Deliverable 1.1

Mapping of end-user groups and governance and synthesis of their demands for knowledge

Date: 25 November 2022

The AquaticPollutantsTransNet partners have received funding from BMBF, ANR and SRC within the 2020 Transfer Project Call, implemented under the ERA-NET Cofund AquaticPollutants of the Joint Programming Initiatives (JPIs) on Water, Oceans and Antimicrobial Resistance (AMR).

Version History

WP	1. Demand for knowledge and knowledge gaps on aquatic pollutants from key water stakeholders
Task	1.2 Current state of knowledge on aquatic pollutants
Responsible partner	ACTeon Environment
Authors	Maïté Fournier[1] (ACTeon), Nicole Baran (BRGM), Manon Berge (ACTeon), Katie Carter (DECHEMA), Antoine Dubiau (ACTeon), Hanna Matschke Ekholm (IVL), Lara Oppelt (DECHEMA), Gunnar Thorsén (IVL)
Reviewers	Corinne Merly (BRGM), Dr. Thomas Track (DECHEMA)
Versions	1. Draft – 09/05/2022 2. First inputs – 14/08/2022 3. Additions (Germany) – 18/08/2022 4. Additions (Sweden – methodologies – EU) – 25/08/2022 5. Revisions after first review – 26/09/2022 6. Revisions after final review – 23/11/2022

The AquaticPollutantsTransNet partners have received funding from BMBF, ANR and SRC within the 2020 Transfer Project Call, implemented under the ERA-NET Cofund AquaticPollutants of the Joint Programming Initiatives (JPIs) on Water, Oceans and Antimicrobial Resistance (AMR).

[1] m.fournier@acteon-environment.eu ; www.acteon-environment.eu

Table of Contents

List of Figures

List of Tables

List of Acronyms

AMR	antimicrobial resistance
AP	aquatic pollutants
ARG	antibiotic-resistant genes
BWD	Bathing Water Directive
CEC	contaminant of emerging concern
CLP	Classification, Labelling and Packaging
DE	Germany
DDT	dichlorodiphenyltrichloroethane
DWD	Drinking Water Directive
EC	European Commission
EDC	endocrine disrupting compounds
EQS	European Quality Standards
EU	European Union
FR	France
GESMW	Good Environmental Status of Marine Waters
GIS	geographic information system
GWD	Groundwater Directive
IED	Industrial Emissions Directive
IS	information system
ISO	International Standards Organization
JPI	Joint Programming Initiative
MPHU	medicinal products for human use
MS	Member States
MSFD	Marine Strategy Framework Directive
NBS	nature-based solution
PAEI	public access to environmental information
PCB	polychlorinated biphenyl
PFAS	per- and polyfluoroalkyl substances
PhD	Doctor of Philosophy
PMT	persistent, mobile and toxic
PPP	plant protection products
PRTR	pollutant release and transfer register
PSD	Priority Substances Directive
RBD	river basin district
RBMP	river basin management plan
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
R&D	research and development
SDG	Sustainable Development Goals
SE	Sweden
THM	trihalomethanes
UN	United Nations
USAF	undesirable substances in animal feed
UWWTD	Urban Wastewater Treatment Directive
WFD	Water Framework Directive
WHO	World Health Organisation
WISE	Water Information System for Europe
WP	work package
WWTP	wastewater treatment plant

Summary

Pathogens, contaminants of emerging concern (CECs) and antimicrobial resistant bacteria are a rising concern in European water sources, including rivers, estuaries and coastal ecosystems. In 2020, a Joint Transnational Call was launched to fund 18 research and innovation projects focusing on measuring, evaluating and taking actions on the abovementioned "Aquatic Pollutants". To support this call, the transfer project, AqauticPollutantsTransNet ("TransNet"), is investigating innovative strategies and methods for knowledge transfer, scientific networking, and increased public engagement.

As part of this work, the TransNet consortium (DECHEMA, BRGM, ACTeon, IVL, and ISOE) identified the knowledge gaps on aquatic pollutants, defining the needs and demands for knowledge from different stakeholders as well as from the requirements in national and European legislation. **This report presents a mapping of water stakeholders and driving forces for France, Sweden, Germany and the European Union (EU). It also reviews the existing national and European policy context and identifies and compares the political demands pertaining to aquatic pollutants.**

Our methodology consisted in identifying and mapping the stakeholders dealing with aquatic pollutants in three countries (Germany, France, Sweden) as well as at the EU level. We carried out an analysis of their working relations and networks, to identify who the core groups are that should be contacted. An overview of the main European institutions or networks dealing with aquatic pollutants was also performed.

KEY TAKEAWAY

Our analysis highlighted the importance of professional networks, working groups and national agencies to support the stakeholders in dealing with emerging contaminants and accessing information about them. We also highlighted the barriers between the public and private sectors, as well as the difficulties of communication between national level organisations and local water managers and authorities.

Key organisations to interact with were selected by considering a balance between the different stakeholder groups (public, private) and roles (problem owner, producer of substances or emitter of pollutants, technology designer, etc.). We interviewed several "key" stakeholders to collect their opinions on the available or missing knowledge on aquatic pollutants, on the challenges in accessing the knowledge as well as on the tools and networks they use to get information or to disseminate their results.

KEY TAKEAWAY

The persons interviewed commented on the wealth of information on aquatic pollutants, which is both perceived positively (when one knows what to look for) and negatively (lack of efficiency and risk of redundancy). ***Data sharing*** *is thus a focus for improvement. The main difficulties reported are in navigating the many databases existing at the European or national level, to understand protocols to ensure comparability of datasets from various sources, to access experimental results from the chemical industry and to collect information on substances' uses and pathways into the environment.*

The identified knowledge gaps can be grouped into three main categories:

- ***Measuring and analysis**: characterizing substances in aquatic systems, defining common assessment parameters and indicators, expanding analytical methods to detect substances at low concentrations and new chemicals.*
- ***Risk assessment and management**: on hazardous substances (PFAS), toxicity of compounds mixture, influence of physical parameters on the becoming of chemical pollutants (especially in the marine environment), AMR, microplastics and nano-plastics.*
- ***Pollution treatment and mitigation techniques**: including the social drivers and behavioural change on the use of chemical products.*

In parallel, the demands from the European and national regulations were assessed in the light of new knowledge production, its capitalisation and dissemination. To do so, a literature review of policy documents in France, Germany and Sweden as well as the EU legislation was undertaken. We analysed if, and how, chemicals of emerging concern (CECs), antimicrobial resistance (AMR) and pathogens are a focus point in European and national legislation in the three countries. Furthermore, we examined the extent to which these substances are part of the requirements regarding monitoring, data transfer and communication.

KEY TAKEAWAY

We concluded that there are strong national regulations in place for pesticides and biocides as well as a few known hazardous substances (i.e. bisphenol or metals), but regulations remain weak for pharmaceuticals, cosmetics or household products. The EU legislation strongly shapes national legislation regarding substance regulations or environmental objectives, while each Member State is responsible for implementing the means to prevent, monitor and remediate pollutions. The legislation, though it sets obligations in terms of sampling and analysis of chemical substances in water, does not rule the transfer and storage mechanisms of this information.

1 Introduction & Objectives

1.1 Transfer Project and Deliverable Context

To address the presence of pathogens, contaminants of emerging concern (CECs) and antimicrobial resistant bacteria in our water sources, including rivers, estuaries and coastal ecosystems, the three European Joint Programming Initiatives on Water (Water JPI), Oceans (JPI Oceans), and Antimicrobial Resistance (JPI AMR) set up the ERA-Net Cofund AquaticPollutants. The Cofund addresses the entire "ecosystem" of aquatic pollution – from the source to the sea – and spans from the classification of pollutants to solutions, via funding from 32 ministries, authorities and other funding organisations from 22 different countries.

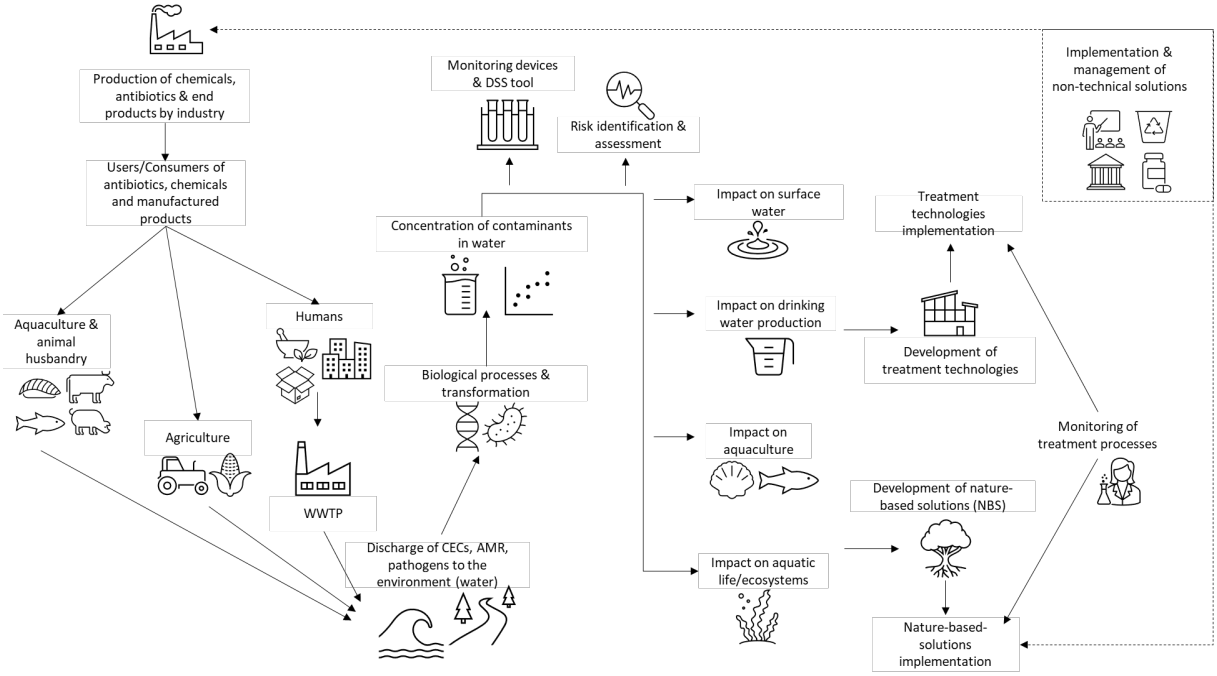


Figure 1-1. Visualisation of the “ecosystem” of aquatic pollution from production, emission, discharge into the environment, to impact on water and aquatic life.

The approach includes two calls:

1. 2020 Joint Transnational Call, which funds 18 research and innovation projects focusing on the 3 themes of measuring, evaluating and taking actions.
2. **2020 Transfer Project Call** funds the AquaticPollutantsTransNet project (“TransNet), which addresses two main themes:
   i. Research and development (R&D) of innovative strategies and methods for knowledge transfer, scientific networking, and increased public engagement
   ii. Implementation and valorisation of new methods for transfer, communication, and dissemination, achieved through implementing the results from Call 1.

The first work package (WP1) of the TransNet project aims to identify the knowledge gaps on aquatic pollutants, defining the needs and demands for knowledge from different stakeholders (see Figure 1-2). The work is divided into three sub-tasks:

1. The identification of targeted audiences and the demand for knowledge
2. The definition of the knowledge available
3. The assessment of the knowledge gap and the knowledge transfer channels in use

This present deliverable is part of the first sub-task. It presents a mapping of water stakeholders and driving forces for France, Sweden, Germany and the EU. It also reviews the existing national and European policy context and identifies and compares the existing political demands. The report is a basis document for further work within WP1 (national workshops with stakeholders to assess the knowledge gaps) as well as the WP2 activities on developing innovative knowledge transfer tools.

1.2 Methodology Outlines

The first step of the methodology consisted in **identifying and mapping of the stakeholders** dealing with aquatic pollutants in the three countries (Germany, France, Sweden) as well as at the EU level. The term "stakeholders" includes both "**knowledge end-users**" and "**knowledge producers**", who have a role to play in the transfer mechanisms. The identification of stakeholders stemmed from the AquaticPollutants projects stakeholders lists, which were collected through a **questionnaire** (September 2021, involving all 18 selected projects under the AquaticPollutants Call) as well as the knowledge from the TransNet team. Mapping of the stakeholders included an analysis of their working relations and networks. It enabled the identification of the core groups to contact for further stakeholder interactions (such as **interviews, national workshops or communication and dissemination activities**). The stakeholder identification and mapping are presented in the **Chapter 2.**

Once stakeholders were characterised, **interviews** were carried out to collect stakeholders' opinions on the **available or missing knowledge on aquatic pollutants, on the challenges in accessing the knowledge as well as on the tools and networks** they use to get informed or to disseminate their results. The interview material thus benefits both WP1 and WP2 (knowledge transfer) goals. The interview results are presented in **Chapter 3.**

Third, the **demands from the European and national regulations** were assessed in the light of new knowledge production, its capitalisation and dissemination. To do so, a **literature review** of policy documents in the three countries as well as the EU legislation was undertaken. The outcomes of the review are presented in **Chapter 4.**

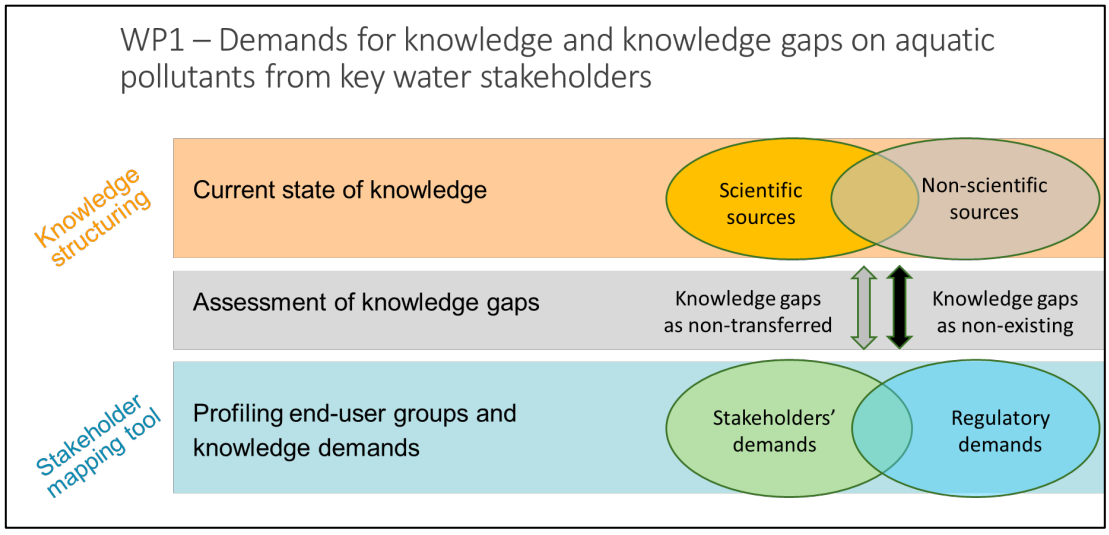


Figure 1-2. Methodology outline of WP1. The methods and results described in this deliverable are highlighted in blue and green.

2 Mapping of Water Stakeholders, Driving forces and Sphere of Influence

To begin identifying the knowledge demands pertaining to aquatic pollutants, it is important to first understand who, either persons or organisations, is active in this field and how these different actors exchange and collaborate with each other. Identifying the "stakeholders"[2] is therefore a key first step in understanding the current situation. Further, the identified stakeholders can be directly targeted in the later stages of the project via various knowledge transfer methods.

Key Findings

Stakeholders

Germany

- There is a large number of actors in the German water sector with varying responsibilities, partly due to the three-tier water management structure, where municipalities are given the responsibility for implementation.
- Stakeholders from various fields (research institutions, universities, water suppliers) are well connected through associations and via participation in funded research initiatives. However, exchange with local authorities is limited.

France

- There are many organizations involved in the topic of aquatic pollutants, some of them joining forces to develop expertise and projects.
- However, the number of experts of CEC, AMR or pathogens within each organization is small and the professionals know each other's fairly well.

Sweden

- The management of water bodies is performed by regional water authorities, based on water catchments. The Water Authorities are housed at five County Administrative Boards, and prepare cases for regional Water District Boards, that decide on environmental quality standards, measures and management plans. They have support from a multitude of local networks of stakeholders for different water bodies concerning implementation of measures.
- Many different actors can be viewed as stakeholders dealing with CECs, AMR and pathogens in water, from the support and advisory role of the government agencies, through the management levels of the Water Authorities to the municipal water and wastewater companies. These collaborate with universities and research institutes or with environmental or technical consultants and commercial environmental labs.

Cross-national perspectives

- The water sector is fragmented, small-scale units providing drinking water or dealing with wastewater treatment.
- The management of aquatic pollutants is centralised at the national level in France, contrary to the other two countries.
- AMR and pathogens are managed by dedicated organisations or networks in Germany and Sweden, contrary to France.
- There are barriers between the private sector and the public sector in all three countries.

[2] Stakeholder means any people or groups who are positively or negatively impacted by a project, initiative, policy or organisation.

Stakeholder Networks

Germany

- Private companies (e.g. technology development) are to a certain extent an active part of the German stakeholder network, but they also have their own networks (i.e. GWP, Mechanical Engineering Industry Association [VDMA]).
- There are various networks within the German field of aquatic pollutants, including technical communities and policy-oriented communities, combining stakeholders from various sectors.

The abundance of networks helps with knowledge transfer, but one must know which network is most suitable to access the needed information.

Sweden

- There are several associations through which stakeholders are connected, the most pronounced being Swedish Water.
- Concerning AMR, the association Strama works for a responsible use of antibiotics and their work has resulted in Sweden having a comparatively restrictive use of antibiotics.

France

- There are many professional networks in the water sector – each dedicated to a different category of stakeholders: networks for the local authorities and water managers, research networks, networks for the water industry sector, etc.
- No network is solely focused on aquatic pollutants.

Cross-national perspectives

- AMR and pathogens are managed for some years by dedicated organisations or networks in Germany and Sweden. In France, an AMR dedicated network has very recently been launched.
- The NORMAN network is composed of more than 80 universities, research institutes, and agencies. It coordinates interlaboratory comparisons, promotes collaborative research projects and maintains database infrastructure for prioritization of emerging contaminants, concentrations in environmental compartments, substance and (eco)toxicity data, mass spectra, digitalized archiving of sample raw data, etc.

2.1 Methodology for Stakeholder Identification, Mapping & Analysis

The stakeholder mapping activity followed an iterative process to ensure that all sectors of the stakeholder environment were identified. A detailed description of the process is provided in Annex 1 "Guideline for Stakeholder Mapping". This can also be used as a separate tool for future projects when conducting stakeholder identification.

Based on desk research and the expert knowledge from the TransNet consortium and the AquaticPollutants projects, an initial list of stakeholders was created for Germany, Sweden and France. The compilation was done via an Excel Spreadsheet, containing columns to classify stakeholders according to their roles (producers, problem owners, actors in characterization and risk assessment, solution designer, solution provider, regulators for permission and control), the type of aquatic pollutants they deal with (CECs, AMR, pathogens), and their organisation sectors (public, private, different economic sectors). The list was completed with information received during bi-lateral stakeholder interviews (see Chapter 3).

This list was analysed to determine relationships and connections among and between the stakeholders and professional networks. The resulting stakeholder maps summarize the various actors in umbrella terms (e.g. industry, water utilities) and place the stakeholders according to their role (e.g. producer, problem owner, etc.).

Templates were used to list the stakeholders and to analyse their relationships and memberships in various professional networks. The stakeholder mapping is therefore comparable over the three countries (Germany, Sweden, France) and the EU.

The stakeholder identification process was conducted internally by the respective TransNet partner (i.e. German, Swedish and French partners). The directories were used to identify key stakeholders and to understand the overall national water sectors. The directories are considered confidential and are therefore not included in this document. However, the following sections outline some of the major actors in each of the national contexts, providing a better understanding of the interaction and communication among the various groups.

2.2 Stakeholders & Networks – Sweden

In Sweden there are many different actors in the field of aquatic pollutants. Sweden is a precursor EU country regarding these issues. The stakeholder map (see Figure 2-1) for Sweden was created mainly through knowledge within the TransNet project and then completed with stakeholder interviews.

Among stakeholders involved in aquatic pollutants, not all actors interact with each other. For example, the private companies and the municipal water works are affected and controlled by legislation as well as policy and strategies, which the national authorities are responsible for. Swedish environmental goals are a guide for the Swedish environmental work and define which environment Swedish policy should steer towards.

The **Swedish EPA (Naturvårdsverket)** is the national public authority that oversees the environmental monitoring and follows up the environmentally hazardous activities. There are many other national public authorities which are also involved in aquatic pollutants in different ways, all with different perspectives but mostly from a policy one. These are for example: **Swedish Medicinal Products Agency (Läkemedelsverket), Swedish Agency for Marine and Water Management (HaV)** and **Geological Survey of Sweden (SGU**).

The management of Swedish water bodies is divided into five water districts, and these are governed by regional Water Authorities, led by regional governments. **Swedish Agency for Marine and Water Management (HaV)** and **Geological Survey of Sweden (SGU**) support with guidance and regulation concerning surface water and groundwater, respectively. In each of these districts, networks of many actors in collaboration with Water District Boards and Water Councils contribute in setting goals, implementation of remediation measures and in monitoring. The management is performed in cycles of six years consistently with the EU WFD. The County Administrative Boards and municipalities also collaborate to reach the set goals.

An essential part of the aquatic pollutant issues is addressed by the water networks. The water authorities and the water district boards are large networks of actors working together with water related issues. **Mälaren's water management association** for example consists of about 60 member organizations and have set objectives towards a cleaner and healthier water and good ecosystem in Lake Mälaren. Another important network regarding AMR is **Strama, a network aiming for a responsible use of antibiotics.** They have worked through the health care system for a long time and aim to reduce the effects of antibiotic resistance and the threat it poses. Strama has also branched out to include veterinaries and dentists and have been a key figure in Sweden low consumption of antibiotics.

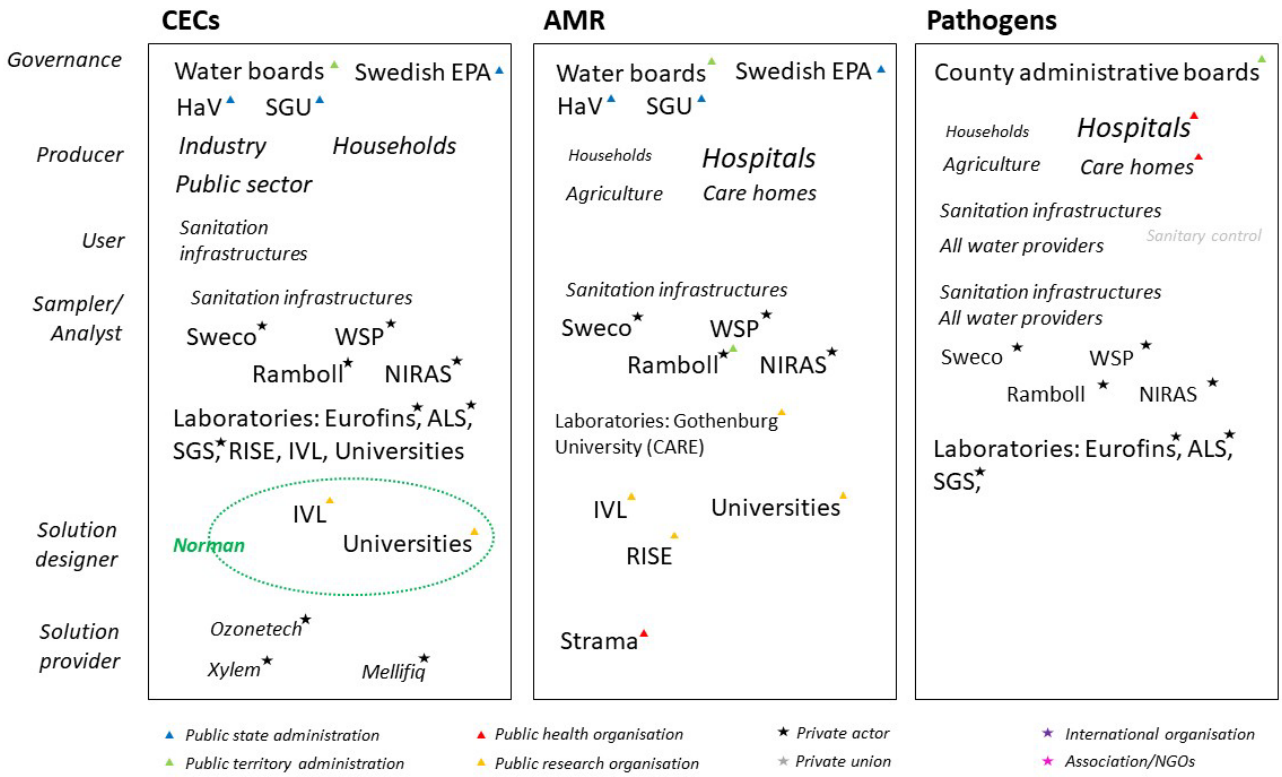


Figure 2-1. Explanatory map of Swedish water stakeholders.

Swedish water is also an important actor. They support municipal services on water issues by providing new knowledge, speaking on their behalf on a higher level and by advising them on regulation. The municipal water associations, gathering several municipalities are important actors responsible for wastewater. Solution providers are mainly private companies who help, for example, municipalities and water works to reduce pollutants in the water, according to directives and regulation. They provide purification techniques such as ozonation or construction of artificial wetlands and develop new

products to the market. Research institutes such as IVL and RISE also aid in both knowledge development and implementation of new solutions for reducing the release of aquatic pollutants from WWTPs. Several universities undertake R&D in advanced treatment methods for removal of aquatic pollutants and generate knowledge on the spreading of CECs or antibiotic resistance. The Center for Antibiotic Resistance Research (CARE) at Gothenburg University is one of the most established groups in Sweden concerning antibiotic resistance.

Municipalities and County Administrative Boards often use consultancy firms for sampling campaigns or implementation of remediation measures, such as the design of advanced treatment facilities. These consultancy firms may be small national or regional firms but also include large multinational firms. Environmental sampling and analysis are often carried out by consultancy labs, but chemical analysis or other services may also be performed by research institutes (IVL or RISE) or by university research groups, especially concerning CECs or antibiotic resistance genes.

Stakeholders mentioned several networks:

- National environmental monitoring (regarding CECs)
- International chemical secretariat, Chemsec (on CECs)[3]
- Expert groups on the implementation of EU directives
- WHO workshops on AMR[4]
- EU Parliament's AMR group and EU AMR One Health network[5]
- Antibiotic Collaboration, steered by the Swedish Public Health Agency and the Swedish Board of Agriculture on the spread of antibiotic-resistant bacteria and antibiotic resistance.
- Antibiotikasmart Sweden[6], an initiative led by RISE and the Swedish Public Health Agency together with the National Working Group Strama and ReAct. Three municipalities (Lund, Nässjö and Tanum) and four regions (Stockholm, Gävleborg, Jönköping and Västra Götaland) are also partners in the work.
- Strama is a voluntary network with the aim of preventing the spread of antibiotic-resistant bacteria to and within Sweden[7].
- Raf - the reference group for antibiotic issues[8]
- projects with SVA - the Swedish Veterinary Institute on the spread of AMR and pathogens between animals and humans SWAACS[9] – Swedish Academic Consortium on Chemical Safety (previously SweTox) is an association of 13 universities that strive to limit risks from chemicals.
- Samtox[10] - the coordination group for new chemical risks

[3] ChemSec – the International Chemical Secretariat – is an independent non-profit organisation that advocates for substitution of toxic chemicals to safer alternatives. Founded in 2002, ChemSec engages the work of chemists, political scientists, business experts and communicators, among others. The organisation is run with financial support from the Swedish Government, foundations, private individuals and other non-profit organisations. https://chemsec.org/

[4] https://openwho.org/channels/amr

[5] NV, the Swedish Board of Agriculture and the Swedish Public Health Agency participate in a steering group together with France and the Czech Republic to develop proposals for measures around AMR https://health.ec.europa.eu/antimicrobial-resistance/eu-action-antimicrobial-resistance_en

[6] https://www.antibiotikasmart.se/

[7] https://strama.se/

[8] https://www.sls.se/raf/

[9] https://www.swaccs.se/

[10] https://www.kemi.se/en/about-the-swedish-chemicals-agency/organisation/the-coordination-group-for-new-and-emerging-chemical-threats---samtox

2.3 Stakeholders & Networks – Germany

There are many actors involved in the water sector in Germany, spanning several levels of responsibilities in both the public and private sectors. The public sector includes the organisations and municipalities responsible for water regulations, water supply and wastewater treatment[11]. At the highest level, the **Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)** is responsible for setting regulations pertaining to the protection of water resources[12]. Germany has several other federal ministries, who operate in different areas of national water management with specific responsibilities. There are two ministries in particular that are most relevant in the context of this analysis. The **Federal Ministry of Health (BMG)** deals with drinking water supply within the healthcare sector. Meanwhile, the **Federal Ministry of Education and Research (BMBF)** coordinates funding for the majority of research initiatives within Germany, especially those addressing water research and water technology[13].

The federal ministries are supported by both federal authorities and research institutions. The **German Environment Agency (UBA)[14]** is under BMUV and collects and analyses data pertaining to environmental health, collaborates with state environmental and health authorities, and serves as an advisor to policymakers. UBA is an information hub concerning several thematic areas, including pharmaceuticals, biocides, and water management (drinking water and wastewater treatment). The provided resources include databases, publications, technical guidelines, stakeholder workshop summaries and more. Attached to UBA is the newly established **German Centre for Micropollutants (SZB)[15]**, which aims to bundle information and data on a federal level regarding the presence of trace substances in water. Among its responsibilities, the SZB organises "stakeholder dialogues" with various actors and hosts regular meetings of the "Panel for the Assessment of the Relevance of Trace Substances".

The various federal ministries and state authorities formed the **German Working Group on Water Issues (LAWA)** in 1956 to have a platform to discuss inter-state and joint water management laws. LAWA consists of five working groups: water law, groundwater and water supply, surface and coastal waters, flood protection and hydrology, and climate change[16]. Through its publications, LAWA informs the public about the working group findings and proposes measures for policy makers.

