EUROPEAN
COMMISSION

Brussels, 26.10.2022
SWD(2022) 541 final

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Proposal for a Directive of the European Parliament and of the Council

concerning urban wastewater treatment (recast)

{COM(2022) 541 final} - {SEC(2022) 541 final} - {SWD(2022) 544 final}

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Glossary

Term	*Explanation*
Agglomeration	According to the Urban Wastewater Treatment Directive (UWWTD): 'Agglomeration' means an area where the population and/or economic activities are 'sufficiently concentrated' for urban wastewater to be collected and conducted to an urban wastewater treatment plant or to a final discharge point. (Article 2(4)). An agglomeration can be a city or municipality, but it can also be a number of smaller cities or towns clustered together.
Anti-microbial Resistance (AMR)	AMR occurs when e.g. fungi and bacteria transform over time and no longer respond to medications (WHO, 2022). The main drivers of the development of drug-resistant pathogens are misuse and overuse of anti-microbials e.g. antibiotics, antivirals, antifungals and antiparasitics. AMR has been declared as one of the top 10 global public health threats facing humanity by the World Health Organization (WHO).
Biochemical oxygen demand (BOD)	According to the UWWTD: in the wastewater discharge, biochemical oxygen demand (BOD) needs to be reduced to 25mg/l of Oxygen or a minimum reduction of 70-90% needs to be achieved. (Annex I). BOD is 'the amount of dissolved oxygen used by micro-organisms in the biological process of metabolising organic matter in water. The more organic matter there is (e.g. in sewage and polluted bodies of water), the greater the BOD. And the greater the BOD, the lower the amount of dissolved oxygen available for higher animals such as fishes. The BOD is therefore a reliable gauge of the organic pollution of a body of water. One of the main reasons for treating wastewater prior to its discharge is to lower its BOD — i.e., reduce its need of oxygen and thereby lessen its demand from the streams, lakes, rivers, or estuaries into which it is released.' (Britannica, 2019a). BOD is most commonly expressed as milligrams of oxygen consumed per litre of samples over 5 days of incubation at 20°C – this is called BOD_5 (Sawyer et al., 2003). In this text "BOD" means "BOD_5".
Chemical oxygen	The UWWTD states that chemical oxygen demand (COD) in the wastewater discharge needs to be reduced to 125mg/l O_2. Alternatively, a minimum reduction of 75% needs to be achieved. COD 'is a second method of estimating how much oxygen would be depleted from a body of receiving water as a result of bacterial action. While the BOD test is performed by using a population of bacteria and

demand	other micro-organisms to attempt to duplicate what would happen in a natural stream over a period of five days, the COD test uses a strong chemical oxidising agent (potassium dichromate or potassium permanganate) to chemically oxidise the organic material in the sample of wastewater under conditions of heat and strong acid.' (Woodard & Curran, 2006).
Collecting system	The UWWTD defines this as a system of conduits which collects and conducts urban wastewater. (Article 2(5)).
Combined sewers	Combined sewers are defined as 'Systems that carry a mixture of both domestic sewage and storm sewage'. Combined sewers typically consist of large-diameter pipes or tunnels, because of the large volumes of storm water that must be carried during wet-weather periods. They are very common in older cities but are no longer designed and built as part of new sewerage facilities.' (Britannica, 2019b).
Contaminants of emerging concern	The UWWTD does not include a reference to contaminants of emerging concern. According to the Organisation for Economic Co-operation and Development (OECD) "*Contaminants of emerging concern*" (CECs) comprise a vast array of contaminants that have only recently appeared in water, or that are of recent concern because they have been detected at concentrations significantly higher than expected, or their risk to human and environmental health may not be fully understood. Examples include pharmaceuticals, industrial and household chemicals, personal care products, pesticides, manufactured nanomaterials, and their transformation products' (OECD, 2018). The Environmental Quality Standards Directive explains *pollutants* of emerging concern. Recital 26 states that 'emerging pollutants … can be defined as pollutants currently not included in routine monitoring programmes at Union level but which could pose a significant risk requiring regulation, depending upon their potential eco-toxicological and toxicological effects and on their levels in the aquatic environment.'
Dilution rate	In the context of this IA, the dilution rate refers to the ratio between the flow of released wastewater from a treatment plant and the flow of the receiving body (river). A dilution rate of 10 means that 1 litre of released wastewater from the treatment plant is diluted in less than 10 litres in the river. Lower dilution rates represent more risks for the environment but also for potentially for public health.
Distance to target	'Distance to target' reflects the remaining efforts to be made to collect and treat the load generated in accordance with the requirements of the Directive. For instance, in 2018, 98% of the generated load is collected, across all Member States, in line with Article 3 of the Directive, meaning that, for this goal, the EU average distance to target is 2 %.

Eutrophication	UWWTD definition: The enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. (Article 2(11)).
E. coli	Indicators of faecal contamination are commonly analysed in treated wastewater prior to discharge or reuse. *Escherichia coli* (*E. coli*) is one of the most commonly adopted indicators for the determination of the microbiological quality in water and treated wastewater since it is considered a good indicator of this type of contamination. It is also easily detectable, almost exclusively of faecal origin and its presence is linked to the presence of pathogens. Due to this, *E. coli* is used in most regulations regarding the microbiological quality of treated municipal wastewater (Vergine et al, 2017; Annex 10, report 1).
Fourth treatment	Fourth treatment consist of micro-pollutant removal notably via ozonation and/or filtering with activated carbon or advanced techniques like nano-filtration, membranes. It comes after tertiary treatment (Nitrogen treatment in particular) – which is a pre-requisite to ensure an optimal functioning of the 4th treatment. So far there is no obligation in the UWWTD to treat micro-pollutants.
Individual or other appropriate systems (IAS)	The UWWTD states that '*where the establishment of a collecting system is not justified either because it would produce no environmental benefit or because it would involve excessive cost, individual systems or other appropriate systems which achieve the same level of environmental protection shall be used*.' (Article 3(1)). This covers simple facilities such as sceptic thanks up to more sophisticated small facilities.
Micro-pollutants	Emerging micro-pollutants are defined as synthetic or natural compounds released from point and nonpoint resources and end up to the aquatic environments at low concentration - typically µg/L or less (Barbosa et al., 2016) Pollutant which exists in very small traces in water (Source: EEA). Most micro-pollutants are considered as "Contaminants of emerging concern" (see above). In this IA and in the context of the study on EPR, a more specific definition focusing on organic substances was used (See report 2, Annex 10).
Micro-plastics	According to the European Chemicals Agency (ECHA), 'the term "micro-plastic" is not consistently defined, but is typically considered to refer to small, usually microscopic, solid particles made of a synthetic polymer. They are associated with long-term persistence in the environment, if released, as they are very resistant to (bio)degradation.'

Population equivalent (p.e.)	UWWTD definition: '1 p.e. (population equivalent)' means the organic biodegradable load having a five-day biochemical oxygen demand (BOD5) of 60 g of oxygen per day.' In this IA, one p.e. includes on average 11.18 g/day for total Nitrogen, and 1.68 g/day for Phosphorus. It also includes a range of micro-pollutants (around 1.300 chemicals were considered in this IA) each having a specific load – see Annex 4. In summary, 1 p.e. describes the average pollution load release by one person in one day.
PRO – Producer Responsibility Organisation	'PRO' are organisations set up by the sectors subject to a producer responsibility. Their role is to implement the legal obligation in the name of their Members. PRO's are usually requested by law to establish self-control mechanisms controlled by regular independent audits for both their financial management and the quality of collected and reported data. In the case of micro-pollutants, PRO would collect the required funds based on their members' declaration (quantities placed on the EU market and toxicity). They would then finance wastewater operators for more stringent treatment.
Primary treatment	According to the UWWTD, 'Primary treatment' means treatment of urban wastewater by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD of the incoming wastewater is reduced by at least 20% before discharge and the total suspended solids of the incoming wastewater are reduced by at least 50% (Article 2(7)).
Secondary treatment	UWWTD definition: 'Secondary treatment' means treatment of urban wastewater by a process generally involving biological treatment with a secondary settlement or other processes in which the requirements established in Table 1 of Annex I are respected (Article 2(8)).
Tertiary treatment	More stringent treatment or tertiary treatment is the third stage of treatment and can consist of nutrient removal, chemical or physical disinfection. In the UWWTD, table 2 in Annex I lays down the thresholds for nutrient reduction.
Toxic load	In the context of this IA an indicator of the toxic load was built on the basis of a set of micro-pollutants found on the wastewaters (pollutant quantity weighted by toxicity of individual substances more details are provided in Annex 4.
PFAS	Per- and polyfluoroalkyl substances (PFAS) are a large family of thousands of synthetic chemicals that are widely used throughout society and found in the environment. They all contain carbon-fluorine bonds, which are one of the strongest chemical bonds in organic chemistry. This means that they resist degradation when used and also in the

	environment. Most PFAS are also easily transported in the environment covering long distances away from the source of their release. PFAS have been frequently observed to contaminate groundwater, surface water and soil. Cleaning up polluted sites is technically difficult and costly. If releases continue, they will continue to accumulate in the environment, drinking water and food (Source: ECHA).
PNEC	The 'Predicted No Effect Concentration' is the concentration of a substance, below which exposure is not expected to cause adverse effects. E.g., a concentration of a pharmaceutical for which no pharmacological effect is expected to occur for a specific organism.
Separate sewers	The UWWTD allows for the use of combined and separate sewers. Separate systems: "New wastewater collection facilities are designed as separate systems, carrying either domestic sewage or storm sewage but not both. Storm sewers usually carry surface runoff to a point of disposal in a stream or river. Small detention basins may be built as part of the system, storing storm water temporarily and reducing the magnitude of the peak flow rate. Sanitary sewers, on the other hand, carry domestic wastewater to a sewage treatment plant. Pre-treated industrial wastewater may be allowed into municipal sanitary sewerage systems, but storm water is excluded." (Britannica, 2019c).
Storm Water Overflows (SWO)	A footnote in Annex I to the UWWTD states '…*during situations such as unusually heavy rainfall, Member States shall decide on measures to limit pollution from storm water overflows. Such measures could be based on dilution rates or capacity in relation to dry weather flow or could specify a certain acceptable number of overflows per year*.' As mentioned under combined sewers, these systems carry wastewater and storm water. According to Britannica, 'because wastewater treatment plants cannot handle large volumes of storm water, sewage must bypass the treatment plants during wet weather and be discharged directly into the receiving water. These combined sewer overflows, containing untreated domestic sewage, cause recurring water pollution problems and are very troublesome sources of pollution.' (Britannica, 2019b).
Surface water	Water Framework Directive definition: inland waters, except groundwater; transitional waters and coastal waters, except in respect of chemical status for which it shall also include territorial waters. (Article 2(1)).
(Total) nitrogen	Total nitrogen is defined in the UWWTD as 'the sum of total Kjedahl nitrogen (organic and ammoniacal nitrogen), nitrate-nitrogen and nitrite-nitrogen'. The UWWTD requires a reduction of total nitrogen in

	wastewater discharges to concentrations of 15 mg/1 N (in agglomerations with 10.000 – 100.000 p.e.) and 10 mg/1 N (in agglomerations with more than 100.000 p.e.) (Annex I of the Directive). Nitrogen is, together with phosphorus, one of the main nutrients in wastewater. Nitrogen becomes ammonia/ammonium, creating an additional oxygen demand. This can lead to excessive plant and algae growth, which can then prevent other organisms from living and growing.
(Total) phosphorus	The UWWTD requires a reduction of total phosphorus in wastewater discharges to concentrations of 2 mg/1 P (in agglomerations with 10.000 – 100.000 p. e.) and 1 mg/1 P (in agglomerations with more than 100.000 p.e.) (Annex I). Together with nitrogen, phosphorus is one of the main nutrients in wastewater. Phosphorus becomes ortho-phosphate, creating an additional oxygen demand. This can lead to excessive plant and algae growth, which can then prevent other organisms from living and growing.
Urban runoff	Urban runoff consist of storm water from city streets and private or commercial properties that contains litter, as well as organic and bacterial waste (EEA glossary). Depending on local conditions, urban runoff can be collected in combined or separate networks.
Urban wastewater	The UWWTD defines 'urban wastewater' as domestic wastewater on its own or domestic wastewater mixed with industrial wastewater and/or runoff rain water. (Article 2(1)).
Water resilience	'Resilience' is the quality of being able to return quickly to a previous good condition after problems. (Source: Cambridge Dictionary). 'Water resilience' refers to those characteristics in a water system (droughts, floods, water pollution).

