billion** – was due to the variability of costs found in the case studies collected. A major driver of the higher end of this range was due to the estimate of EUR 1-3 billion to clean up the soil contamination at Rastatt, Germany, an estimate that dates from 2015 and would certainly be considerably higher today. Today, the additional information available on the possible extent of soil and water contamination in Europe, e.g., through the *Le Monde* "forever chemicals" mapping project (Horel 2023), strengthens the case that the non-health (environment) costs of inaction estimates are low estimates.

3) The cost of cleaning up Europe's contaminated drinking water

The widespread contamination of surface water and groundwater from PFAS released to the environment mentioned in "The cost of inaction" report is documented in studies across Europe, including Germany (Neuwald 2022), Sweden (Nguyen 2017; Banzhaf 2017), the Netherlands (Sadia 2023), Belgium (Jeong 2022), and Czech Republic (Jurikova 2022). How widespread is not yet known because few EU Member States have carried out comprehensive testing.

The recently revised Drinking Water Directive that came into force in January 2021 sets two parameters for PFAS in drinking water (100 ppt = sum of 20 PFAS; 500 ppt = PFAS total) (EU 2020). Member States have five years, e.g., January 2006, to ensure that water intended for human consumption meets those parameters. However, they are not obliged to monitor for PFAS before that date. At that point there will be better data on PFAS contamination in Europe's waters.

Extensive PFAS contamination has been found in the drinking water resources of the US, and the findings could also apply to Europe. According to data gathered by the USEPA in 2013-2015, an estimated 200 million US residents, i.e., almost two-thirds of the US population, were receiving PFAS-contaminated drinking water from public water systems (Andrews 2020). This widespread contamination was confirmed by the US Geological Survey in a study released in 2023. Testing of more than 700 unregulated private-well and regulated public-supply tap water across the US found at least one of 32 PFAS in 45% of all tap water in the US (Smalling 2023).

In March 2023, the USEPA proposed a National Primary Drinking Water Regulation that sets maximum contaminant levels for six PFAS (USEPA 2023a). It will cover 66,000 water systems in the US, 3,400 to 6,300 of which are expected to exceed one or more of the proposed MCLs for the six PFAS (USEPA

2023c). Public water systems will need to monitor PFAS at each source of drinking water and, if necessary, take mitigation measures such as installation of treatment systems.

Note that the MCLs for PFAS in drinking water proposed by the US in March 2023 are much lower (4 ppt for PFOA, 4 ppt for PFOs) than the PFAS parameters (100 ppt for sum of 20 PFAS; 500 ppt for total PFAS) in the revised Drinking Water Directive (EU 2020). The proposed US parameters reflect the most recent scientific understanding of the potential for health impacts from long-term low-level PFAS exposure.

The cost of drinking water remediation depends on a number of factors, including the technology used, the extent of the contamination, and the applicable regulatory parameter, e.g., minimum contamination level (MCL). Methods to lower PFAS levels in drinking water include granular activated charcoal (GAC), reverse osmosis (RO), ion exchange (IO), or blending with less contaminated water from other sources, but none of these fully eliminate PFAS, especially the ultra-short chain PFAS.

The USEPA estimated the cost of complying with the proposed MCLs at USD 771 million a year, over an 80-year period (USEPA 2023b). This estimate has been challenged by the American Water Works Association (AWWA), which criticized the cost of treatment model used by USEPA as resulting in seriously underestimated costs of compliance (AWWA2023). A cost model commissioned by AWWA from the consultancy Black & Veatch was used to carry out a parallel economic analysis, based on more than 100 case studies. The B&V model estimated the annualized costs for compliance with the proposed NPDWR at more than USD 3 billion a year over a 20-year period, at a 3% discount rate.

The US Association of State Drinking Water Administrators raised concerns that USEPA's cost estimates had underestimated the true burden to state agencies for the considerable time required for rule adoption, treatment review and approval, mandatory reporting requirements and provision of technical assistance to local water systems (ASDWA 2023). The ASDWA also recommended that USEPA propose waste disposal methods as soon as possible to ensure that PFAS contamination was not simply moved from one media type to another.