In Germany, most water management processes are regulated via a three-tier management structure, in which federal and state ministries implement overarching legislation and procedures, regional authorities help with planning, and municipalities and other local authorities are responsible for

[11] Association of Drinking Water from Reservoirs (ATT), German Association of Energy and Water Industries (BDEW), German Alliance of Water Management Associations (DBVW), German Technical and Scientific Association for Gas and Water (DVGW), German Association for Water, Wastewater and Waste (DWA), and German Association of Local Utilities (VKU) (2021): Profile of the German Water Sector 2020. Wirtschafts- und Verlagsgesellschaft Gas und Wasser mbH. Published January 2021.

[12] BMU/UBA (Hrsg.) (2017): Wasserwirtschaft in Deutschland. Grundlagen, Belastungen, Maßnahmen. Umweltbundesamt, Dessau-Roßlau.

[13] BMU/UBA (2017).

[14] UBA (2018). Was wir tun, https://www.umweltbundesamt.de/das-uba/was-wir-tun.

[15] UBA (2022). Spurenstoffzentrum des Bundes: Über uns, https://www.umweltbundesamt.de/spurenstoffzentrum-des-bundes-ueber-uns?parent=93380.

[16] LAWA (n.d.) Ständiger Ausschüsse, https://www.lawa.de/Ausschuesse-361.

permitting and monitoring, including that pertaining to hazardous substances[17]. Municipal authorities and suppliers may work together via *Zweckverbände* (administration unions), which are also considered public institutions[18]. One example is the **Association for Regional Water Supply (Zweckverband Landeswasserversorgung),** a large long-distance water supply company in southern Germany. As a drinking water supplier, they are controlled by local health authorities and interact with other water suppliers and research organisations through their analytical service lab, where they analyse samples for various trace substances using non-target analysis[19]. As another example, the **Wolfsburg Drainage Works (Wolfsburger Entwässerungsbetriebe)[20]** is responsible for wastewater disposal and water maintenance in Wolfsburg and surrounding areas. At the end of pipe, they have a direct connection to the discharge of wastewater into the environment and research new technology systems that can be used to remove aquatic pollutants, including pharmaceutical residues.

In addition to the associations of municipalities, Germany has several technical scientific associations made up of not only scientific organisations, but also political ones at the federal, state and municipal levels, who develop recognized technical guidelines[21]. The **German Association for Water, Wastewater and Waste (DWA)** is an association with approximately 14,000 members from municipalities, universities, engineering firms, public authorities and private companies[22]. Via its more than 350 expert working groups, the DWA serves as a resource for information regarding regulations, events, new technology, and their applications. Additionally, DWA publishes various monthly magazines, two of which are especially relevant for this project – *KA Korrespondenz Abwasser, Abfall* and *KW Korrespondenz* Wasserwirtschaft – which are considered important dissemination mediums for the German water sector. The **German Technical and Scientific Association for Gas and Water (DVGW)** is another example and interacts with federal authorities such as BMUV and BMG, establishing standards for gas and water supply, including water protection. DVGW has their own laboratories and therefore also plays a role in advancing policy, combining their research activities with their other standard-setting and policy-advising functions. They established a list of trace substances that should be addressed via regulations[23] and organised their own stakeholder dialog, Wasser-Impuls[24], to determine calls of action for policymakers.

These associations often span several sectors via either their members or their outreach/collaboration activities. DWA and DVGW are considered important information sources regarding new innovations and developments and most of the interviewed stakeholders were members in either one or both DWA and DVGW. Researchers and academia are also members of these associations and make up a key component of the German water sector. The research sector includes not only universities, but also research institutions, such as the **DVGW Water Technology Centre (TZW)** and the **IWW Water Centre**.

Another important association is the **German Institute for Standardization (DIN)**[25] and its **Standards Committee Water Practice (NAW)**, which is composed of water users, the public sector, industry and

[17] BMU/UBA (2017).
[18] ATT, et al. (2021).
[19] Landeswasserversorgung Stuttgart (n.d.). Unsere Dienstleistungen für Sie, https://www.lw-online.de/unternehmen-dienstleistungen.
[20] WEB (2021). Das Unternehmen, https://www.web-wolfsburg.de/.
[21] BMU/UBA (2017).
[22] DWA (n.d.). Über uns, https://de.dwa.de/de/die-dwa.html.
[23] DVGW e.V. (2022a). Spurenstoffe und Arzneimittel, https://www.dvgw.de/themen/wasser/ressourcenmanagement-und-gewaesserschutz/stoffe-und-arzneimittel.
[24] DVGW e.V. (2022b). Wasser-Impuls: Dem Wasser seinen Wert zurückgeben, https://www.dvgw.de/themen/wasser/wasser-impuls.
[25] DIN e.V. (2022). DIN Standards Committee Water Practice, https://www.din.de/en/getting-involved/standards-committees/naw.

research institutions and is responsible for providing input to European and international standardization.

While some water supply and wastewater treatment organisations can be privately managed[26], private companies play a more significant role in other areas of the aquatic pollutants "ecosystem". Private companies often provide the technology development for implementation in water treatment, monitoring, etc. They collaborate with research institutions and universities, oftentimes through BMBF-funded projects, to develop needed tools based on new research. Their impetus for development comes from client requests and thus their work is oftentimes closely tied to current requirements or emerging trends in the water sector. The different associations mentioned earlier, as well as the **German Water Partnership (GWP)**, offer a platform for exchanges between the private and public sector.

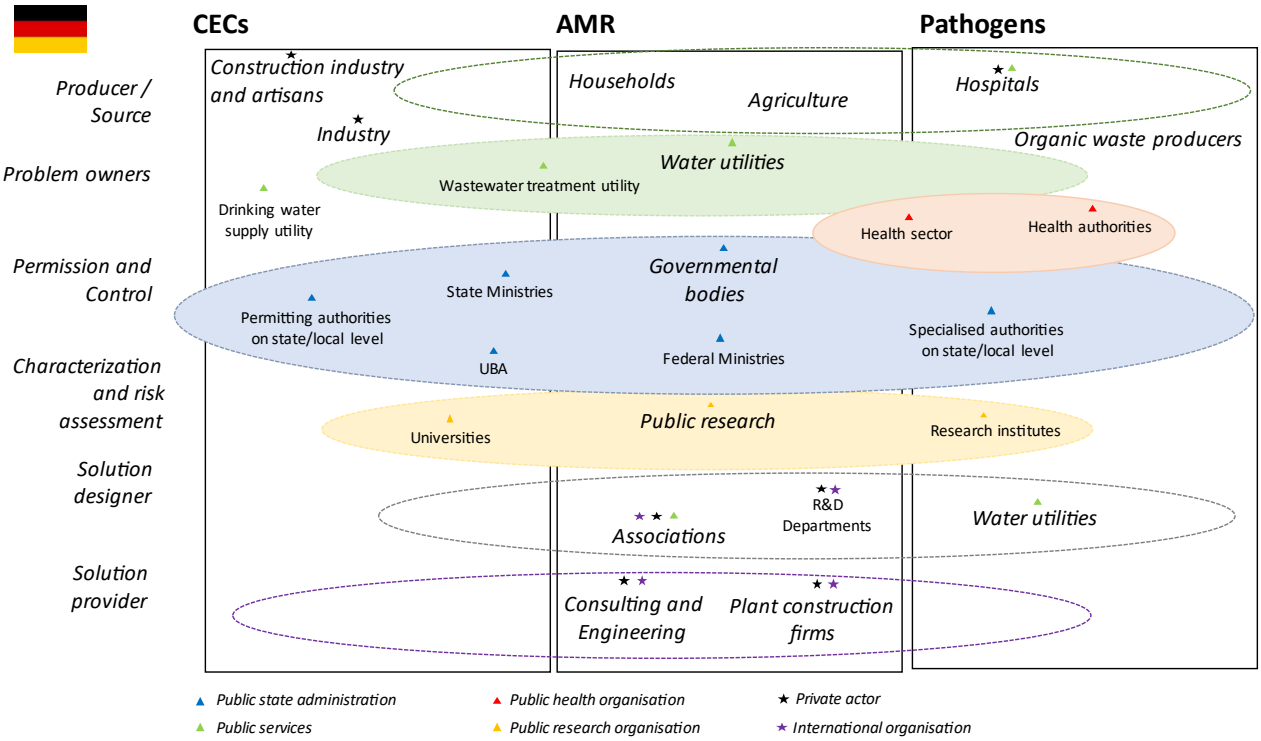


Figure 2-2. Explanatory map of German water stakeholders. General stakeholder groups (e.g. industry, universities, etc.) are listed with large text, whereas examples of specific organisations/companies are provided with smaller text. The oval groupings indicate where stakeholder groups are the same across substance group.

To further elaborate on the stakeholder environment in Germany, we conducted several interviews with actors from associations, authorities, utilities and the private sector in the field of aquatic pollutants (see Chapter 3). The key actors mentioned during these interviews were grouped into broad stakeholder categories (e.g. water supply utilities, governmental bodies) and organized according to their roles within the aquatic pollutants "ecosystem" (e.g. problem owners, solution providers) as depicted in Figure 2-2. The figure shows that the key German water actors are concerned with all three substances (CECs, AMR and pathogens) and differences occur only between the producers of potential pollutants in the aquatic ecosystem. Governmental bodies on the different levels play a crucial role for the permission and control matters concerning aquatic pollutants and are also involved in characterization and risk assessment, for example via environmental agencies. Public research institutions and universities are mainly involved in the design of solutions while private companies,

[26] ATT, et al. (2021).

such as consulting and engineering companies, provide solutions on the market. Located at the end of pipe, water utilities are classified as problem owners but are also involved in providing solutions via their treatment and analysis services.

Several networks exist in Germany. Moving from general to specific, stakeholders listed technical committees, water boards, research projects, public authorities, and European networks as players in information and knowledge exchange. Specifically named are networks such as the **European Chemicals Agency** (ECHA), **European Federation of National Associations of Water Services** (EurEau), **Water Chemical Society** (GDCH), **Health Canada**, **UBA**, **DVGW** and its working groups, **DWA**, **German Centre for Micropollutants** (SZB), and the **Competence Center Trace Substances Baden-Württemberg** (KomS). DVGW is closely connected to European networks, such as EurEau, bridging the gap between technical analytical work and political processes. At the national level, there is an exchange between operators and members of various associations.

2.4 Stakeholders & Networks – France

In France, there are many interconnections between the different actors in the field of aquatic pollutants. Some public institutions appear to be particularly central.

Firstly, the **OFB** (French Office for Biodiversity, *Office Français de la Biodiversité*[27]) is the public office for the conservation and restoration of the environment. It plays a central role in the field of aquatic pollutants. The OFB interfaces research activities and the public authorities. The OFB is also in charge of funding (along with ANR[28], ANSES[29], water agencies[30], etc.). All the actors interviewed had, at one time or another, dealt with the OFB, and ranked it high on the issue of aquatic pollutants on the national scale.

In France, the aquatic pollutant field is supported by commercial and industrial public establishments. **INERIS** (The French National Institute for Industrial Environment and Risks[31]), which studies the technological risks potentially threatening the environment, health or human assets, and supports public policies under the supervision of the Ministry of Environment. INERIS is a technical expert for industrial substances in all the environment compartments (including water). **BRGM** (French geological Survey[32]) which studies and manages risks related to soils and sub-soils. BRGM is specialized in water quality and quantity (groundwater and surface water) and supports public policies on aquatic pollutants. **Aquaref** (National reference laboratory for aquatic media monitoring[33]) is a consortium of public institutions (INERIS, BRGM, INRAE[34], Ifremer[35], LNE[36]), partly financed by the OFB and in charge of developing tools and guidelines to monitor water quality and support the implementation of the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). For the other actors in the field (both public and private), Aquaref plays the role of technical and methodological

[27] https://www.ofb.gouv.fr/
[28] National agency for research, is the authority that manages funds for public research in France https://anr.fr/fr/
[29] National agency for health safety - https://www.anses.fr/fr
[30] https://www.lesagencesdeleau.fr/les-agences-de-leau/les-six-agences-de-leau-francaises/?lang=en
[31] https://www.ineris.fr/en
[32] https://www.brgm.fr/en
[33] https://www.aquaref.fr/
[34] National Institute for Agriculture, Food and Environment - https://www.inrae.fr/en/about-us
[35] French research institute on marine issues - https://wwz.ifremer.fr/
[36] National Laboratory - https://www.lne.fr/en

reference in terms of monitoring aquatic environments. The reference laboratory is thus connected to all the public organizations and participates in the feedback to the authorities of improvements in terms of monitoring on the national territory. The missions of these different institutions are complementary, particularly in their support to public policies.

The **water agencies** and the **water offices** (in overseas territories) are privileged operational actors for a certain number of other end-users, who take part in their events or training courses to acquire knowledge and expand their professional network. The water agencies also play a role in financing several technical programs, from which local authorities and companies marketing a particular technology can benefit.

The **ministerial departments** mobilize specialized technical experts to inform public decision-making. There are several ministries involved (environment, health, research, economy) with known struggles to establish partnerships, common visions or joint tools. However, in each domain, the Ministry officers have many connections and are active in the networks, thus being able to solicit expertise as needed. Working groups are coordinated at the national level, and their work flows out to the rest of the institutions. The French **regional governments** may also play a role in funding research of projects on aquatic pollutants.

The **private companies** that were easier to identify are the ones providing solutions to treat water to remove pollutants, or that are specialised in the development of monitoring devices. Some private laboratories are also working closely with the public institutions to analyse the water samples. The chemistry industry was harder to approach, therefore, the producers of biocides have not been listed and mapped.

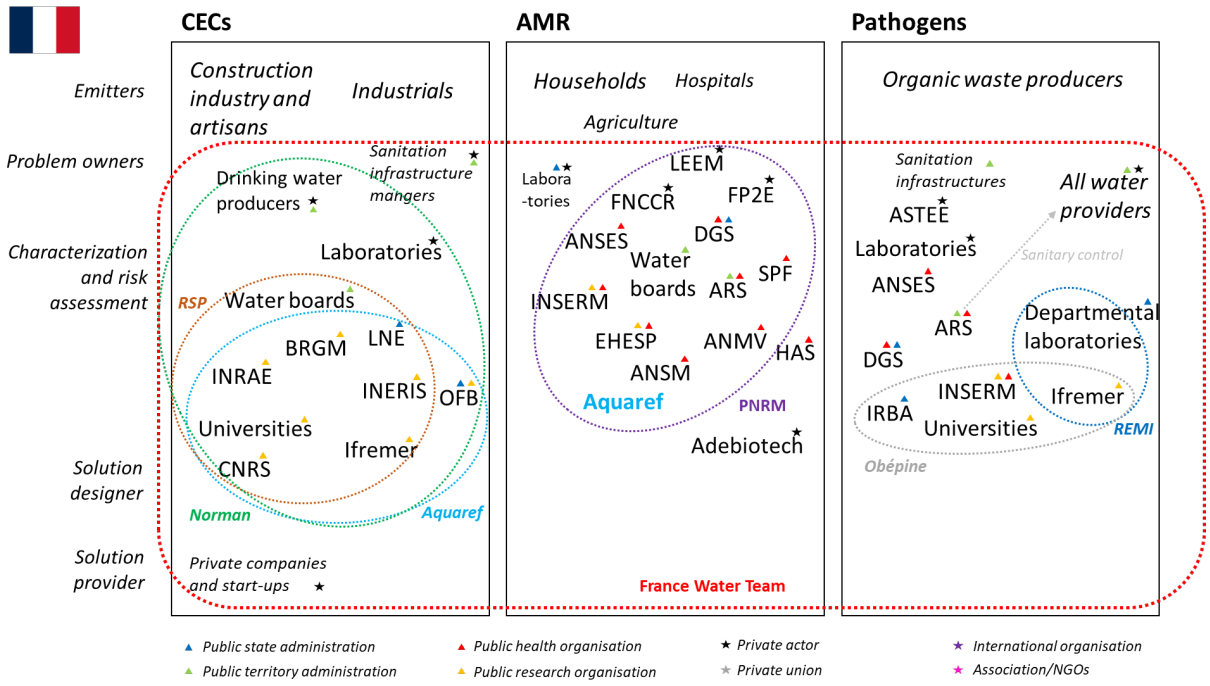


Figure 2-3. Explanatory map of French stakeholders in aquatic pollutants.

Several types of networks can be distinguished:

- **The operational networks of actors**, which exist at the regional and national levels, often in an associative form. These associative networks include local authorities as well as private sector companies and research institutions among their members. This is the case, for example, of GRAIE (Groupe de Recherche, Animation technique et Information sur l'Eau)**,** whose vocation in water management is to be a resource center on sustainability, a research/operational interface, to lead technical networks, conferences, projects, etc. Several networks with similar functions exist on the national territory, including: **ASCOMADE, AMORCE, FNCCR**. These organizations are generally partners of each other and tend to share, in an informal way, the monitoring information. For the other actors in the sector, who may be involved in several networks, it becomes difficult to distinguish them and to assign them a clear and unique role.
- The France Water Team (FWT) consists of various clusters throughout France: the **DREAM** cluster in Orleans, **Aqua-Valley** in Montpellier and **Hydreos** in Nancy. It is a water industry competitiveness cluster, which enables to better support the innovation and growth objectives of water actors in France, Europe and internationally, and to develop a better interface with institutional actors at these three levels. FWT aims to promote the deployment of certain technologies, whereas GRAIE and its associative networks aim primarily to change practices and integrate certain issues into public policies. The competitiveness cluster produces various sources of information and news for its members (private sector and research institutions), as well as tools for connecting network members. More or less important organizations may be involved, from international groups such as Veolia (the cluster's leader) to small companies such as those interviewed in TransNet.
- Under the French Priority Research Programme on Antimicrobial resistance, a Professional community network on antimicrobial resistance (**PROMISE**[37]), have been created in 2021. This network has been launched in line with the One Health Community on Antibiotic resistance and is meant to be a unique place gathering professionals and academics from all sectors (42 42 academic partners and 21 existing French professional networks). Its ambitions are to 1) provide a platform for data interoperability, 2) develop a strong one-health vision and 3) strengthens the knowledge and skills of the meta-network members.
- **Scientific networks are numerous** and more or less official. Most of them are informal and consist of direct exchanges between researchers. Mentioned as a source of knowledge by several actors, the **Norman network** aims to disseminate knowledge between different actors working on emerging contaminants. It is a research project initially financed by the European Union, now perpetuated as a network of actors led by INERIS. Mainly researchers from European public institutions participate, but some researchers from industry are also involved.

Other networks exist (in addition to the ones described above) both nationally and internationally, too many to list in full, but a number were mentioned by the actors interviewed. In France: ASTEE, national plans (PNRM, Micropollutant Plan), Rhone basin workshop area, Axelera, France Eau Biosurveillance. No network has been identified for marine waters specifically.

2.5 Stakeholder Networks in Europe

European-level and international institutions such as the **European Commission**, **International Water Association**, and the **World Health Organisation** have missions spanning a very wide range of topics,

[37] https://www.rencontressantepubliquefrance.fr/wp-content/uploads/2021/05/0-PLOY.pdf

including emerging pollutants or AMR. **NORMAN**[38] is the worldwide network of reference laboratories, research centres and related organisations, for monitoring of emerging environmental substances.

In addition to the Member States and national organization representatives in the EU institutions, we identified five working groups with specific missions on aquatic pollutants in Europe:

- **European Environment Agency (EEA)** is responsible for the consolidation of the mandatory reporting by the MS to the EU
- **European Topic Center (ETC) "Inland, Coastal and Marine" (ICM) Waters**[39] works under the supervision of EEA to produce outlooks and summaries of the data reported to the EU as well as other data collections (national ones, NORMAN, …)
- **Water Europe's "Zero Pollution" Working Group** is a professional network to share knowledge among water managers and enhance collaboration. The WG also influences the research and political agenda, provide state-of-the-art knowledge to EU officials and writes "white papers"
- **Water Reuse Europe**[40] is an association to promote the reuse of wastewater in Europe, advocate for better laws framing water reuse and supporting its members in the development of reuse technologies
- **EurEau**[41] is the federation of 30 national networks in the drinking and wastewater sectors, campaigning for the polluter-pays principle and a strong control of the production and use of aquatic pollutants in the EU. This is also a platform to exchange knowledge and experiences on innovative solutions, tools and technologies.

2.6 Comparison Between Countries

There are large numbers of stakeholders, from the local to the national level, involved in the topic of aquatic pollutants. In each country, there are several organisations involved respectively with regulation and policy, production of substances, monitoring and analysis, water treatment, etc. In all three countries studied, the water sector is fragmented, often with small-scale units for providing drinking water to the populations or dealing with wastewater treatment.

In France, the management of aquatic pollutants is centralised at the national level, though several ministries are involved. In the other countries, there is a lack of central authority regarding aquatic pollutants. However, AMR and pathogens are better addressed by specific institutes or work groups or networks in Germany and Sweden than in France. However, in France, a professional community network on antimicrobial resistance (PROMISE) was very recently launched late 2021.

There are barriers between the private and public sector in all three countries, which translates into poor communication and cooperation. However, this situation does not seem to be institutionalized, meaning there is a willingness to collaborate across sectors if opportunities arise (i.e. via funded projects). In the stakeholder mapping exercise and interviews, it was hard to identify and contact representatives from the private sector to get their opinion on the poor links with the public sector.

[38] https://www.norman-network.net/
[39] https://www.eionet.europa.eu/etcs/etc-icm/contact-us
[40] https://www.water-reuse-europe.org/
[41] https://www.eureau.org/

3 Synthesis of Stakeholder Demands for Knowledge

Once the stakeholder directories were in place and the relevant actors identified, the consortium organized interviews in order to contribute to 1) the understanding of the stakeholders' roles (see Chapter 2), 2) the evaluation of the available knowledge and the knowledge gaps, 3) the identification of currently applied knowledge transfer tools, and 4) the characterization of the regulatory demand regarding CECs, AMR and pathogens.

Stakeholders with whom interviews were undertaken were selected by considering a balance between the different stakeholder groups (public, private) and roles (problem owner, source of pollution as producer or user of substances, technology designer, etc.). Stakeholders were selected by TransNet partners according to national specificity.

Key Findings

Knowledge Demands

Germany

- Almost all sectors have knowledge demands for treatment and mitigation techniques.
- A specific demand from the public sector relates to data sharing for the registration process of chemicals and substances: more information from other sectors is needed.
- The network of aquatic pollutant stakeholders, consisting of associations and organizational networks, is the key communication channel.

France

- Improvement of monitoring is a shared concern that each actor tries to solve with its own skills.
- There are many initiatives to transfer knowledge in a wide range of formats.
- Communication remains difficult in between the categories of actors involved.

Sweden

- There is not enough coordination of the monitoring that is done within Sweden.
- Dysfunctions have also been noted on the low level of control over what substances may be placed on the market, with consequences for the environment and health.
- Social drivers and behavioural change are a new field to investigate.
- The language barrier has been mentioned as the reason of difficulties to get comparative information across countries.

Europe

- Persons interviewed did not report knowledge gaps but rather current topics on the agendas: microplastics and nano-plastics, AMR, toxicity of compounds mixture, influence of physical parameters on the becoming of chemical pollutants, management of the PFAS pollution, reuse technologies and nature-based solutions.
- They regret the lack of information available in the EU databases about the real uses of substances for human activities nor the exposure pathway to the environment.
- The lack of homogeneity among the EU countries, as well as the long delay to access the data are perceived as the main barriers to act.
- There is no database to retrieve information about the presence of antibiotics in the environment, or the monitoring of micro- and nano-plastics.
- In terms of sources of information, the connection to experts is central, as well as knowing about the research projects funded by the EU. Up-to-date information can also be accessed through literature reviews produced by PhD students and through social media.

Cross-national perspective

- Monitoring needs to be improved to make it consistent, permanent, reliable and comparable.
- Several stakeholders mentioned that the sheer amount of information or knowledge available on CECs, AMR and pathogens is what inhibits knowledge transfer, not the lack of it.
- The wealth of information can be misleading unless you are already active in the right networks, know the right persons or have experience navigating the official databases. Centralizing this knowledge and disseminating it more efficiently is a central need for improvement.
- A common knowledge gap has been identified regarding the toxicity of substances (and cocktail mixtures) in the environment.
- Knowledge gaps have been reported on the information pertaining to hazardous substances (PFAS at the top of the list) or AMR and associated risks.
- Stakeholders from all sectors stated knowledge gaps concerning measuring, analysing and characterizing substances in aquatic systems such as the need to define assessment parameters and indicators and analytical methods to detect substances at low concentrations and new chemicals/substances.

3.1 Methodology for Stakeholder Interviews

The interviews were used a semi-structured method, which means that an agreed-upon list of questions was used as a guide (for the sake of consistency and comparability) but the interviewer was free to arrange the questions in a different order, skip questions irrelevant to the person being interviewed, ask additional questions to elaborate on an answer, or reformulate the questions if needed. Training material on performing semi-structured interviews was shared within the consortium. The list of interview questions along with the interview guidelines is available in Annex 2.

The interviews were carried out in the national language, with a few exceptions when the expert chose to perform the interview in English. All interviews were held online (phone or web conference platforms) and lasted about one hour. An introductory email was also shared as a template, to explain our project and the goals of the interviews. Data protection was essential (an explanatory document was shared with contacted persons prior to the interviews in Germany). The interview answers were anonymised.

Notes were taken by the interviewer during the discussion and reported in an excel table to allow for analysis and cross-referencing over several interviews. Some partners preferred to translate the answers before reporting them in the excel table.

3.2 Stakeholder Demands – Germany

3.2.1 Panel of Actors Interviewed

In Germany, over 150 stakeholders were identified whose work in some capacity relates to CECs, pathogens and/or AMR. The identification process was conducted by DECHEMA e.V. who, as a leader of the "Industrial Water Management" expert group and as organizer of several water-related conferences, is part of an extensive network of experts across the water sector. Additional input was provided by ISOE, who has developed contacts through their various workshops and project consortia.

Out of the 150 identified stakeholders, a total of 72 were contacted for an interview. This narrowing down was conducted based on several factors: stakeholder's field of expertise within the water sector, closeness to other stakeholders in terms of past or current collaboration, and perceived readiness to participate in an interview. The main goal in selecting stakeholders to interview was ensuring that all organization statuses and roles were covered and that all three aquatic pollutant classes were addressed (i.e. CECs, pathogens and AMR).

From these 72 requests, AquaticPollutantsTransNet conducted 18 interviews. We noticed that those stakeholders who had a closer relationship with DECHEMA or ISOE were more likely to 1) respond to the email request and 2) agree to an interview. The success rate with stakeholders with whom DECHEMA or ISOE had had no previous contact was noticeably lower.

Of those interviewed, 14 stakeholders are in the public sector, two stakeholders operate from the private sector and two represent private not-for-profit associations. For data protection reasons, the name of the respondents and their organizations will not be mentioned but it will be referred to them by their role. In the public sector, AquaticPollutantsTransNet interviewed five operators (Operator A-E), covering both wastewater treatment and drinking water supply. Of the four public authorities (Authority A-D), two are state level environmental authorities, one is a state-level authority responsible for water management and other tasks, while another one acts on the federal level. AquaticPollutantsTransNet interviewed four research/academic organisations (Research A-D), covering different disciplines, including hydrobiology, sanitary engineering and water pollution control, animal physiological ecology, and water and wastewater treatment. In the private sector, we interviewed a provider of innovative water technologies and solutions (Business A), and the Environmental Management Division of one of the largest pharmaceutical companies in the world (Supplier A). We also interviewed two German not-for-profit associations (Associations A-B). One serving as a central resource for research and development, testing and analytics among others. The other supports the research and implementation of membrane technology for various applications.

Table 3.1 provides a summary of the interviewed stakeholders, including their specific fields of work, their role within the aquatic pollutants ecosystem and the compounds and environmental media they focus on.

Table 3-1. Summary of conducted interviews with German stakeholders. The stakeholder organisations have been anonymised for their data protection.