Abbreviations

Term or abbreviations	*Meaning or definition*
AMR	Antimicrobial resistance
BWD	Bathing Water Directive
BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
CJEU	Court of Justice of the European Union
CSO	Combined sewer overflow
DWD	Drinking Water Directive
ECA	European Court of Auditors
ECHA	European Chemicals Agency
EEA	European Environment Agency
E-PRTR	European Pollutants Release and Transfer Register
EED	Energy Efficiency Directive
EPR	Extended Producer Responsibility
EQS	Environmental quality standards
EU	European Union
GHG	Greenhouse gas
GWh	Gigawatt hour

Term or abbreviations	*Meaning or definition*
IAS	Individual or other appropriate system
IED	Industrial Emissions Directive
IPCC	Intergovernmental Panel on Climate Change
JRC	European Commission Joint Research Centre
MSFD	Marine Strategy Framework Directive
N	Nitrogen
ND	Nitrates Directive
NVZ	Nitrates vulnerable zones
OECD	Organisation for Economic Cooperation and Development
OPC	Open Public Consultation
P	Phosphorus
PFAS	Perfluoroalkyl chemicals
p.e.	Population equivalent
PNEC	Predicted No Effect Concentration
PRO	Producer Responsibility Organisation
RBMP	River basin management plan
REACH	Registration, evaluation, authorisation and restriction of chemicals

Term or abbreviations	***Meaning or definition***
REDII	Proposal of revision of the Renewable Energy Directive
RTC	Real time control
SME’s	Small and medium-sized enterprises
SSD	Sewage Sludge Directive
SWO	Storm water overflow
UWWTD	Urban Wastewater Treatment Directive
WFD	Water Framework Directive

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

The European Union adopted in 1991 the Urban Wastewater Treatment Directive (UWWTD). The objective of this Directive is to "*protect the environment from adverse effects of wastewater discharges from urban sources and specific industries*". Member States (MS) are required to ensure that wastewater from all agglomerations above 2.000 inhabitants is collected and treated according to minimum EU standards. Stricter standards apply for 'sensitive areas' which have to be identified by MS according to criteria included in the Directive – for instance in case of risk of eutrophication.

MS report every two years on the implementation of the Directive. This information is published by the Commission in biennial reports. Across the EU, 21.708 agglomerations generating wastewater equivalent to the pollution from 517 million population equivalents (p.e.)[1] are treated in centralised systems. Wastewater operators are either private companies operating for a public competent authority or public companies owned by the public competent authorities (around 60%) or mixed companies. Collection and treatment of urban wastewater have improved over the last decade: 98% of the generated load is appropriately collected, 92% meet the primary and secondary treatment standards (basic treatment of organic pollution – see glossary), while another 92% meet more stringent treatment standards (tertiary treatment removing Nitrogen and Phosphorus). There are differences between MS – a limited number of MS still having difficulties to reach compliance (Annex 7, Table 1).

The 2019 UWWTD REFIT Evaluation (hereby referred to as 'the Evaluation'), which entailed a comprehensive stakeholder consultation, confirmed that the Directive's implementation has caused a significant reduction of pollutant releases. The effects on the quality of the EU lakes, rivers and seas are visible and tangible. The Evaluation also identified remaining challenges which served as a basis for the definition of the problem for this impact assessment (IA). MS supported the main findings of the Evaluation during an **Environment Council** meeting as well as the **European Parliament** through a Resolution focusing on the need to improve the energy balance of the sector. There is a **large consensus** in the Council and the Parliament, as well as within the stakeholder community, on the need to modernise the Directive and to better link it with the European Green Deal (EGD) ambitions. Similarly, the European Committee of the Regions agreed with the Evaluation findings, pushing for a revision of the UWWTD to adapt it to new societal needs and urging the Commission to better apply the "polluter pays" principle.

Since the publication of the Evaluation, the EU took important steps to set out its ambitions with the adoption of the European Green Deal. The review of the Directive is included as one of the actions of the Zero Pollution Action Plan (ZPA), in close connection with a sound implementation of the Chemicals Strategy for Sustainability and the Pharmaceuticals Strategy. There are direct connections with the Biodiversity Strategy as reducing water pollution has a direct beneficial effect to ecosystems. Actions to green the cities, such as those stemming from the upcoming Nature Restoration Law, can not

[1] In this impact assessment, the standard unit to measure pollution is the 'population equivalent' (p.e.) – see Glossary. For some pollutants (N, P and BOD) it is possible to convert p.e. into tons. The wastewater treatment plants treat water mainly from inhabitants, but also from small enterprises or rain waters, which explains why total number of covered p.e. is higher than the total number of EU27 citizens.

only create a good habitat for pollinators, birds and other species, but also directly help to control rain water and related pollution, while improving the overall quality of life. Better management of water quality and quantities in the urban areas will also contribute to **climate adaptation**. The new Circular Economy Action Plan sets out that a better integration of the urban wastewater sector with the circular economy is needed. This is particularly relevant for the Sewage Sludge Directive (currently being evaluated), which regulates the use of sewage sludge in agriculture and has implications for the Soil Health proposal announced in the EU Soil Strategy for 2030.

Furthermore, the EU **climate neutrality** objective as included in the EU Climate Regulation, combined with the Effort Sharing Regulation, requires MS to reduce their GHG emissions according to national objectives from the sectors such as the wastewater treatment sector which are not covered by the EU Emission Trading Scheme.[2] At the same time, the recent recast proposal of the Energy Efficiency Directive (EED) requires MS to reduce their overall energy consumption by 9% by 2030 compared to 2020, while including a specific target of 1,7% reduction each year of the energy consumption of all public bodies. The EED also includes the obligation to achieve energy audits for enterprises consuming large amounts of energy. As detailed in section 2.1.2.2, a large part of the UWWT facilities would be excluded from this obligation. The 2021 proposal for a revision of the Renewable Energy Directive ("REDII") includes an objective of 40% of renewable energy in the energy mix by 2030. The Evaluation showed that the wastewater sector has specific potential not only to reduce its own energy consumption, currently amounting to around 0.8% of the overall EU energy use, but also to produce, in a steady and reliable manner not dependent on weather variations, renewable biogas out of sewage sludge next to offering well-suited locations for the production of renewable energies (wind and solar). This sector-specific potential should be untapped, in line with the recently adopted Repower EU Communication insisting on the need to accelerate action for more affordable, secure and sustainable energy, including from biogas.

Over the past months it has become apparent that surveillance of different health related parameters in wastewaters can provide useful information for public health purposes. This was the case with **SARS-CoV-2 virus** and its variants monitoring in wastewaters, used as a complementary approach to public health measures. To support the use of this tool and enhance the early detection capacities across all MS the Commission published a Recommendation and provided in 2021 financial support to 26 MS. Also in line with the "A Europe fit for the Digital Age" Communication, the potential benefits of digitalisation should be further explored as they are particularly relevant in the water sector.

The revision of the UWWTD is linked to the revision of the pollutants lists under the Environmental Quality Standards Directive and the Groundwater Directive – two 'daughter' Directives of the Water Framework Directive (WFD), regulating the acceptable levels of pollutants in surface and ground water bodies. It is also connected to the revision of the Industrial Emissions Directive (IED) and the related review of the E-PRTR Regulation, as some industrial emissions are collected in public collection networks. It will have a positive impact on the ongoing review of the Marine Strategy Framework Directive (MSFD) and on the review of the Bathing Water Directive (BDW). These parallel revisions and reviews help to ensure that any coherence issues can be resolved. N emissions to the environment are regulated both by the UWWTD (urban

[2] The main interactions of this initiative with other ongoing initiatives are summarised in Annex 8.

pollution) and by the Nitrates Directive (N from agriculture) and, as recalled in the ZPA, the revision of the UWWTD will support the concrete implementation of the future Nutrient Management Action Plan. Over the last decades, the UWWTD has contributed to achieving the Sustainable Development Goals (SDGs), in particular SDG 6 on access to adequate and equitable sanitation and hygiene for all. Most MS have signed the 1999 UN Protocol on Water and Health, setting out requirement on access to sanitation. As such, it contributes to achieving the commitments made under the European Pillar of Social Rights Action Plan on access to essential services.

2. PROBLEM DEFINITION

2.1 What are the problems and their drivers?

In the Evaluation, **three main sets of problems** were identified, which are discussed in more depth below together with their drivers:

1) Remaining pollution from urban sources (section 2.1.1);
2) Insufficient alignment of the Directive to new societal ambitions and the Green Deal objectives (section 2.1.2);
3) Insufficient/uneven level of governance of the sector (section 2.1.3).

The stakeholder consultation[3] showed a broad consensus on (1) the necessity to undertake a revision of the Directive, and (2) the list of problems to be tackled in a possible review. No other important issue emerged during the different consultations. Overall, no major problems of coherence with other legislation were found in the Evaluation, even if some adjustments might be needed as several Directives were adopted after the UWWTD. This is further detailed in the ad hoc sections below.

2.1.1 Remaining pollution from urban sources – problem and drivers

The Evaluation provided a first quantification of the remaining sources of pollution not optimally addressed by the Directive. This quantification was updated and fine-tuned using the same model developed by the JRC for the Evaluation (see Annexes 1 and 4). The Evaluation also pointed to the new types of pollutants requiring more attention (such as micro-pollutants) having emerged since the adoption of the Directive.

At the time of its adoption the focus of the Directive was on organic pollution from domestic sources emitted in usual ('dry weather') conditions and collected and treated in centralised facilities, for which the requirements are clear and precise. Less attention was given to rain waters, smaller agglomerations and individual appropriate systems for which the requirements were kept more generic. The emissions from these sources have progressively become equivalent to the releases from centralised facilities. This is illustrated in modelling results presented in *Table 1* and *Figure 1* below showing the remaining load of pollutants rejected in the environment from different sources. The total initial load generated amounts to 708,8 p.e. Of this, 517 million p.e. is sent to centralised wastewater treatment plants and 191,8 million p.e. is not collected and thus not treated in centralised facilities (49,3 million p.e. is generated in small agglomerations, 16,5 million in IAS and 126 million are coming from SWO/urban runoff.)

[3] More details on stakeholder views are provided in Annex 2 and in Appendix F of the report 1 (Annex 10). When divergent views amongst stakeholders were expressed, they are reported in the main text of this IA.