For comparison, the "cost of inaction" report estimated the costs of improving the water treatment works serving Europeans to reduce PFAS concentrations at a range of EUR 684 million to EUR 25.3 billion over a 20-year period, with a best estimate of EUR 8.9 billion. "The cost of inaction" estimate does not take into account more recent information about the costs of drinking water remediation. On the other hand, at this point the parameters in the EU Drinking Water Directive are at least 25 times higher than the much more health-protective parameters proposed for the US. Europe may be willing to accept higher levels of PFAS in drinking water, which could result in lower costs for cleaning up drinking water in Europe. On the other hand, it would also imply that Europe accepts a higher risk of PFAS-related disease in the future.

The health-protective parameter developed by the European Food Safety Agency for PFAS in food of tolerable weekly dose (TWI) of 4.4ng/kg body weight for four PFAS is an indicator that European regulators do think about health concerns in setting limits on sources of exposure to PFAS (EFSA Panel 2020). In 2021, Denmark adopted a national standard for PFAS in drinking water that is equivalent to the EFSA recommendation for PFAS in food (DHI 2021) and more stringent than the EU drinking parameters.

4) Costs of cleaning up legacy contamination

Calculating the cost of treating drinking water to remove PFAS is relatively straight forward because in most cases the systems are in place to collect the water for treatment before delivery to downstream users. But in a world of limited resources where PFAS can be found even in remote environments (Cousins 2022), reducing exposure to PFAS may require even more radical clean-up. PFAS may have to be removed from wastewater to permit re-use in water-scarce regions, or from sewage sludge so that it can be safely applied to agricultural land.

The *Le Monde* "forever chemicals" mapping project illustrated the possible extent of legacy PFAS contamination in Europe (Horel 2023). It used the "presumptive contamination" methodology (Salvatore 2021) to identify nearly 21,500 sites across Europe suspected of being contaminated by industrial and commercial activities.

If action is not taken, legacy contamination will spread further throughout the environment over time, from soils to surface and groundwaters and air, leading to increased exposure to PFAS in agricultural crops and untreated drinking water.

A recent study prepared for the US state of Minnesota Pollution Control Agency looked at how much it might cost to deal with the extensive contamination of its territory due to 3M's decades of PFAS production there (Barr 2023). The study suggests that to minimize contamination of food, soils and ambient waters from PFAS in waste streams, future actions could focus on "breaking the cycle" of PFAS contamination being transferred between soil, groundwater, surface water and air. This might require removing PFAS from waste streams and carrying out final destruction.

The Minnesota study illustrates the technical difficulties and cost factors to consider for removing PFAS from an environmental media and then destroying it. The study looked at four waste streams – liquids such as wastewater discharges, landfill leachate and compost contact water, and biosolids, i.e., sewage sludge. It reviewed >50 PFAS separation and destruction technologies and selected thirteen to look at in more detail. Removal of PFAS from wastewater effluent was found to be more expensive (USD 2.7 to USD 18 million per pound of PFAS removed) than removal of PFAS from sewage sludge (USD 1.0 to USD 2.7 million per pound).

The total cost to retrofit Minnesota's existing wastewater treatment plants to remove PFAS from wastewater and biosolids before discharge into the environment was estimated to be at least USD 14 billion, ranging to as much as USD 28 billion over 20 years (Barr 2023). This is for a state with a population of just 5.7 million. The study also suggested reducing stocks of PFAS currently entering the environment via waste streams by limiting the use of PFAS in products and industrial processes.