Sector	Name in Deliverable	Interview Date	Status	Field of Work	Targeted Compounds	Role regarding Aquatic Pollutants	Targeted Environmental Media
Operator	Operator A	13.04.2022	Public	Wastewater disposal, water maintenance, precipitation management Specifically: investment plans, strategies, citizen services, technology assessment	Regulated (pathogens, biocides) and non-regulated (CECs, AMR)	Problem owner: end-of-pipe Solution provider: water treatment	Wastewater, rainwater
	Operator B	20.04.2022	Public	Drinking water supply - Analytical chemist in laboratory for operation control and research, focusing on new contaminants & organic micropollutants	Regulated (pathogens, biocides) according to the Drinking Water Ordinance and non-regulated (CECs, AMR)	Problem owner: end-of-pipe Solution provider: water treatment	Drinking water, surface water
	Operator C	26.04.2022	Public	Drinking water monitoring & analysis, research & development	Regulated substances	Problem owner: end-of-pipe	Drinking water
	Operator D	09.05.2022	Public	Drinking water and service water production, wastewater treatment Specifically: Asset management and strategic planning	Regulated substances	Problem owner, solution designer, solution provider	Fresh groundwater, drinking water, municipal wastewater
	Operator E	20.05.2022	Public	Wastewater treatment plant operator, water management & chemical engineering studies	Regulated (pathogens, biocides) and non-regulated (CECs, AMR)	Problem owner: end-of-pipe Solution provider: water treatment	Fresh surface water, wastewater
Authority	Authority A	13.04.2022	Public	Surface water quality monitoring and assessment, supporting regional authorities with decision making, designing recommendations & guidelines, supporting implementation of the 4th treatment step	Persistent organic micropollutants, CECs, biocides	Permission & control, characterization, risk assessment; solution provider (treatment measures)	Surface water, groundwater, drinking water wastewater, industrial wastewater
	Authority B	26.04.2022	Public	Division Director with focus on circular economy, soil	CECs; pathogens; natural,	Regulator, permission & control	Groundwater, drinking water

Sector	Name in Deliverable	Interview Date	Status	Field of Work	Targeted Compounds	Role regarding Aquatic Pollutants	Targeted Environmental Media
				conservation, groundwater management, permission & control	anthropogenic, radioactive substances, heavy metals		
	Authority C	28.04.2022	Public	Toxicologist in Department of Drinking and Swimming Pool Water, conducting chemical & toxicological evaluations	Regulated substances	Permission & control, risk assessment	Drinking water, swimming pool water
	Authority D	16.05.2022	Public	Point of contact for authorities, laboratory analysis	All regulated substances in the German Drinking Water Ordinance	Permission & control	Groundwater
Business	Business A	25.04.2022	Private	Research & development for products, technologies, and applications	Trace substances, micropollutants, PFAS, pharmaceuticals, endocrine disruptors, CECs	Solution provider: development of technologies	Wastewater, industrial wastewater, drinking water
Supplier	Supplier A	05.05.2022	Private	Environmental manager responsible for monitoring environmental emissions; close cooperation with wastewater treatment plant at the chemical park	REACH-regulated substances and federally mandated discharge limits	Producer of pesticides	Industrial wastewater, crop protection & agriculture
Healthcare	Healthcare A	27.04.2022	Public	Division on water & environment, conducting analytics for hygiene & water chemistry	CECs - especially antibiotics, AMR & pathogens	Characterization, risk assessment, advisory support for authorities & water suppliers	Surface water
NGOs/ Associations	Association A	23.05.2022	Private non-profit	Technical rules and regulations for water protection, target & non-target analyses	Regulated (pathogens, biocides) and non-regulated (CECs, AMR)	Solution provider: water treatment	Drinking water, wastewater
	Association B	26.04.2022	Private non-profit	Consulting & research, focus areas of water, flocculation & membranes	Organic micropollutants	Solution designer	Groundwater, surface water, wastewater, drinking water
Research,	Research A	20.04.2022	Public	Research, knowledge transfer and consulting for	Regulated (pathogens, biocides) and	Solution designer, characterization	Wastewater, groundwater, surface water

Sector	Name in Deliverable	Interview Date	Status	Field of Work	Targeted Compounds	Role regarding Aquatic Pollutants	Targeted Environmental Media
				external expert groups	non-regulated (CECs, AMR)	& risk assessment	
	Research B	21.04.2022	Public	Department of Soil Culture, Environmental Chemistry, Food, Biotechnology, research project management	Regulated (pathogens, biocides) and non-regulated (CECs, AMR)	Solution designer, characterization & risk assessment	Wastewater, surface water
	Research C	26.04.2022	Public	Research focus on environment & resource use, wastewater reuse, research & development	Regulated (pathogens, biocides) and non-regulated (CECs, AMR)	Characterization & risk assessment, solution designer	Municipal wastewater, drinking water
	Research D	17.05.2022	Public	Antibiotic resistance in the wastewater treatment sector and associated impacts on environment and health	Regulated (pathogens, biocides) and non-regulated (CECs, AMR)	Solution designer, risk management	Fresh water, aquatic bacteria (not fauna), municipal & industrial wastewater, drinking water

3.2.2 Knowledge Demand on Aquatic Pollutants

3.2.2.1 Knowledge Needs & Gaps

When analysing the interview responses, it is impossible to assign certain knowledge demands to specific sectors or even stakeholder organisations. For one, a total of 18 interviews does not provide enough data to contribute the opinions of an interviewed stakeholder as representative of that entire sector. Secondly, the knowledge demands that were identified were echoed across sectors in most cases – a stakeholder from a public authority may have expressed a knowledge gap that was also expressed by industry. Therefore, **the analysis of the knowledge demands from German stakeholders was grouped by broad category, rather than by stakeholder group/sector**.

Information pertaining to measuring, analysing and characterising compounds/substances

Almost every sector interviewed mentioned an interest in knowing more about micropollutants present in aquatic systems. This includes the measurement of pollutants in the environment, the analysis of pollutants in the lab, and the evaluation of their effect on the environment and human health. Researchers, operators, and public authorities alike are interested in defining parameters or indicators for the assessment of multiple substances in the aquatic environment (. Because of the large number of aquatic pollutants, it is difficult to measure for specific substances. The implementation of certain indicator values or the identification of indicator genes/bacteria could limit the effort required to test water quality and increase the amount of knowledge on present substances – where they occur, at what concentrations, and how pollutants interact with each other in aquatic ecosystems (Supplier A, Association B). Another need is the development of analytical methods to detect substances at low concentrations (Supplier A) and new chemicals/substances that were previously unknown and/or are not yet regulated (Operator B). Regarding specific pollutant classes, PMT substances (i.e. PFAS) and AMR were highlighted as areas where more information is needed (Research D, Operator B, Operator E, Authority C).

Multiple stakeholders also mentioned the need for information for the risk management of micropollutants (i.e. human and ecotoxicology assessments). Stakeholders stated that more information regarding the toxicity of substances would help to better regulate them, leading to more concrete limits and allowing targeted approaches. This was stated as a major knowledge gap by stakeholders in the public and private sector (Healthcare A, Authority A, Operator D, Supplier A).

Information pertaining to treatment & mitigation techniques

Again, almost all sectors interviewed mentioned a knowledge need pertaining to the treatment and mitigation of aquatic pollutants. The topic of sustainability in treatment came up several times during the stakeholder interviews. When developing advanced treatment options for the removal of micropollutants, operators, researchers, and suppliers are concerned with the environmental impact of various technologies, suggesting a desire for a comprehensive treatment approach that looks at the entire pollution chain. Further, Operator E stated that it would be helpful to identify the treatment efficiencies of existing and developing treatment technologies, to ease the selection and implementation process. Regarding developing technologies, one authority mentioned that the approval process of new technologies needs to be improved, enhancing knowledge transfer of new developments and their uptake.

Information pertaining to data sharing

One specific knowledge demand was mentioned by Authority C. It stated that data is not always available for all stages of the registration process of chemicals and substances. Industrial data may be restricted or confidential, or industries may be unwilling to share data with the public. As an example, Authority B mentioned that in the case of polyfluorinated compounds (class containing PFAS), information is often missing regarding what is contained in products with these compounds. This can make it difficult to establish regulations or to determine toxicity of substances. This data problem is not only between sectors, but also within sectors and even organisations. Data sharing represents a major challenge for water treatment, as well as a major trend (see the following section).

3.2.2.2 Identified Trends & Innovations

The stakeholders we interviewed stated that their work is largely driven by current regulatory requirements, but they also identified several regulatory demands that are currently missing or needed. Many of these regulatory demands can be linked to current trends or developments in the field of aquatic pollutants, new or emerging shifts in focus regarding research and policies. As the field of aquatic pollutants evolves, new demands for knowledge will simultaneously emerge to support this evolution. To better prepare for this future knowledge demand, we asked the stakeholders about current trends and innovations they have witnessed in this field.

- **Substance Analysis** – To cope with the large number of various micropollutants in aquatic ecosystems, there is a need to further develop non-target analytics (Association A, Business A, Operator E). Current analytical methods focus on micropollutants that are already under regulation. However, to test water bodies for additional substances requires robust non-target analytical measures. This would enable the determination of site-specific pollution and help to identify new or emerging substances and their sources. Developments in non-target analysis, including the incorporation of machine learning would provide a more complete picture of aquatic pollutants and help scientists in measuring non-regulated substances.

- **Treatment/Removal of Micropollutants** – A fourth treatment step in the water treatment process is emerging as an effective method to remove micropollutants. The question is which treatment technology, or combination of multiple, is best suited and what which locations.

Multiple stakeholders mentioned this as a development trend (Authority A, Operator C, Operator E, Research A, Research B and Supplier A), which includes technologies such as ozone treatment, activated carbon and nanofiltration. Authority A is already incorporating this advanced treatment step into various municipal wastewater treatment plants. One stakeholder mentioned the need to look at solutions to address the effects of combined sewer overflow on aquatic pollutants (Operator E). An additional development in the treatment of micropollutants is the need to analyse and determine the effects of climate change (e.g. droughts, extreme events) on the performance of water treatment systems (Operator B).

- **Risk Management** – As stated in Section 2.3, one regulatory demand identified by German stakeholders is the need for more toxicology assessment and understanding for micropollutants to better regulate them. This demand was also identified by several stakeholders as a current trend in this research field. As part of a BMBF-funded project "ToxBox", UBA and other project members worked on developing an approach for hazard-based risk management of trace substances. In a follow-up project "NeuroBox", UBA further investigated the neurotoxic effects of these substances. A future step would be to establish these approaches as accepted methods and strategies for them to be actively implemented. A related trend is the increasing application of the adverse outcome pathway (AOP) framework to help better understand adverse health effects from biological events (Research B).

- **Digitalization** – Operator B and Healthcare A stated there is a general trend towards digitalization occurring, which includes the sharing and interaction of data between institutions and advancements in measuring and analysis (i.e. on-site determination and remote operability).

3.2.3 Information Sources & Communication Channels

3.2.3.1 Acquiring New Knowledge and Information

The interviewed stakeholders drew a comprehensive picture of the network of actors and organisations that is largely responsible for the transfer and dissemination of knowledge and information. In fact, besides when there is an official notification about a major policy change, the networks of water stakeholders serve as the key communication channel. This information flow is largely made up of various associations and organizational networks and their various activities (see Section 0). Multiple stakeholders stated that they receive updates and learn new information thanks to **their networks**.

Beyond networks, the second most commonly stated source of new information/knowledge are the **two monthly magazines published by DWA** (*Korrespondenz Abwasser- Abfall* and *Korrespondenz Wasserwirtschaft*) and **scientific publications**. Additionally, organisational newsletters (e.g. WHO, European Food Safety Authority (EFSA)), public databases (e.g. UBA, REACH), and conferences (e.g. IWA events, Essener Tagung) were listed as sources of information. In fact, **several stakeholders mentioned that the sheer amount of information or knowledge available on CECs, AMR and pathogens is what inhibits knowledge transfer, not the lack of it.**

3.2.3.2 Knowledge Sources: Needs for Improvement

This leads directly to a problem with knowledge transfer identified by stakeholders. **Due to the extensive amount of new and emerging information on micropollutants, the processing and sharing of this information is not efficient.** Stakeholders mentioned it is both time and resource intensive to

sort through the many scientific publications, making it difficult to find needed information or be informed of developments. This is because there is no central processing of information and no centralized dissemination or automatic mechanism to receive information. Further, there is no prioritization of information or recommendation of information sources. Finding the appropriate information can therefore happen randomly, dictated by the networks a stakeholder is involved in, by the acquaintances one has or by the time one has for active searching.

- *Stakeholders' idea for improvement:* Create centralized public databases managed by a federal or EU-level agency to share information on new/emerging pollutants and AMR, such as the National Center for Biotechnology (NCBI) or European Molecular Biology Laboratory (ENBL) databases.

In addition to the surplus of information, **stakeholders also report that the communication and collaboration between organisations, sectors, and countries is oftentimes missing**. It can be that divisions within an organisation have access to different data or varying data access rights, highlighting that communication channels can fail even within organisations. At the sector level, many stakeholders stated there is a need for exchange between producers, environmental authorities and water suppliers. Each sector has valuable information or expertise for the protection of water resources, but a mediating structure or channel must exist to transfer this information. When exchange does occur, it is often time-consuming and behind the curve of development. For example, the communication between researchers or water suppliers and authorities is slow, which means regulators are often behind in publishing rules or guidance for new substances. Or, if new guidance is published, the notification of this is often not executed adequately. Overall, stakeholders reported a lack of transparency and interdisciplinarity. On an international level, one stakeholder mentioned the benefits of creating an exchange between countries to share expertise. This would also be helpful when transposing EU-level regulations to national legislation.

- *Stakeholders' ideas for improvement:* Local exchange and discussion groups could be organised via organisations such as DWA or DVGW, where experts from different fields could come together. To enhance exchange at the international level, EurEau is currently working on an Innovation Sharing Platform, which aims to be online this year. Further, a WHO Collaboration Centre could be established to exchange information, research and data regarding micropollutants.

3.3 Stakeholder Demands – Sweden

In Sweden, a total of 22 stakeholders were contacted for an interview, based on IVL expertise. Due to time limitations (within the project and of the contacted stakeholders), 9 interviews were conducted, covering a representative group of stakeholders according to their types, roles and field of expertise. The list of interviewed stakeholders is displayed below.

Table 3-2. List of organizations interviewed in Sweden to determine stakeholders' demands.

Sector	Organization	Inter-view Date	Status	Field of Work	Targeted Compounds	Role regarding Aquatic Pollutants	Targeted Environmental Media
Operator	Association for 11 municipals north of Stockholm (Käppalaförbundet) *Third largest treatment plant in Sweden*	21.06. 2022	Public	Strategies and planning; mostly Permission / control of (water related) operations / activities upstream issues and recipient responsibility, outgoing water.	CECs- based on the water directive. All hazardous substances and phase-out substances.	Producer of substances / Emitter - Wastewater plant, so there is emitting because not everything is purified. Solution designer Characterization and risk assessments	Domestic wastewater Industrial wastewater Aquatic fauna - based on the water directive.
	Municipal water company (Vivab) Varberg and Falkenbergs municipality	20.04. 2022	Public	VA issues and recycling, waste management.	Unregulated: on a pilot scale, reduction of bacteria from the treatment plant, reduction of other micro-pollutants, drug residues above all. CECs - The same pilot who removes other contaminants. AMR - Does not work directly but works to remove drug residues so it becomes indirect.	Producer of substances / Emitter Solution designer - for us not solutions for everyone. Process solutions.	Fresh surface water Fresh groundwater Drinking water Domestic wastewater Industrial wastewater

Sector	Organization	Inter-view Date	Status	Field of Work	Targeted Compounds	Role regarding Aquatic Pollutants	Targeted Environmental Media
Authority	Swedish EPA (Naturvårdsverket). Department of contaminants	07.06. 2022	Public	Environmental monitoring provides a basis for following up environmentally hazardous activities. Emissions etc. NV is also responsible for guidance for supervision of activities that affect the aquatic environment, treatment plants and industries.	CECs: Not regulated. Also, contaminants that are regulated.	Characterization and risk assessment /Regulator / Solution designer - Policy development - regulation of activities - emissions of pollutants that may emit to the aquatic environment. Polluted areas, with follow-up of condition in the environment.	Fresh surface water Marine water Fresh groundwater Brackish water Domestic wastewater Terrestrial fauna Industrial wastewater
	Swedish Medicinal Products Agency (Läkemedelsverket) Swedish Knowledge Centre on Pharmaceuticals in Environment (Kunskapscentrum för läkemedel i miljön).	08.06. 2022	Public	Strategies / Planning	Regulatory level. - government assignment to work with drug contamination. Reduce impact of the pharmaceutical environment. Start of pipe and end of pipe. Also involved in sludge management at policy level.	Characterization and risk assessment - Make risk assessments of effects from drugs. Most often in relation to water in recipient/Solution provider/ Regulatory policy-wide	All at an overall level.
Business	Nordic water Part of a Swiss company – Sulzer.	30.06. 2022	Private	Understanding of water purification processes, applications and functions development department and strategic decisions. Water treatment, movement of water, i.e. pumps, water management and wastewater management, including industrial water management.	Do not handle, but customers want to reduce these substances in their water. Often municipal treatment plants - in outgoing wastewater which is seen as pollution in government requirements.	Solution designer - for handling substances present in water. Water purification equipment. Solution provider	Fresh surface water Marine water (International markets - desalination production Fresh groundwater Brackish wate Drinking water Industrial wastewater

Sector	Organization	Inter-view Date	Status	Field of Work	Targeted Compounds	Role regarding Aquatic Pollutants	Targeted Environmental Media
Supplier	Xylem Water Solutions Supplier of equipment for water and sewage treatment plants and pumping stations. Provides services to products	01.07. 2022	Private	Key Account treatment: products around offers and purification. Transport = pumps. Treatment = filtration, aeration, stirrers, particle separation.	In the company but not in the role	Designs solutions - /Solution provider	Fresh surface water / Fresh groundwater/ Drinking water / Domestic wastewater Industrial wastewater (priority business area)
NGO/ Associations	Swedish water (Svenskt vatten)	18.05. 2022	Private non-profit	Industry organization for municipal companies. A corporation owned by an association of municipal water and sewerage companies.	Everything in different ways. The least with pathogens	Problem owner /solution provider	Fresh surface water / Aquatic fauna / Fresh groundwater / Brackish water / Terrestrial fauna
	Mälaren's water management association (Mälarens vattenvårdsförbund)	24.05. 2022	Public non-profit	Association with ca. 60 member organizations (municipalities/ treatment plants) around Lake Mälaren: county administrative boards, water councils, water management associations, water producers, regions and larger companies, the fishing association LRF and the Swedish Society for Nature Conservation.	CECs	Solution designer / Water resource manager / Solution provider / Characterization and risk assessment / Other: Environmental monitoring and follow-up - control and sampling of water pollutants.	Fresh surface water / Drinking water / Domestic wastewater /Industrial wastewater /Aquatic fauna

Sector	Organization	Inter-view Date	Status	Field of Work	Targeted Compounds	Role regarding Aquatic Pollutants	Targeted Environmental Media
	STRAMA Collaboration against antibiotic resistance, a network in Sweden that must exist in each region.	13.07. 2022	Public associa tion	Strama in region Västra Götaland and at national level.	Not at Strama (AMR)	Awareness of the risk of antibiotic release during production, has been clearly highlighted. Main task is to develop and bring forward treatment guidelines for bacterial infections to clinically active doctors.	Strama does not work with those issues. In research, wastewater, and resistance genes in lakes, etc.

3.3.1 Knowledge Demand on Aquatic Pollutants

3.3.1.1 Knowledge Needs & Gaps

Information pertaining to measurements and data hosting

The persons interviewed reported a lack in measurement protocols, and above all coordinated measurements. There is **not enough coordination of the monitoring** that is done within Sweden. Data from municipalities, companies, regions would be valuable if it would become more consistent and systematic. When "case studies" are designed for the goals of research projects or thesis, they are not done consistently to allow for historical or geographical comparisons, nor to perform a national-level overview. The chosen methods used for measuring are mainly chosen based on what best suits the researchers that are leading the case. Therefore, it is quite unsynchronized how monitoring is done from one place to another. Though it is stated clear from the EU level that monitoring shall be put in place, and which the basic criteria are, the roles and responsibilities for measurements remains unclear from a national perspective, as the government according to the respondents has not appointed anyone responsible for making the necessary analyses. It has been built on a voluntary basis and therefore it is not complete.

Problems have also been identified with the **quality of measurements** themselves **and data hosting** when dealing with environmental toxins, for example who owns what data and who should be responsible for managing it. In the absence of sufficient monitoring, no action can be taken, and no comparison can be made. Uncertainties in the measurements sometimes are too significant because the technology is not yet fully developed. Missing measurements are for example:

- environmental toxins in Lake Mälaren and neighbour flowing watercourses.
- impact of certain substances on ecosystems

Sometimes study results are based on only one set of sampling. There is also a lack of analytical methods for some aquatic pollutants such as antibiotic-resistant genes (ARG).

Information pertaining to hazardous substances or AMR and associated risks

There are still difficulties to assess the risks associated with the presence of substances in the environment (e.g. landfill, wastewater, etc). Indeed, it is uneasy to make a link between the substance environmental concentrations and its risks to human health and the environment as information on toxicity is very limited (due to the wide range of substances) and the conceptual scheme Source-Pathway-Receptor is not always well expressed.

Responsibilities and the bigger picture

The responsibilities on aquatic pollution are spread over very different stakeholders. No one is or feels responsible for the situation and gets the overall picture along the substance lifecycle: from the substance production, its use, its disposal in water and waste, its treatment and its release in the environment. No actor has the complete understanding of how substances are produced, what products or formulation contain them, what they are used for and where do they go.

Regulation

Most of the regulatory work is done by the European Commission. The persons interviewed however consider that the EU regulatory framework is more an "end-of-pipe" approach. They think there is not enough control over what may be placed on the market and wish the EU regulated substances more (chemicals in our homes, clothes, building materials, etc. as referred to in the EU Chemical Strategy). They also identify shortcomings in historical or current legislation (national or European) which in some cases can delay sufficient knowledge which would be needed in order to assess whether there is a problem or not.

Information pertaining to social change

Interviewed persons express a greater need for behavioural research and knowledge about how people can be convinced to "do the right thing" (e.g. lower the consumption of substances, etc.; social sciences).

Some respondents state that aquatic pollutants is an area where a lot is confidential, and each party is struggling to find information. More reliable information and better access to tools are therefore needed. More frequent, more detailed and better tailored information is also required to help navigate in this enormous flow of information. Universities have an important role to play but one respondent mean that they are a group that lack incentive to transfer knowledge to others as it is often not part of their responsibility, or they do not gain anything by doing it.

3.3.1.2 Identified Trends & Innovations

Swedish interviewed stakeholders showed that **PFAS** was an important issue. There are many other pollutants that are of concern in the country, but PFAS can be considered as a blueprint to tackle the other substances and avoid previous shortcomings. Regarding **AMR**, the priority has been set on behavioural research, mainly within the health sector and prescriptions of antibiotics.

Stakeholders interviewed gave some information on the new technologies and innovations being developed to tackle emerging pollutants. A prominent one is systems to **separate waters** (instead of the mixed situations which is mainstream today) to improve the purification of water with better and more advanced technology. For instance, it would mean separate chemicals and urine sewage networks. The advantages are three-fold:

1. from an upstream perspective: it allows circulation and reuse of water at the water treatment plant more easily.
2. to sort the sewage early and build energy-positive treatment plants instead of energy consuming today.
3. to facilitate sludge management, which is a major concern for today's treatment plant. Pyrolysis (for sludge) is coming. It is a most needed technology and will enter the market soon.

The persons interviewed mentioned **mapping and modelling** as well. Mapping is very useful when it comes to climate adaptation (where there is a risk of flooding and thus overspill of untreated waters). Modelling refers to the fate and transport of pollutants. Improvements in chemical analysis were also mentioned. Some respondents see opportunities to **recycle pollutants** (e.g. metals, nutrients, phosphorus) that can be extracted from water to be reused for agriculture or even for other industrial applications. Finally, on-going **effect-based analyses** research was mentioned: i.e. what effect different metals, micro-contaminants, drug residues, etc. have on cells, water and so on.

3.3.2 Information Sources & Communication Channels

3.3.2.1 Acquiring new knowledge

To access **updates about the legislation**, many sources are used (official websites, specialized reviews or newspapers, social media, conferences, …). The interest organization *Swedish Water* was mentioned as a reliable source of information. Some persons also keep track of the job place to consult who is hiring who and identify contact points and experts who might be helpful for one to be informed about legislation changes or to call for better regulations.

Updates about scientific or technological knowledge come from official (governmental) publications / notifications, social media, expert-groups publications (such as *VA (*Water and sewer companies "Vatten & Avlopp") *teknik södra* or *Newspaper Circulation magazine* which gives a daily status in the water and sewerage industry), collaborations with other organizations and research institutes (such as IVL), conferences & meetings (see the wastewater conference, the drinking water conference, …), mainstream press and call for projects. Most interviewed persons think these sources are enough. If not, additional data are collected in the field, through experiments, survey or interviews.

An example of adequate information enabled more effective work and actions taken is illustrated through the waterborne major outbreak in Skellefteå, highlighting the poor sanitation of waterworks causing pollution in the drinking water. Since this outbreak and the information of this came to light, the entire water industry now invests in disinfection (high-grade filtration with fine membranes; UV light). The mobilization around the outbreak was the push needed to act according to one of the respondents.

3.3.2.2 Knowledge Sources: Needs for Improvement

Still, they expressed difficulties to identify grey literature from other authorities or internationally (government reports or consultancy reports in other countries) because of the **language barrier**. To some extent, it is made accessible from the EU networks. More research forums would be a plus to be informed of the **latest findings**. Finally, it is difficult to get **comparative information** on pollution from one country to another as each has its own protocols and regulations (when not coordinated at EU level).

3.4 Stakeholder Demands – France

3.4.1 Panel of Actors Interviewed

Of all the stakeholders identified in France, 15 were interviewed by the AquaticPollutantsTransNet team. The public sector is very strongly represented, with nearly 73.3% of the profiles interviewed. Research institutions responded (INERIS, BRGM, INRAE, Inserm, Ifremer), as well as public agencies (OFB, AERMC, Aquaref), direct representatives of the State (MTE) and local institutions (SIBA). As for the private sector (26.7% of the survey panel), two SMEs from public research (Biomae, TreeWater) responded, as well as an analytical laboratory (WatchFrog), a federation of competitiveness clusters (FWT) and an association bringing together a multitude of players in the water sector (GRAIE, which brings together companies, local authorities and research institutions).

In the public sector, the survey panel appears to be fairly representative of the field: the main public players in the field of pollutants are well represented (both on the research side and the public agency side). This resulted in interviews that were both rich in information and complementary to each other. The representation of the private sector in the survey panel is somewhat less satisfactory: industrial actors, whether water users or managers, did not wish to exchange with the AquaticPollutantsTransNet team. Some contacts were made with researchers working in large private laboratories, but these profiles may not be representative of their company's position in the water field. Exchanges with private actors were thus reduced to two SMEs (Small and Medium Enterprises) that were interesting but not very representative of the field, as well as two federative actors with an essentially strategic vision of the problems, since they were not directly involved with the issue of aquatic pollutants.

The specificity of the French water sector could explain the public/private imbalance in the survey panel. Several large multinational groups share the bulk of the sector, while a multitude of small companies are emerging on new themes and new technologies. There are no medium-sized groups, unlike in other countries (Germany is often cited as an example). Thus, large industrial companies are difficult to reach, as their activity is often based on the secrecy of their methods and data. In a way, the absence of industries from the survey panel reflects the reality of the field: while all other actors are rather well connected, industries still remain outside the public sector. On the other hand, many small companies in the water sector come from the world of research: they commercialize technologies resulting from applied research. Thus, their representatives are rather easy to contact and know the public side of the water sector well. However, the disconnection is not total and the reticular structuring of the field of aquatic pollutants will be the subject of a dedicated analysis later.

The fields of these different organizations (public or private) cover almost the entire life cycle of pollutants in aquatic environments. According to a qualitative division of tasks, the public sector is involved in several missions: (1) risk characterization and assessment, (2) design of technological solutions, (3) regulation, and (4) management of the water resource. The research institutions are thus mainly concerned by missions (1) and (2) but serve as technical support to the authorities on (3). Mission (4) is essentially carried out by local institutions, which are under-represented in the survey panel in relation to their importance on the national territory. The private sector follows these multiple missions, by commercializing certain technologies resulting from research in a mission (5) of supplying technological solutions, but also by participating in the monitoring of the state of aquatic environments by the permanent realization of samples, within the framework of mission (1). The only important lack concerns (6) the emission of substances into the environment, due to the lack of response from

industrial actors. Since it is located at the beginning of the chain, this lack is particularly damaging to analyse the rest of the activities in the sector.

Most of the actors interviewed are concerned with CECs in priority, and with AMR or pathogens to a minor degree. This imbalance corresponds to several current realities of the sector, some of which will be analysed later. The contrasting regulatory context between micropollutants and anti-biological resistance is one relevant factor. Another is the multiplicity of substances grouped together under the name of "micropollutants": several thousand have already been identified. Research programs and regulatory provisions are therefore more developed for such a set of substances than for other seemingly smaller - yet very important - issues. Thus, due to the structure of the field, the survey results detailed below deal more with CECs than with AMR or pathogens.

Table 3-3. List of organisations interviewed in France.

Name or organisation	Name of Department/Laboratory/Service	Status	Role
Agences de l'eau	Rhone-Méditerranée	Public state organisation	Problem owner
AQUAREF - Laboratoire national de référence pour la surveillance des milieux aquatiques	N/A	Associations & NGOs	Characterization and risk assessment
BIOMAE	N/A	Private organisation - tertiary sector (services, studies)	Characterization and risk assessment
BRGM	Direction de la Recherche, de la Programmation scientifique et de la Communication (DRPC)	Public research organisation	Characterization and risk assessment
France Water Team	N/A	Associations & NGOs	Solution provider
GRAIE	N/A	Associations & NGOs	Solution provider
Ifremer	Unité Biogéochimie et Ecotoxicologie	Public research organisation	Characterization and risk assessment
INERIS	Direction Scientifique	Public research organisation	Characterization and risk assessment
INRAE - Institut Carnot	N/A		
INSERM	UMR 1092	Public research organisation	Characterization and risk assessment
MTES - Ministry of Environment	Bureau de la Lutte contre les Pollutions Industrielles et Domestiques - Direction de l'Eau et de la Biodiversité	Public state organisation (government representatives)	Regulation & Control
OFB	N/A	Public state organisation (government representatives)	Regulation & Control
SIBA (Syndicat Intercommunal du Bassin d'Arcachon)	N/A	Public territory organisation (communities, provinces)	Problem owner
TreeWater	N/A	Private organisation - secundary sector (industry)	Solution designer
WatchFrog	Laboratoire dédié à l'identification des perturbateurs endocriniens	Private organisation - tertiary sector (services, studies)	Characterization and risk assessment

3.4.2 Knowledge Demand on Aquatic Pollutants

3.4.2.1 Knowledge Needs & Gaps

Several major problems appear from the researchers and other public (authority) actors interviewed:

- Researchers are currently studying **the effect of a mixture of different substances on health (i.e. the "cocktail effects")**. This is essential work because hundreds of pollutants are permanently present in the environment, particularly in water. They rarely act in isolation on human health. They add up and form combinations that can in some cases be harmful. Everyone agrees that knowledge on the subject remains limited, while many cocktail effects are likely to have devastating health and environmental effects.

- Many stakeholders are more or less openly questioning the **stability of measurement series** if the metrological devices used change too regularly. Metrologists are interested in new tools (passive samplers as well as biological tools) but fear not being able to link these new data with those produced over the past several years. In terms of monitoring, this discontinuity in measurement poses a real problem that scientific work could help to overcome. Expectations concern methods of accounting for the different technologies and their results. Such a change would thus facilitate the mobilization of new tools, which would not systematically upset the entire organization in place.

- **As an extension of the compatibility of the series of measurements, the sources of knowledge are innumerable, but sometimes lack consistency**. Each actor tends to develop his own reasoning, without always connecting it to the others that already exist. On some subjects, knowledge is vast, but it is difficult to have a quick and exhaustive overview. For example, interviewees regret the lack of coherence of all the information on phytosanitary products, from their sale to their final effects. Experts consider that many studies are almost duplicated because the different actors do not make the knowledge, they have produced consistent. Thus, some databases cannot automatically be used in other contexts, which forces researchers to create new tools adapted to their practices. This adds more and more complexity, and therefore difficulty in making all the available knowledge coherent.
- Groundwater represents the overwhelming majority of continental waters (more than 95%), but it remains much less studied than surface water. Therefore, **knowledge remains much weaker on underground aquatic environments**, in terms of microbiological composition of water, but also of presence, diffusion and effects of pollutants. The tools currently applied, in particular biological tools, are not designed for groundwater where kinetics is much slower: the effects of pollutants present on living organisms are much weaker and slower, making biological tools of little use for studying groundwater. This information demand is especially important for institutes such as BRGM since they focus on groundwater.