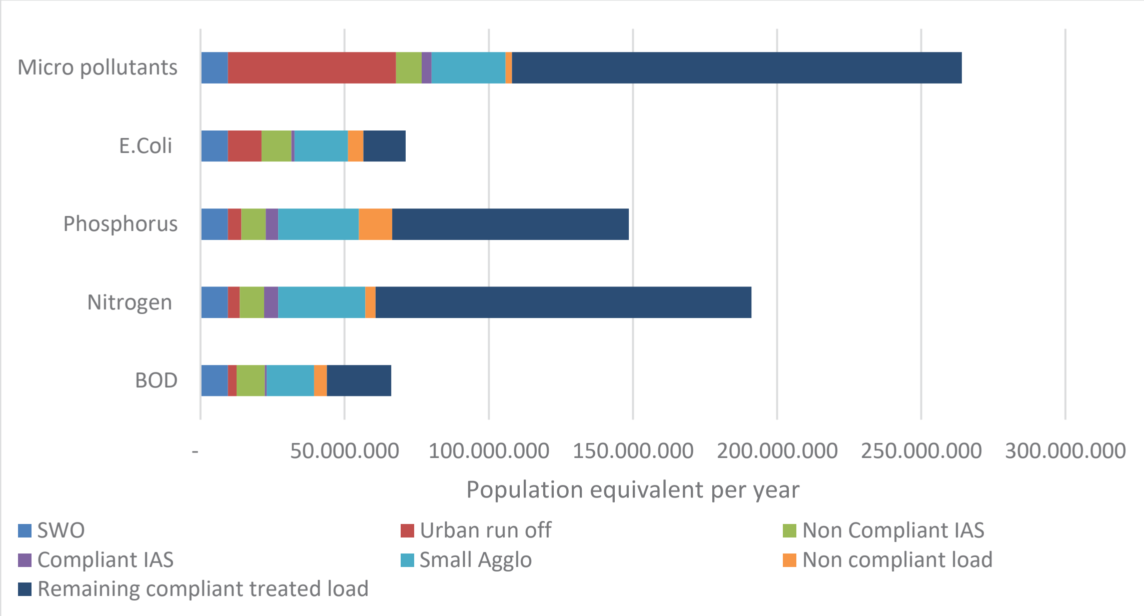

Figure 1: Remaining loads from urban sources (p.e./year) *- Source JRC - see Annex 4. Breakdown per MS is provided in Table A7.5 in Annex 7*

The remaining load sent to the environment varies from one pollutant to another (from 66,2 million p.e. for BOD to 264 million p.e. for micro-pollutants). Part of this pollution could be avoided. However, as shown in *Table 1*, with the maximum feasible scenario[4], there are limits to what can be technically achieved: with the current techniques, it is indeed impossible to remove and treat 100% of the load from the wastewaters (between 48% for BOD to 92% for *E. Coli* – could be removed - see line (5) in Table 1).

	BOD (p.e.)	Nitrogen (p.e.)	Phosphorus (p.e.)	*E. coli* (p.e.)	Micro pollutants (p.e.)
(1) Remaining load from 191,8 million p.e. from SWO/urban runoff, small agglo., and IAS	39.395.928	57.159.194	54.993.361	51.224.149	105.766.283
(2) Remaining load from 517 million p.e. sent to centralised facilities after treatment	26.752.894	133.967.530	93.607.423	19.886.613	158.360.974
(3)Total remaining load (1) + (2)	66.148.823	191.126.725	148.600.784	71.110.762	264.127.257
(4) Remaining load if maximum feasible treatment is applied	*34.239.042*	*88.219.608*	*47.658.013*	*5.736.591*	*130.837.224*
(5) % of the remaining load which is 'treatable'((3) –(4))/(3)	*48,24%*	*53,84%*	*67,93%*	*91,93%*	*50,46%*

Table 1: Remaining loads sent to the environment (p.e./year) - source JRC - see Annex 4*. More details are provided in Annex 7, Table A7.2 and Table A7.5 (details per MS)*

2.1.1.1 Non-compliant agglomerations

Discharges from **non-compliant agglomerations** above 2.000 p.e. represent around 6,7% of the remaining load for BOD, 1,9% for Nitrogen (N), 7,78 % for Phosphorus (P) and 7,4% for bacteria (*E. coli*). The Evaluation pointed out that the deadlines set in the

[4] This scenario was built as a reference using all the available treatment techniques without taking into account costs – see Annex 4 for more details.

Directive might have been overly ambitious for some MS. As explained in the Evaluation, effective legal actions were taken by the Commission to ensure timely and correct implementation of the Directive. More than 40 CJEU rulings were issued against nearly all MS and 30 horizontal cases are still open today. Despite significant progress accomplished by MS, implementing the Directive remains challenging in a limited number of them (see Annex 7, Table 1).

The Evaluation showed that this is mainly due to the lack of institutional/administrative capacity, combined to a lesser extent with insufficient financing capacities. At the same time, some MS have managed to fully implement the Directive in a rather short time, particularly MS having joined the EU after 2004. Such better performances are mainly due to a proper organisation and planning of the required investments combined with a sound financing strategy and the support of EU funds. These MS have also benefitted from newest and more effective technologies compared to MS having invested in their infrastructures after the adoption of the 1991 Directive.

2.1.1.2 Storm water overflow (SWO) and urban runoff

During rainfall events, **storm water overflows (SWO-** see Glossary**) and urban runoff** represent a sizeable remaining source of loads sent to the environment: 19% of the remaining load for BOD, 7,2% for Nitrogen, 9,5% for Phosphorus, 29,77% for *E. coli* and 25,7% for micro-pollutants (see *Figure 1*). These emissions are expected to increase due to the combined effects of urbanisation and progressive change of the rain regime due to climate change. Most of this pollution takes place during a relatively short period of time bringing suddenly, in the receiving water body, a peak of untreated pollutants including waste and litters from the streets, such as plastics and micro-plastics ('flushing effect'). The Evaluation showed that part of this pollution is due to a lack of detailed provisions in the Directive: in case of heavy rain, MS have indeed the possibility to send directly to the environment part of SWO and urban run-off without any need for previous treatment.[5]

Reporting under the WFD showed that at least 15% of UWWTPs above 10.000 p.e. are in waterbodies failing to meet the WFD ecological status due to SWO pressure.[6] According to a report from the EEA, the absence of proper management measures for SWO and urban run-off combined with the increasing number of heavy rains events due to climate change are the main reasons why the limit values of the BWD for bacteria are exceeded in several EU bathing areas. The situation differs from one agglomeration to another depending on the local conditions (rainfall patterns, density of population, urbanisation green spaces), but also according to the performance of the collecting/treatment system.

The Evaluation also showed that the lack of specific provisions in the Directive has led to an uneven management of the issue across the MS (see Annex 5). Only very few MS have put in place systematic integrated water management approaches in their cities: the division of competences between services in charge of wastewater collection and/or

[5] Annex I to the Directive states '*during situations such as unusually heavy rainfall, MS shall decide on measures to limit pollution from SWO. Such measures could be based on dilution rates or capacity in relation to dry weather flow or could specify a certain acceptable number of overflows per year.*'
[6] it was not possible to assess the status of another 15% of UWWTPs.

treatment, urban planning, monitoring of water bodies quality, often represents an obstacle for designing integrated, optimal and cost effective solutions.

2.1.1.3 Individual appropriate systems (IAS)

As seen in *Figure 1* and Table A7.2 in Annex 7, the use of IAS contributes to 15,7% of the remaining load for BOD, 7% for N, 8,6% for P, 16,1% for *E. coli* and 4,7% for micro-pollutants. The Directive allows the use of these individual systems where building a collecting system comes at disproportionate costs, and as long as these systems achieve the 'same level of environmental protection' as in a centralised plant.

However, in the absence of more precise requirements, it is difficult to verify whether IAS are conform or not. Also, some MS report high and non-justified use of IAS (***Figure 2***) in their agglomerations above 2.000 p.e. (more than 21% of the total load in Croatia).

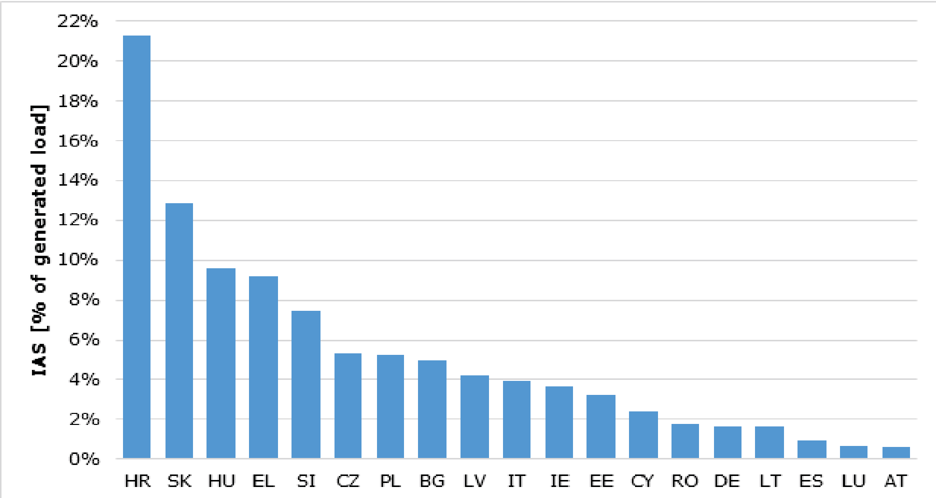

Figure 2: Percentage of reported generated load treated by IAS in agglomerations above 2.000 p.e. in 2018, *Source: Annex 10, report 7*

There is a variety of requirements for IAS set at national level, with a few MS applying best practices in terms of design, maintenance, monitoring and reporting (see Annex 5 for more details). Some MS (such as AT, DE, NL, BE and FR) have put in place their own national environmental standards to complete or replace the standards laid down under the Construction Product Regulation (CPR) for smaller facilities below 50 p.e. The multiplication of national standards has resulted in some degree of **disruption of the internal market** – but also in some confusion, as the 'CE marking' under the CPR does not relate to the environmental performances of the installations (source: Annex 10, report 16).[7] Under the March 2022 proposal for reviewing the CPR, wastewater treatment would be excluded from the CPR scope. This will contribute to clarify the situation while increasing the importance of developing environmental standards under the UWWTD.

[7] The main reports used for this IA are referenced in the first part of Annex 10.

2.1.1.4 Small agglomerations

Small agglomerations are covered by the Directive only in a very general manner[8] and yet constitute a significant pressure on 11% of the EU's surface water bodies (EEA): as shown in ***Figure 1***, around 24,9% of the remaining load for BOD, 15,8% for N, 18,9% for P, 26,2% for *E. coli* and 9,7% for micro-pollutants. The situation varies across MS: some MS like AT, DE, SE and FR have established in their legislation that all urban wastewater needs to be treated. Other MS have set standards for smaller agglomerations with a few, like EE, IE and PT, going beyond the requirements set out in the Directive.

2.1.1.5 Remaining releases from Nitrogen and Phosphorus

Despite the significant reduction of emissions achieved with the existing Directive for Nitrogen and Phosphorus[9], wastewater treatment plants remain an **important point source of both N and P** (see *Figure 3*). Released wastewater is a more important source of P than fertilizers used in agriculture. N from urban wastewater is the second most significant source of inputs into rivers and seas after agriculture.

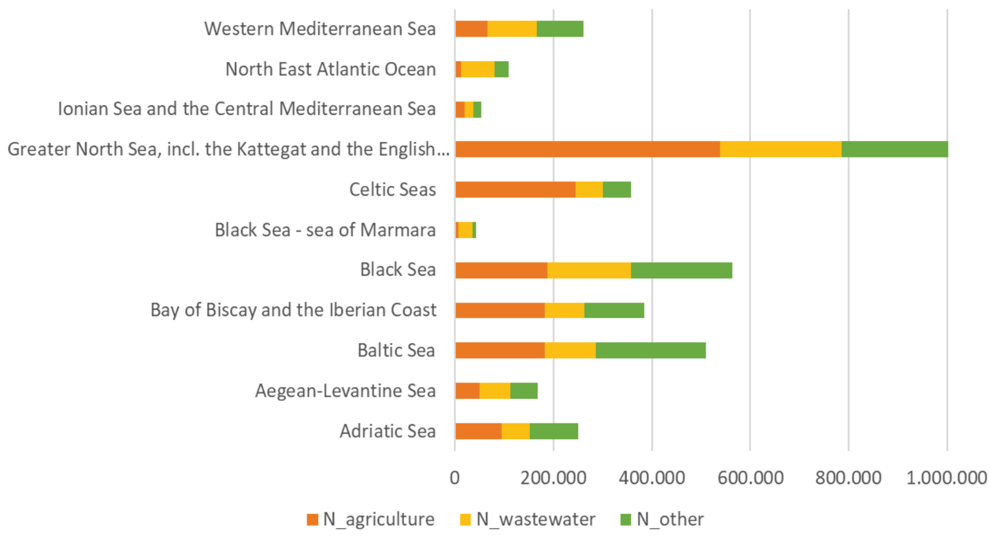

Figure 3: Loads of N (tonnes/year) to EU regional seas by source (JRC).