5) Not yet quantified costs of PFAS

Since the 2019 study, awareness has grown concerning many other impacts linked to PFAS contamination, e.g., burdens on local governments, lost agricultural resources; and damaging effects on real estate. "The True Cost of PFAS and the Benefits of Acting Now" (see attached) is a 2021 commentary that gives a fuller picture of the many externalized costs to society from PFAS contamination (Cordner 2021). Many of these societal costs cannot be quantified. They include:

- Burden on local and state governments, e.g., monitoring for contamination and related health impacts, interactions with concerned citizens, identifying whether measures are needed to remediate drinking water, and so on;
- Impact on circular economy ambitions, e.g., materials that cannot be safely recycled because of PFAS contamination;
- Loss of tax-income when the most resourceful people move away from PFAS-pollution impacted communities;
- Loss of resources (polluted soil, water, food, use of energy to remediate resources and to mitigate (filter) pollution, loss of water in water treatment)
- Costs from loss of property value in polluted areas, and loss of tax-income when the most resourceful people move away from PFAS-pollution impacted communities.

Impact on property values. A not yet published paper looked at the impact of PFAS-contaminated drinking water on local housing prices. It found that PFAS concentrations above health advisory levels reduced average housing prices from 1.5% to 2.8%. The price differential was higher for houses closer to the PFAS contaminated sites than those further away. The study concludes that the local housing market was sensitive to perceived risks of PFAS contamination (Islam 2023). Another study found impacts in five US residential real estate markets (Georgia, Alaska, Wisconsin, California, and Arizona) where local media had raised awareness of PFAS contamination (Orell 2022).

6) Tracking costs to the PFAS industry from settlements and litigation

Regulatory and litigation developments in the US illustrate the rising business costs of continuing to produce PFAS and to manufacture products using PFAS (Wallender 2022). A few US states have received compensation from the companies responsible for directly polluting their territories with PFAS. These include Minnesota (USD 850 million), Alabama ($39 million) and Michigan ($168 million) (Gardella 2020). However, the number of lawsuits is rapidly proliferating, and the size of the settlements is an indicator of how widespread PFAS contamination is in the US and the costs linked to that contamination.

Over 3000 lawsuits have now been brought against 3M, Dupont, Chemours and other companies by state and local governments, airports, firefighter training facilities, private well owners and others. For example, in 2022 the attorney general for Massachusetts sued PFAS manufacturers for contaminating drinking water and damaging natural resources, in efforts to cover the $110 million in costs that the state has spent to address the contamination (Government of Massachusetts 2022). The contamination cases have been consolidated by a US district court in South Carolina.

In June 2023, 3M announced it had reached a major USD 10.3 billion settlement to provide funds to hundreds of public water providers over a 13-year period to test for and treat contaminated drinking water (Flesher 2023) The settlement was initially opposed by the attorneys general from 19 US states, Washington DC and two US territories as not giving individual water suppliers enough time to figure out how much they would get and whether it would be enough to cover their costs of reducing PFAS to meet regulatory standards. After 3M agreed to certain changes in the terms of the settlement, the objections were withdrawn. The proposed settlement will be subject to a “fairness hearing” in February 2024 before final approval (Mindock 2023).

Solvay also recently proposed a USD 393 million settlement with the state of New Jersey for cleaning up PFAS around a Solvay production facility, for drinking water remediation, and for lost value of natural resources (Mitman 2023). In addition, PFAS producers DuPont, Chemours and Corteva announced another USD 1.1 billion settlement for clean-up of contaminated drinking water (Perkins 2023). These amounts are considered only a fraction of the real cost of cleaning up US drinking water, estimated to be as much as USD 400 billion (Perkins 2023).

Litigation is also being used in Europe to make PFAS polluters pay, e.g., 3M in Flanders, Chemours in the Netherlands, Sovay and Miteni in Italy. However, these suits are less advanced and information on size of settlements is not yet available. Note that in France, criminal charges have been brought against Arkema for a rare case of testicular cancer in a 1-year-old child living downwind from PFAS emissions near Lyon (Mandard 2023).

Unfortunately, these legal actions can be pursued only after the contamination and health damage has already occurred.