- Recent "global" approaches, such as OneHealth, EcoHealth and GlobalHeath, which focus primarily on antibiotic resistance, do not directly concern technologies but rather the framing of environmental and health problems. In a way, these "global" approaches seem to be in line with the new biological tools: **the aim is to study effects rather than particular substances**, whose trajectory in the environment and in complex organisms is difficult to identify correctly.

3.4.2.2 Identified Trends & Innovations

Two major "technological" changes have taken place in the field of aquatic pollutants over the last decade. As mentioned above, these changes have not necessarily led to new regulations, but have become an important issue for the various players in the sector.

- **Passive samplers** have thus become new measurement tools, considered more reliable than their predecessors. Instead of measuring the presence of a pollutant in an aquatic environment at a given time, these passive samplers take a more prolonged measurement, which is considered more representative. This comparative advantage is touted by researchers as well as water resource authorities and managers: the measurement is less random, more representative, and therefore more interesting for conducting well-founded research or for implementing appropriate policies and strategies. Some research actors have been directly involved in the development of such passive samplers. Other scientific actors are regular users, without having developed any in-house technology.

- **Biological tools** (using aquatic species as samplers or sentinels for pollutants, in the natural environment) appear to be even more innovative than passive samplers. Instead of focusing on the concentrations of a certain number of substances in the water, the aim is to identify their effects on living organisms. Other research actors seem to be more distant from these technologies, whose implications in terms of changes in practices are important. Moreover, not all aquatic environments are suitable for them (particularly groundwater or marine waters).

In the absence of regulations, public authorities are still cautious about promoting passive samplers and biological tools, even though their virtues are recognized. However, metrologists believe that passive samplers are tools that should be used increasingly. This reflects a difference in the relationship to technology among different public actors: those working on the regulatory side seem more cautious about technological change than those with more operational objectives.

The two companies interviewed are responsible for commercializing the two new tools presented above. Both are research-based, thus associating scientific specialists to their technological approach, mobilizing their own expertise to serve their new organization. Thus, the activities are concentrated around the development, but especially the marketing, of their technology: the objective is to make it known, to standardize it among the practices of the actors likely to use it in replacement of older measuring devices.

3.4.3 Information Sources & Communication Channels

The different actors are well aware of their limitations. Through their network, they are able to mobilize other actors likely to share the necessary information. There is therefore a transfer of information within the field of aquatic pollutants, with advantages and disadvantages.

Type of information available

There is **no shortage of documentation on aquatic pollutants** and one of the challenges is to sort it out by acquiring an exhaustive vision of the field and the players involved. The production of information is indeed enormous, whether in terms of scientific articles (several tens of thousands) or in terms of regulatory texts (at both European and national levels), technical notes and reports

(produced by various institutions), etc. Most of the actors interviewed were satisfied with this mass of available information. There was a distinction made between **scientific publication** and **more operational information**. From the scientists side, searching from existing databases appears relatively easy. For operational stakeholders, the problem was that there was too much information, that which could be relevant ends up being diluted in the midst of other information of little interest.

Regarding the **tools** (knowledge bases, etc.) stakeholders mobilized, they are **oriented towards one specific actor**: researchers do not use the tools designed for the authorities, or vice versa. Each sector has its own databases, methods, indicators, interests, etc.; their results are transmitted through their own channels.

Communication channels

Almost all public institutions have a **newsletter and a regular technical publication**. These spaces allow the dissemination of information reprocessed by specialists and made available to other audiences. The **professional networks** carry out a similar work of translation of scientific and regulatory information through different publications as well. **The areas of expertise and specialization of these different intermediary publications tend to overlap**. This point of view is shared by a number of actors, whether they are closer to the scientific world or to more operational sectors. The former mentioned the abundance of scientific publications, the continuous monitoring of which is long and tedious because of the excessive number of works published. The latter complain rather that their specific work is drowned in a multitude of other information that passes through the same channels. It is impossible to know all the devices, all the plans, all the networks.

Information & communication transfer demands

The connections between different types of actors facilitate this informal circulation. **However, this is not enough to transfer information, which also uses many more permanent communication channels**.

Despite communication channels exist and transfer knowledge to different sectors, **not all stakeholders have access to the various channels, while some channels do not function properly or exist at all.** For example**,** while there are exchanges between researchers and authorities, researchers feel obliged to step outside of their scientific rigour by not expressing their doubts or uncertainties, so the message is clear and simple enough for authorities. In the end, the existence of connections (institutional or informal) between actors does not mean that information circulates naturally or correctly between them.

According to public research institutes, there is a **lack of international connections**, even in the world of research and public institutions. When bibliographies have been produced, they are mainly based on **French or French-speaking sources.** Thus, there is a lack of institutional translation work to succeed in connecting different scientific and operational cultures.

Many stakeholders emphasized the **lack of connection with the industry** who produces the substances, which may end into the water. The disconnection with the industrial community is a concern both for the interviewed public institutions (authorities or research organizations) and for solution providers. Industry data are needed for technological and strategical development. It was noted that we had very little feedback from industries during the survey.

Many plead for the **information transmitted to be more adapted and clearer**. This adaptation must tailor the needs of the different actors present in the field.

3.5 Stakeholder Demands – Europe

Some representatives of the major European networks were interviewed in order to get a deeper understanding of their role as well as their perceived issues on aquatic pollutants and knowledge transfer. Their view complements the national evaluations of the stakeholder demands from an EU perspective.

3.5.1 Panel of Actors Interviewed

Some European organizations or associations (EEA and EurEau) were interviewed through contacting their own staff. Others are working groups that bring together experts and researchers from different institutes or companies: we contacted the leaders or co-leaders of these groups (from the Netherlands, Spain, UK, Germany or Sweden) and asked questions specific to their European engagement – and not in relation to their home organization.

Table 3-4. List of organizations interviewed at the EU level.

Name or organisation	European Network or Institution	Interview Date
DELTARES	Water Europe - Water & Zero Pollution WG Leader	04/07/2022
Luleå University	Water Europe - Water & Zero Pollution WG Co-Leader	07/07/2022
Umweltbundesamt (UBA)	European Topic Center (ETC) "Inland, Coastal and Marine" Waters	06/07/2022
Fundación AZTI	European Topic Center (ETC) "Inland, Coastal and Marine" Waters	22/06/2022
Thames Water Utilities Limited	Water Reuse Europe	30/06/2022
EurEau	EurEau	01/07/2022
European Environment Agency	European Environment Agency	05/07/2022

3.5.2 Knowledge Demand on Aquatic Pollutants

The different European networks can benefit from the expertise and knowledge of their members, who are involved in research projects or active in their respective national networks. Moreover, several European networks are also partners in research projects themselves. The persons interviewed did not readily identified knowledge gaps, but rather reported topics that currently have a high priority:

- Microplastics and nano-plastics: their behaviour in the environment, their cumulative impact and how they interact with other chemical contaminants. Plastics is not only about chemicals (and their eventual toxicity) but also about the physical properties of the material (sedimentation, adsorption, etc.).
- AMR and how to tackle it at source (wastewater treatment, storm water management, etc.)
- AMR processes in the natural environment (interaction with aquatic chemicals, monitoring methods, acceptable thresholds, etc.). It was highlighted that stronger cooperation between chemists and biologists is necessary to make progress.
- Toxicity of compound mixtures
- Influence of physical parameters (sediment load and sediment properties, salinity and temperature, etc.) on the behaviour of chemical pollutants, especially in the context of climate change and sea level rise
- Management of PFAS pollution (behaviour of PFAS in the environment, sedimentation, persistence and cumulative effects, sustainable treatment solutions, alternatives to PFAS, etc.)
- Mainstreaming reuse technologies by creating new business models and improving public perception through education and demonstration

- Nature-based solutions (NBS) and how to use them to mitigate pollution (behaviour of pollutants, performance of NBS in various pedoclimates, maintenance of NBS, incentives to mainstream their use by local managers)

Insufficiencies have been pointed-out regarding the lack of information available in the EU databases. The example was given of the REACH database which is used along the procedure to place a new substance or product on the market, describing its properties. But the database does not give information about the real uses for human activities nor **the exposure pathway** to the environment (such as substances' leaches from building materials). It does not give information about the by-products of the substance either. The sources of diffuse pollutions are, by definition, numerous and hard to track (it can be households, vehicles, etc). A track and trace digital system should be put in place, at least for the most hazardous substances, suggested one person.

The persons reported issues related to the **lack of homogeneity** among the EU countries (data reporting, transposition of EU regulations or directives, assessment methodologies, etc). The MSFD or WFD-related reporting is mandatory for all Member States so there is consistency and comparability. However, the reporting is limited to the substances targeted by the Directives. It is also limited to 4 sampling a year. The data collected feeds into the WISE[42]. Outside of this obligation, the voluntary contribution of States to European databases is irregular, in time and space. It is therefore hard to produce outlooks at the EU level without the tedious effort of contacting each Member State and asking for data that has not been reported back to the EU. Even some national-level compilations are not representative of the wealth of information available at regional or provincial level.

The delay to access the data is perceived as too long and not adequate to undertake action against pollutants spread. An early-warning system has been called for. There are **no databases** to retrieve information about the presence of **antibiotics** in the environment (and the potential risk on AMR), or the monitoring of **micro- and nano-plastics**, at the EU level, which is an important gap in consideration of the currently most discussed topics.

A lack of knowledge has also been identified regarding the toxicity of each substance and the acceptable concentrations in the environment. As a consequence, the operators of wastewater treatment plants tend to overtreat to avoid any outbreaks and media attention – which is costly and resources consuming. The main complaint is that **discharge thresholds** are set based on the laboratories' detection capacity and not based on the risks for the environment.

3.5.3 Information Sources & Communication Channels

Sources used by the networks

All persons interviewed agree that **knowing the right people** is key to access updated and reliable information. This includes the persons working in the industry, developing new substances or new tools to detect them. Project partnerships and professional networks have been listed as the best way to connect private and public organisations and spark collaborations. **Research projects funded by the EU** were mentioned as a source of information, though it is hard to keep track of all on-going calls, selected teams and published results. The continuous update proves to be too time-consuming.

Faced with the wealth of scientific or technical publications, some respondents rely on the **synthesis or states-of-the-art reviews** produced by PhD students in their field of research. **Social media** such as

[42] https://water.europa.eu/

Twitter and LinkedIn is being used to identify new projects, organisations or professionals involved on emerging contaminants, in addition to the review of the literature.

Transfer tools from the networks

The goal of the networks is to connect people and facilitate the identification of experts. Their added value is to know who has the relevant information. Most of their communication activities (newsletters, conferences, posts on social media, etc) **put the prominent experts under the spotlight** so they can have time and space to expose their results, and in return be more easily contacted.

The EU networks provide information on state-of the-art **methodologies or technologies**. Some organise trainings, field trips or returns of experiences. They share their knowledge also through the publication of white papers or comparative assessments, that benefit many stakeholders including outside their members. Innovation prices or competitions have also been listed as a good way to attract attention and disseminate new practices or tools. The networks also facilitate the identification of living labs (locations and interested organisations to test innovations) and contribute to upscaling.

Finally, most networks also publish outlooks on the applicable legislation and keep their members informed of on-going negotiations. Some groups are involved themselves in the discussions on the improvement of European legislation, as representatives of private interests.

3.6 Comparison Between Countries

One main concern across all countries was to **improve monitoring to make it consistent, permanent, reliable and comparable**. A lack of methodologies or tools was pointed out to monitor the behaviour (sedimentation, degradation, bioaccumulation, etc.) of aquatic pollutants in the environment.

The overall opinion from interviewees was that **the wealth of information can be misleading** unless you are already active in the right networks, know the right persons or have experience navigating the official databases. This wealth of information is hiding the problem of timely delivery of new results, as well as being notified of relevant findings. The interviews revealed an apparent contradiction: there is too much unspecific information, not enough tailored information, and it is hard to access the right information in due time.

Across Europe, data quality is not an issue, it is considered reliable. However, complains were noted regarding the conservative behaviour of data producers, who take great precautions (and thus time) to discard data which is not sensitive and has been validated. Difficulties to access confidential data from the private companies or the public authorities (data which is not mandatory to share) has also been pointed out. Overall, stakeholders interviewed in the three countries call for **easier access to data and digitalization**.

A common knowledge gap has been identified in regard to the **toxicity of substances** in the environment: At what point is it toxic to who or to what? How should toxicity tests and assessments be carried out? There is a lack of threshold values (or arbitrary threshold values) for specific pollutants as it is a challenge to study the toxicity of each of the many substances, as well as **their combined effects**. Discussions are ongoing about the best way to proceed (prioritised individual assessments or new approaches to study the cocktail effect). This knowledge gap was also pointed out specifically for PFAS in all three countries and across Europe.

4 Review of the existing policy context, identification and comparison of the political demand

The scope of the literature review is to see if, and how, chemicals of emerging concern (CECs), antimicrobial resistance and pathogens are a focus point in European and national legislation in France, Germany and Sweden. Furthermore, we examined the extent to which these substances are part of the requirements regarding monitoring, data transfer and communication. Since the European context heavily influences the national legislation, we also describe the regulatory demand at the EU level.

Key Findings

Policy Context

Europe

- Biocides, PPP and pharmaceuticals have their own pieces of legislation ruling their production, marketing and use, considering the goals set by the environmental legislations regarding the chemical quality of water bodies.
- However, in the absence of specific environmental thresholds or substance lists, most biocides and pharmaceuticals have weak constraints to their release in the environment. Endocrine Disrupting Compounds (EDC), water-borne pathogens, metals (and now PFAS) are listed in the environmental legislation.
- AMR is not yet integrated into binding legislation at the EU level.
- EU legislation prioritizes its focus on acting at the source (regulation of human activities and associated water contaminants) and promotes risk assessments.
- EU legislation defines goals, common criteria and joint strategies. The Member States remain responsible for defining and implementing the means to reach the EU objectives.
- There are few substances for which threshold values are agreed-upon at the EU level, even more so for water bodies that have no direct use for human consumption. The Member States are responsible for defining the threshold values for the chemical substances they monitor in the environment.
- The EU legislation sets strict criteria and reporting procedures as regards the necessary justifications before placing a chemical product on the market. Member States are the competent authorities for allowing chemical products on the EU market.
- Regulations are slow to be drafted once substances have been identified as harmful.
- No standards are yet defined at the EU level to monitor the situation about AMR spread.
- Member States are compelled to report the state of their water resources periodically – including the presence of pollutants. The reporting is specific to each Directive. However, there is a lack of mandatory data collection involving the end-users of the products to inform about the pathways towards the aquatic environment.
- Several platforms or databases are in place to collect information on point source and diffuse pollution but seem insufficient to meet the EU's ambitions because the data is consolidated at the national / regional / basin level, which is too coarse for impact assessments.
- Public and free access to information on aquatic contaminants has not been a priority in EU legislation in the last decades. Recent initiatives tend to remediate this point.

Germany

- Knowledge transfer and reporting requirements for water stakeholders are not specified by German legislation.
- However, various open-access databases on AMR, biocides and further hazardous substances including EDC, pharmaceuticals and pesticides are publicly available.
- Strategy papers emphasize the importance of knowledge transfer and the need to improve access to data concerning micropollutants.
- Water stakeholders consider EU and national legislations to be driving forces for their work related to aquatic pollutants.
- The German Environment Agency (UBA) is considered a helpful resource by many stakeholders.
- Existing regulations are in some cases not precise enough (i.e. do not include all relevant information, such as toxicity concentrations, threshold values, etc.).
- Guidelines are needed for substances or compounds that are newly discovered or not yet regulated (i.e. AMR, micropollutants).

Sweden

- Sweden's regulations regarding water management are strongly influenced by EU legislation. Centrals are the EU WFD & Environmental Quality Standards (EQS).
- Local rules are negotiated by the Water Delegations in each water district.

France

- Regulatory short-comings are pointed-out regarding AMR, groundwater and marine environments. Microplastics are poorly covered by French legislation.
- In addition, French authorities have dedicated means to the monitoring and reduction of other CEC especially EDC, solvents and metals which are relevant for the country.
- Risk management of pharmaceuticals in the aquatic environment is problematic due to the lack of transparency regarding these products, but the issue has been identified by authorities and monitoring is in place.
- There are many pieces of legislation listing substances to be monitored, monitoring protocols or quantification methods. The updates or modifications are frequent.
- A paradigm change is needed to better regulate and monitor all substances in terms of their properties / effects.
- The reviewed texts did not contain information on the ruling of the centralization of the data, but national platforms exist to facilitate access to water monitoring results
- The French legislation on aquatic pollutants does not rule the dissemination of data and knowledge which is collected as part of the obligations of the water authorities and supporting agencies
- Improvements regarding information and data access are demanded by the successive action plans dealing with aquatic pollutants (especially on AMRs and EDC).

Cross-national perspectives

- The EU legislation is strongly shaping the national legislations regarding substances regulations or environmental objectives. When new issues emerge, the authorities wait for the EU to take the lead and negotiate the rules.
- National agencies are key to translate EU directives and regulations into national texts and support the stakeholders through guidelines
- Little freedom is allowed at the regional or river basin district levels to deviate from the EU or national rules regarding substances to be monitored in water or monitoring protocols.
- There is a lack of information in the legislation regarding toxicity levels, maximum concentrations or threshold values that shall be applied for the assessments of risks.

4.1 Methodology for the Review & Analysis of Regulatory Documents

Each country was requested to provide insights into how the topics of CEC, AMR and pathogens is referred to in its own legislation. Due to time constraints, the number of documents reviewed had to be limited and we chose to focus on the most binding documents within each regulatory framework (eventually supported by guidelines or assessments when relevant). The review had to cover all three subjects of the call (CECs, AMR and pathogens).

The identification of the regulatory documents (sources of information and relevance for the Transnet project) is described for each country in the following chapters. Analysis of the regulatory documents was undertaken in a comparable way by the APTN partners (Figure 4-1) and aimed at assessing to what extent CECs, AMR and pathogens are addressed in legislation and what requirements exist.

The national regulatory review was complemented with information provided by stakeholders during bi-lateral interviews (see Chapter 3) in order to assess the importance of the legislation over the actors' decisions and behaviours. Specific questions regarding the regulatory context in which they operate and how much this drives their work have been asked during the interviews (see Annex 2, questions 8-10).

Title	
Reference number	
Date	
Summary	
Scale (WW, EU, national, ...)	
Related framework directive or framework regulation	
Written / Elaborated by	
Type of regulation	directive / law / strategy / agreement / action plans / etc.
Focus	Environment (media) regulation (surface water quality or marive water quality) vs Substances regulation
Substances targeted or AMR process	
Pharmaceuticals	
Personal care products (PCPs)	
Endocrine disrupting	
Plasticisers	
Solvents and THMs	
Chemical household products	
Artificial sweeteners	
Trace metals	
Microplastics and nanoplastics	
Biocides	
AMR processes ?	
Pathogens	
Others	
Themes of the call (and sub-themes)	
Measuring - Environmental behaviour of contaminants of emerging concern (CECs), pathogens and antimicrobial resistant bacteria in aquatic ecosystems	Subtheme 1.1 - Assessment of the significance of different potential sources, reservoirs and pathways Subtheme 1.2 - Understanding and predicting the environmental and cumulative behaviours, including the development of tools and digital solutions
Evaluating - Risk Assessment and Management of pollutants from aquatic ecosystems (inland, coastal and marine) to human health and environment	Subtheme 2.1 - Characterising the exposure routes and effects, on aquatic ecosystems and on human health Subtheme 2.2 - Development of integrated risk assessment and risk management procedures Subtheme 2.3 - Parameters and strategies for monitoring potential antimicrobial resistant bacteria
Taking Actions - Strategies to reduce pollutants in aquatic ecosystems (inland, coastal and marine)	Subtheme 3.1 – Implementation of strategies to reduce at the source Subtheme 3.2 – Development of methods for preventing the spread of pollutants
Knowledge / Data that is required by the regulation	= list of parameters and indicators
(Mandatory) producers of the data / knowledge ; responsibility of the monitoring	
End-users of the data / knowledge	
(Mandatory) means for the transfer, storage, access of data / knowledge	
Goal of the data collection ?	
(Mandatory) tools / technologies / guidelines / protocols / ... to monitor or remediate the substances or assess the exposure	
AP Projects that relate to the regulation	(and how they contribute)

Figure 4-1. Template used by TransNet to review relevant legislative, policy, and strategy documents.

4.2 European Political Demand and Identification of Gaps

4.2.1 Short Overview of the European Documents Reviewed

The European regulatory context is teeming. For the purpose of this task, we limited our review to **36 documents** (and their annexes) that are *in force* in 2022. Our review covers a period **from 1991** (date of enforcement of the UWWTD, which is still valid today) **to 2021**. However, considering that our goal was to review applicable legislation, most of the reviewed documents are **posterior to 2000** (date of enforcement of the WFD). Our review period thus covers a 20-year span, with the exception of two pieces of legislation. This is consistent with the EU Commission's fitness check of chemical legislation[43], which considers that there is a second generation of legislation – repealing the older ones – starting from 2000. The directives dealing with the state of the environment (WFD, BWD, GWD, MSFD) or human health (MPHU) were drafted in the years 2000 and are still applicable; whereas the directives and regulations related to substances (IED, PPP, Biocides and PSD) were drafted or updated more recently (2009-2013) following the entry into force of REACH.

We reviewed **22 pieces of legislation focusing on the substances** (their production, marketing and uses) and **13 pieces of legislation focusing on the state of the environment** in which these substances can be found. There is but one document which is not linked to substances nor the environment, the Directive on PAEI, which felt important for our assessment in relation to knowledge transfer. The list of documents, their abbreviations and the web links to access are listed in the following table.

Table 4-1. List of EU-level policy documents and strategies reviewed by TransNet.

Title	Acronym	Reference number	Summary
EU Water Framework Directive	WFD	2000/60/EC	The directive is to achieve good status in all bodies of surface water and groundwater by 2027. The WFD covers surface water pollutants in 2 ways: 1) By identifying and regulating those of greatest concern across the EU (priority substance list = Annex X) 2) Requiring MS to identify substances of national or local concern
DIRECTIVE on the protection of groundwater against pollution and deterioration	GWD	2006/118/EC	It's a directive on the protection of groundwater against pollution and deterioration. which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater.
DIRECTIVE on priority substances in the field of water policy	PSD	2013/39/EU	This directive incorporates 45 substances which should be monitored, and the necessary actions need to be taken in order to meet the environmental quality standards.
DECISION establishing a watch list of substances for Union-wide monitoring in the field of water policy	Watch List	2018/840	This is a "Commission Implementing Decision" of the EQS/PSD, that constitutes the last update of a watch list of substances that may pose a significant risk and for which monitoring data are insufficient to conclude on the actual risk posed.

[43] Findings of the Fitness Check of the most relevant chemicals legislation (excluding REACH) and identified challenges, gaps and weaknesses, COM(2019)264, EU Commission, 2019 – p.4

Title	Acronym	Reference number	Summary
Environmental Quality Standards Directive	EQS	2008/105/EC	It sets environmental quality standards (EQS) for the substances in surface waters identified as priority pollutants because of the significant risk they pose to or via the aquatic environment.
DIRECTIVE on public access to environmental information	PAEI	2003/4/EC	The objectives of this Directive are: (a) to guarantee the right of access to environmental information held by or for public authorities and to set out the basic terms and conditions of, and practical arrangements for, its exercise; and (b) to ensure that environmental information is progressively made available and disseminated to the public in order to achieve the widest possible systematic availability and dissemination to the public of environmental information.
DIRECTIVE concerning the prohibition on the use in stock farming of certain substances having a hormonal or thyrostatic action and of beta-agonists	HTBA	96/22/EC	Member States shall prohibit the placing on the market of the substances listed in Annex II for administering to any animals, the meat and products of which are intended for human consumption
COMMISSION DECISION laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment	GESMW	2017/848	This Decision lays down: (a) criteria and methodological standards to be used when determining a set of characteristics for good environmental status; (b) specifications and standardised methods for monitoring and assessment; (c) a timeline for the establishment of threshold values, lists of criteria elements and methodological standards; (d) a notification requirement for criteria elements, threshold values and methodological standards.
DIRECTIVE concerning the management of bathing water quality	BWD	2006/7/EC	This Directive lays down provisions for: (a)the monitoring and classification of bathing water quality; (b) the management of bathing water quality; (c) the provision of information to the public on bathing water quality. The purpose of this Directive is to preserve, protect and improve the quality of the environment and to protect human health. This Directive shall apply to any element of surface water where the competent authority expects a large number of people to bath and has not imposed a permanent bathing prohibition or issued permanent advice against bathing.
Directive on the quality of water intended for human consumption	DWD	2020/2184	This directive ensures the quality of water intended for human consumption and thus protect human health. Additionally the directive aims to avoid and treat contamination by applying water safety plans using risk assessments.
Sustainable Development Goals	SDG		The Sustainable Development Goals (SDGs) are a collection of 17 interlinked global goals designed to be a "blueprint to achieve a better and more sustainable future for all".
REGULATION concerning the making available on the market and use of biocidal products	Biocides	528/2012	The purpose of this Regulation is to improve the free movement of biocidal products within the Union while ensuring a high level of protection of both human and animal health and the environment.

Title	Acronym	Reference number	Summary
Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030	Aquaculture	COM/2021/236	This document is the last update of the Commission's Strategic Guidelines for the sustainable development of EU aquaculture adopted in 2013. It constitutes the main pillar of the strategic coordination of aquaculture policy in the EU.
Directive on undesirable substances in animal feed	DUSAF	2002/32/EC	This directive sets maximum levels for undesirable substances and products in animal feed including imports on the EU market.
REGULATION laying down Union procedures for the authorisation and supervision of medicinal products for human use	Monitoring	726/2004	The purpose of this Regulation is to lay down Community procedures for the authorisation, supervision and pharmacovigilance of medicinal products for human and veterinary use, and to establish a European Medicines Agency.
DIRECTIVE on animal health requirements for aquaculture animals and products, and on the prevention and control of certain diseases in aquatic animals	Aquaculture	2006/88/EC	This directive sets out: -animal health requirements for the sale, import or transit of aquaculture animals (farmed fish and shellfish); -minimum measures to increase general awareness and prevent disease; -minimum measures in the event of a suspected, or established, outbreak of disease
Marine Strategy Framework Directive	MSFD	2008/56/EC	The Directive is the environmental pillar of Europe's maritime policy designed to create a framework for sustainable use of Europe's marine waters. It provides a legislative framework to sustainably manage human activities at all scales - from local to national to regional seas. The MSFD promotes an Ecosystem Approach to reach Good Environmental Status (GES) by 2020.
REGULATION concerning the placing of plant protection products on the market	PPP	1107/2009	The purpose of this Regulation is to ensure a high level of protection of both human and animal health and the environment and to improve the functioning of the internal market through the harmonisation of the rules on the placing on the market of plant protection products, while improving agricultural production.
A European One Health Action Plan against Antimicrobial Resistance (AMR)			The goals of this action plan are to: -improve awareness and understanding of AMR through effective communication, education and training; -strengthen the knowledge and evidence base through surveillance and research; -reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures; -optimize the use of antimicrobial medicines in human and animal health; -develop the economic case for sustainable investment that takes account of the needs of all countries and to increase investment in new medicines, diagnostic tools, vaccines and other interventions.
DIRECTIVE on the Community code relating to medicinal products for human use	MPHU	2001/83/EC	This Directive shall apply to medicinal products for human use intended to be placed on the market in Member States and either prepared industrially or manufactured by a method involving an industrial process.
REGULATION on veterinary medicinal products	Veterinary	2019/6	This Regulation lays down rules for the placing on the market, manufacturing, import, export, supply, distribution, pharmacovigilance, control and use of veterinary medicinal products.

Title	Acronym	Reference number	Summary
REGULATION on the manufacture, placing on the market and use of medicated feed	Medical feed	2019/4	This Regulation lays down specific provisions regarding medicated feed and intermediate products. This Regulation does not apply to veterinary medicinal products.
DIRECTIVE on urban wastewater treatment	UWWTD	91/271/EEC	This directive focusses on the performance of WWTP and the maximum allowable emissions. The emissions depend on the receiving water body and the size of the WWTP.
EU Mission: Restore our Ocean and Waters			The goal of this mission is to help achieve a full recovery and regeneration of European marine and freshwater ecosystems by 2030, with a holistic approach towards a better understanding of the human footprint (including climate change), innovative governance, better connections between water and the public.
European Union Strategic Approach to Pharmaceuticals in the Environment	Pharmaceuticals	COM(2019) 128	OBJECTIVES: - identify actions to be taken or further investigated to address the potential risks from pharmaceutical residues in the environment, not least to contribute to the Union's action on combatting antimicrobial resistance; - encourage innovation where it can help to address the risks, and promote the circular economy by facilitating the recycling of resources such as water, sewage sludge and manure; - identify remaining knowledge gaps, and present possible solutions for filling them;
Chemicals Strategy for Sustainability - Towards a Toxic-Free Environment	Chemicals	COM(2020) 667	This white paper informs about the complexity regarding a toxic-free environment and the related facts. Furthermore, EU's philosophy on the matter is transcribed.
Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil'	Zero Pollution	COM(2021) 400	Air, water and soil pollution is reduced to levels no longer considered harmful to health and natural ecosystems and that respect the boundaries our planet can cope with, thus creating a toxic-free environment.
On the experience gained by Member States on the implementation of national targets established in their National Action Plans (NAPs) and on progress in the implementation of Directive 2009/128/EC on the sustainable use of pesticides	Return of Experience	COM(2020) 204	Less than one third of Member States have completed the review of their NAPs within the five-year legal deadline. Of those that have reviewed their NAPs, most have failed to address the weaknesses identified by the Commission, with just 20% of revised NAPs setting high-level, outcome-based targets, as part of a longer-term strategy to reduce the risks and impacts of pesticide use. Despite these weaknesses, Member States have made progress in implementing the SUD. The majority of Member States have established comprehensive systems for the training and certification of operators, and a range of measures for water protection and the safe handling and storage of pesticides.
Registration, Evaluation, Authorisation and Restriction of Chemicals	REACH	1907/2006	Containing several criteria for ranking the substance in terms of persistency, toxicity, etc.
REGULATION concerning the establishment of a European Pollutant Release and Transfer Register	PRTR	166/2006	This Regulation establishes an integrated pollutant release and transfer register at Community level in the form of a publicly accessible electronic database and lays down rules for its functioning, in order to facilitate public participation in environmental decision-making, as well as contributing to the prevention and reduction of pollution of the environment.