As shown during the stakeholder consultation (see Annex 2), the problem is due to a combination of two factors: (1) not enough areas were designated by the MS as 'sensitive' for eutrophication, and (2) the standards of the Directive for N/P are outdated.

Under Article 5.1 of the Directive, MS are required to designate 'sensitive areas' subject to eutrophication and apply either more stringent standards for N/P for each facility or an overall load reduction rate for N/P. The Evaluation showed that MS have applied the Directive in different ways (see *Figure 4*) leading to some inconsistencies: for the same river the designation might not be the same. It means that the efforts made by some MS to reduce N/P are undermined by the lack of efforts by others. On the contrary, in the Baltic Sea basin, for instance, coordination is ensured at regional level: the same more stringent standards for N/P is applied for all incoming waters.

[8] MS have to ensure 'appropriate treatment' from agglomerations of less than 2.000 p.e. (Article 7).

[9] Emissions from treatment plants are reduced from 517 to 134 and 94 million p.e. for N and P.

From MS current practices[10], it appears that emission limit values in the Directive for N/P could be reinforced: several MS (DE, AT, NL, HU and DK) are achieving better performances than those prescribed by the minimum requirements of the Directive.

N and P releases are directly contributing to **eutrophication** (see Glossary) which remains an important problem in several rivers, lakes and seas in the EU. According to the EEA assessment, there are significant impacts from nutrient pollution on 426.267 km of rivers and 19.460 km^2 of lakes across the EU. According to a recent report on the implementation of the MSFD, eutrophication occurs in the Baltic and the Black Seas, along the North-western coast of France within the North-east Atlantic Ocean and along coastal areas mainly in the vicinity of riverine outflows within the Mediterranean Sea.

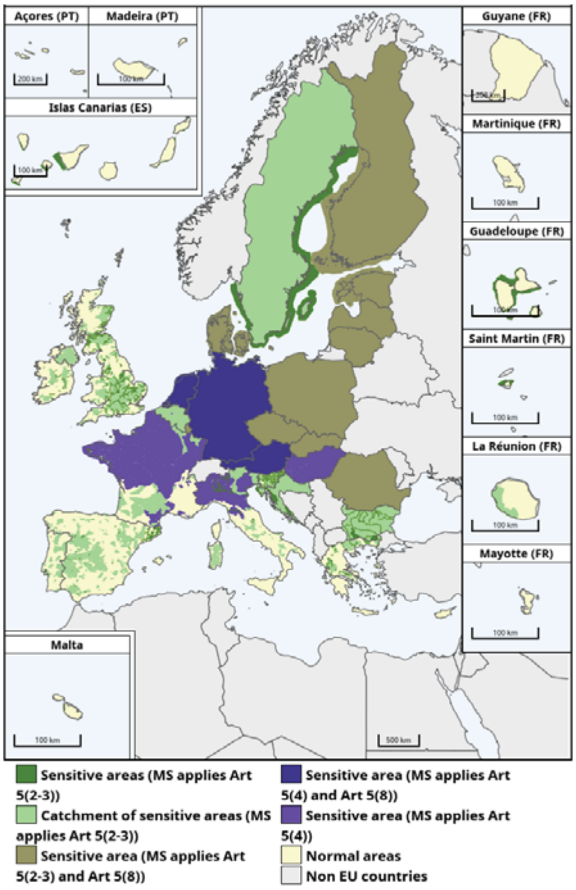

Figure 4: Overview of sensitive areas and their catchments in the EU (2016) *- Article 5(2-3): more stringent treatment > 10.000 p.e.; Article 5(4): 75% removal of N and P; Article 5(8): more stringent treatment on the whole country, Source: Annex 10, report 7.*

2.1.1.6 Micro-pollutants and Micro-plastics

As shown in the Evaluation, the scientific community, policy makers and general public consider the growing evidence of **micro-pollutants** and **micro-plastics** in water bodies

[10] More details on the starting position of each MS are provided in Annex 5 but also in Annex 4, Table A4.5 and Annex 7, Table A7.5

an increasingly important issue. The need for action was also highlighted in the Commission's recent strategies.[11]

Micro-pollutants arise from the use of many products in households. Pharmaceuticals and to a lesser extent Personal care products (PCP) represent a large share of the potentially harmful substances found in wastewater (see report 2, Annex 10). The toxic load (see glossary) corresponding to 264 million p.e. is emitted to the environment, part of it (158 million p.e.) coming from centralised treatment plants, the rest being emitted by other sources (see *Table 1* and ***Figure 1***). Part of these emissions are taking place in rivers with a relatively low dilution rate, leading to higher risk of toxicity: the outlet of around 115 million p.e. are emitted in rivers with a dilution rate lower than 5 (Source: JRC, Annex 10, reports 13 and 14). Their accumulation in the environment and the creation of 'hot spots' with low dilution rates are becoming a serious environmental and, in some instances, public health concern, notably where the downstream waters are used for bathing or for extracting and producing drinking waters.[12]

As shown in the Evaluation and in *Figure 5*, micro-pollutants are now detected in all EU waters. The cumulative effects of these substances, notably in fish communities, were already shown on several occasions: fish exposed to micro-pollutant residues may change their behaviour, harming their survival abilities, or even change sex, harming their reproduction abilities and fertility rates.

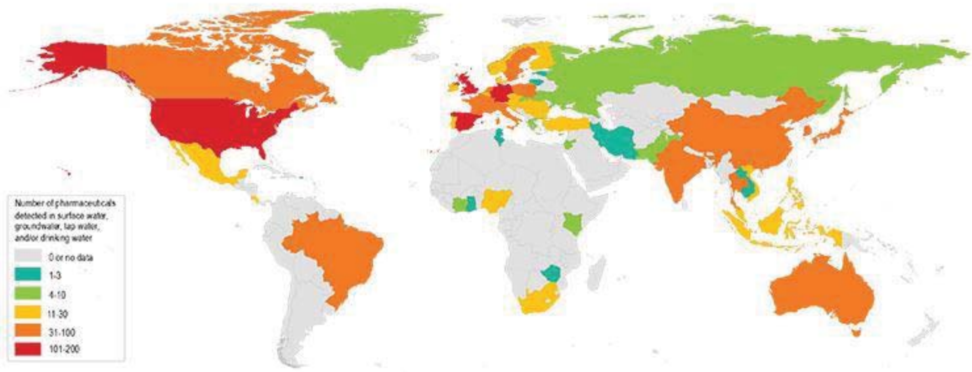

Figure 5: Number of pharmaceuticals detected in surface, ground or drinking water. *Source: Aus der Beek et al., 2015*

These findings were confirmed by a 2022 study on pharmaceutical pollution (US National Academy of Science) based on samples from 1.052 locations in 104 countries from all continents. 25.7% of the samples included at least one pharmaceutical in concentration higher than what is considered safe for aquatic organisms. According to this study, 'pharmaceutical pollution poses a global threat to environmental and human health, as well as to the delivery of the United Nations Sustainable Development Goals'.

Plastics and Micro-plastics: Most of the micro-plastics found in the domestic wastewaters directly stem from the use of textiles (micro fibres emitted during the washing of clothes). They also come from the degradation of tyres on the roads or from the uncontrolled use of plastic pellets in plastic production, when wastewaters are mixed

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[11] Including the Plastics Strategy, the Strategic Approach to Pharmaceuticals in the Environment, the Chemical Strategy, the Zero Pollution Action Plan.

[12] Additional treatment is applied for the production of drinking water. In line with the revised Drinking water Directive, all efforts should be done to reduce sources of pollution at source

with rain waters (source Annex 10, report 3). The recently adopted **Textile strategy** as well as the upcoming EU initiative on **Micro-plastics** are expected to reduce micro-plastics emissions from these sources. As a result, less micro-plastics from these sectors should over time be found in incoming waters of the urban wastewaters treatment plants.

Currently, when collected and sent to centralised treatment facilities, nearly all large pieces of plastics are removed at the beginning of the treatment process. Also micro-plastics are relatively well captured in the treatment plants – 80,5% with a primary treatment, 97,5% with a secondary treatment and 99,2% with a tertiary treatment (Annex 10, report 8). Significant amounts of (micro) plastics can be released in the environment in case of heavy rains (see previous section 2.1.1.2). It thus remains crucial to secure that appropriate measures are put in place in order to cater for SWO/urban run offs.

The captured micro-plastics are partly degraded in the treatment plants. A recent Swedish study show that about 40-60% of the micro-plastics in the incoming wastewater were found in the sludge. This is confirmed by another recent Norwegian study: over 500 billion micro-plastic pieces are released each year into the environment via sludge use on the soils. As half of the sludge is used agriculture in the EU (see *Figure 8* below), attention should be given to the presence of micro-plastics in the sludge and then in the soils.

Micro-plastics biomedia (micro pieces of plastics used in very specific treatment process) are also used in a limited number of wastewater treatment plants (0,1% in France in 2016). According to a report from the Surfrider foundation, significant amount of micro-plastics were found under the stream of such wastewater plants.[13]

2.1.1.7 Non domestic releases

Treatment plants covered by the UWWTD, although designed to treat 'domestic wastewaters', also receive other types of waters including industrial wastewaters, mainly from SMEs. These wastewaters can include a range of pollutants not targeted by the Directive such as heavy metals, micro-pollutants or other chemicals. Wastewater operators are in the first line when harmful releases are not controlled enough.

Under Article 11 of the Directive, industrial releases in the public network are subject to pre-authorisation and, if required pre-treatment. Releases to water from the larger installations regulated by the Industrial Emission Directive (IED) are already subject to authorisation requirements. As detailed in the Impact Assessment (adopted by the College on 5 April 2022) on the review of the IED, there is a need to better align the IED and the UWWTD to avoid the release of pollutants not abated in urban treatment plants into the public network. When it comes to releases from smaller installations not covered by the IED, the consultation showed that the regulatory approach, the level of control as well as the degree of involvement of wastewater operators in the permitting process differ from one MS to another (see Annex 5).

Since the UWWTD entails no requirement for monitoring and reporting on such non-domestic pollution entering the wastewater treatment plants, it is difficult to provide a quantification of this issue. The current lack of understanding prevents additional actions

[13] notably in FR, PT, ES but also in Switzerland.

to reduce pollution at source notably through stricter permits and better control of industries connected to the public network.

2.1.2 Alignment with Green Deal, new societal challenges - problems and drivers

Since the adoption of the Directive, new societal challenges have emerged. The European Green Deal (EGD) sets ambitious policy objectives to fight climate change and environmental degradation. The below listed topics are the most relevant aspects of the EGD to which the UWWTD needs to align.

2.1.2.1 Green House Gas emissions

In 2018, wastewater treatment was responsible for 34,45 million tons CO_2e/year - around 0,86% of the total GHG emissions of the EU including 4% of methane (CH_4) and 3% of Nitrous Oxide (N_2O) emissions (source: Annex 10, report 9). GHG emissions are specific to each facility and the type of treatment applied. As shown in *Figure 6*, 14,1 million tons CO_2/year are due to carbon footprint of the infrastructures (mainly sewer networks). Another 3,98 million tons is due to rejected effluents and further degradation of the remaining load. A last part – 3,34 million tons - is linked with the use of inputs produced by other industries, such as chemicals used for the treatment. These emissions cannot be avoided with measures in the wastewater sector.

The remaining and avoidable GHG emissions (13,03 million tons) are related to operational activities: use of energy (electricity) for the collection and treatment of wastewaters (4,6 million tons) and emissions linked with the treatment process (8,4 million tons – diffuse emissions of N_2O in the process). The potential impacts of the existing or forthcoming EU legislations on GHG emissions is discussed in section 5.1 on the baseline.