7) Costs associated with the release of fluorinated greenhouse gases

PFAS as a group include a number of fluorinated gases. In another contribution from the Global PFAS Science Panel to the public consultation on the proposed REACH restriction on PFAS, we have raised concern about the contribution of these fluorinated gases on the increasing levels of trifluoroacetic acid (TFA) in the environment. Additionally, several of these fluorinated gases contribute significantly to global warming as they have a global warming potential (GWP) that is hundreds to thousands times higher than that of CO_2. We have documented that commercially viable alternatives for many applications of fluorinated gases as refrigerants are available.

It is well-known that we cannot continue with the current high level of global greenhouse gas emissions, whether for fluorinated gases or for CO_2. Some European countries have therefore started or are considering storing CO_2 underground and are spending and will spend billions on this. For example, in Norway, CO_2 from gas production on the Norwegian continental shelf has been captured and reinjected into sub-seabed formations since 1996 (Norskpetroleum 2023). The newest project – Longship – will initially link two sub-projects that capture CO_2 from cement and waste-to-energy plants, with a storage plant in the North Sea. The initial storage capacity is 1.5 million tonnes of CO_2 over an operating period of 25 years, with the aim to increase storage to 5 to 7 million tonnes per year by 2026 (Canadian Climate Institute 2023). The total cost estimate for Longship (investments and 10-year operating costs) is a total of approximately NOK 28 bn (EUR 2.4 billion). The government's share of expected investments and operating costs is estimated around NOK 18 bn (EUR 1.5 billion €) (Canadian Climate Institute 2023).

The European F-gas Regulation is already limiting the emissions of fluorinated greenhouse gases via the current 2014 version of the Regulation (EP 2014). It allows a maximum of around 60 million tonnes of CO_2 equivalent for hydrofluorocarbons by 2023 (EEA 2021; EP 2014). The latest proposal for a revision of the F-gas Regulation (still under negotiation) has proposed an additional 300 million tonnes CO_2 equivalent of hydrofluorocarbons be allowed to be emitted during the next 25 years (until 2047) (EC 2022).

The GPSP contribution to the consultation shows that alternatives for fluorinated gases are commercially available and that the amounts of fluorinated gases used in refrigerators, coolers and heat pump can be significantly reduced. If the additional 300 million tonnes of CO_2 equivalent HFCs that would be allowed under the pending revision of the F-gas Regulation were not emitted, this would also save costs. One measure of the cost to society is to double the cost of the Longship effort to store CO_2 over 25 years (EUR 2.4 billion times two, or EUR 4.8 billion). These costs would still be an underestimation as they only take the investments and 10-year operating costs into account, missing 15 years of additional operating costs.

8) Concluding remarks

The Annex XV dossier only lists the costs to industries that may lose their businesses. However, there will be a parallel benefit, as providers of alternatives gain market shares.

In the meantime, the costs of the long-term PFAS exposure due to the use of PFAS in industrial applications and consumer products continue to mount. These are routinely and disproportionately externalized to society at large (Cordner 2021). The costs of cleaning up contaminated drinking water will be substantial, but the costs of *not* acting to reduce PFAS exposure are much greater.

Evaluation of long-term socioeconomic costs will document the opportunity cost of delaying action. Such cost information along with mounting legal costs will help provide incentives for companies to look for alternatives to the use of PFASs. While polluters should pay as soon as costs have been estimated, there should also be support for producing less hazardous products and use and emit less hazardous substances from chemical processes.

The proposed REACH restriction on uses of PFAS is a critical step in minimizing future socioeconomic costs of PFSA. It should be noted that a few US states are taking similar pro-active measures. For example, the states of Maine and Minnesota have set in place broad class-based measures to restrict the sale of certain products containing intentionally added PFAS (Maine 2022, Minnesota 2023). The state of California has banned the intentional use of PFAS in textile articles and cosmetics (Lane2022)

It is important to keep in mind that many of the socioeconomic costs cited above, particularly the health-related costs of PFAS exposure, are already a burden to society due to current impacts from exposure to legacy PFAS and to the PFAS still used in industrial processes and consumer products. To cap these costs at current levels, it is urgent to limit the derogations in the REACH restriction proposal to as few as possible.

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