Title	Acronym	Reference number	Summary
DIRECTIVE establishing a framework for Community action to achieve the sustainable use of pesticides	Pesticides	2009/128/EC	This Directive establishes a framework to achieve a sustainable use of pesticides by reducing the risks and impacts of pesticide use on human health and the environment and promoting the use of integrated pest management and of alternative approaches or techniques such as non-chemical alternatives to pesticides.
DIRECTIVE on industrial emissions (integrated pollution prevention and control)	IED	2010/75/EU	This Directive lays down rules on integrated prevention and control of pollution arising from industrial activities. It also lays down rules designed to prevent or, where that is not practicable, to reduce emissions into air, water and land and to prevent the generation of waste, in order to achieve a high level of protection of the environment taken as a whole.
REGULATION on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and PPP	Controls	2017/625	Specific rules on official controls and for action taken by the competent authorities in relation to plant protection products (PPP)
REGULATION on pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin	PAS classification	37/2010	Pharmacologically active substances and their classification regarding maximum residue limits (MRL) are set out in the Annex.
REGULATION laying down Community procedures for the establishment of residue limits of pharmacologically active substances in foodstuffs of animal origin	PAS residue limits	470/2009	For the purposes of ensuring food safety, the regulation sets: (a) the maximum concentration of a residue of a pharmacologically active substance which may be permitted in food of animal origin (maximum residue limit); (b) the level of a residue of a pharmacologically active substance established for control reasons in the case of certain substances for which a maximum residue limit has not been laid down
Evaluation of Regulation (EC) No 1107/2009 on the placing of PPP on the market and of Regulation (EC) No 396/2005 on maximum residue levels of pesticides	Evaluation of PPP	COM(2020) 208	The evaluation found that the PPP Regulation is largely effective in protecting human health and the environment due to the stringency of the approval criteria. The PPP Regulation has in particular been effective in further phasing out of high-risk substances.

We decided to focus on directives and regulations, which are the most binding. The other types of documents are only included because they either:

- Provide examples on how the Directives and Regulations are implemented (watch lists, GESMW, …)
- Evaluate the implementation of EU legislation
- Provide insights into the most recent debates or agreements undergoing at EU level (zero pollution plan i.e.)

All legislations reviewed are applicable at the **EU level** to the exception of the SDG and WHO guidelines (worldwide scope) that have also been included. The action plans, strategies, decisions and evaluations considered here are thus only a selection of the buzzing activity going on at EU level around the topics of emerging pollutants, waterborne pathogens and antimicrobial resistance.

Figure 4-2. Proportions of reviewed EU pieces of legislation.

For each document studied, we listed the other directives or regulations it refers to. This allowed us to perform a cross-check and ensure that the most important – and updated – pieces of legislation have not been overlooked. Still, some pieces of legislation that are frequently mentioned have deliberately been left aside as they do not target substances within our scope (i.e. Nitrates Directive) or "environments" we consider (i.e. the Regulation (EC) No 1881/2006 on maximum substances in foodstuff). **We consider our selection of documents is relevant for the task and that our review has been as thorough as possible** considering our available means to perform it.

Annex 3 maps the documents reviewed and how they refer to each other.

4.2.2 Pollutants Targeted by EU Legislation

Before diving into the regulatory demand, we examine which substances are explicitly targeted (or not). The specificity and requirements of the demand varies from one group of substances to the other. Since REACH and the IED, no EU Directive exists which is specific to one substance only.

By far, **pharmaceuticals and pesticides are the main groups of chemicals** explicitly referred to in the EU documents that have been reviewed There are two reasons that explain why these pollutants score high:

- **Biocides and Plant Protection Products (PPP) are meant to harm the environment**. Natural fauna, flora or fungus are targeted by the chemical active substances, to be destroyed or controlled. The biocide products are bound to have consequences and are therefore strictly ruled by the EU legislation to prevent as much as possible the side effects. Some legislations include in their annexes the lists of active substances as well as threshold values.

- **Human or animal health ranks higher than the environment**. Pharmaceuticals are developed in order to have a potent action to improve human or animal health. Before the years 2000, medicine products did not need to have an environmental impact assessment to be authorized for marketing. The "avoid – reduce – mitigate" sequence will shift to mitigation immediately if the pharmaceutical product demonstrates an interest for our health. The EU legislation is extensive to rule these mitigation actions through, for instance, production protocols, storage security and good uses.

Second comes the **endocrine disrupting compounds (EDCs)** – usually in order to ban them from use – and **trace metals**, arsenic, lead, cadmium and mercury being at the top of concern **because of their strong toxic effect**. EDCs and trace metals are individually listed in the documents.

The **other chemicals of emerging concern** which are explicitly mentioned in the EU documents reviewed are:

- Solvents, in rather general terms, because of their use as co-formulants, safeners or synergists to other active substances
- Chemical household products, personal care products, plasticizers and artificial sweeteners, in very general terms along with other chemical categories, as a precautionary principle regarding all chemicals that may be released in the environment

The EU Commission identified in 2019[44] that the legislation on PPP, human or animal medicine and food account for the "cocktail effect" that these products can have together. The dossiers to be submitted by the industry must include test results and risks analyses including the possible combination of their substance with others. However, the pieces of legislation ruling all the other chemical compounds yet **fail to set-up joint rules to account for the "cocktail effect" before authorization of the products.**

Water-borne pathogens are hardly mentioned as a general threat to human or animal health. **Only two documents refer to specific pathogens** – 1 refers to exotic diseases (Aquaculture Directive) and 1 refers to *Escherichia coli* and *Intestinal enterococci* (BWD)among the reviewed documents.

The concept of **antimicrobial resistance** as well as the associated threats are covered by 7 documents, but these are mainly **strategies, decisions or action plans**, not binding regulations (only 3 regulations and none are specific to AMR), despite the fact that Europe identified early on the issue[45].

Some Directives are focusing on monitoring the pollutants or removing them and therefore only deal with the protocols or technologies that should be harmonized at EU level. They **never mention the pollutants** themselves – but refer to other pieces of legislation such as the WFD, REACH or the IED. These Directives are the EQS, USAF and UWWTD. Other documents remain very general about *pollutants* such as the Regulation on Official Controls (2017/625) or the EU Action Plan "Towards Zero Pollution".

The review of the two worldwide documents, UN SDG and WHO Guideline for Drinking Water, brought little added value to the EU legislation review. The UN or WHO visions are indeed already taken-up by EU strategies and guidelines, already mainstreamed in the directives or regulations (or will soon be).

[44] Findings of the Fitness Check of the most relevant chemicals legislation (excluding REACH) and identified challenges, gaps and weaknesses, COM(2019)264, EU Commission, 2019 – p.12
[45] See: Community strategy against AMR, COM (2001) 333, EU Commission, 2001

4.2.3 EU Regulatory Demand on Monitoring and Data Production

Now that we have established which are the groups of substances mentioned in the regulations, we can look at what policies plan exist, and whether the demand is explicit (or not), sufficient (or not).

4.2.3.1 Objectives and Scope of the EU Legislation

In line with **the "avoid – reduce – mitigate" principle and the precautionary principle**, the EU legislation takes measures at the source of chemical production (call subtheme 3.1) as well as their spread in the environment (call subtheme 3.2). The legislation is also quite extensive on **risk management** (call subtheme 2.2)[46]. Main debate to date regarding the assessment and management of risks related to pollutants in the environment is whether to:

- Prioritise some substances to rationalize the effort dedicated to their monitoring, assessment and (eventually) mitigation or remediation. That means that selection criteria must be defined to choose the priority substances among the thousands that have a marketing authorization. This approach has prevailed so far (see tables of substances in annexes of the WFD, DWD or BWD as well as the Watch lists and recent EU communications[47]).

- Identify techniques to monitor and evaluate batch of substances[48] that share the same hazard, characteristics or behaviours. In addition to increased efficiency and extensiveness, this approach aims at avoiding substitution of harmful substances by other new substances from the same group with similar or even worse impacts on the environment.

There are less pieces of legislation ruling the monitoring of pollutants in the environment[49], the evaluation of behaviours of substances or the exposure. **In a nutshell, EU legislation is setting common goals for European countries, not the means** to achieve these goals, which are left in the hands of the Member States. As a result, the pieces of EU legislation remain quite vague in terms of protocols or technologies that shall be used to monitor, evaluate or take actions on aquatic pollutants.

4.2.3.2 Threshold values for pollutants in the aquatic environment

The threshold values for pollutants and indicators of pollution are **left to be decided by each Member State**, following a set of commonly agreed upon criteria (see for instance Annex II of the GWD).

But for drinking water, maximum thresholds have been set for all EU countries: when human health is at stake, the EU legislation sets a stricter frame as regards acceptable pollution levels. This can be

[46] Our literature review only considered a part of this extensive regulation on risk management which could be extended to the CLP – classification, labelling and packaging of chemical products, as well as the work done by the EU Agencies for chemicals (ECHA), food safety (EFSA), medicines (EMA) or the Scientific Committees for consumer safety (SCCS) or health, environment and emerging risks (SCHEER)

[47] "It is important to identify the pharmaceuticals that pose a risk through their individual presence in the environment so that risk management efforts can be targeted." in *European Union Strategic Approach to Pharmaceuticals in the Environment* (2019)

[48] "Support the gradual move away from assessing and regulating chemicals substance-by-substance to regulating them by groups". in *Chemicals Strategy for Sustainability* (2020) and "ECHA's grouping approach can help authorities to use all available data to cover a bigger share of registered substances, including those where hazard and exposure information is lacking. It also helps to improve regulatory consistency and increases the predictability of authority actions when similar substances are addressed together." in ECHA's annual report 2022 – Integrated Regulatory Strategy

[49] See IED as well as Directive 595 EC 2009/90, to guarantee the reliability of the data

explained by the fact that toxicity levels have been better studied for humans than for other species or entire ecosystems, and that there is a scientific consensus on the acceptable concentration in drinking water. However, threshold values for the degradation molecules of pesticides are ruled at the national level – with possible divergent approaches from one country to another. As it is virtually impossible to assign a specific maximum value for every known and new chemical substances, as every day 4,000 new components are created by the industries (Binetti, Marina Costamagna, & Marcello, 2007), sometimes **a generic maximum value is implemented for a group of components**. Pesticides are thus limited to 0.1 µg/l (individual substance) in waters abstracted to produce drinking water for human consumption and a cumulative value of 0.5 µg/l (sum of all substances' concentrations) is deemed acceptable (DWD). The values were not defined based on toxicity studies but on the analytical capacity (the toxic values defined by WHO guidelines on drinking water production – applicable worldwide - may thus defer).

Although **biocides** are more regulated and monitored than the other CEC, the 2020 report on the experience gained by MS on the implementation of national targets in their National Action Plans (NAP) and on progress in the implementation of the Pesticides Directive, concluded that Member States needed to establish specific and measurable targets and indicators as part of a long-term strategy to reduce the risks and impacts from pesticide use.

The same applies to **pharmaceuticals** according to the 2019 European Union Strategic Approach to Pharmaceuticals in the Environment: "*One reason is that many pharmaceuticals put on the market several years ago were not subject to an environmental risk assessment as part of the authorisation process*". This legacy of the past use of pharmaceuticals complexifies the setting of environmental standards and monitoring techniques, as there was no evaluation of potential side effects. The communication also adds that "*monitoring of pharmaceuticals in the environment is very limited, although selected substances are monitored in surface and groundwaters under the WFD*". Pharmaceuticals should also be monitored close to the discharge points (such as hospitals), but the report points out that there is far "*limited monitoring of "hotspot" locations*".

One can only assume that **specific targets and indicators are therefore hardly in place for other chemicals** in the EU Member States. In 2020, the **Chemicals Strategy for Sustainability**[50] pointed out the lack of consolidated repository of limit values based on existing human / animal / environmental health studies. An EU-centralised and curated database could support the Member States in the setting of their threshold values, safety assessments as well as national regulations.

4.2.3.3 Assessment and regulation of compounds in industry

The EU legislation is very strict regarding the development and placing on the market of new chemical substances or products. The EU Commission considers[51] that European legislation is the world's leader. The producers of chemical compounds and the competent authorities delivering the permits are requested to report detailed information to the EU[52], including impacts and risk assessments. For instance:

- The **Biocides** regulation lists the criteria for an application for approval of an active substance, including a summary of the results of the tests required pursuant to Article 20

[50] COM(2020)667

[51] Findings of the Fitness Check of the most relevant chemicals legislation (excluding REACH) and identified challenges, gaps and weaknesses, COM(2019)264, EU Commission, 2019 – p.5

[52] The list of all registered chemical substances are accessible through ECHA's website: https://echa.europa.eu/fr/universe-of-registered-substances .

to establish the product's efficacy and **effects on humans, animals and the environment** and, where applicable, its ability to promote resistance.

- The Community code relating to **medicinal products** for human use (MPHU) also includes in the application documents

Despite this constraining framework, two main pitfalls are highlighted in the assessment reports of the EU legislation:

1. **The inconsistencies in the classification of chemical compounds**

The EU Commission[53] found out that "*there are often multiple classifications for the same substance because different notifiers fail to arrive at an agreed entry[54]. (…) This situation is exacerbated by the lack of a legal basis for ECHA to perform quality checks of the self-classifications and to ensure that the Inventory does not contain any obsolete notifications or errors*". The 2018 evaluation of the implementation of REACH[55] also pointed-out some insufficiencies in the registration of the chemicals by the industry.

2. **The lack of knowledge on chemical compounds' properties.**

The Chemicals Strategy for Sustainability recognized[56] that "*there is much knowledge to be acquired by authorities on the intrinsic properties of a vast majority of chemicals, including polymers and chemicals that are not manufactured in high volumes*". Polymers are not yet subject to registration under REACH. Lack of coordination between the competent authorities to deliver the permits has been pointed out (resulting in some chemicals being banned in one country on the basis of toxicology studies but authorized in others) as well as dysfunctions or delays in the reporting of adverse effects from authorized compounds (through the RAPEX system).

The recent launch of PARC research partnership shall accelerate knowledge on chemicals' properties and associated risks: https://www.anses.fr/en/content/launch-european-research-and-innovation-parc-programme-improve-chemical-risk-assessment

In its annual report, ECHA added a third pitfall, which is the **lack of regulation** for a number of substances for which a hazard evaluation is available. They are called **the "candidate list"[57]**. ECHA stated that "*This accumulation of candidates for harmonised classification is a bottleneck for the efficient implementation of the Integrated Regulatory Strategy, as harmonised classification is often a prerequisite for moving ahead with other regulatory measures under REACH, such as authorisation, or under other EU legislation*".[58]

[53] Findings of the Fitness Check of the most relevant chemicals legislation (excluding REACH) and identified challenges, gaps and weaknesses, COM(2019)264, EU Commission, 2019 – p.9

[54] ECHA received around 65 000 dossiers for placing chemical products on the EU market corresponding to approximately 17 000 unique substances (date: Dec.2017)

[55] Commission General Report on the operation of REACH and review of certain elements - Conclusions and Actions, COM(2018) 116, EU Commission, 2018

[56] COM (2020)667

[57] The Watch list are the few substances on which there is consensus in favor of a monitoring for a maximum period of 4 years. The Candidate list are substances on which ECHA has not worked yet… though they are registered and authorised by some EU Member States. The Watch List is about 20 substances to be monitored in water bodies. The candidate list is >200 substances, some of which may be found in air but not water.

[58] ECHA annual report (2022) *Faster action on groups of harmful chemicals*

Finally, we also point-out that the legislation is focusing on quantities produced by the industry (e.g. REACH registration is required for substance production above 1t/year) but not enough on the quantities that are susceptible of being released in the environment. Each industry shall define and state clearly the maximum quantities that may be applied by the users, for each substance, but are not responsible for the respect of these recommendations not the cumulative effect with similar substances also released in the environment on the same location.

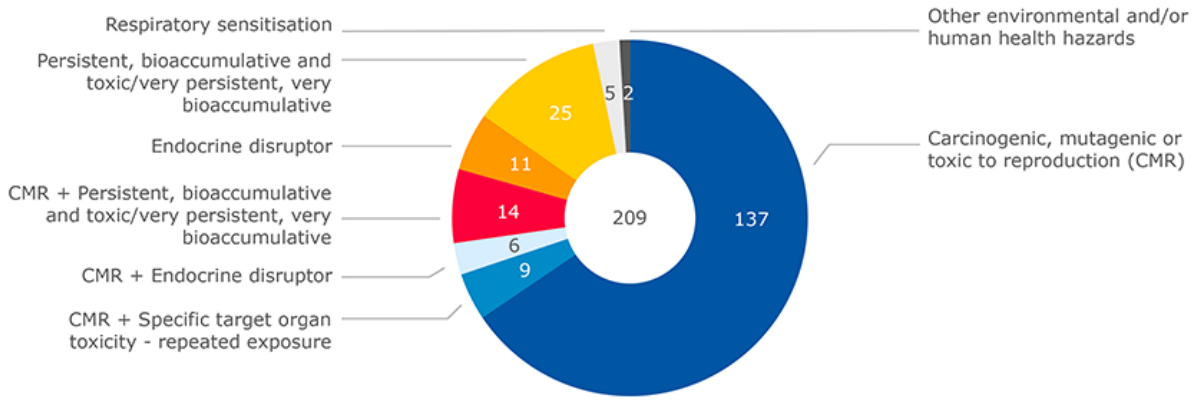


Figure 4-3. Hazard properties of chemical substances which are not yet regulated in the EU (Source: ECHA[59], 2020).

The lack of shared information about all uses of chemical products is also detrimental to the producers of substances themselves as they cannot – in the trial tests and risks assessments – account for the diversity of situations of use (or misuse). The fitness check of the EU legislation on chemicals[60] identified that: "*industry and public authorities may not always be aware of all the uses of certain hazardous chemicals that have a broad range of applications in a myriad of different consumer products. (This) affects their capacity to develop realistic, acceptable and robust exposure scenarios and as a consequence to identify the most appropriate risk management measures*."

4.2.3.4 Monitoring of Substances in the Aquatic Environment

For chemicals, the spatial density of the monitoring of substances in waterbodies (for instance to establish the ecological or chemical status) is not ruled at the EU level: only the criteria to design the surveillance monitoring have been set in Directives (see for instance Annex V of the WFD). **The frequency of the monitoring of chemical substances** in water bodies is however specified[61]: every month for priority substances and every three months for other pollutants.

In 2008, the EQS Directive defined **the indicators** for water quality monitoring for chemicals: the EU indicator is "*concentrations of contaminants in micrograms per litre (µg/l) for water, in micrograms per kilogram (µg/kg) of dry weight for sediment and in micrograms per kilogram (µg/kg) of wet weight for biota*".

Following the EQS Directive, "Watch lists" have been established of **chemical substances that are to be monitored at EU level in surface waters.** For these 19 substances monitored at EU level, acceptable detection limit (in ng/l) are also specified. Watch lists are updated every two years and one substance can only be monitored for 4 years in a row. The goal of the watch lists are not long-term assessments

[59] https://echa.europa.eu/fr/-/candidate-list-update-four-new-hazardous-chemicals-to-be-phased-out
[60] Findings of the Fitness Check of the most relevant chemicals legislation (excluding REACH) and identified challenges, gaps and weaknesses, COM(2019)264, EU Commission, 2019 – p.12
[61] WFD, Annex V, chapter 1.3.4.

but detection of pollutants which may have a wide or fast progression across Europe. After the 4 years of trial, a decision is taken whether the chemical compound enters the list of "priority substances" that have to be monitored continuously.

In 2013, the WFD and the EQS were modified by a new **Directive on Priority Substances (PSD). A list of 45 substances (mainly pesticides)**[62] was established, associated to quality threshold values in the water bodies or aquatic biota. This PSD – in addition to the regularly updated watchlists – form a consistent base across EU countries to compare pollution levels. However, the number of monitored substances is far too low compared to the thousands used for human activities.

In 2017 were defined the Good Ecological Status (GES) for marine waters, following application of the 2008 MSFD. However, this definition is not specific enough to be measurable (contaminants in marine waters, contaminants in seafood and marine litter are parameters of GES). Member States' Programmes of measures were also found to be insufficiently focused on preventing / mitigating the impacts of human activities on the marine environment. Opportunities remain for the MSFD to facilitate further data gathering, for example on pollution affecting health and the environment (contributing to the Zero Pollution Ambition).

In 2021, the European Chemicals Agency (ECHA) evaluated 1,900 substances[63] and concluded on a need for additional knowledge for 440 of them. Efforts were prioritized **on phthalates and bisphenols**: potential restrictions were proposed, to be taken up by MS or EU regulations. Further, the EU Commission may develop specific technical guidelines to support the Member States in the monitoring or evaluation of their aquatic pollutants. For instance, the recent concern around **PFAS** has resulted in:

- The listing of PFAS substances in the 2020 update of the DWD (see Annex III part B)
- The production of EC Staff working document and call for projects[64]

As regards **the AMR spread**, the lack of detailed data on the use (and conditions of use) of antimicrobial medicine, is the first key element highlighted by the EU Commission in its One Health action plan against AMR (2017): *"The main cause of AMR is antimicrobial use. A comprehensive, collaborative and coordinated collection and analysis of data from multiple domains, i.e. a One Health AMR surveillance system, is therefore essential (…). Although in the EU a wide range of surveillance programmes and activities across different sectors exist,* ***gaps in surveillance remain."***

4.2.3.5 Sampling and Analysis Protocols

For **water-borne pathogens**, **standard protocols** are specified for *intestinal enterococci* and *Escherichia coli* in the EU regulation (see BWD and DWD) and mandatory for all Member States. Sampling, storage and transport for microbiological analysis are also detailed in these two regulations. **No standard protocols or guidelines have been identified in the EU legislation regarding the assessment of AMR in aquatic environments.** Reviewed documents limit themselves to stating the growing problem of microbial resistance and the concern of potential cocktail effects from the cumulative presence (in water but also in sediments) of several antimicrobial molecules. It is important

[62] Annex II of the PSD

[63] ECHA annual report https://echa.europa.eu/documents/10162/5641810/irs_annual_report_2021_en.pdf/b38d8eec-d375-beb2-98b2-1fb0feb3612a?t=1655382672222

[64] https://ec.europa.eu/environment/chemicals/pfas/index_en.htm

to stress out that **the laboratories responsible for the sampling and analysis of water pollutants** have to be reported at EU level and must meet minimum professional requirements (ISO standards).

4.2.4 EU Regulatory Demand on Data Reporting, Access and Dissemination

4.2.4.1 Reporting on Substances

Competent authorities for the management of the environment have periodic reporting to do regarding the state of the water bodies as well as existing pressures from human activities (see the requirements from the WFD – this mandatory reporting will not be developed here). The goal of this data collection is to determine or adjust impactful measures in order to reduce the concentration of pollutants in the aquatic environment, as well as for early warning systems.

However, in between the production of chemical compounds (ruled by MPHU, REACH, IED, Pesticides Directive, PPP regulation or Biocides regulation) and the presence of pollutants in the environment (ruled by WFD, BWD, GWD, MSFD, DWD), there is **a lack of obligations regarding data reporting – at the EU level – on the actual use of the chemical products placed on the market, geographic location, frequency and period in the year, storage and transport, as well as combined use with other substances**.

Surprisingly, **none of the pieces of legislation that were reviewed referred to the PRTR**, though it entered into force in 2006. The aim of the register is to "*give the public, industry, scientists, insurance companies, local authorities, non-governmental organisations and other decision-makers a solid database for comparisons and future decisions in environmental matters*". The producers and users of pollutants concerned by the PRTR range from the energy sector, the metal manufacturing industry, the mineral industry, the chemical industry, the waste and wastewater sectors, the wood and paper industry, the intensive livestock production and aquaculture, the food and beverage industry, etc. **Yearly maximum quantities of substances that can be released into the water have been defined for 70 pollutants[65]. The legislation covers both point source and diffuse pollution**. The European PRTR was archived in 2020, but it can still be downloaded from the EEA website[66]. It contains information covering the period 2007 to 2017 and approximately 34 000 facilities. **The E-PRTR has been merged with the IED reporting**. The new merged database can be freely downloaded from EEA[67]. Similarly, **very few pieces of legislation mention the Directive on PAEI** though it entered into force in 2003. Only the BWD, REACH, IED and DWD refer to PAEI and have a dedicated chapter to public information.

Some Directives are explicit on the fact that their **target groups for data access** are not the citizens. For instance, the Biocides regulation clearly states that "*The Register for Biocidal Products shall be used for the exchange of information between (…) applicants and competent authorities, the Agency and the Commission*".

4.2.4.2 Data Accessibility

Despite not referring to PAEI, INSPIRE or WISE, some regulations ambition to build registers to facilitate the access to the information. For instance, the Biocides regulation states that "*the following up-to-date information held by the Agency or the Commission on active substances shall be made **publicly and easily available free of charge**:*

[65] Annex II of PRTR

[66] https://www.eea.europa.eu/data-and-maps/data/member-states-reporting-art-7-under-the-european-pollutant-release-and-transfer-register-e-prtr-regulation-22

[67] https://www.eea.europa.eu/data-and-maps/data/industrial-reporting-under-the-industrial-6

(a) the physicochemical endpoints and data on pathways and environmental fate and behaviour;
(b) the result of each toxicological and ecotoxicological study;
(c) the acceptable exposure level or predicted no-effect concentration established in accordance with Annex VI;

The regulation on PPP also promotes the easy access to information: the applicants' dossiers, the renewal requests or the withdrawal of the authorisation. However, some information remains restricted:

"*Producers, suppliers, distributors, importers, and exporters of plant protection products shall keep records of the plant protection products they produce, import, export, store or place on the market for at least 5 years. Professional users of plant protection products shall, for at least 3 years, keep records of the plant protection products they use, containing the name of the plant protection product, the time and the dose of application, the area and the crop where the plant protection product was used. They shall make the relevant information contained in these records available to the competent authority on request.* ***Third parties*** *such as the drinking water industry, retailers or residents,* ***may request access to this information by addressing the competent authority.***"

In parallel to the work carried-out by EEA, the EU Commission has launched in 2012 the development of IPCHEM - **the Information Platform for Chemical Monitoring**[68] - administered by the JRC. The goal of IPCHEM is to "*help identify links between exposure and epidemiological data in order to explore potential biological effects and lead to improved health outcomes*". The platform hosts data about:

- chemical monitoring on existing, new, emerging and less-investigated chemicals covering a range of matrices and media;
- data currently not readily accessible (e.g. outcomes of research projects, off-line stored monitoring data, etc.);
- chemical monitoring data and information of defined quality in terms of spatial, temporal, methodological and metrological traceability.

However, in 2020, the Chemicals Strategy for Sustainability[69] recommended to:

- "Develop a common open data platform on chemicals (as part of the European Green Deal data space announced under the EU data strategy) to facilitate the sharing, access and re-use of information on chemicals coming from all sources;
- remove legislative obstacles for the re-use of data and better streamline the flow of chemical data between EU and national authorities;
- extend the principle of open data and the relevant transparency principles from the EU food safety sector to other pieces of chemical legislation."

This statement seems to consider that **the available databases are still insufficient or dysfunctional**. The restricted access to data relative to the use of chemical products leads to a dispersal of the information, inconsistencies in the data format across the EU and therefore difficulties to undertake assessments of the pollutants pathways from human activities to the aquatic environment.

The former PRTR and IED registers only apply to the largest factories and thus do not cover the full extent of chemicals spread in the environment. Those registers also **do not apply for pathogens and AMR.**

[68] https://ipchem.jrc.ec.europa.eu/#intro
[69] COM(2020)667

The 2020 evaluation of the PPP regulation[70] pointed-out that **some applicants held back information** regarding the impacts of the products or substances proposed for authorization. In order to counteract that situation, it recommends that the EU creates a register of all commissioned studies so the applicants' dossiers exhaustivity can be assessed. The Chemicals Strategy for Sustainability also pointed out that "*knowledge on uses and exposure is fragmented, in particular as it relies on industry to provide accurate information".*

4.2.4.3 Voluntary Initiatives to Disseminate Data at EU Level

Other platforms are in use at the EU level to submit or retrieve data on aquatic pollutants. For instance, the SIEF – **Substance Information Exchange Forum**[71] is open to applicants for a chemical substance authorization. It complies with the REACH requirements. The **European Commission** has also developed a meta-website[72] in 2017 (under the Dutch Presidency) to list all links towards the national registers or actions plans on the sustainable use of pesticides. Not all EU Member States are contributing though.

4.2.5 Importance of the EU Regulatory Demand from Experts' Points of View

The stakeholders interviewed, both within national-level organizations or EU-level organizations, stress upon the **importance of the EU regulatory demand to shape their work**. Most have internal alert systems to keep-up with the evolution of the legislation and the EU texts under revision. It is indeed a key added value of the EU-level professional networks to inform their members in real-time of ongoing discussions and potential changes.

Some persons interviewed regretted that some national legislations are more ambitious or conservative than the EU – which can be a trigger for business development (i.e. for reuse or nature-based solutions to treat the water).

Stakeholders are also attentive to other demands: public opinion and consumers' satisfaction (stakeholders from the drinking water or sanitation sectors); knowledge demand from their members or students; funding opportunities for business or research.

The introductory European context pointed out that European directives are legislative acts that sets out goals that all MS must achieve. However, it is up to the Member States to devise their own laws on how to reach these goals. National, regional and local governments, have the ultimate responsibility for developing, implementing, supporting the policies and actions. Their responsibilities include legislation, regulation and auditing compliance with legal, policy and professional standards. **We now highlight three examples of national legislation framing the monitoring, evaluation and acting on CEC, AMR and pathogens.**

4.3 German Political Demand and Identification of Gaps

When looking at what regulations currently exist in Germany, it is useful to use a top-down approach, moving from EU-level documents to the local level. This is because EU directives are binding, and the implementation of these directives is left to the European member countries. Most regulation in

[70] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0208&from=EN
[71] http://www.sief-it.com/
[72] https://webgate.ec.europa.eu/europhyt/cgi-bin/sud_europa.cgi#/

Germany is conducted at the state (*Bundesländer*) level, with action and management plans specific to individual river basin districts.

This section summarises a selection of German policy documents, highlights available resources for knowledge transfer, and analyses the demand for additional guidance regarding CECs, pathogens and AMR.