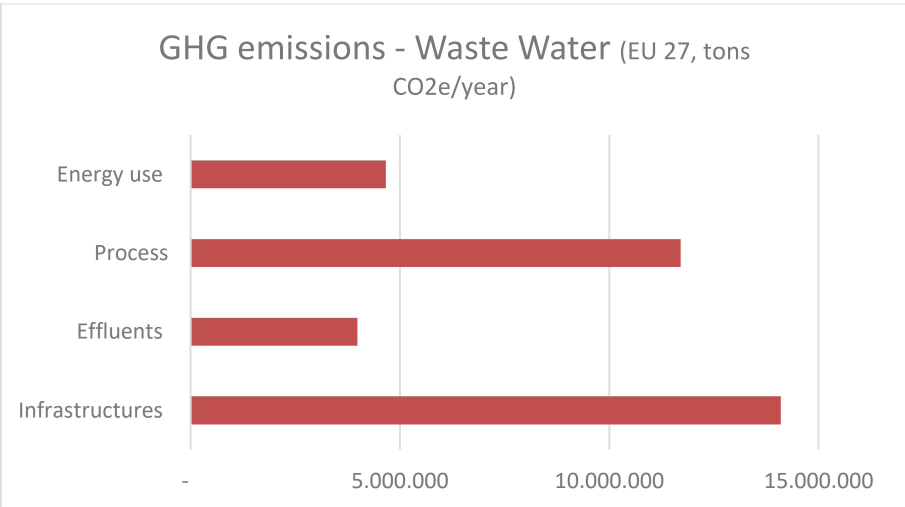

Figure 6: Breakdown of GHG emission from wastewater sector – EU 27, *source JRC 2022, ref in Annex 10, report 9*

2.1.2.2 Energy use

As shown in *Figure 7*, there are large differences between operators in terms of energy use depending on the size of the facilities and the technologies in place. Overall, the wastewater sector is using about 0,8% of the total EU energy consumption. This comes at high expenses: around €2 billion per year representing between 25% and 56% of the operational costs (source: Annex 10, report 1). Despite the significant potential, there is a poor uptake of energy efficiency and renewable technologies in the sector. The Evaluation showed that, apart from some advanced MS (see Box 1), there is a **lack of understanding** of the potential to reduce energy use or even produce energy partly due the absence of systematic energy audits for the wastewater treatment plants but also at the level of the collecting networks.

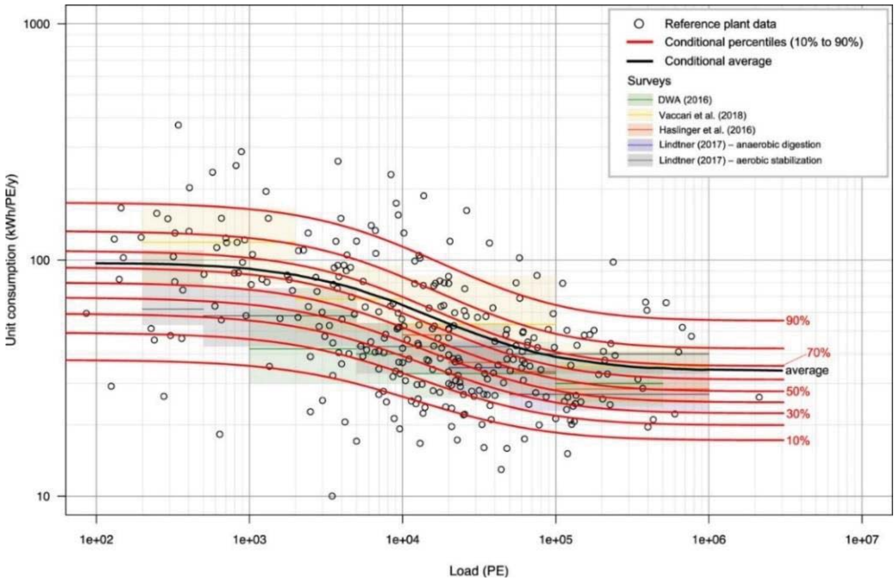

Figure 7: Annual electricity used vs size of treatment plants, *source: Ganora et al, 2019*

The recent proposal to revise the EED, tabled by the Commission as part of the "Fit for 55" package, entails the requirement, for large enterprises consuming more than 10 tera-joules/year, to be subject to energy audits. Most of the wastewater treatment plants would however not be covered by this new obligation, as the average energy consumption of large wastewater facilities of 100.000 p.e. amounts to 7,2 terajoules/ year (or 2Mw/h). The REFIT evaluation has shown the lack of understanding of the sector on the potential energy savings in the treatment facilities and to a certain extent in the collecting systems.

2.1.2.3 Sludge and water re-use

Sludge reuse in agriculture is governed by the Sewage Sludge Directive (currently under evaluation). The UWWTD contains limited provisions on sludge reuse or recovery[14]. The Evaluation concluded that, currently, **sludge management** is not optimal and not aligned with the principles of the **circular economy:** today about half of the sludge is reused in agriculture while another large part is being incinerated or landfilled representing a clear loss of valuable resources, including Phosphorus (see *Figure 8*).

A joint seminar was organised on sludge management in the context of the ongoing Evaluation of the SSD and of this IA. It confirmed that, over the past years, some MS have heavily restricted the use of sludge in agriculture on public health grounds (DE, AT, NL, BE), while others do use it extensively. Without additional action to limit pollution at source and improve sludge control before its use in agriculture, there is a risk that this trend increases in the coming years. Phosphorus could also be easily recovered from the ashes of mono-incinerated sludge, but this is not yet current practice in most MS.

[14] MS are 'incentivised' to re-use sludge and 'minimise the adverse environmental effects' (Article 14).

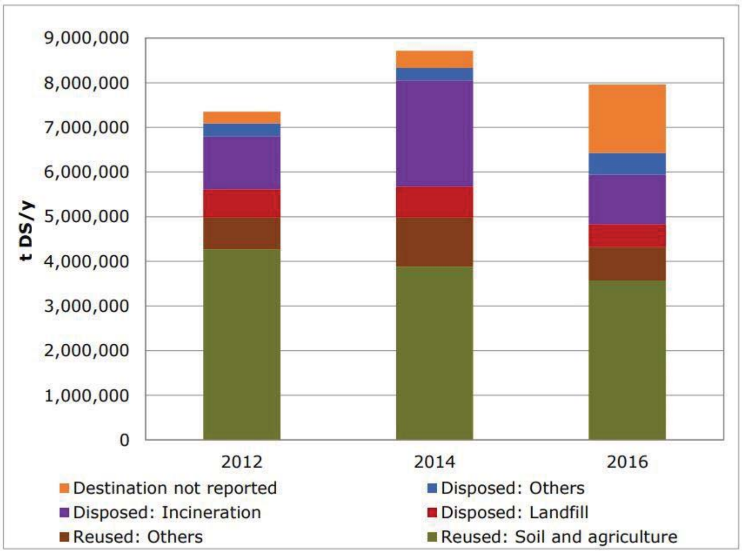

Figure 8: Sewage sludge reuse in EU-28 in the period 2012-2016 (% of sewage sludge reused in soil and agriculture – *source: Annex 10, report 7****)***

Water reuse after treatment in wastewater facilities should also be better incentivised: in 2015, according to the impact assessment on the Water Reuse Regulation, only 2,4% of the treated wastewater was reused. In the aggravating climate change context leading to more frequent instances, across the EU, of droughts and water scarcity, the entry into application, in 2023, of that new Regulation creates further incentives to reuse water.

2.1.2.4 Health and wastewaters

Today there is lack of understanding of the added value of accurate monitoring of public health relevant parameters in urban wastewaters. This is partly due to the absence of systematic dialogue and coordination between public health and wastewater authorities. The **COVID-19 pandemic** has revealed the added value of tracking the virus and its variants in wastewaters. Such surveillance helps to anticipate and follow the dissemination of the virus into the population. Today, with the financial support of the EU and in line with the 2021 Commission Recommendation on Covid 19, 26 MS have a surveillance infrastructure in place. Other types of health parameters could be monitored in the wastewaters as a complementary and reliable indicator of the public health state of the population.

Antimicrobial Resistance (AMR – see glossary) is a major human-health threat aggravated by the fact that, for the time being, there are no alternatives to antibiotics. Wastewater treatment plants are a potential entry point of antimicrobial-resistant genes and organisms in the environment. Treatment plants may contribute to the removal of AMR from the effluents. There is no obligation to monitor and remove AMR, neither at the outlet of the treatment facilities nor in the receiving water bodies.

2.1.3 Modernisation and Governance - problem and drivers

Like drinking water operators, wastewater operators are part of a ‘captive’ market: both citizens and businesses connected to the public network cannot choose their operators. The Evaluation and the consultation process confirmed that the wastewater sector is mainly **reactive to legal requirements**. Most competent authorities are implementing only the minimum requirements of the Directive. There are indeed **few incentives to ‘do**

better' beyond such legal requirements, as doing more usually entails additional costs, to be covered by water tariffs or further budgetary expenditures. Some MS apply more stringent standards, for instance when it is necessary to meet the objectives of other relevant legal obligations such as the Bathing, Drinking and Water Framework Directives, but this is not systematic (see Annex 5).

2.1.3.1 Operators' performances and transparency

A recent OECD analysis (Annex 10, report 6) showed differences in terms of performances between operators in relation to energy efficiency, GHG emissions, social and economic governance, operational aspects (see *Figure 9*). Some of these differences can be explained by different operating conditions (facilities size, climatic/geographical conditions). Others can only be explained by a sub optimal management due to lack of real incentives ('captive' market) and/or a lack of technical skills in fragmented utilities.

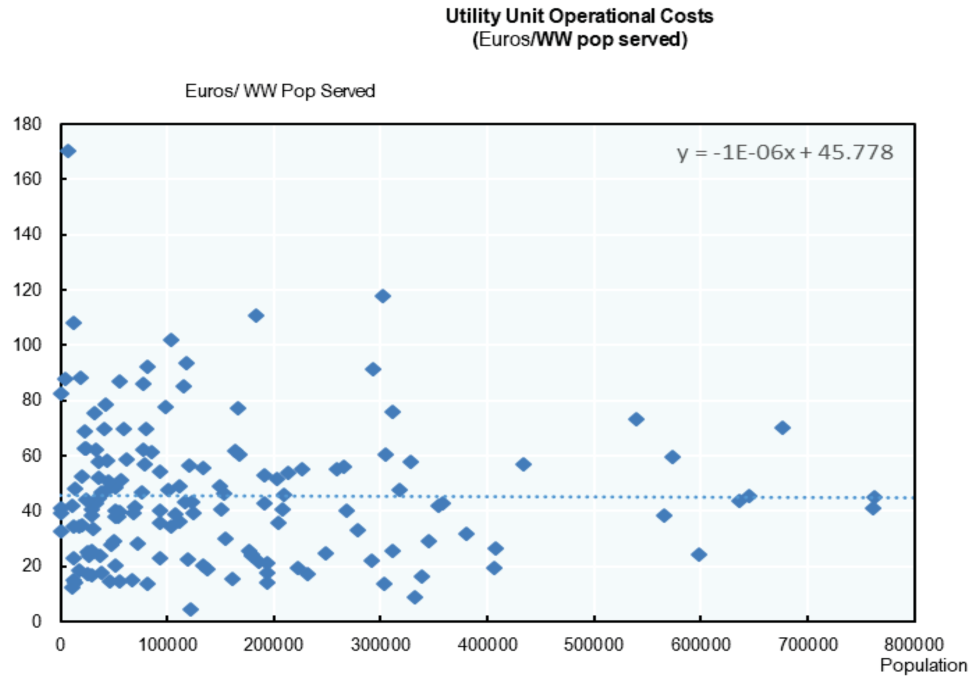

Figure 9: Operational costs – EU wastewater operators – *OECD (2022), Annex 10, report 6*

The level of transparency also differs from one operator to another: some operators are providing detailed information either on the bills, on their web sites or via apps not only on their level of performance but also on the main elements included in the water bills. This uneven level of access to information prevents an equal empowerment amongst EU citizens. Respondents to the OPC indicated the need for receiving more information.

2.1.3.2 Uneven application of the 'polluter pays' principle

The lack of the application of the "polluter pays" principle in the water sector was raised in a recent report for the Court of the Auditors. In order to cover the costs related to the implementation of the Directive, MS are using a mix of public budget and water tariffs.

Many relied, and some still rely, on EU funding to build up the initial infrastructure.[15] As shown in ***Figure 10***, public budget covers around 30% of the expenses for water supply and sanitation – the rest (70%) is covered by water tariffs. Water tariffs are usually covering both water supply and sanitation: on average wastewater collection and treatment account for about 60% of the water bill although drinking water represents 40%.

There are large differences between MS: some MS like DK or FI are nearly at full cost recovery through water tariffs. In these MS, the 'polluter pays' principle can be considered as respected for households connected to the public network. This is however not the case in other MS, such as IE, LU or CY, where less than 22% of the overall costs is covered by water tariffs (source: OECD, see Annex 10, report 5). According to OECD (see also ***Figure 19***), **affordability** is not a major issue in the EU. The effects of additional requirements set at EU level should nevertheless be carefully analysed.

Contrary to households, the 'polluter pays' principle is not applied for non-domestic/ industrial pollution gathered in public networks: so far there is no mechanism to make industrial producers financially responsible for the water pollution generated by the products they place on the EU market. This is the case for instance for pollutants of emerging concern such as micro-pollutants or micro-plastics partly collected and treated in the wastewater treatment plant without any support from the producers/importers.

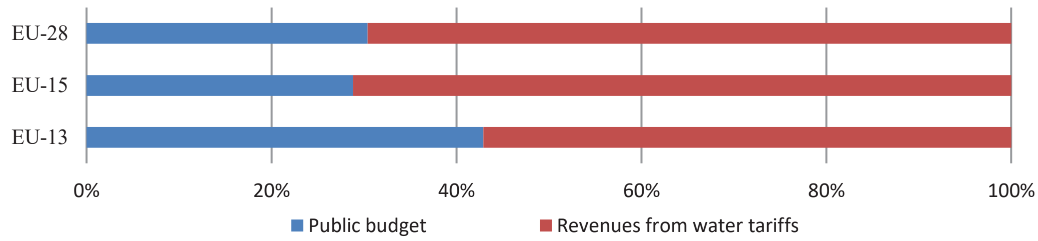

Figure 10: Sources of financing for water supply and sanitation services – EU 28, *Source: OECD (2020) – ref in Annex 10, report 5*

2.1.3.2 Not adapted monitoring and reporting

Monitoring requirements set in Article 15 of the Directive have proven effective to drive compliance. However, technological advances allow today for more efficient and accurate monitoring of both existing and emerging pollutants. Information gathered from MS in the context of this IA (Annex 5) shows that there are large divergences among MS in terms of monitoring. Most MS are already collecting more frequent and broader information on more pollutants than what is required by the Directive.[16] Yet, the knowledge on the quality and quantity of wastewaters is insufficient in many instances. Several cases of over dimensioning of facilities but also storage capacities to reduce SWO and urban runoff, leading to excessive costs and inefficient water collection and treatment, could have been avoided with a better understanding of the actual load to be treated.

[15] Since 2000, € 38.8 billion of cohesion policy funding was allocated to wastewater

[16] For example, the Directive requires only a very limited number of samples even for large facilities.

Reporting requirements[17] set by the Directive could be improved and modernised to ensure a better enforcement of the Directive. Some provisions are by now outdated. This is the case for the bi-annual Commission report required under Article 17: while today most data are accessible in real time, these reports are published few years after the actual monitoring. Also, precise data with the numerical values are available in all MS although only 'passed/failed' values are reported. At the same time, the Directive does not request reporting on some key data for instance on remaining sources of pollution.

The bi-yearly requirement to produce national implementation programs under Article 17 might be excessive for those MS which have reached 100% compliance with the Directive. This information remains on the contrary indispensable for the other MS: having a proper investment planning combined with a financing strategy is key to achieve full compliance. Also, the information requested under Article 17 is not fully consistent with the 'enabling condition' for EU funding under the Cohesion Policy.[18]

2.1.3.2 Insufficient access to sanitation

Access to sanitation remains an issue preventing the EU to fully implement SDG 6 and its objective of ensuring 'access to adequate and equitable sanitation and hygiene for all': the Directive does not require MS to guarantee access to sanitation. In the EU, according to Eurostat, approximately 2% of the population have no access to an indoor flushing toilet. Around 10 million people living in the EU still lack access to sanitation services (EC, 2020). According to EU statistics, 10 to 12 million Roma people are living in Europe, 2.6 million refugees, and 700.000 people sleeping in the rough every night.

During the consultation it appeared that the problem can be split in 3 parts: 1) vulnerable and marginalised people such as homeless ones having no or poor access to sanitation; 2) people living in rural areas with a lack of flush toilets and other sanitation facilities; and 3) cities with insufficient access to public sanitation facilities.

2.2 How likely is the problem to persist?

The Evaluation has shown that the 'carrot and stick' (combination of enforcement and support notably with Regional funds) approach followed by the Commission to ensure the implementation of the Directive has paid off. It had helped to progressively ensure **high levels of compliance** with the Directive. Yet, in the absence of EU rules combined with possible renewed ways of funding the necessary measures, only poor progress can be expected at EU level in controlling remaining pollution from remaining urban sources, such as SWO and urban runoff, releases from smaller agglomerations, N/P or micro-pollutant releases. Information collected for this IA (see Annex 5) shows that only limited or uneven progress were achieved to limit pollution from these sources.

Urbanisation is expected to progressively modify the needs of wastewater collection and treatment: in line with OECD predictions, the trend of urbanisation - people leaving rural areas to move in urban areas - will continue in the coming years which will have an effect on soil sealing, in turn potentially inducing more urban floods and SWO. These impacts might be mitigated by the implementation of the Biodiversity and the Soil Strategies. **Ageing population** will lead to an increased use of pharmaceutical products

[17] According to the Directive, MS have to notify to the Commission every two years 'situation reports' (Article 16) but also their national 'programme for the implementation of the Directive' (Article 17).
[18] Enabling conditions for water consist in establishing national investments plans for the water sector.

but also to a higher demand for security and control of health risks. With the effects of **climate change** already seen on rainfall regimes, more frequent heavy rains are expected which will exacerbate the problems linked with SWO and urban runoff.

No major new technological developments are expected in the coming years for the 'classical' treatment processes of wastewater. However, **digitalisation, permanent automated monitoring and instrumentation, control and automation (ICA)** are expected to help in better managing the collection, storage and treatment of wastewater, notably for what relate energy use and related GHG emissions. It could also help to avoid building larger infrastructures, for instance to tackle the issue of SWO and urban runoff, by optimising the infrastructures in place. Digitalisation will also help rationalise and simplify reporting from the local/national authorities to the EU. **New testing techniques** have the potential to change monitoring and assessment practices and costs in the future. Instead of testing for the presence of hundreds of potentially harmful substances, effect-based monitoring would allow for more targeted monitoring and control measures. This might be particularly relevant, for instance, for micro-pollutants.

In the absence of obligation of energy audits, the lack of understanding of potential for implementing energy saving measures and, to a lesser extent, for producing renewable energies and biogas is expected to persist. Technological developments and experience gained across some MS (see Box 1 below) show that there is a potential for the wastewater treatment sector to become 'energy neutral' (see section 5.2.7).

3. WHY SHOULD THE EU ACT?

3.1 Legal basis

The current UWWTD is based on Article 192(1) of the Treaty on the Functioning of the European Union (TFEU), which states that "*Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay*". Action in the field of wastewater management must therefore be taken according to these key provisions and in the respect of the shared competence with the MS. This means that the EU can only legislate with due consideration for the principles of necessity, subsidiarity and proportionality.

3.2 Subsidiarity: Necessity of EU action

The Evaluation confirmed the added value of the Directive and found that EU action was and is necessary to achieve a high level of environmental and human health protection via a sound wastewater management, as the vast majority of MS would have not achieved the same results on their own. This is confirmed by the results of the OPC suggesting that continued action from the EU is considered necessary to ensure further progress. The **incentive to reinforce and improve** the level of environmental and health protection linked to wastewater management is indeed **limited** as it is directly linked with additional costs for operators, users and/or national budgets. As explained above, the wastewater sector is mainly responsive to EU legislation on which national legislation is based. Without EU intervention, only modest new progress is expected.

Transboundary rivers cover 60% of the EU – the impacts of discharges in one MS will directly affect the environment in other MS. It is therefore indispensable to ensure simultaneous efforts in all MS with a same level of standards for wastewater collection and treatment. That will avoid that efforts made by some MS are partly jeopardised by the lack of investments in others MS. Such an approach cannot be ensured at MS level alone.

The Evaluation also confirmed that the EU action has ensured and has a potential to further ensure an **equal level of environmental and human health protection** across all Member States. More than half of respondents to the OPC across all stakeholder categories rated the risk perception of pollution from untreated wastewater as a significant concern. There was consensus among respondents on addressing all contaminants listed in the survey (corresponding to the pollutants addressed in this IA). Over the last 30 years of implementation of the UWWTD, the quality of bathing water sites (hence tourism and recreation), raw water used for the production of drinking water and of water bodies in general has been either preserved or, in several instances, improved (see section 5.1 of the Evaluation of the Directive). Similarly, making sure that **key health parameters** are tracked in wastewaters will increase the health protection of all EU citizens. Improving **access to sanitation** but also empowering all EU citizens by ensuring an equal **access to information** should be ensured: the Evaluation has shown large differences among EU citizens, from that perspective. All MS are facing the consequences of **climate change** notably on their hydrological regimes and urban micro-climate. Similarly, pollutants of emerging concern such as micro-pollutants or micro-plastics are present in all MS. This is also the case for most of the remaining loads from urban sources which affect water quality in all MS. Also, the drivers for the identified problems are very similar from one MS to another.

3.3 Subsidiarity: added value of EU action

As shown in the Evaluation, EU action remains essential to ensure that **benefits** from improved water quality of the EU rivers, lakes, ground-waters and seas are **optimised**. Experts consulted as part of the evaluation agreed on the decisive role that the UWWTD had in establishing collection and treatment infrastructures. EU action ensures that water bodies benefit from the same level of protection at the same time. Without EU action, part of the efforts made by some MS at national and local level could be overridden by lack of progress of the others. This is valid not only for **transboundary water bodies** but also inside MS as, for most of them, the Directive was the key driver for investing in the required infrastructures.

The Evaluation showed that EU standards were a crucial driver for the development of a globally **competitive EU water industry**. Since the adoption of the Directive, several major worldwide leaders in the field of wastewater treatment have been created and are exporting their services all around the world. Further modernising the EU standards, for instance with new requirements on micro-pollutants or energy use would further stimulate **innovation** and ultimately **economies of scale**. This is also the case if, in line with the objectives of the Green Deal and the EU Climate Law, common efforts are taken to improve energy efficiency, develop renewables and produce more biogas in the sector.

Establishing new rules in application of the "polluter pays" principle particularly for micro-pollutants should be done at EU level to **avoid market distortion**. Also, given the multiplication of national standards (see section 2.1.1.3), adopting EU **standards** for IAS will limit barriers to the internal market. Ensuring harmonised approaches for the remaining loads identified in section 2.1 will help develop common approaches, favour the development of **new skills** and **new markets**. For instance, applying best practices at EU level for storm water overflows and urban runoffs would lead to better urban planning, the development of nature-based solutions, full use of digitalisation and optimisation of existing infrastructures. This will require new competences and create new market opportunities. This is also the case for other aspects such as energy and GHG reduction.

The recent pandemics has shown the interdependence of the MS in terms of virus circulation. Ensuring an effective, rapid, and harmonised tracking of pathogenic factors in wastewaters can benefit the whole EU. Without EU harmonised and integrated action, the possibilities of tracking new types of viruses but also of surveying other relevant **health parameters** in wastewaters would only be achieved in a few, most advanced MS.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1 General objectives

The **main objective** of the initiative is to contribute, in an effective and efficient way, to protecting the environment and human health from the adverse effects of urban wastewater discharges. The aim is to modernise the legislation by adapting it to current and future societal needs while adapting it to the objectives of the European Green Deal and of a Europe fit for the Digital Age. There was a broad consensus amongst the stakeholders regardless their background on the key objectives for this review. The Evaluation highlighted that, according to business and WWTP operators, the Directive does not sufficiently deal with resource recovery and emerging pollutants. Stakeholders also insisted on the necessity to **give predictability to the sector** with clear legal requirements for the next decades – so that the necessary investments can be planned on due time.