4.3.1 Brief Overview of the 13 Reviewed Documents

German water regulation is closely tied to the EU Water Framework Directive (WFD). The targets and management rules stated in the WFD play a central role in the **German Water Law** (Wasserhaushaltsgesetz, WHG), the most important national regulation for the German water sector. The WHG establishes legal requirements for the management of surface and groundwater, while designating the management responsibilities largely to the German states and river basin districts. The WHG regulates the handling of substances hazardous to water, but specific limits and requirements are provided in its many "daughter" ordinances (e.g. groundwater ordinance, surface water ordinance). See Table 4.2 for more information.

The entire regulatory context in Germany cannot only be described through the various laws and ordinances, however. The legal requirements are complemented, or supported, by strategies, which while not mandated, represent a first step towards regulations and signal future priorities of decision makers. Further, various supporting materials are available within Germany to help with reporting requirements, as laid out in regulations, or to distribute information within specific sectors (i.e. research, health sectors).

As part of the regulatory analysis, DECHEMA reviewed **15 documents,** which represent the regulatory context in Germany concerning aquatic micropollutants. These include ten ordinances or laws, four strategies and one publication of tolerance values, spanning the timeframe from 1999-2021 (Table 4.2).

Table 4-2. Policy documents and strategies reviewed as part of the German regulatory context analysis.

Document Title	Acronym	Pollutants Targeted	Summary
German Water Law (Wasserhaushaltsgesetz)	WHG (2009)	See daughter ordinances	Implementation of the EU WFD. Sets legal conditions for the management of water in terms of quantity and quality, and to control human impacts on water bodies
Wastewater Ordinance (Abwasserverordnung)	AbwV (2004)	Lists targeted substances specific for 52 industries	Contains requirements for the discharge of (municipal, industrial, commercial) wastewater into water bodies, establishes best available techniques (BAT), specifies the analysis and measurement procedure for wastewater
Groundwater Ordinance (Grundwasserverordnung)	GrwV (2010)	Organic compounds, trace metals, nitrates, phosphates	Defines the chemical status of groundwater, identifies parameters for which national threshold values should be derived, identifies measures to prevent or limit pollutants into groundwater

Document Title	Acronym	Pollutants Targeted	Summary
Surface Waters Ordinance (Oberflächengewässerverordnung)	OGewV (2016)	Metals, chemicals, herbicides, insecticides	Specifies EU-wide good ecological status requirements, rules for monitoring substances from the European watch list, an updated list of pollutants.
Ordinance for Facilities Handling Substances Hazardous to Water (Verordnung für Anlagen zum Umgang mit Wassergefährdenden Stoffen)	AwSV (2017)	Substances ordered into water hazard classes	Implements the EU WFD and Nitrates Directive by classifying substances and their mixtures according to hazardousness to water and outlining requirements for facilities handling such substances.
Drinking Water Ordinance (Trinkwasserverordnung)	TrinwV (2001)	Bacteria, chemicals, trace metals, pesticides, biocides	Specifies the requirements for drinking water quality and the processing and disinfection of drinking water
Ordinance on the Placing on the Market of Fertilizers, Soil Additives, Culture Substrates and Plant Auxiliaries 1 (Düngemittelverordnung)	DüMV	Nutrients, metals, organic materials, chemicals	Regulates the approval and labelling of fertilizers, soil additives, and plant aids. Defines labelling requirements for thresholds and limit values.
Ordinance on the Application of Fertilizers, Soil Additives, Culture Substrates and Plant Auxiliaries in Accordance with the Principles of Good Fertilizing Practice 2 (Düngeverordnung)	DüV		Establishes good agricultural practice regarding the use of fertilizers, including rules concerning emission abatement.
Federal Soil Protection Act (Bundes-Bodenschutzgesetz)	BBodSchG (1999)		Outlines actions to remediate contaminated soil sites and to prevent future contamination. Includes good agricultural practices to be used when working with soil for agricultural purposes. Enacted more specifically at the state level.
German Infection Protection Act (Infektionsschutzgesetz)	IfsG	Pathogens (in water, wastewater, water for human consumption and water for swimming or bathing)	Outlines measures to prevent communicable diseases in humans, detect infections at an early stage and prevent their further spread. Regulates the necessary cooperation and collaboration of federal, state and local authorities, physicians, veterinarians, hospitals, scientific institutions and other stakeholders
Marine Strategy Framework Directive* * see Section 4.2.	MSFD (2008)	Includes pesticides, pharmaceuticals, pathogens.	In Germany, the coastal Länder (Küstenbundesländer) are responsible for implementing the MFSD. Regular reports on the progress of implementation to the European Commission are mandatory. The national cooperation is organized by the Federal-State Committee North Sea and Baltic Sea (BANLO).

Document Title	Acronym	Pollutants Targeted	Summary
Derived tolerance values for selected active pharmaceutical ingredients in drinking water (Abgeleitete Toleranzwerte für ausgewählte Arzneimittelwirkstoffe in Trinkwasser)	-	Active pharmaceutical ingredients	Provides tolerance values of certain non-regulated foreign substances in drinking water, including active pharmaceutical ingredients.
German Antibiotic Resistance Strategy (Deutsche Antibiotika-Resistenzstrategie)	DART 2020	AMR (both from human and veterinary medicine) in general, no specific compounds	Summarises measures to reduce antibiotic resistance through six overarching goals. Explains what progress has been made regarding the reduction of AMR in human and veterinary medicine, and outlines needed future actions. Discusses reporting requirements and databases.
"Stakeholder-Dialogs" – Federal Trace Substance Strategy (Spurenstoffstrategie des Bundes)	-		As a result of multiple workshops, the Strategy includes recommendations for action to reduce discharges of trace pollutants into water bodies. The recommendations focus on mitigation at the source, during the application and also downstream.
National Water Strategy (Nationale Wasserstrategie 2021)	-		The draft strategy lists recommended measures to be implemented in order to ensure adequate and affordable drinking water for Germany by 2050. Part of this strategy is the founding a national trace substance center (under UBA) – the German Center for Micropollutants (SZB) – to improve knowledge on water pollution.

4.3.2 Analysis, Data Production and Reporting

There are no specific requirements concerning data gathering and monitoring in German regulation, but it is implicitly mentioned. For instance, the WHG contains legal provisions for the German Environment Agency (UBA) and plant operators to cooperate in gathering data that is required for the determination and classification of substances hazardous to water[73]. For help with this monitoring and classification, the German Institute for Standardization (DIN) has created several protocols. These standards or protocols help streamline the implementation of the various water regulations and aid stakeholders responsible for the measurement and analysis of pollutants. A sample of these standards can be found in Table 4.3.

Table 4-3. Selection of German sampling and analysis protocols.

Field and environmental media	Standard/protocol
Analytical methods for certain parameters and thresholds for the chemical status of groundwater, including trace substances	DIN EN ISO/IEC 170251
Quality management system for laboratories that monitor biological quality elements or chemical or chemical-physical quality elements in groundwater	DIN EN ISO/IEC 17025

[73] WHG §62 (4)

Analysis and assessment methods for wastewater	Specific DIN norms for various parameters[a], e.g.: organic matter (TOC), chemical oxygen demand (COD)
Self-assessment for the classification of hazardous substances (WGK) which are not already registered	Documentation forms provided (and assessed) by UBA[b]

[a] https://www.gesetze-im-internet.de/abwv/anlage_1.html

[b] https://www.umweltbundesamt.de/themen/chemikalien/wassergefaehrdende-stoffe

The classification of substances and their mixtures according to their hazardousness to water (water hazard class [Wassergefährdungsklassen, WGK]) is regulated by the Ordinance for Facilities Handling Substances Hazardous to Water (AwSV). As specified in Annex 5 of this regulation, the classification of substances is based on a European test methods regulation and the REACH regulation ((EC) No 440/2008 and (EC) No 1907/2006, respectively). **According to the AwSV, UBA must publish catalogued substances in the Federal Gazette** (*Bundesanzeiger*) and in an open access database[74], Rigoletto. The Federal Gazette includes a list of substances from 2017, which is updated by official notices from UBA when new substances are classified. UBA's open-access database Rigoletto contains the catalogued substances according to their hazardousness to water. Several **CECs** are listed in the database, such as **endocrine disruptors** (e.g. Bisphenol A, Triclosan, Atrazine, Nonylphenol), **pharmaceuticals** (e.g. Paracetamol, Carbamazepine), **pesticides** (e.g. Permethrin, Lindane, Endosulfan, Terbutryn), and **personal care products** (e.g. Titanium dioxide, Silver chloride). Since the AwSV regulation pertains to hazardous substances directly handled by facilities/plants, the list of classified substances does not include **AMR** or **pathogens**.

The collection in Table 4.4 include further examples of national databases which house some of the regulatory mandated data in addition to providing non-required data. They are an important source of information for stakeholders working in the field of aquatic pollutants but do not represent an exhaustive list of databases or information systems available. As explained above, many ordinances require the collection and publication of water-related data, but the methods for this collection and publication are not included. The databases included in the table were identified during the regulatory analysis process, but **no overarching document or process naming the various databases was found**.

Table 4-4. Monitoring and Information Systems available within the German water sector.

Information System	**Coordinated by**	**Targeted Pollutants**	**Summary**
WasserBLIck[a]	Federal Institute of Hydrology (Bfg)		Comprehensive national communication and reporting platform. The application is used to handle Germany's electronic reporting to the EU for several water-related directives. It contains maps, statistics, electronic reports for EU including the management plans for each river basin district which are mandatory according to the WFD and WHG (national)
Antibiotic Resistance Surveillance[b]	Robert Koch Institut	AMR	Resistance data from laboratories performing microbiological diagnostics on a voluntary basis since 2008

[74] AwSV §6 (4)

Information System	Coordinated by	Targeted Pollutants	Summary
Antibiotics Consumption Surveillance (AVS)[c]	Robert Koch Institut	AMR	Consumption data provided by general hospitals on a voluntary basis since 2015
Rigoletto [d]	UBA	(CECs) endocrine disruptors, pharmaceuticals, pesticides, personal care products	Classified substances and their mixtures according to their water hazard class.
Database – Pharmaceuticals in the Environment [e]	UBA	Pharmaceutical residues	Compiles MECs (Measured Environmental Concentrations) of human and veterinary pharmaceutical residues published in peer-reviewed papers from 2017-2020. The latest update (2021) contains 276,895 entries from around the world.
Biocide Porta [f]	UBA	Biocides	Internet portal for the general public to inform on biocides concerning their risks, preventive measures and potential alternatives.
Soil information systems for each federal state [g]	Authorities of federal states	Pollution with nitrates, other pollutants, and heavy metals in soil	Overview maps, land area register
Federal groundwater databases [h]	e.g. State Institute Baden-Württemberg		Relevant measuring point data as well as indicator parameters for groundwater, including parameters for EDCs, pesticides, PCBs, etc.
Marine Environmental Database [i]	UBA (Owner), Federal Institute of Hydrology (Manager)		Marine monitoring data provided by coastal federal states as well as other federal and research institutions since 1994.

[a] https://www.wasserblick.net/servlet/is/1/

[b] Covers inpatient care as well as the outpatient care sector (https://ars.rki.de/Content/Database/ResistanceOverview.aspx)

[c] Includes data from hospital basic and standard care as well as specialized and maximum care facilities that have submitted data to AVS for at least one year. Data from specialist hospitals and rehabilitation facilities are not included. (https://avs.rki.de/Content/ReferenceData/Databasis.aspx)

[d] Contains micropollutants and biocides, e.g. octylisothiazolinone (Water Hazard Class (WGK) 3 = Highly hazardous to water) https://webrigoletto.uba.de/rigoletto/)

[e] https://www.umweltbundesamt.de/en/database-pharmaceuticals-in-the-environment-1

[f] https://www.umweltbundesamt.de/themen/chemikalien/biozide/biozid-portal-start

[g] Example: Soil information system for Hessen: https://bodenviewer.hessen.de/mapapps/resources/apps/bodenviewer/index.html?lang=de

[h] Example: Baden-Württemberg provides download options of data sheets: https://www.lubw.baden-wuerttemberg.de/wasser/grundwasserdatenbank

[i] https://geoportal.bafg.de/MUDABAnwendung/

The **German Antibiotic Resistance Strategy (DART) of 2020** emphasizes the importance of representative data in order to continuously adapt therapy and hygiene recommendations to the situation and to develop targeted prevention strategies[75]. Improving the data basis is one important

[75] Bundesministerium für Gesundheit (BMG), 2020. DART 2020: Abschlussbericht. S. 11

part of the second and third objectives of the strategy – "detecting resistance developments at an early stage" and "maintaining and improving therapy options". Towards this goal, monitoring and surveillance systems have been expanded. For the human pharmaceutical sector, **the Antibiotic Resistance Surveillance (ARS)**[76] and the **Antibiotics Consumption Surveillance (AVS)**[77] databases support hospitals in implementing the requirements of the **Infection Protection Act** (IsfG). Furthermore, they provide national data for two international surveillance systems on antibiotic resistance: the European Antimicrobial Resistance Surveillance Network (EARS-Net)[78] and the Global Antimicrobial Resistance and Use Surveillance System (GLASS)[79], managed by WHO.

Furthermore, an important development at the federal level for compiling information on micropollutants is the newly established **German Centre for Micropollutants (SZB)**, which is currently working on a national strategy to address trace substances. Part of the strategy includes establishing a network of important actors to create an adequate dataset identifying relevant pollutants for monitoring and regulation[80]. SZB aims to foster knowledge exchange between the federal states, UBA at the federal level, literature and databases, and experts from practice through their regular stakeholder dialogues.

4.3.3 Regulatory Demand as a Driving Force for Stakeholders

4.3.3.1 Role of European Legislation in the German Context

As part of its analysis, DECHEMA e.V. interviewed 18 German stakeholders who operate in various water sectors and deal with pathogens, CECs and AMR (see Section 0). The purpose of these interviews was to discuss the context in which these stakeholders conduct their work – how their work relates to various aquatic pollutants and what regulatory requirements or demands exist pertaining to their work. The national interviews and accompanying analyses are explained in more detail in Chapter 3.

When asked about the regulatory demand for their work, all stakeholders mentioned at least one EU-level regulation. The Water Framework Directive (WFD) was most often mentioned and was stated as part of the regulatory context for all stakeholder sectors. Even though the WFD applies mainly to the management of surface water, water actors who do not directly deal with surface water (i.e. drinking water suppliers using groundwater) nevertheless stated that the WFD is interesting and useful as a reference because of the regulated substances list ("priority substances").

Stakeholders also listed other EU-level policies and regulations as relevant for their daily work. The most often cited were those regulations pertaining to specific chemicals or substances – the REACH Regulations (1907/2006) and CLP (Classification, Labelling and Packaging) Regulation (1272/2008).

[76] Can be accessed here: https://ars.rki.de/
[77] Can be accessed here: https://avs.rki.de/
[78] Can be accessed here: https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/ears-net
[79] Can be accessed here: https://www.who.int/initiatives/glass
[80] Halbach, K., Starke, M., Kubelt, J., Schonsky, H., Warnke, I., Eisenträger, A. (2022). Spurenstoffstrategie des Bundes – Ein Wichtiges Puzzleteil auf dem Weg in eine zukunftsfähige Wasserwirtschaft [Powerpoint-Präsentation]. Spurenstoffzentrum des Bundes.

4.3.3.2 National Regulatory Context in Germany

The implementation of EU regulations and directives is done at the national and local level, with Germany defining various responsibilities and processes for the regulation of CECs, pathogens and AMR. The stakeholders interviewed all listed various national regulations, some depending on the specific area of work (i.e. surface water protection, ecotoxicology, drinking water supply, etc.). As an overarching regulation, the German Water Law (WHG) was mentioned by all interviewed stakeholder sectors, including its many "daughter regulations", such as the Drinking Water Ordinance (TrinV), Wastewater Ordinance (AbwV), Groundwater Ordinance (GrwV) and Surface Water Ordinance (OGewV).

These ordinances include various thresholds, values, or statuses, which must be complied with, which are a major driving force for German water stakeholders. As the body in charge of protecting Germany's water bodies, UBA not only transposes EU-level regulations into German legislation, but also serves as a reference for stakeholders regarding the implementation of existing water protection requirements as well as the assessment of new micropollutants.

4.3.3.3 Perceived Shortcomings of Current Regulatory Context

When analysing the regulatory context, it is not only important to assess the current regulations that are in place, but also to understand what demands or improvements are needed within these existing regulations. The major demands referenced by the stakeholders during the semi-structured interviews (see Section 0) can be summarized as follows:

- **Assessment and monitoring of new pollutants:** As stated in the above regulatory analysis, both EU and German legislations list regulated and priority substances. Included in these lists are, in most cases, threshold values, emission limits, and monitoring and analysis methods. However, the amount of micropollutants found in the environment far exceeds the number of pollutants that are currently regulated. This refers to individual substances or entire classes of pollutants (i.e. AMR). Thus, a demand exists for determining if newly found (or not yet regulated) substances are acceptable in various water resources and, if so, at what concentrations. Further, the procedures for analysing these compounds are also unclear. Currently, if new compounds are encountered in water bodies, stakeholders will contact UBA for guidance and assistance. The regulatory process – the codification of new legislation to regulate emerging pollutants – currently takes several years, impacting the ability to protect water resources.
- **Increase transparency and transfer:** Several interviewed stakeholders stated that the regulatory demands do not relate to the regulations themselves, but to the transfer and transparency of these regulations. As detailed in Section 0, German stakeholders receive information on new regulations via expert networks, of which they are part, or scientific publications, but the amount of information available regarding the regulations of CECs, AMR and pathogens is so extensive, making it time- and resource-intensive to understand current or new requirements. Therefore, there is a need within the German context to increase the transparency across sectors regarding how regulations and requirements are prepared and communicated.

As stated earlier, the stakeholders that were interviewed operate in various sectors and have varying responsibilities, which means that they also can highlight individual improvements for regulations. These sector-specific demands are summarized as follows:

- **Operator A, Association B** – Two stakeholders mentioned the need for more threshold values for micropollutants, specifically regarding quantity specifications with associated toxicity or risk. Additional information for regulated substances is needed. This includes also where substances are most often encountered in the environment, what sources – point or diffuse – are present, and where should monitoring be implemented.
- **Authority C, Operator E** – Building upon the previous point, it was stated that more data on the effects and toxicology of substance and micropollutants is needed. The inclusion of this data into the substance lists, for example, then threshold values can be better determined.
- **Operator C, Association A** – An increase focus on prevention, rather than removal or treatment, was stated as a regulatory demand. The regulation of substances based on discharge limits from wastewater treatment plants focuses on the removal of existing micropollutants without addressing the future protection of water resources. By establishing regulations pertaining to producer responsibility or the quicker regulation of new substances, environmental and human health protection can be increased.

4.4 Swedish Political Demand and Identification of Gaps

Sweden's regulations regarding water management are strongly influenced by EU legislation. This is mainly due to the EU Water Framework Directive (Directive 2000/60/EC)[81]. As stated in the Treaty on the Functioning of the European Union, a directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods.[82] Therefore, due to the fact that the Water Framework Directive is an EU directive, the Member States' regulation of water management must achieve the same results but can be implemented in different ways in national legislation due to differences in national legal systems. The Framework Directive has three so-called daughter directives: one for groundwater (Directive 2006/118/EC), one for priority substances in surface water (2008/105/EC) and a technical directive on quality requirements for chemical analyses and laboratories engaged for monitoring (Directive 2009/90/EC).

In Sweden, the literature review was focused on **the texts transposing the WFD** into national legislation[83]. They are listed below:

- Environmental Code (1998:808) (*Swedish: Miljöbalk (1998:808)*)
- Water Management Ordinance (2004:660) (*Swedish: Förordning (2004:660) om förvaltning av kvaliteten på vattenmiljön, numer vattenförvaltningsförordning (2004:660)*)
- Ordinance (2017:868) Containing Instructions for the County Administrative Board (*Swedish: Förordning om ändring i förordningen (2002:864) med länsstyrelseinstruktion, upphävd, numer förordning (2017:868) med länsstyrelseinstruktion*)
- Public Water Services Act (1970:244) (*Swedish: Lag (1970:244) om allmänna vatten och avloppsanläggningar, upphävd, ersatt av lag (2006:412) om allmänna vattentjänster*)
- Ordinance on Environmentally Hazardous Activities and Health and Safety protection (1998:899) (*Swedish: Förordning (1998:899) om miljöfarlig verksamhet och hälsoskydd*)
- Geological Survey of Sweden Regulation (SGU-FS 2008:2) on Environmental Quality Standards and Groundwater Status Classification (*Swedish: Sveriges geologiska undersöknings föreskrifter (SGU-FS 2008:2) om statusklassificering och miljökvalitetsnormer*

[81] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
[82] Article 288 TFEU.
[83] https://eur-lex.europa.eu/legal-content/SV/NIM/?uri=CELEX:32000L0060

för grundvatten, upphävd, numer föreskrifter (SGU-FS 2019:1) om ändring av Sveriges geologiska undersöknings föreskrifter (SGU-FS 2013:2) om miljökvalitetsnormer och statusklassificering för grundvatten)

- Geological Survey of Sweden Regulation and Reccomendation (SGU-FS 2017:1) on Management Plans and Action Programs for Groundwater (*Swedish: Sveriges geologiska undersöknings föreskrifter (SGU-FS 2008:3) om redovisning av förvaltningsplan för grundvatten, numer föreskrifter och allmänna råd (SGU-FS 2017:1) om redovisning av förvaltningsplaner och åtgärdsprogram för grundvatten)*
- Geological Survey of Sweden Regulation (SGU-FS 2013:1) on Mapping and Analysing Groundwater (*Swedish: Sveriges geologiska undersöknings föreskrifter (SGU-FS 2013:1) om kartläggning och analys av grundvatten*)

4.4.1 Environmental Quality Standards

Environmental Quality Standards (EQS) play a role in water management in the following way (40 & 42 of the preamble to the Water Framework Directive).

With regard to pollution prevention and control, Community water policy should be based on a combined approach using control of pollution at source through the setting of emission limit values and of environmental quality standards. Common environmental quality standards and emission limit values for certain groups or families of pollutants should be laid down as minimum requirements in Community legislation. Provisions for the adoption of such standards at Community level should be ensured.

4.4.2 Regulations in Practice

There are two major documents[84] framing the implementation of the WFD in Sweden. Sweden is divided into five Water Districts (see Chapter 2, Section 1 of the Water Management Ordinance): The Gulf of Bothnia (County Administrative Board of Norrbotten County), the Bothnian Sea (County Administrative Board of Västernorrland County), the North Baltic Sea (County Administrative Board of Västmanland County), the Southern Baltic (County Administrative Board of Kalmar County) and the North Sea (County Administrative Board of Västra Götaland County). A county administrative board in each district is appointed as the water authority.

Each Water District has a decision-making Water Delegation. The Water Authorities' Registry (*Swedish: Vattenmyndigheternas Kansli*) proposes which EQS, Action Programs and Management Plans that are to apply, and the Water Delegation have the final say.

The Swedish Agency for Marine and Water Management provides the Water Authorities with guidance and regulations for surface water and the Geological Survey of Sweden issues regulations on water management for groundwater.

The water management is conducted in **Management Cycles** of six years, where different work steps recur. The first cycle ended in 2009, the following ended in 2015, and the next ended in 2021.

- A cycle begins with water being mapped based on existing monitoring.
- The data collected is later used to assess and classify the condition and impact of the water and to EQS and which measures need to be taken to achieve good water quality.

[84] Vattenmyndigheterna & Vattenförvaltning - Planering, förvaltning och samverkan - Havs- och vattenmyndigheten (havochvatten.se)

- The Government may issue regulations EQS (Chapter 5, Section 1 MB followed by Chapter 4 Sections 1–10 of the Water Management Ordinance on environmental quality standards.
- Then Management Plans are drawn up for the work and as a final step we report the work to the EU.
- What a Management Plan must contain is stated in the Water Management Ordinance, Chapter 5.

4.5 French Political Demand and Identification of Gaps

4.5.1 Short Overview of the 30 Documents Reviewed

The documents reviewed to assess the political demand in the French regulatory context have been identified from two complementary sources:

- Expertise of the Aquatic Pollutants TransNet partners
- List of applicable orders, decrees and laws in the field of environment protection and risk prevention, provided by INERIS[85]

Only the texts that are presently *in force* have been selected for review. Successive improvements or updates of the texts have been accounted for. In total, 30 documents were selected for review of the regulatory demand on CECs, AMR and pathogens in France: 14 orders ("arrêtés"), 4 instructions, 4 guidance, 3 analysis and 5 action plans. Among the 18 documents which are legally binding (orders and instructions), 9 are based on the Code of Environment and 6 are based on the Code of Health, 1 is referring jointly to the two codes and 2 have another legal basis.

Selected documents range from 1998 to 2022. They all apply at national scale (no regional or local texts have been reviewed) and have been written by Ministry authorities (environment or health). **We kept a balance between documents targeting the pollution problem at source (human activities) and texts ruling the state of the environment.**

The list of documents, their summaries in English and the web links to access them are listed below.

Table 4-5. List of French regulatory documents reviewed.

Title	Summary	Link
Arrêté du 02/02/98 relatif aux prélèvements et à la consommation d'eau ainsi qu'aux émissions de toute nature des installations classées pour la protection de l'environnement soumises à autorisation	Order setting the obligations of Owner / manager of the of equipments listed under the environment protection regulations; wastewater operating conditions; spreading conditions of waste or wastewater on farmland; risk managements plans and emergency plans.	https://aida.ineris.fr/reglementation/arrete-020298-relatif-prelevements-
Instruction du 04/03/02 relative à la lutte contre la pollution du milieu marin (documentation nationale POLMAR)	Action plan against pollution of the marine environment. Defines roles and responsibilities among the State services. Three types of measures: prevention, preparedness, protection	https://aida.ineris.fr/reglementation/instruction-
Arrêté du 22/09/08 relatif à la fréquence d'échantillonnage et aux modalités d'évaluation de la qualité et de classement des eaux de baignade	Sampling and assessment methods for the evaluation of the quality of bathing waters Definition of good quality (criteria)	https://aida.ineris.fr/reglementation/arrete-
Arrêté du 17/12/08 établissant les critères d'évaluation et les modalités de détermination de l'état des eaux souterraines et des tendances significatives et durables de dégradation de l'état chimique des eaux souterraines	Evaluation criteria for the chemical status of groundwater Description of steps to determine the threshold values. Stricter values can be fixed in the RBMP.	https://aida.ineris.fr/reglementation/arrete-171208-etablissant-

[85] https://aida.ineris.fr/

Title	Summary	Link
Arrêté du 17/07/09 relatif aux mesures de prévention ou de limitation des introductions de polluants dans les eaux souterraines	Measures to limit or prevent pollutants in groundwater. Lists of substances are established. Substances can be added at RB level (via the RBMP). All substances that are already banned from marketing or use are de facto forbidden. Lists of derogations.	https://aida.ineris.fr/reglementation/arrete-170709-relatif-mesures-
Arrêté du 12/01/10 relatif aux méthodes et aux critères à mettre en œuvre pour délimiter et classer les masses d'eau et dresser l'état des lieux prévu à l'article R. 212-3 du code de l'environnement	Implementation of the WFD	https://aida.ineris.fr/reglementation/arrete-120110-
Arrêté du 08/07/10 établissant la liste des substances prioritaires et fixant les modalités et délais de réduction progressive et d'élimination des déversements, écoulements, rejets directs ou indirects respectivement des substances prioritaires et des substances dangereuses visées à l'article R. 212-9 du code de l'environnement	List of priority substances + timeframe (20 years) + conditions for reducing or banning their release in the environment	https://aida.ineris.fr/reglementation/arrete-080710-etablissant-liste-substances-prioritaires-fixant-
Note du 27/04/11 relative aux adaptations des conditions de mise en oeuvre de la circulaire du 05/01/09 relative aux actions de recherche et de réduction des substances dangereuses dans les rejets aqueux des IC	Based on the annual reports from the owner of the ICPE, this note helps decide which measures to take or which substances to prioritise for further monitoring. Note addressed to the inspection of ICPE.	https://aida.ineris.fr/sites/aida/files/fichiers/doc_7290_1.pdf
Circulaire du 07/07/11 relative aux modalités de mise en oeuvre par les préfets des mesures de gestion dans le cadre du plan national d'actions sur les polychlorobiphényles (PCB)	Measures following the detection of PCB in fishes. PCB have been monitored from 2008 to 2010 (along with dioxins and mercury).	https://aida.ineris.fr/reglementation/circulaire-070711-
Arrêté du 02/05/13 relatif aux définitions, liste et critères de la directive 2010/75/UE du Parlement européen et du Conseil du 24/11/10 relative aux émissions industrielles	Definition of best techniques available List of pollutants of water (families) including WFD lists	https://aida.ineris.fr/reglementation/arrete-020513-relatif-
Arrêté du 07/09/15 modifiant l'arrêté du 07/07/10 établissant la liste des substances prioritaires et fixant les modalités et délais de réduction progressive et d'élimination des déversements, écoulements, rejets directs ou indirects respectivement des substances prioritaires et des substances dangereuses visées à l'article R. 212-9 du code de l'environnement	Update of the list of priority substances and hazard substances	https://aida.ineris.fr/reglementation/arrete-070915-modifiant-larrete-8-juillet-2010-etablissant-liste-
Instruction n° DGS/EA4/2015/356 du 04/12/15 relative à la gestion des risques sanitaires en cas de dépassement de la limite de qualité pour la somme des concentrations en tétrachloroéthylène et en trichloroéthylène dans les eaux destinées à la consommation humaine	Action plan if threshold values of tetrachloroethylene and trichloroethylene are exceeded in natural waters used for drinking water production	https://aida.ineris.fr/reglementation/instruction-ndeg-dgsea42015356-041215-relative-a-
Note technique du 20/01/16 relative à la mise en œuvre de la liste de vigilance introduite dans la directive 2013/39/UE du 12/08/13 modifiant les directives 2000/60/CE et 2008/105/CE en ce qui concerne les substances prioritaires pour la politique dans le domaine de l'eau	Presentation of the watch list decided at EU level and coordination of action to implement it in 2016-2017	https://aida.ineris.fr/reglementation/note-technique-200116-relative-a-mise-oeuvre-liste-
Arrêté du 04/08/17 modifiant plusieurs arrêtés relatifs aux eaux destinées à la consommation humaine pris en application des articles R. 1321-2, R. 1321-3, R. 1321-10, R. 1321-15, R. 1321-16, R. 1321-24, R. 1321-84, R. 1321-91 du code de la santé publique	Update of the quality criteria for drinking water	https://aida.ineris.fr/reglementation/arrete-040817-modifiant-
Arrêté du 19/10/17 relatif aux méthodes d'analyse utilisées dans le cadre du contrôle sanitaire des eaux	Analysis method for the health control of waters: drinking waters, bathing waters	https://aida.ineris

Title	Summary	Link
Arrêté du 14/01/19 relatif aux conditions de mise sur le marché des produits introduits dans les installations utilisées pour le traitement thermique des eaux destinées à la consommation humaine	Marketing conditions of products used in drinking water production	https://aida.ineris.fr/reglementation/arrete-140119-
Arrêté du 15/04/19 relatif au programme d'analyses de la qualité de l'eau et aux limites et références de qualité des baignades artificielles	Definition of quality analysis, protocols and values for artificial bathing waters - depending on temperature and attendance	https://aida.ineris.fr/reglementation
Arrêté du 09/09/19 relatif à la définition du bon état écologique des eaux marines et aux normes méthodologiques d'évaluation	Definition of good status of marine waters and norms to evaluate the status	https://aida.ineris.fr/reglementation
Guide de mise en œuvre de la directive sur les émissions industrielles	Guidance to implement the IED Questions / Answers format	https://aida.ineris
Note technique du 29 septembre 2020 relative aux objectifs nationaux de réduction des émissions, rejets et pertes de substances dangereuses dans les eaux de surface et à leur déclinaison dans les SDAGE 2022-2027	National targets (and deadlines) for reducing the discharge of hazardous substances in the aquatic environment, to be included in the RBMP: - 53 priority & hazardous substances by 100% (30% for 7) - other substances used to classify the water chemical status: 10% to 30% reduction by 2027	https://aida.ineris.fr/sites/aida/files/gesdoc/105293/Note20200929_BO18122020.pdf
Plan de surveillance des contaminants chimiques du milieu aquatique dans les produits de la pêche – 2022	Monitoring program of chemical contaminants in the aquatic media via fish products	https://info.agriculture.gouv.fr/gedei/
Arrêté du 26/04/22 modifiant l'arrêté du 25 janvier 2010 établissant le programme de surveillance de l'état des eaux en application de l'article R. 212-22 du code de l'environnement	Monitoring program of waters	https://www.legifrance.gouv.fr/jorf/id/JORFTEXT0000
Plan national sur les résidus de médicaments dans l'eau	National action plan on residual medical products in waters	https://sol/sidarites
MÉDICAMENT ET ENVIRONNEMENT - La régulation du médicament vis-à-vis du risque environnemental (CGEDD, 2010)	Analysis of the lack of regulatory framework on human medicines in regard to the environmental impacts	https://cgedd.documentation.developpement
Un cadre pour conduire une politique de santé animale dans la filière aquacole	Synthesis of current challenges on animals' health in aquaculture and recommendations	https://agriculture
COMITÉ INTERMINISTÉRIEL POUR LA SANTÉ - MAÎTRISER LA RÉSISTANCE BACTÉRIENNE AUX ANTIBIOTIQUES - FEUILLE DE ROUTE (2016)	A roadmap to prevent bacterial resistance to antibiotics	https://solidarites-sante.gouv.fr/
Plan national de réduction des risques d'antibiorésistance en médecine vétérinaire 2017-2021	Second national action plan to reduce the risks associated to AMR in veterinary medicine.	https://agriculture
Deuxième stratégie national sur les perturbateurs endocriniens 2019-2022	Second national strategy to monitor and reduce EDC	https://solidarites-
Synthèse des valeurs réglementaires pour les substances chimiques, en vigueur dans l'eau, les denrées alimentaires et dans l'air en France au 30 juin 2020	Bi-annual synthesis of all threshold values applicable in France for food, air and water	https://www.ecologie.gouv.fr/sites/default/files/Rappo
SDAGE 2022-2027 sur les 6 Agences de l'eau et les DROM	RBMP and associated PoM on the 6 continental RBD	https://www.gestea

The transposition of European texts into French legislation is done through laws, decrees or orders. A matrix has been built to show the links between the French texts examined and the EU Directives which they quote (among the EU Directives and regulations selected for the EU review on aquatic pollutants). This matrix was helpful to check that no major aspect of CEC / AMR / pathogen – related legislation was overlooked by our review. **The EU WFD 2000/60/EC has the most references** into French legislation associated to aquatic pollutants.