The planned EU intervention would have two main general objectives:

1. To protect EU citizens and ecosystems from the remaining sources of insufficiently treated wastewater;
2. To provide a predictable framework for the sector, improve its transparency and governance and align it to “a Europe fit for the Digital Age”;

and two complementary objectives:

3. To align the sector to the objectives of the Green Deal and the recently adopted Communication ‘Repower EU’, regarding in particular the 2050 goal of climate neutrality in synergy with the ESR, transition to circular economy, zero pollution and a restoration of biodiversity;
4. To use wastewater health related parameters as a support for public health and to improve ‘adequate and equitable sanitation and hygiene for all’ in line with SDG 6.

4.2 Specific objectives

The following achievements should be met in an effective and efficient way:

In relation to objective 1:

- Contribute to identifying and then preventing pollution reaching wastewater treatment plants with particular attention to pollutants difficult to treat in these plants;
- Further reduce pollution from the 'remaining sources' (storm water overflows, urban runoff, smaller agglomerations and IAS);
- Further reduce nutrient (N and P), micro-pollutants and micro-plastics pollution from urban sources;
- Reinforce the coherence with key EU water legislations (such as the Bathing Water, Water and Marine Framework Directives and the Drinking Water Directive);
- Encourage investment and innovation in wastewater management.

In relation to objective 2:

- Ensure high level of transparency and access to information;
- Ensure that investments are taking place 'where it makes sense' for environmental or health reasons (based on clear criteria);
- Promote a solid financing strategy while ensuring affordability of water tariffs and better applying the 'polluter pays' principle besides household users;
- Modernise, simplify and adapt monitoring and reporting obligations.

In relation to objective 3:

- Move towards energy neutrality of wastewater sector;
- Create the conditions for increasing water reuse and better managing sludge and waste, in close synergy with the new Water Reuse Regulation, the Sewage Sludge Directive and the EU waste acquis.

In relation to objective 4:

- Improve access to sanitation particularly for vulnerable and marginalised people;
- Ensure that health relevant information from wastewaters is fully used;
- Improve the dialogue between health and wastewater competent authorities;
- Better monitor the spreading of AMR in wastewaters and prevent its dissemination.

Two main **trade-offs** between these objectives will require particular attention: (1) additional treatment for micro-pollutants will require more energy and, if this energy is coming from non-renewable sources, this will entail more GHG emissions; (2) increasing our understanding on some key sources of pollution as well as on some key indicators will require additional efforts and might increase the administrative burden related to monitoring and reporting. At the same time, there is a potential to simplify some of the current requirements. These aspects are further discussed in sections 5 and 6.

Respondents to the OPC provided clear indications on the main objectives and topics the revised legislation should address. **Better implementing the polluter pays principle** was indicated as the most important topic, followed by promoting the monitoring of industrial releases into urban wastewater, reducing nutrient discharge into water bodies, and dealing with SWO and urban run-off through an integrated approach. All are addressed in the specific objectives set for the intervention.

The relation between the problems, their drivers, the objectives and the options are summarised in *Figure 11* below although more details on the relation between the problems, drivers, options and their contribution to specific objectives is provided in *Figure 14* below.

<table>
<tr><th>Drivers</th><th>Problems</th><th>Objectives</th><th>Options</th></tr>
<tr><td>Climate change and urbanisation</td><td>Increasing pollution from SWO/urban runoff</td><td rowspan="12">To protect EU citizens and ecosystems from the remaining sources of insufficiently treated wastewater

To align the wastewater sector to the objectives of the Green Deal (climate neutrality in 2050, transition to circular economy, zero pollution and restoration of biodiversity)

To provide a predictable framework for the sector, improve its governance and full use of digitalisation

To improve access to sanitation and to use wastewater health related parameters to prevent and manage public health issues</td><td rowspan="12">SWO and urban runoff
• Set of measures applied from large agglomerations above 100.000 pe (low ambition) to lower agglomerations 10.000 pe (high ambition)
• Measures includes integrated management plans and monitoring
Small agglomerations
• Review of the threshold (from 500 to 1.000 pe)
Individual Appropriate System
• Better control of the IAS combined with EU clear standards
Nutrients
• Set of options from low ambition (N/P removal applied only to facilities above 100.000 pe) to high ambition (N/P removal above 10.000 pe combined with stricter standards for N/P removal)
• Clarified criteria for designating sensitive areas
Micro-pollutants
• Set of options from low ambition (micro-pollutant removal applied only to facilities above 100.000 pe) to high ambition (all facilities >10.000 pe)
• Medium option based on risk assessment (dilution rates)
• Application of the Extended Producer Responsibility
Non domestic emissions
• Improved monitoring of incoming waters in the treatment plants
GHG and Energy
• Energy audits and monitoring
• Energy neutrality by 2040 leading to GHG emission reduction
Governance
• Monitoring performance indicators
• Increased transparency for water users
Monitoring & Reporting
• Digital monitoring/reporting
• Adaptation of monitoring requirements to remaining sources of pollution
• Simplified reporting
Access to sanitation
• Identification of marginalised and vulnerable people
• MS to improve access to sanitation
Health
• Sampling & analysis COVID-19 and its variants/AMR</td></tr>
<tr><td>Small agglo out of the Directive, unclear requirements and unjustified use of IAS in large agglo</td><td>Remaining pollution from small agglo and non-compliant IAS</td></tr>
<tr><td>Unclear criteria for ‘sensitive areas’ and outdated standards for N & P</td><td>High level of N & P releases leading to Eutrophication</td></tr>
<tr><td>Ageing population and Increasing use of pharmaceuticals and personal care products</td><td>Increasing releases of micro-pollutants</td></tr>
<tr><td>Insufficient control of non-domestic pollution</td><td>Poor actions to reduce pollution at source, limited sludge/water reuse</td></tr>
<tr><td>Poor awareness/understanding on GHG emissions and energy potential savings</td><td>High energy use with high costs and high GHG emissions</td></tr>
<tr><td>Captive market, no incentives to ‘do better’</td><td>Diverging operator performances</td></tr>
<tr><td>No tradition of producer responsibility schemes for water pollution</td><td>Insufficient application of the ‘polluters pays principle‘</td></tr>
<tr><td>Inadequate monitoring</td><td>Lack of knowledge on remaining sources of pollution, poor data on actual performances</td></tr>
<tr><td>Non digitalised reporting</td><td>Outdated reports, admin burden</td></tr>
<tr><td>Access to sanitation not in the scope of the Directive</td><td>Poor access to sanitation for some EU citizens contradict SDG 6</td></tr>
<tr><td>Poor coordination between public health and wastewater competent authorities</td><td>Under use of health indicators (notably on Covid and Anti- Microbial Resistance - AMR)</td></tr>
</table>

Figure 11: Links between drivers, problems, objectives and options

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

5.1 What is the baseline from which options are assessed?

The baseline scenario implies the progressive achievement of full compliance by all MS. In designing the baseline, it is assumed that the identified problems would remain, although their scale would be impacted by external trends such as urbanisation, changes in demographics, changes due to climate impacts (e.g. more intense rains and storms), the development of new technologies (see section 2.2). The 'domestic' pollution (BOD, N and P, *E. coli*) is expected to remain globally stable as it is mainly linked to the evolution of the population connected to the network: EU population is expected to slightly increase (0,2%) by 2035 and then decrease (1,36%) by 2050.[19] These changes do not require a significant adaptation of the usually slightly oversized infrastructure. At the local scale, though, there might be needs for adjustment.

EU actions to limit pollution at source might have an effect on the other ('non domestic') pollutants reaching treatment plants and on the quality of the sludge produced afterwards. The impacts might be significant for some substances in case they are fully banned from the EU market.[20] Progress is also expected from the implementation of the 2020 Chemical, Pharmaceutical Strategies and the 2021 Zero Pollution Action Plan. This progress is however difficult to quantify at this early stage. In any event, actions will be required both at source and in wastewater treatment plants, for instance to prevent micro-pollutants to reach receiving waters. Several measures are also envisaged to reduce micro-plastics at source – see Annex 10, report 3. In the absence of final decisions, at this stage, on their exact extent, it has not been possible to quantify their possible effects.

In the baseline, for wastewater treatment in centralised facilities, **full compliance** was assumed with differentiated dates according to the distance to target of each MS (Table A7-1, Annex 7)[21]. On top of the key support from regional funds, some MS are benefiting from the Technical Support Instrument for their water sector. The Commission with the OECD is also providing tailored support to MS (see Annex 10, report 5).

For Individual and other Appropriate Systems (IAS), the effects of full implementation were included in the baseline: it was assumed that all IAS would have an equivalent level of treatment as required by the Directive. Additional initiatives further discussed in sections 5.2 and 6 would be needed to ensure full implementation. According to the data gathered in the context of this IA (see Annex 4 and 5), today 67% of MS are treating wastewaters from small agglomerations below 2.000 p.e. to the level of secondary treatment, 26% to the level of primary treatment and 7,4% is considered as not treated.

The effects of the baseline are summarised in *Table 2* below and illustrated in *Figure 1*. Full compliance with the existing legislation would reduce the remaining loads emitted to the environment by 21,4% for BOD, 6,3% for N, 13,4% for P, 21,9% for *E. coli* and

[19] According to Eurostat, total EU population is expected to increase from 447.319.916 (2020) to 448.233.662 (2035) and then decline to 441.220.961 by 2050

[20] This might be the case for some harmful substances such as PFAS, intentionally-added micro-plastics in some products such as paints, PCP's, or mercury in dental amalgams

[21] 8 MS are fully compliant today (with less than 1% distance to target), 15 other MS are expected to become fully compliant within the next 3 years. Full compliance was assumed by 2028 for RO, SI, MT and by 2031 for BG (Annex 10, report 1).

4,2% for micro-pollutants. The bulk of the effects of the baseline scenario would appear by 2025 (when 23 MS are expected to become fully compliant), with full effects by 2031.

	BOD	N	P	*E. coli*	Micro-pollutants
Current (**p.e.**)	66.148.823	191.126.725	148.600.784	71.110.762	264.127.257
Baseline (**p.e.**)	51.966.775	179.087.499	128.621.614	55.510.146	252.954.625
Current situation (**Tons/year**)	1.448. 659	779.711	91.122	-	-
Baseline (**Tons/year**)	1.138.072	730.802	78.871	-	-

Table 2: Summary of the of the baseline scenario (full compliance) – *remaining loads per year emitted to environment – A breakdown per MS is provided in Annex 7, Table A7.6*

In terms of energy use and GHG emission reduction, progress could be expected from the combined application of the Fit for 55 package, the EED, the RED II, the ESR and the very recently adopted RePowerEU package (see Annex 8). In the context of this IA, efforts were made to build a dynamic scenario taking into account the potential effects of these legislations and policy packages on energy use and GHG emission reductions:

- The recently adopted RePowerEU Plan aims at rapidly reduce dependence on Russian fossil fuels and fast forward the green transition. Several actions are included in the Plan notably to promote renewables including the production of biogas. No specific quantifies targets per sector are included in the Plan making it impossible to quantify its possible effects on the wastewater sector;
- Under the Fit for 55 package, the EED, the RED II and the ESR, MS have to meet national targets (see Annex 8 for more details) and can choose in which sector efforts will be made to meet these targets. There is no sufficiently detailed data on how MS intends to meet these targets with a sufficient level of disaggregation to identity to what extent the wastewater sector would be included or not in MS efforts. It is therefore not possible to quantify the effects of national based targets on the wastewater treatment sector. A few MS (like DK and NL – see Box 1 below) have well understood the high potential of the sector but so far they remain an exception. The starting position of the other MS is largely unknown in absence of any reporting obligations on energy use and production of renewables from this sector. The potential impacts of these uncertainties are summarised in *Table 18*. In summary, those MS using more energy today for their wastewater operations will proportionally benefit more from systematic energy audits and the related investments in energy efficiency and production of renewables. These investments will be more significant in these countries but also more profitable.
- Nevertheless, as detailed in the recast EED, the public sector should lead by example, and therefore a **specific mandatory target** was introduced for **all public bodies** which covers the wastewater sector (1.7% per year reduction of energy use starting by 2025).