In addition to the binding documents, Ministries are also putting up strategies or action plans. They have different roles: putting together in one document the existing pieces of legislation in order to give

them coherence, improve readability and implementation; detailing relevant measures in a pluriannual plan to meet the EU or national goals ; support funding schemes of the Ministries ; raising awareness on emerging issues and gathering means and knowledge. As the *in force* French legislation is poor on topics such as AMR, we added to the review the most recent action plans and strategies associated to these.

4.5.2 Pollutants Targeted by the French Legislation

The transposition of the EU WFD and associated directives in French legislations has led to 3 categories of substances:

- "SEC"[86] - Substances for the determination of the qualitative state of water bodies (45 "priority" substances defined at EU level in surface water and about 150 substances in groundwater decided at national level)
- "PSEE"[87] - Specific pollutants of the ecological state of surface water bodies (about 30 substances)
- "SPAS"[88] - Relevant substances to be monitored because their presence in the environment and associated risks are poorly known (about 200 substances in surface waters). They are not used for the calculation of the state of the water bodies. Mandatory threshold values are elaborated by INERIS for this category.

These three categories rank the substances according to the risk they pose for the aquatic environments as well as the risk to not meet the WFD's goals for water bodies. However, this is not a description of the substances' properties or family groups. The template for the regulatory review (see chapter 4.1) had a different categorisation.

Endocrine disruptive compounds (EDCs) have the most mentions in the reviewed documents. The orders ruling the release of pollutants in the environment in the '90's already took the risks associated with EDC into account. The first national strategy on EDC was drafted in 2014. Many substances with endocrine disruptive properties have since been included in the national lists to be monitored in the aquatic environment (SPAS). Knowledge acquired is shared at the EU level. There is still work to be done however to prioritize substances based on an inventory of all pharmaceuticals and cosmetics which may have ED properties.

Solvents and trihalomethanes (THMs) are also frequent in the SPAS lists and therefore in the pieces of legislation ruling both the monitoring of these substances in the environment and the reduction at source. **Metals** are regulated in all aquatic environments: France is following the EU incentives but is also driven by legacy pollutions from its industrial sites.

Pesticides are already well regulated within the EU. The French texts reviewed (9) complements this European framework. For each pesticide substance, a Product Assessment Report is established at the EU level. This report may include restrictions for use, minor environmental impacts, remaining risks to be mitigated, uncertainties in the assessment, missing or contradictory data. It is then up to each MS to finalise the assessment and grant, or not, the possibility to place the product on the market. This role is given to ANSES in France, the National Health Agency, which may coordinate with other national agencies if the producer also wants to market its product in other EU countries. ANSES has defined guidelines[89] for taking decisions specifically for **biocides**, using the EU technical guidelines as well as

[86] Substances de l'état chimique
[87] Polluants spécifiques de l'état écologique
[88] Substances pertinentes à surveiller
[89] https://www.anses.fr/fr/system/files/LignesDirectricesBiocides.pdf

the precautionary principle. The pluriannual plans on PPP reduction ("Ecophyto") are listing measures and (financial and organizational) means to try to achieve the European goals. Of notice: France has banned the self-service purchase of amateur-use PPPs since 2016.

France was the highest consumer of pharmaceuticals, for human and animal health, in Europe[90] in 2010. **Pharmaceutical** residues in the environment are high in the agenda since the 2010's when a report[91] exposed the situation and recommended that a concentration threshold be fixed for all pharmaceutical substances detected in the water – as it is already done for all pesticides[92]. The 2011 action plan against residual medical products in waters ("PNRM")[93] recommended alternatively that existing knowledge be used to prioritize medical substances to be monitored in the environment. An expert group was put in place to set up a database and select a first list. However, the evaluation of the plan in 2016 pointed out the non-achievement of this work due to difficulties in accessing the data (quantities used and sold, metabolites, information on toxicity, etc.). The evaluation concluded on the need to merge the unfinished actions in wider action plans (health & environment plans) and to wait for guidance from the EU level. 18 medical substances have been integrated in the SPAS as of 2016.

Pathogens are also clearly targeted by the EU: we found no added value in the French legislation nor specific programs. **AMR** has not been identified in the legally binding documents, so we looked for targeted action plans. We conclude that AMR is not yet ruled by national pieces of legislation. However, plans for the reduction of use of antibiotics on animals farming are in place since 2012. The successive plans put the emphasis on the reduction at source by identifying and promoting alternatives to antibiotics, especially vaccines. AMR is also the singular focus of a report[94] from the health inter-ministerial committee (2016). The report refers to international organizations' actions as well as examples from the USA or UK, highlighting the fact that there was not (to this date) a European policy on AMR. It does refer to preliminary works by the European Council (One Health approach) and the JPI-AMR, though.

Microplastics remain a black spot in French policies on aquatic pollutants (only 1 mention regarding the criteria to evaluate the ecological state of the marine environment). No dedicated strategy or program exists about microplastics in waters.

Other chemical substances such as cosmetics, household products, plasticisers or artificial sweeteners do not have specific pieces of legislation nor strategies. Molecules of these 4 categories can be listed (i.e. in SPAS) but the category in itself is not a target. Cosmetics are explicitly excluded from documents reviewed about pharmaceuticals.

---

90 https://cgedd.documentation.developpement-durable.gouv.fr/documents/Affaires-0006157/007058-01_rapport.pdf p.16

91 https://cgedd.documentation.developpement-durable.gouv.fr/documents/Affaires-0006157/007058-01_rapport.pdf p.16

92 threshold value is 0.1µg/l for all pesticides detected in waters used for human consumption

93 https://solidarites-sante.gouv.fr/IMG/pdf/Plan_national_sur_les_residus_de_medicaments_dans_les_eaux_PNRM_.pdf

94 https://solidarites-sante.gouv.fr/IMG/pdf/feuille_de_route_antibioresistance_nov_2016.pdf

4.5.3 French Regulatory Demand on Monitoring and Data Production

4.5.3.1 Monitoring Networks

France has put in place two monitoring networks ("RCS"[95] and "RCO"[96]) for the chemical quality of surface and groundwater under the WFD. The coordination is ensured by the Ministry of Environment, but the local monitoring is under the responsibility of the Water Agencies. The minimum network (RCS) is to qualify the state of the water bodies, completed by the RCO to evaluate the impacts of human activities and successive River Basin Management Plan (RBMP) measures. Additional controls can be decided by each Basin Authorities in case of unknown degradation of the water body, incidence of accidental pollutions, reasons for non-achievement of WFD goals, sensitive drinking water abstraction points.

The number of monitoring points in each River Basin District (RBD) is presented below, as well as the number of monitoring sites mandatory for the reporting under the watch list of emerging substances[97]. The sampling and analysis of pollutants in water is contracted out to national laboratories. Parameters range from physical parameters (e.g. temperature, pH) to chemical parameters (e.g. nitrates, pesticides). The data collected is used to evaluate the RBMP and to prioritise measures for the following cycle.

A different monitoring system is in place for drinking water abstraction points or bathing waters, which is supervised by ARS (the regional health agencies).

ROCCH is the observatory of chemical contamination of coastal waters in the Atlantic Ocean and Channel. RINBIO is the network for biomonitoring of the Mediterranean coastal waters.

Table 4-6. Number of monitoring stations for surface and groundwater chemical quality in France (2016).

WATER AGENCY	NUMBER OF STATIONS under the Watch List	NUMBER OF STATIONS for the regular monitoring (RCS & RCO)
Artois-Picardie	1	50
Rhin-Meuse	2	107
Seine-Normandie	4	216
Adour-Garonne	5	355
Loire-Bretagne	7	418
Rhône-Méditerranée-Corse	7	418
Total	26	1 564

4.5.3.2 Threshold Values

Since there are several pieces of legislation applicable to CECs, some of them being regularly updated such as the Watch Lists, the INERIS has been mandated by the Ministry of Environment since 2006 to produce **every two years a synthesis[98] of all regulatory threshold values for chemical substances in the environmental media** as well as food products. On October 19, 2017, a French order modified threshold values and lists of parameters for natural water resources used for human consumption,

[95] Réseau de contrôle de surveillance
[96] Réseau de contrôle opérationnel
[97] The Watch List changes every two years, each substance cannot be listed more than four years in a row.

[98] The latest report to date is 30th June 2020: https://www.ecologie.gouv.fr/sites/default/files/Rapport-Ineris-20-200358-2190502_Synth%C3%A8se%20des%20valeurs%20r%C3%A9glementaires%20v2.pdf

which was taken into account by INERIS on the 2020 synthesis. Main additions to the list are metals. The degradation molecules of biocides have also been included. No recent evolutions have been reported regarding the threshold qualities for bathing waters, surface or groundwater, waters for fish or shellfish production.

Additional parameters (and associated threshold values) can be added by each RBD authority in case of a specific pressure: 3 chemical substances were added in Seine-Normandie for instance and Rhône-Méditerrannée RBMP[99] has listed water bodies where PCBs have to be systematically included in the monitoring plans.

4.5.3.3 Sampling and Analysis Protocols

Sampling and analysis protocols are defined by the national legislation, either copying the EU regulations (when they exist) or introducing new norms (when the MS are free to define their own). The work is coordinated by the federal ministries (of environment, health and research) in close collaboration with the research centers and national agencies. For water resources used for drinking water, the norms are also determined at the national level.

There are three public laboratories in France that carry-out the analysis of chemical substances in water for the state services of BRGM, LNE and INERIS. The protocols for sampling and analysing are coordinated by AQUAREF, who is responsible for data production and reporting. A few examples of protocols are provided in Table 4.6.

Using the analysis results, the public laboratories send information to the Ministry of Environment. In 2007, the Ministry merged several databases and indicators in order to create SEEE[100], the centralized system for the evaluation of water body statuses in line with the WFD. This interface facilitates the reporting to the EU and is the **official reference for the calculation of the quantitative, qualitative and environmental state of the water bodies**.

Table 4-7. Protocols for measuring microbiology parameters in waters abstracted to produce drinking water[101].

Microbiological Parameters	**Analysis protocol**
Cryptosporidium-Giardia	NF T 90-455
Entérocoques	NF EN ISO 7899-1 (surface waters) NF EN ISO 7899-2 (groundwaters) NF EN ISO 7899-1 (bathing waters)
Entérovirus	Concentration: XP T 90-451 Numbering: XP T 90-451 or NF EN 14 486
Escherichia coli (E. coli)	NF EN ISO 9308-3 (surface waters) NF EN ISO 9308-1 (groundwaters) NF EN ISO 9308-3 (bathing waters)
Salmonelles	NF EN ISO 19250

Other specific protocols are mentioned in the legislation:

[99] https://www.rhone-mediterranee.eaufrance.fr/sites/sierm/files/content/2022-03/20220318-SDAGE-2022-2027_vol.principal_ADOPTE-1.pdf pp.132-133

[100] https://seee.eaufrance.fr/

[101] https://aida.ineris.fr/reglementation/arrete-191017-relatif-methodes-danalyse-utilisees-cadre-controle-sanitaire-eaux

- A norm has been validated in 2013 *AFNOR février 2013: XP T 90-223* for the quantification of **residual medical products** in waters. Laboratories in France now have credential to perform the analysis.
- Regarding **PFAS**, since no EU regulations are yet in place to describe threshold values or methodologies, the monitoring carried out (sampling and analysis methods) follow the same protocol as other substances (PCB for instance). The monitoring of PFAS in food products first started in 2022 for a 3-years period.
- The EU requires one sampling each year for substances on the **Watch List,** but France decided to carry-out two samplings (in spring and autumn) / year.

Sometimes, ISO norms have not been defined but the French legislation provides lists of sampling material or frequencies, calculation of indicators, lists of validated laboratories, etc.

4.5.4 French Regulatory Demand on Data Reporting, Access and Dissemination

It appears that, at least for the CECs that are explicitly targeted by the legislation, **the data collection aims to be comprehensive, covering statistical analysis and supporting action**. However, **the reporting is hardly mentioned**: no names of databases or platforms on which the data shall be posted, no standardized format or reporting, etc. At best, a state service is named or a contact person (which is prone to frequent changes, though). As most of the Ministry orders are addressed to other State services (local State representatives, national agencies, …), it is assumed that the civil servants know about the internal communication channels and reporting procedures.

Despite the absence of specifically mentioned databases on aquatic pollutants in the French legislation we reviewed, **tools have been developed to facilitate the access** for a wide range of professionals as well as the general public. Many user-friendly platforms exist as well as a centralized system for all water-related data called "EauFrance"[102]. Two examples of available platforms are provided below:

- Naïades is the public portal for data on the quality of surface waters (it also displays information for sediments and aquatic fauna & flora). The platform allows free access to the exact value and exact sampling date, on all monitoring points (all water bodies). Anyone can derive maps and graphs, locate the regions where this substance is exceeding threshold levels and plot trends.
- ADES is the platform dedicated to groundwater. One can research measurements of any substance (in a defined geographical area).

Both databases (and other water-related databases in France) are administrated by **EauFrance**[103]. This public service is however **never explicitly named in the French orders or instructions** that we reviewed, despite the fact that it handles the data that is to be collected under these pieces of legislation. EauFrance is also not listed as end-users of the data collected.

Data on aquatic pollutants that are not measured in the water, but in sediments or in the aquatic fauna, such as PCBs, can be trickier to access: one has to know the dedicated websites. For PCBs, a national action plan exists with an independent website[104] to download the monitoring results.

[102] https://data.eaufrance.fr/
[103] ruled by the order of October 19th, 2018
[104] http://www.pollutions.eaufrance.fr/pcb/resultats-xls.html

Regarding the emission of pollutants, **a national register exists** ("IREP")[105], which is connected to the European PRTR. It allows free access to data on pollutant discharges by the largest industrial sites or treatment plants for a list of 150 substances. Data can be filtered to select only the water media (IREP is also valid for air pollution).

4.5.5 French regulatory demand on data dissemination and knowledge transfer

Same as the data reporting, data dissemination and transfer knowledge are not included in the pieces of legislation that we reviewed. The below information only comes from the technical guidance, assessments or action plans.

The diagram below describes how the information is produced, shared and stored regarding the **substances from the Watch Lists**. The red arrows correspond to the preparation of the template for reporting the results of the substances analysis. The blue arrows correspond to the sharing and storing of the results.

- Samplers ("*Préleveurs")* can be many stakeholders: water agencies, river basin authorities, water managers, local State services, industries, etc. The analyses are done by laboratories with an official credential to perform quantification of CEC or pathogens in waters.
- SANDRE is checking that the results format is consistent with the data system in France. The results themselves are verified by Aquaref. The data is then transferred to the water agencies to be stored on their own information system (one IS for each RBD) and to ONEMA to be stored on the national IS. INERIS is also retrieving the data to merge within its own IS. The Ministry of environment is responsible for reporting this data back to the EU.
- BRGM is coordinating the different organisations responsible for handling the data on chemicals and pathogens in waters.

[105] Registre des Emissions Polluantes: https://www.georisques.gouv.fr/risques/registre-des-emissions-polluantes/accueil , also sometimes referred to as RRTP

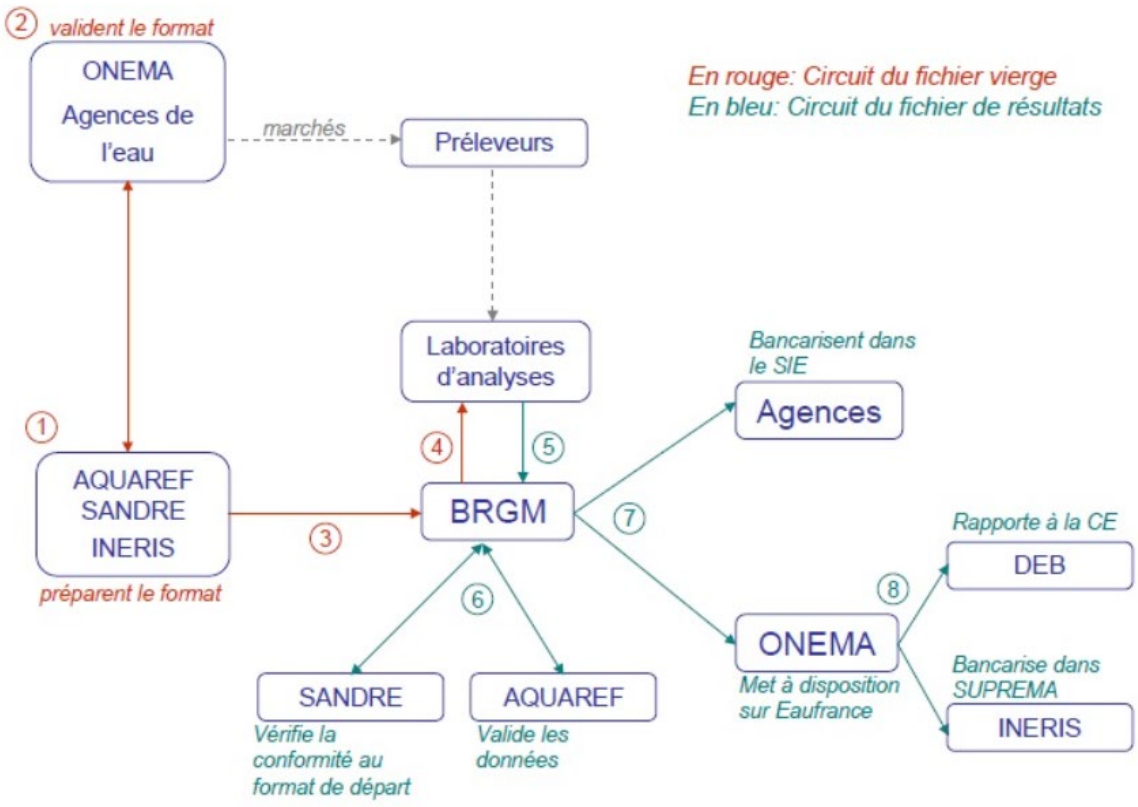


Figure 4-4. Data journey of the results of the monitoring of Watch List substances in France (source: INERIS[106])

The **assessments, strategies or actions plans we reviewed always recommend improvements in terms of data sharing and information**. The AMR action plan[107] (2016) lists among the measures the creation of a web portal to inform professionals and citizens about **AMR** (Action n°3), the creation of an interactive portal to identify public & private stakeholders, networks and observatories as well as research projects on AMR (Action n°18), the consolidation and opening of laboratories' data on AMR (Action n°29) as well as the organization of a Hackathon to exploit databases on antibiotics consumption for human health (Action n°32). The 2019-2022 national strategy against **EDC** calls for setting-up a national platform to store and share data on biomonitoring (Action 48).

4.5.6 Regulatory Demand as a Driving Force for Stakeholders

Weight of the European legislation in the French context

When asked about the regulatory framework of their activities concerning aquatic pollutants, all the **stakeholders interviewed (see chapter 3) mentioned the Water Framework Directive (WFD) as the most important and structuring document**. Several facets of this important European policy were mentioned, since the WFD influences the field of aquatic pollutants in several ways, at several scales:

- For those actors who were more focused on water management itself (public actors such as INERIS or INRAE, or private actors such as FWT), the WFD was systematically presented as the most structuring policy. The European scale is considered the most important because the

106 https://aida.ineris.fr/reglementation/note-technique-200116-relative-a-mise-oeuvre-liste-vigilance-introduite-directive Annex III

107 https://solidarites-sante.gouv.fr/IMG/pdf/feuille_de_route_antibioresistance_nov_2016.pdf

WFD is completed by "daughter directives", some of which concern pollutants in aquatic environments.

- Most of the actors (both public and private) mentioned the WFD as the structuring regulatory framework, highlighting in particular the national implementation tools. GRAIE explicitly mentioned the RSDE (research and reduction of discharges of hazardous substances into water) while Aquaref cited various technical notes (note on wastewater treatment plants, in particular).
- Several actors (water agency, BRGM, MTE) mentioned the role of the WFD in territorial planning documents for water management, in particular the RBMP.

Other Directives have been cited as being structuring for the stakeholders' activities:

- As a groundwater specialist, BRGM, notably supported by Aquaref, has widely insisted on the importance of the Groundwater Directive, as these aquatic environments are often ignored scientifically or by regulations despite their importance for drinking water production in France.
- Ifremer and INERIS mentioned the Marine Strategy Framework Directive (MSFD).
- Aquaref mentioned the EQS directive, which is specifically focused on the monitoring and reduction of pollution in aquatic environments. The company Biomae also mentioned this text, since it directly impacts the diffusion of the biological technology it markets.
- GRAIE mentioned the Urban Wastewater Treatment Directive (UWWTD).
- WatchFrog was the only actor that did not explicitly mention the WFD as a structuring regulatory framework, but the European scale remains the most important in their activities. The interviewee cited the European regulations on plant protection products and on endocrine disruptors.

Perceived shortcomings of the regulatory demand

Many persons interviewed have formulated regulatory requests, i.e. improvements in the regulations that they would like to see in the near future. Three main improvements can be distinguished, each one complementary to the other:

- The current regulatory situation remains very insufficient because it imposes a focus on particular substances. **The list of pollutants monitored is currently very small compared to what is actually found in the environment.** The system of monitoring by substance also has some methodological limitations, as mentioned by Aquaref. The principle of threshold values sometimes lacks relevance for very weak substances that are difficult to measure. The values obtained through the monitoring systems are not as reliable as required by the regulations. For these different reasons, many public actors (research institutions and public agencies) in the field would like to see a "paradigm shift" in the monitoring and control policy for aquatic pollutants. On the government side, such a shift would completely change the political approach to the risks associated with pollutants. Initiating such a transformation of public action is not only a question of regulations and new laws, but also of philosophy. The substance approach is particularly well suited to statistical work, with monitoring data available over a long period. Conversely, the new "effects-based" paradigm has the advantage of not being focused on a few substances out of several thousand, but it is more difficult to manage pollution control publicly.
- In the wake of this call for a paradigm shift, a number of stakeholders are calling for greater emphasis to be placed on certain new technologies. Companies that market **new**

measurement solutions (passive samplers and biological tools) are leaders in the call**.** The State is considered to be late in implementing these new tools in the regulations, but once again, it is a matter of testing these technologies to ensure their added value compared to the methods in force. Indeed, changing measurement tools also modifies the frame of reference for public action in the fight against pollutants, which explains the reluctance of authorities to completely change the paradigm. However, new technologies are increasingly used in the field. In some departments, prefectural decrees may recommend them because of their effectiveness. More and more public contracts are now available to companies that market these technologies.

- Several actors, including BRGM and AERMC in particular, have insisted on **the absence of forecasting tools.** Action against aquatic pollutants cannot be taken only in response to a measured situation; according to these stakeholders, a more preventive approach is also needed. This would complement the attempts to reduce pollutant emissions at source - which do not directly concern the actors working on aquatic pollutants, but rather the emitters of these pollutants, who did not respond to this survey.

For structural reasons, research is advancing much faster than regulation. This differential results from the requirements of both sectors. Researchers tend to define themselves the coordinates of the problems they study, leading to results that are of great interest at the fundamental level, but not necessarily adapted for application to concrete situations. BRGM mentioned in particular the **problem of translating scientific results into applicable public policies**, which works both ways. Scientists are well connected to the authorities or other public organizations, but their scientific work is still quite independent of their advisory work for the public sphere. The research community is willing to invest in the construction of public policies but has little understanding of the level of confidence in knowledge that is required to produce regulatory texts. There is also a concern about translating regulatory needs into research programs: researchers tend to define their own problems, responding to policy needs only in the very long term.

Stakeholders involved in very specific issues have also mentioned regulatory shortcomings of importance to their activities:

- Ifremer pointed to the lack of regulations (national or European) on **polluting substances for coastal environments**. The regulatory requirements are indeed focused on surface water and wastewater of all types. This also echoes the feedback from BRGM on the **lack of consideration for groundwater.** In both cases, the water bodies are particularly important, but the regulations seem relatively small.
- The regulatory framework for **anti-biological resistance is still largely exploratory**, according to Inserm. Indeed, the involvement of the State on these issues is currently limited to the financing of research programs and the establishment of a monitoring plan, to which researchers are invited. However, the issue of antibiotic resistance in water is still hidden in the middle of other organic environments in which antibiotic resistance phenomena can develop. Inserm researchers are still waiting for regulatory advances on the issue and are counting on their good connection to the authorities to put antibiotic resistance on the agenda of health authorities.

4.6 Comparison Between Countries

The EU legislation is strongly shaping the national legislations regarding substances regulations or environmental objectives. However, it is left to the countries to define protocols (locations, density, sampling, …) to monitor substances in water as well as which substances shall be monitored (apart

from the few registered under the mandatory lists from the WFD). France added contaminants to the EU “regulated” lists for instance. National agencies are key to translate EU directives into national texts and support the stakeholders through guidelines – though this process takes time and guidelines are late (compared to new emerging substances or new issues).

The regulatory system in France is more centralised. Much is decided at the national level, to be implemented at the level of the river basin districts. Only minor adaptations to the local situation are allowed. In a less-centralised country such as Germany, there are still no major differences between the Landers (rules are the same, but different strategies can be picked to reach the goals).

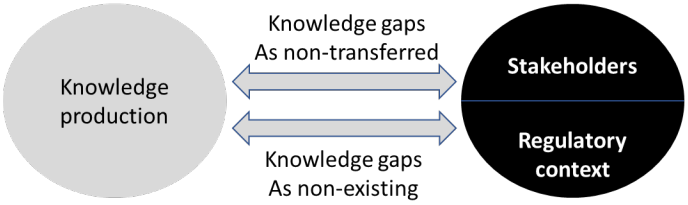
There is a lack of information in the legislation regarding toxicity levels, maximum concentrations or threshold values that shall be applied for the national / local assessments of risks.

The data reporting and dissemination is not ruled by the national legislations: data reporting is required but the texts are not specific on the who shall be responsible for it nor how it shall be organised. The pieces of legislations are limited to a general request to report. However, national platforms exist to facilitate data transfer: some of them are insufficiently used or advertised.

Strategic documents have identified a lack of data dissemination and access. The demand for better access to data has been identified in all three countries but is not met yet. Short-comings are pointed-out in the legislation in regard to AMR, as well to groundwater and marine environments. The authorities are waiting for the EU to take the lead and negotiate the rules. In the meantime, only strategies are being drafted at the national levels but nothing binding.

5 Synthesis and Key Demands

5.1 Stakeholders and Regulatory Context



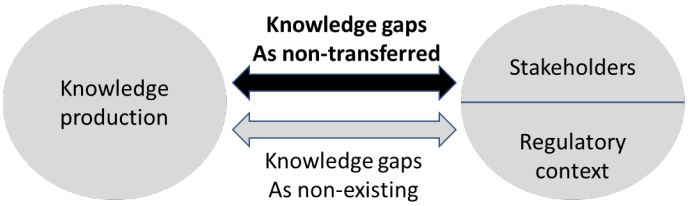
There are many stakeholders involved on the topics of CEC, AMR and water-borne pathogens. Though it is positive that many organisations are concerned with these topics, potentially complementing each other's, it was also found that it dilutes responsibility to tackle the aquatic pollution challenge.

Research institutions, universities, national or regional authorities are well connected through professional networks and via participation in funded research initiatives. Exchanges with local authorities, water suppliers or waste-water services are more limited. Water managers have their own federations in each country as well as representatives at the EU level. The water sector is fragmented in all three countries studied. Cooperation with the private sector is low. There are very few joint initiatives involving the private companies producing or using the pollutant substances. Private sectors also have their dedicated networks. Consultancies or designers of solutions to monitor or remediate the pollution are easier to identify and contact. There is a significant gap between the stakeholders responsible for producing, regulating or using substances, on one side, and the stakeholders involved in the surveillance and management of the water resources, on the other side (different ministry departments or agencies, different research teams, different professional networks, etc.).

CECs are managed at the national level (i.e. decisions on which substances to be monitored, which threshold values are acceptable or not, prioritization of research) following the directives and regulations from the EU. The demands are in constant evolution though, sometimes reacting to pollution accidents or political priorities. On AMR, national working groups exist in Germany, in Sweden and more recently in France.

Strong national regulations are already in place for pesticides and biocides as well as a few known hazardous substances (i.e. bisphenol or metals), but it remains weak for pharmaceuticals, cosmetics or household products. The EU legislation is strongly shaping the national legislations regarding substances regulations or environmental objectives. When new issues emerge, the national authorities wait for the EU to take the lead and negotiate the rules.

5.2 Stakeholder Demands: Existing knowledge – Not transferred



There is a wealth of information on aquatic pollutants which is both perceived positively (when one knows what to look for) and negatively (lack of efficiency and risk of redundancy). Key messages are

diluted. Centralizing this knowledge and disseminating it more efficiently needs to be improved. Some information might also be available in only one (non-English) language which prevents access by experts from other countries. The delays to publish information is also considered too long to effectively act; early-warning systems are required.

Professional networks have been identified as key to facilitate the transfer of knowledge, as they provide easier access to experts, offer trainings and seminars, produce newsfeeds on new regulations, research results or technological innovations, foster partnerships for research projects and sometimes manage their own databases. National agencies are also central to provide guidance for the implementation of national or European regulations, share returns of experiences and disseminate good practices. They have the capacity to tailor information to the end-users' needs.

Professionals also rely on specialised reviews or newspapers, scientific literature, state-of-the-art reviews from PhD students, official websites as well as social media to access recent information about aquatic pollutants.

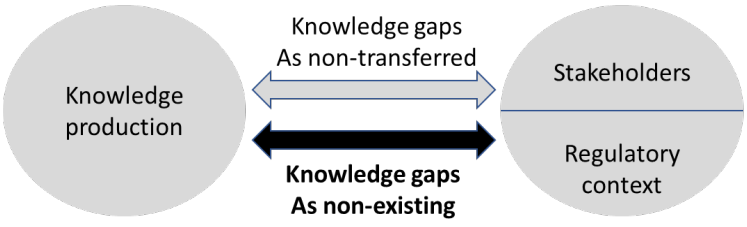
Communication remains difficult in between the categories of actors involved. Emitters of aquatic pollutants tend to be conservative of their data or methodologies. Researchers are precautious when discarding results. Policy makers would need more operational solutions and straightforward answers before taking action. Communication can even be difficult among State authorities (different ministries).

A specific demand from the public sector relates to data sharing for the registration process of substances, making better use of digitalisation tools. This information would allow for better risk assessments (as the managers of the natural resources would have better knowledge of which substances might possibly be present in the environment) and quicker regulation of substances (if toxicity or accumulation effects are demonstrated).

There is also little monitoring about the real uses of substances for human activities (pollution pressure) and the exposure pathway to the environment.

Knowledge transfer and reporting requirements for water stakeholders are not specified by the national legislations in France or Germany, though centralised databases have been developed in both countries at the initiative of national research institutes or State agencies. There are several public databases on AMR, biocides and further hazardous substances including endocrine disruptors, pharmaceuticals or pesticides in Germany. In France, the databases have been set for each environment (soils, surface waters, groundwater, drinking water, etc.) with information on chemical substances as well as other parameters (physical, biological). Strategy papers emphasize the importance of knowledge transfer and the need to improve access to data concerning emerging pollutants.

5.3 Stakeholder Demands: Knowledge Gaps



Knowledge gaps have been reported concerning measuring, analysing and characterizing substances in aquatic systems. The monitoring systems for chemicals in waterbodies are already quite functional in all three countries though there is still room for improvement (better geographical coverage, harmonisation of protocols to allow for comparative studies, quicker reporting, …). There is also a need to define common assessment parameters and indicators, as well as to expand analytical methods to detect substances at low concentrations (passive samplers) and new chemicals/substances (non-target analysis methods). There are no specific protocols yet in place to monitor AMR processes in the environment.

Knowledge gaps have been reported on the information pertaining to hazardous substances (PFAS at the top of the list), toxicity of compounds mixture, influence of physical parameters on the becoming of chemical pollutants (accounting for climate change), transport of pollutants (through modelling), AMR detection and impacts, microplastics and nano-plastics. There is no database yet to retrieve information about the presence of antibiotics in the environment, or the monitoring of micro- and nano-plastics at the European scale. Behaviour of pollutants in the environment, especially the marine waters or groundwaters, also needs to be more deeply investigated.

Developing better treatment (ozonation, activated carbon, nanofiltration) techniques is also an on-going quest in all countries, adopting a more comprehensive approach that looks at the entire pollution chain. The efficiencies of the technologies shall also be assessed under a variety of conditions to demonstrate added-value and applicability throughout Europe (and facilitate their uptake and approval). Mitigation techniques or infrastructures (sewage overflow prevention, nature-based solutions, separated water networks, etc.) also require innovation and replication, taking into account the need to reduce (water and energy consumption), reuse and recycle chemicals. Social drivers and behavioural change are also new fields to investigate to accompany the above development trends.

Annex 1. Guideline for Stakeholder Mapping

This guideline intends to facilitate the identification and mapping of stakeholders who play a role in **aquatic pollutants, at a national scale**.

There are four following steps:

1. **Organisation of the stakeholders' database**
2. **Inventory of stakeholders**
3. **Description of stakeholders**
4. **Mapping of stakeholders**

Step 1: Organisation of the stakeholder database

A stakeholder's database supports the inventory and description of stakeholders. It is developed as a simple Excel sheet, easy to use.

The stakeholders are listed in lines. The descriptors (parameters) are organised in columns.

For the TransNet project, our descriptors are:

- The basic stakeholder information (name of the organisation, name of the department or service within the organisation, contact person and contact details)
- The AP project to which the organisation contributes to (if relevant) as a partner or as a target group
- The status of the organisation (public, private, economic sector, …)
- The type of pollutants on which the organisation (or contact person) is focusing on: CEC, AMR or pathogens; and its role (regulator, emitter, problem owner, surveyor, solution designer or provider)[108]
- The networks in which the organisation is involved and its role
- The organisation end-users or target groups
- The organisation main sources of knowledge

These two descriptors will require interviews to be filled-in. There is no map yet but it is a goal to make one AFTER the interviews.

More columns can be added for comments or specific information relevant for each country.

The stakeholders' database for France is attached to this guideline as a template.

	Be as specific as possible	Make sure they sti	For interviews or	nisation is member					targetted as end-us					Choose organisation's status in the drop-down m	Tick the box if t				Choose a role
Name or organisation	Name of Department/Laboratory/Service	Contact person	Contact details	Project partner					Project target					Status					
				NTACT	REWARN	enWaterTech	ESAGE	RA	RE-SEA	NTACT	REWARN	enWaterTech	ESAGE	RA	RE-SEA	Public state organisation (government representatives) Public territory organisation (communities, provinces) Public health organisation Public research organisation Private organisation - primary sector (agriculture) Private organisation - secundary sector (industry) Private organisation - tertiary sector (services, studies) Associations & NGOs International organisations	erging Pollutants	imicrobial resistance	hogens	Role
Ecole Centrale de Lyon / Universit	Laboratoire Ampere			X				X								Public research organisation	x			
ANSES - Agence Nationale de sécu	Laboratoire de sécurité des aliments				X											Public state organisation (government representatives)	x		x	

Figure 5-1. Screenshot of the stakeholders directory for France.

[108] The term 'decision-maker' is not used. Indeed any stakeholder is making decisions in its own field of activity. The organizations responsible for crafting the laws are the 'regulators'.

Step 2: Inventory of stakeholders

Three complementary ways can help to **identify** the stakeholders involved on a topic:

- **The snowball effect:** You know at least a few stakeholders/people to start with, from your own professional relations: pick one as a starting point and follow its links with other stakeholders (who is he/she working with, who has he/she worked for before, which networks is he/she a member of). This will give you access to other organisation names and contact persons. You repeat the same process with the new organisations/persons identified.
- **The professional networks:** In each network which you come across, try to identify key stakeholders that could be recurrent in the field (lead organizations in the network, regular attendees, etc). Online information can be outdated ! Verify if identified networks are still active or not. If not, it can still be interesting to inventory them, especially when there is continuation with another dedicated network.
- **The literature review:** Publications on the subject are also an easy way to identify the active organisations (publication's authors and affiliations): scientific publications but also public or corporate reports. The most recent publications shall be favoured to avoid targeting organisations or teams who no longer exist or work in the field. The publications can be identified with selected keywords: network – emerging pollutants – water – antimicrobial resistance – pathogens – etc.

At the beginning, there will be plenty of stakeholders to follow, with many networks to browse through. After a few repetitions, key actors identified will become recurrent, and new actors will not appear again: you can stop the identification.

Step 3: Description of stakeholders

When organisations and persons have been identified, the database can be filled-in by searching the complementary information on internet (organisation websites, persons' LinkedIn profiles, conferences minutes, etc.).

Keep in mind that this stakeholder's description and mapping is a preliminary work before more active interactions are launched (workshops, interviews) so it is OK if all the cells in the table are not filled-in in step 3. This is a work-in-progress, and the information will be collected throughout your project/process.

The advantage of using an Excel table is it allows you to sort and filter the different columns. Use it to:

- Avoid duplications (if several people are contributing to the same database)
- Identify the types/fields/roles for which your inventory has been less successful and would require extra efforts (gap analysis)

Step 4: Mapping of stakeholders

The map is there to visualise the information from the database. But the map cannot display all the information contained in your database: you need to choose a point of view (which descriptors/parameters you want to use to create the map).

The mapping step has to be creative: there is no generic shape of map because each map depends on the stakeholders involved and the links between them. A few rules can still be respected to get a useful map, easy to interpret:

- Define a visual way to distinguished stakeholders through their characteristics, for example: coloured pictograms, specific typography, etc.
- Include a legend of the visual elements you are using

We illustrate below two types of maps that can be produced as a preliminary work (get to know the stakeholders before moving on with the interactive parts of your processes) and with limited information gathered through internet research. The maps are not exclusive (it is interesting to draw both to have a deeper analysis of the stakeholders).

- **Link maps**

Goal: Show the main stakeholders of the field

Map development could include, for example, the following steps:

- place the main stakeholders in the centre of the map
- from these, draw links with other stakeholders who partner with them
- add the professional networks to which they belong
- play with the typography and colours to highlight the most important stakeholders and the different types

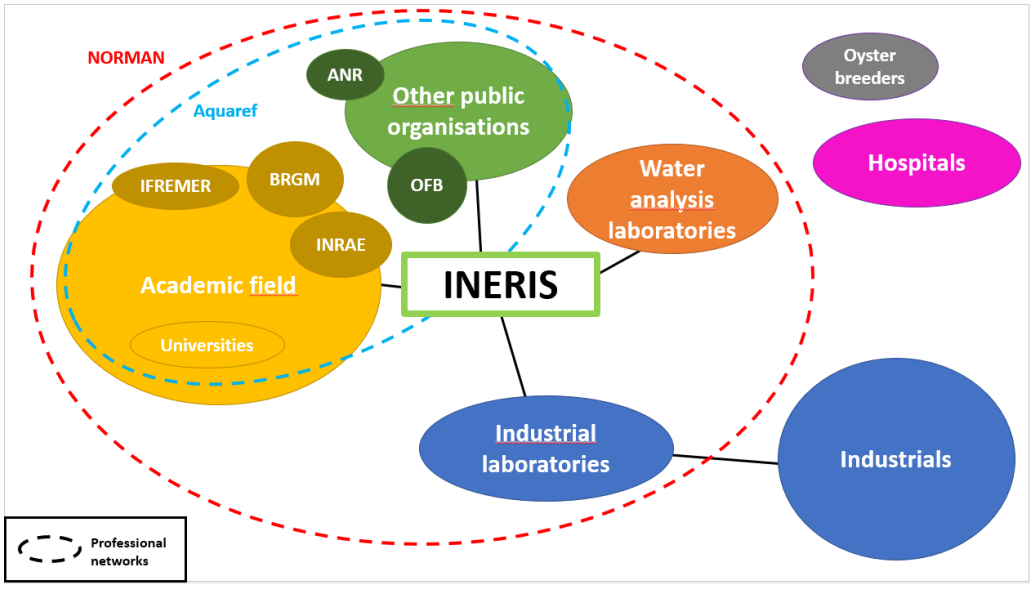


Figure 5-2. Example of stakeholders working on CECs and contributors to the Aquaref and NORMAN networks.

- **Role maps**

Goal (example): Show who is working on / concerned with the different pollutants and at which step of the water cycle

Map development could include the following steps:

- select two subjects (i.e. the kind of pollutant or the role in the water cycle itself) to structure the map with 1 vertical and 1 horizontal information
- position the stakeholders based on their field of expertise and role: a visual can be used to add a third level of information (i.e. the type of organisation)

- draw circles to represent the active teams or partnerships

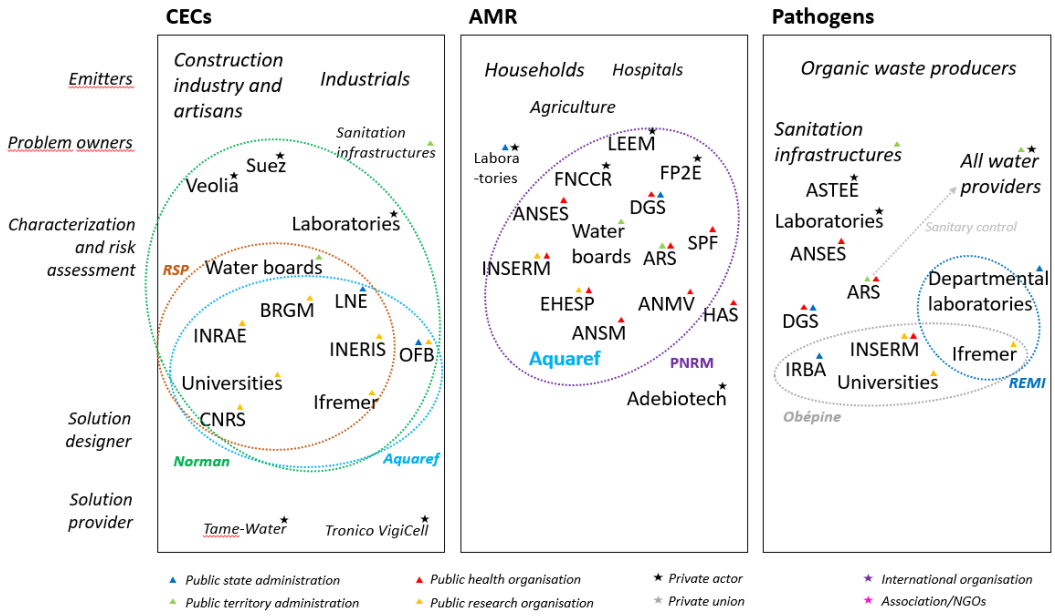
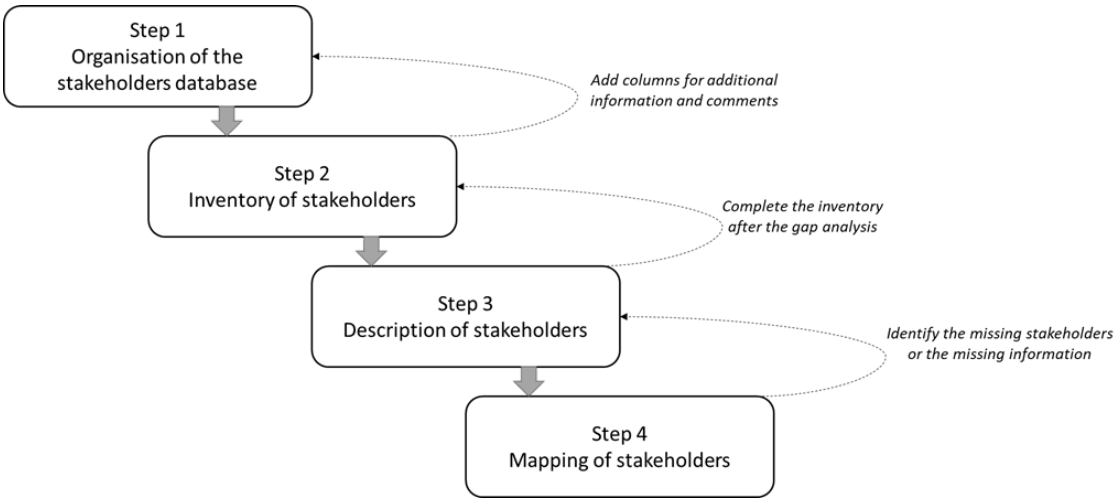


Figure 5-3. Example of the stakeholders and their roles on the topics of CECs, AMR and pathogens

Remember that a map is only one view of a large field of work. Multiply maps can be useful to show different views of the same actors and their links, to complete the imperfect representation of all the stakeholders.

If the database is updated (new stakeholders added, networks disappearing), the maps shall be updated too. Adding a date on your visuals is mandatory!

This is an iterative process!



Annex 2. Stakeholder interview guidelines

Note: the italic words are prompts to help the interviewer guide the conversation and make sure the answer given is thorough enough ; they can be used as sub-questions.

Introduction

Remind about objectives of the interview, who you are, why they have been contacted (see separate document). Overall objective: find the needs, demands, gaps in knowledge on aquatic pollutants.

The notes taken during the interview are restricted to the consultants involved in AquaticPollutantsTransNet. Only the aggregated and anonymised results of interviews carried out will be published. No personalised direct answers of interviewed persons will be published. The interview will be recorded for a quality check (no part of the recorded interview will be disseminated). Do you consent to the recording ?

1. Do you have questions before we start? *(The interviewer can talk more about the TransNet project or AquaticPollutants call at the end of the interview – to avoid bias)*

About you

2. Could you provide a short description of your organisation and position ?

Check that the organisation type in our contact list is correct:

- *Public state organisation (government representatives)*
- *Public territory organisation (communities, provinces)*
- *Public health organisation*
- *Public research organisation*
- *Private organisation - primary sector (agriculture)*
- *Private organisation - secondary sector (industry)*
- *Private organisation - tertiary sector (services, studies)*
- *Associations & NGOs*
- *International organisations*

3. What is your field of work ?

Understanding of chemical, physical and biological processes	*Technologies / Tools developers or users*	*Strategies / Planning*	*Permission / control of (water related) operations / activities*	*Other (please detail)*

4. What do you consider as aquatic pollutants ? (*Goal here is to understand their level of knowledge on these terms – are we interviewing experts or not – so leave the question rather broad and do not mention yet the CEC, AMR, …).*

5. Are you working on / dealing with regulated (pathogens, biocides) or non-regulated (CEC, AMR) compounds ?

Contaminants of Emerging Concern (CEC)	*Antimicrobial resistance (AMR)*	*Pathogens*	*Others (biocides)*

6. How are you (your organisation) concerned / involved with aquatic pollutants ?

Producer of substances / Emitter	*Problem owner*	*Characterization and risk assessment*
Solution designer	*Solution provider*	*Regulator*
Water resource manager		*Other (please detail)*

7. Which environment are you working on/with in relation to these pollutants ?

Fresh surface water	*Marine water*	*Agri-Mari-Aqua culture wastewater*	*Aquatic fauna*
Fresh groundwater	*Brackish water*	*Domestic wastewater*	*Terrestrial fauna*
Drinking water		*Industrial wastewater*	

8. Is there a regulatory context in which your work is carried out (state the EU / National / Sub-national regulations/frameworks/directive/rules) ? List them.

9. Is there a regulatory demand regarding aquatic pollutants? *(i.e. limit values, need to monitor / to plan / to assess and revise / …)* Please specify.

10. What other motivations (aside from regulatory demands) do you have to work with or address aquatic pollutants ? Why are you paying attention to these pollutants ? *(Can be social pressure, care for the environment, economic reasons, etc.)*

Your networks

11. What other organisations do you interact with ? Please name the main ones and explain their role / how they complement you.

Partners to provide knowledge	*Partners to implement regulations*
Partners to provide tools or technologies	*Clients*
Partners to provide funds / subsidies	*Consumers or End-users*
Others	

12. Are you (or your organisation) a member of any professional networks related to CEC/AMR/pathogens? Please name the networks and your role in them.

Your knowledge

KNOWLEDGE THEY DO HAVE

13. What knowledge/information is useful for your work/activity?

On measurement	*On evaluation*	*On action*	*Other*

14. Can you explain how you acquire this knowledge/information? Please detail. *Write down as many details as possible (names of publications, …)*

Data collection in the field and experiments
Analysis of existing databases
Bibliographic review
Synthesis of expert knowledge (interviews, workshops, …)
Training and other educational materials
Other …

15. What are current progresses or trends in your field of work that you are aware of ? Any innovations or R&D activities you know about ?

16. Are there barriers or obstacles or constraints that impede these trends or progresses ? If yes, please describe.

KNOWLEDGE THEY DO NOT HAVE

17. What is the knowledge that you need ? What knowledge is missing to fulfil your activities ?

	On measurements	*On evaluation*	*On actions*	*Other*
Knowledge that exists but is not / inadequately transferred				
Knowledge that does not yet exist				

18. Why is it missing in your opinion ?

Your sources of information

19. How are you informed about new/updated legislation in your field of expertise? Please detail the source (name, link) and the frequency of update. *Write down as many details as possible (names of publications, of congresses, of the media …)*

Official (governmental) publications / notifications	*Social media*
Expert-groups publications on social media or newsletters	*Conferences / Meetings*
Scientific publications	*Trainings / MOOC (massive open online course)*
Internal publications / notifications	*Press (mainstream)*
Call for projects	*Others (please specify)*

20. How are you informed about new/updated scientific or technological knowledge available in your field of expertise? Please detail the source (name, link) and the frequency of update. *Write down as many details as possible (names of publications, of congresses, of the media …)*

Official (governmental) publications / notifications	*Social media*
Expert-groups publications on social media or newsletters	*Conferences / Meetings*
Scientific publications	*Trainings / MOOC*
Internal publications / notifications	*Press (mainstream)*
Call for projects	*Others (please specify)*

21. Would you say the above sources are sufficient to meet the goals of your work ? Please explain. (If *insufficient, why: problem of access, paying to access it, no time to exploit it, language barriers, …)*

22. Which communication channels are lacking / hard to access in your opinion ?

23. Could you share an experience when a lack of information was an issue to meet the goals of your work ? Or an outstanding experience when adequate information enabled to greatly achieve the goals of your work ? *(Not mandatory)*

24. Which lack of knowledge / information is most detrimental to your work ?

25. Do you have ideas how the information gap could be covered ?

More frequent information	*How much is too much ?*
More detailed information	*How much is too much ?*
Better tailored information	*What is relevant and what is not ?*
More reliable information	*Who do you trust ?*
Better media / information tools	*What attracts and retains your attention ?*

Conclusion

26. Is there anyone else we should interview (either from your organisation or a partner organisation)? Please provide the contact details or could you establish the contact ?

27. Would you like to add something / any topic you feel is important but was not discussed?

28. Do you have additional questions?

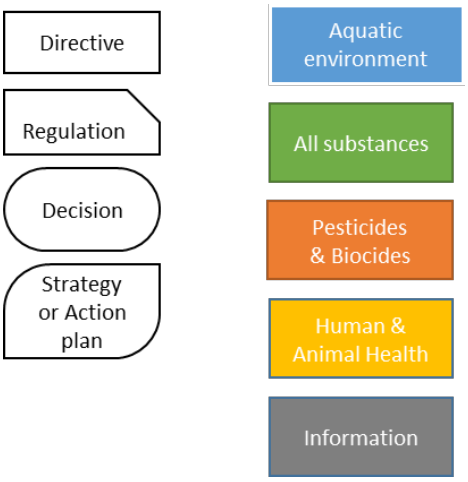
29. Would you be available and interested in further discussions on this topic (i.e. receiving our newsletter, participating in workshops, etc.)?

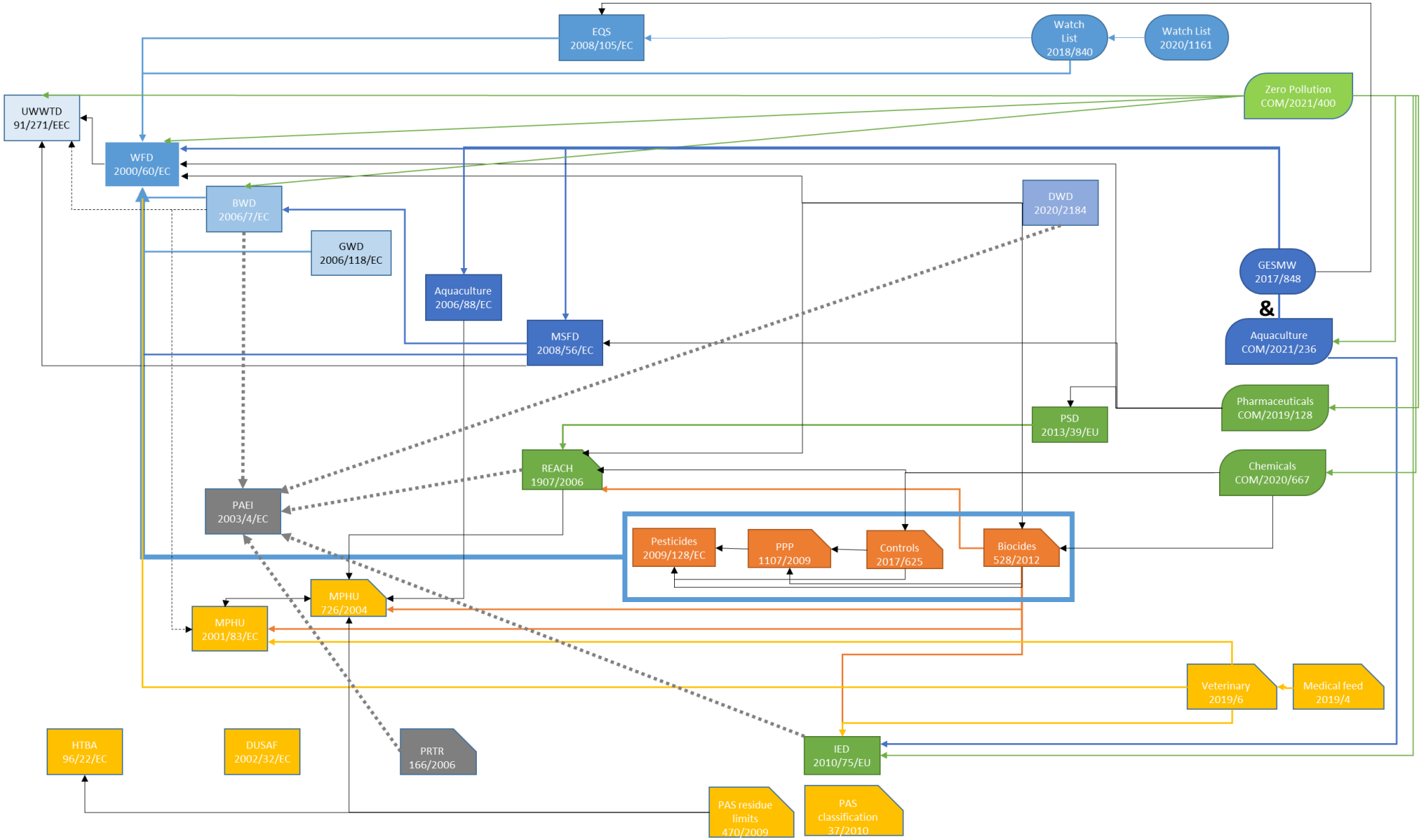
Annex 3. Map of EU pieces of legislation related to CEC, pathogens or AMR

Notes

- Chronology is approximate (this is not a timeline).
- References to regulations or directives which are no longer in force are not listed.
- References to regulations or directives outside of the scope of Aquatic Pollutants (Nitrates Directive or Regulation (EC) No 1881/2006 on maximum substances in foodstuff i.e.) are not listed.
- Evaluations have not been included in the map for clarity purposes (and because they relate to one specific piece of legislation only)

Legend




EQS
2008/105/EC
Watch List
2018/840
Watch List
2020/1161
Zero Pollution
COM/2021/400
UWWTD
91/271/EEC
WFD
2000/60/EC
BWD
2006/7/EC
GWD
2006/118/EC
Aquaculture
2006/88/EC
MSFD
2008/56/EC
DWD
2020/2184
GESMW
2017/848
&
Aquaculture
COM/2021/236
Pharmaceuticals
COM/2019/128
PSD
2013/39/EU
REACH
1907/2006
Chemicals
COM/2020/667
PAEI
2003/4/EC
Pesticides
2009/128/EC
PPP
1107/2009
Controls
2017/625
Biocides
528/2012
MPHU
726/2004
MPHU
2001/83/EC
Veterinary
2019/6
Medical feed
2019/4
HTBA
96/22/EC
DUSAF
2002/32/EC
PRTR
166/2006
IED
2010/75/EU
PAS residue
limits
470/2009
PAS
classification
37/2010