In the baseline, this mandatory target was therefore applied**.** As shown in *Table 3* below, a reduction of energy use of 1,7% per year from 2025 was included in the Baseline. This would represent a reduction of **25,5% of the energy used by 2040 compared to 2025**. This will have a direct effect on GHG emission reduction, which was taken into account in the baseline: **around 1,19 million tons of GHG** would be avoided thanks to the implementation of the EED. This represents 11,89% of the 'avoidable emissions' and will generate a monetised benefits of 118,9 million € per year by 2040. This assumption is based on a (future) legal obligation which is the most solid basis to build a dynamic baseline, but as explained above, there are uncertainties which are further discussed in section 7.1, *Table 17*.

	Emissions of GHG (million tons CO_2e/year per year)	Expected energy savings (based on 1,7% reduction per year)	GHG emission reduction (million tons CO_2e/year)	% of avoidable GHG emissions	Monetised benefits (million €/year)
Current situation	*34.6*	-	-	-	-
Baseline	*33.34*	*25,5%*	*1.188.477*	*11,85%*	*118,9*

Table 3: Baseline scenario – impacts of the EED on the energy use and GHG emissions

5.2 Description of the policy options

Several policy measures addressing each identified problem have been retained for further analysis. For each problem, different solutions were envisaged, ranging from soft approaches - mainly based on non-binding guidance to MS - up to stricter regulatory measures. There are limited interactions among the proposed solutions, which will be clearly identified in the following sections.

The measures detailed below are based on what is already in place in the most advanced MS[22]. As shown in the Evaluation, having in place **enforceable measures** was a key element for the success of this Directive. Therefore, too complex measures difficult to control were avoided. Also, in the initial screening, measures which were not broadly supported by stakeholders or identified as good practice were discarded.

For some problems, the analysis and experience confirmed also by a consensus across the stakeholders groups show that **only a limited set of measures is available without real alternatives**. This is the case for non-domestic waters, some aspects of governance such as transparency, access to sanitation or public health indicators. For other problems, **different options** from low to high level of ambition were tested to find optimal solutions. This is the case for SWO and urban runoff, small scale agglomerations, nutrients and micro-pollutants abatement. The lowest ambition options would apply only to a limited number of large facilities or agglomerations although the highest ambition options would apply to more and smaller facilities and agglomerations.

To fix adequate thresholds for the different options, the share of the treated load amongst the different sizes of facilities and agglomerations is an important factor: **81% of the load is treated in 9% of the EU facilities** and agglomerations **above 10.000 p.e**. – see *Figure 12* (and Tables A7.3 and A7.4 in Annex 7 for more details). Around **47% of the load is treated in 1.3% of facilities** and agglomerations above 100.000 p.e. There are

[22] A lot of information on the practices in place was gathered: detailed pre-filled questionnaires were sent to all MS summarising their starting position and the data used in the model. All MS provided additional data (see Annex 5). Specific technical seminars on each problem identified were organised (see Annex 2).

minor differences between the number of facilities and agglomerations[23] which was taken into account when designing the options and assessing their impacts.

A description of the options considered for the individual problems is provided below.

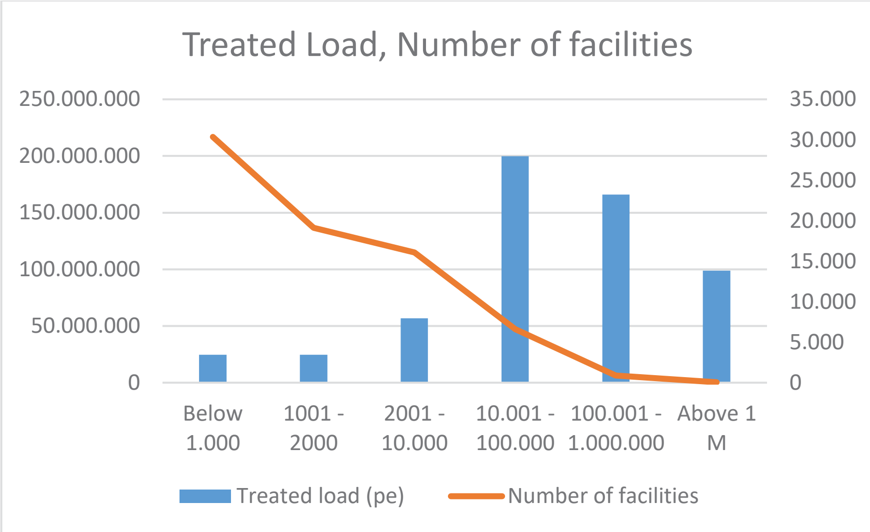

Figure 12: Treated load, number of treatment plants per category *(JRC 2022, Annex 4)*

5.2.1 Storm water overflows (SWO) and urban runoff

The choice of effective measures to control pollution from SWO and urban runoff during rainfall events depends on the local conditions.[24] Therefore, in line with the principle of subsidiarity and proportionality, imposing detailed EU standards constraining the design of solutions would not be appropriate.

Results of the stakeholder consultation identified **'integrated urban water management plans'** established at local level as the right instrument to identify and implement the most cost-effective local combination of measures. This approach is already applied in some MS (such as FI, DE, AT or FR).

Different levels of ambition were tested to reduce emissions from SWO and urban runoff in terms of agglomerations that would be covered:

- A low ambition - Option 1, with measures only in agglomerations >100.000 p.e. with a focus on agglomerations 'at risk';[25]

- A high ambition - Option 3 applied to all agglomerations above 10.000 p.e.;

- Several 'in between' options were modelled of which a representative Option 2 will be presented in section 6 where measures are applied to all 'at risk' agglomerations above 10.000 p.e.

[23] An agglomeration can include more than one facility although a facility can cover more than one agglomeration. The differences are nevertheless marginal – see Annex 7.

[24] Including climatic and geographical conditions, separate or combined collection, storage capacity in the network, capacity of the treatment plants to treat rain waters

[25] Agglomeration where due to SWO and urban run-off there is a risk of not achieving the objectives of other legislation and notably the DWD, the BWD or the WFD – see section 2.1.1.2

The plans would include an analysis of the initial conditions, a definition of the objectives, an analysis of different scenarios to meet the objectives based on an optimisation of the measures to be taken and defined in the plan. The introduction of the plans was generally supported by stakeholders, especially based on the views expressed during the workshops and in the OPC. In the targeted consultation, where respondents had to rate propositions on a scale of 1 to 5, the strategic planning approach was rated high - academia (4.4), citizens (4.2), NGOs (4.7), businesses (4.3), public authorities (3.6). Moreover, there was a consensus amongst stakeholders (academia (4.7), citizens (4.4), NGOs (5.0), businesses (4.5), public authorities (4.1)) on the following combination of measures to be considered in the plans:

- Taking all possible measures to **prevent the entry of 'unpolluted rain waters'** in the wastewater collection network via actions aimed at infiltrating the runoff directly onto pervious surfaces, at removing soil sealing and at increasing the runoff retention also through nature-based solutions (e.g. green roofs, green urban surfaces);

- Measures to buffer polluted storm water flows within the existing treatment infrastructure, by **optimizing the use of existing sto**rage volumes e.g. through RTC of their operation and, when necessary, by building additional storage volume;

- Measures to mitigate the impacts from untreated water discharges, such as further treatment through nature-based or mixed systems, including constructed wetlands.

Effective monitoring of the network, linked with a modelling of urban water systems is key in order to optimise new investments, and indispensable for RTC. Very recent information (see Annex 10, reference 21) based on an analysis of several case studies shows that significant costs savings (on average 21,4%) can be made with a combination of real time control and digitalisation of water management in the cities.

Mixed views were expressed by stakeholder on the added value of setting an EU based objective. At least an indicative objective is nevertheless indispensable to give consistency and added values to the integrated management plans. Based on the experiences and objectives in place in MS, but also on expert judgement on what is "as low as reasonably achievable" (see Annex 10, reports 17 and 18 for more details), a maximum load of 1% of the total sewage produced in a catchment served by combined sewers (or 1% of the annual total 'dry weather' load) was applied as an EU objective for the model calculations detailed in section 6.1.

5.2.2 Small Agglomerations

To better tackle the pollution from smaller agglomerations, the scope of the Directive could be expanded to include agglomerations below 2.000 p.e. Two different options based on lower thresholds for the agglomerations were assessed (1.000 – Option 1 and 500 p.e. – Option 2).

The thresholds to be tested were identified on the basis of the share of the remaining load according to the size of the agglomerations – see *Figure 14*: below 500 p.e., the load is relatively low for a high number of agglomerations, and above 1.000 p.e. the potential pollution reduction would not be too limited in comparison to the baseline.

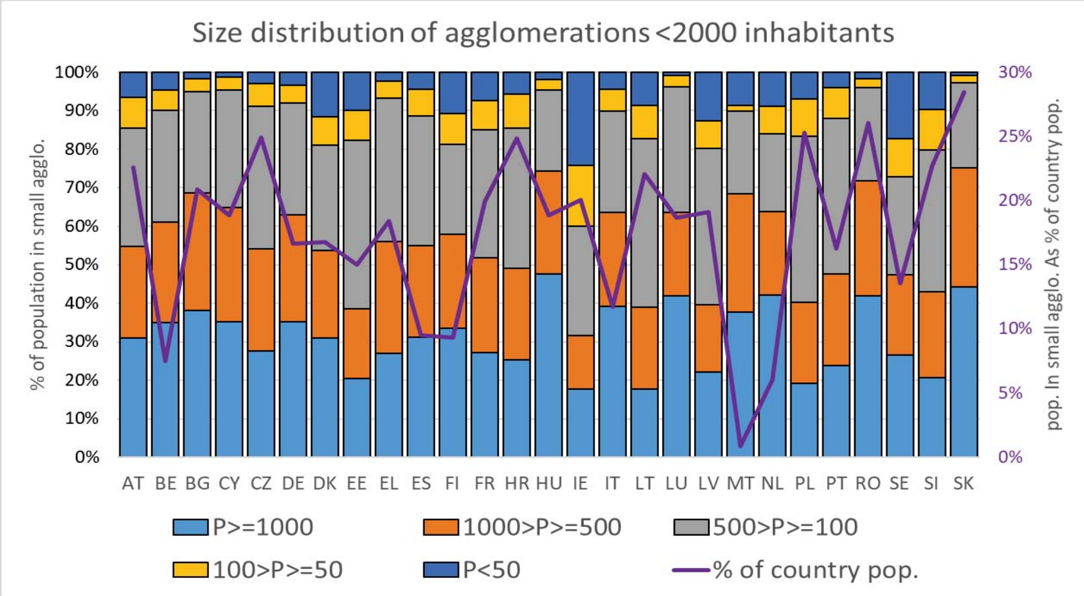

Figure 13: Agglomerations below 2.000 p.e. and population (P), *source JRC, ref in Annex 10, report 10*

18 MS have already decided to impose collection and treatment for smaller agglomerations although others are less active in these areas (ref in Annex 10, report 1). As explained in section 5.1, this was taken into account in the baseline. Stakeholders were broadly in favour of covering smaller agglomerations in the Directive.

5.2.3 Loads from individual or other appropriate systems (IAS)

There was a broad consensus among stakeholders on the need to take the following additional measures (without real alternatives) to ensure a full application of the existing Directive (ensuring the 'same level of treatment' in IAS compared to centralised facilities):

- Establish clear standards in relation to emissions from IAS compatible with the Directive's requirements and supplementing the standards defined in the Construction Product Regulation which was specifically supported by academia (4.8). This measure was rated 3.8 by businesses, 4.2 by citizens and NGOs and 3.5 by public authorities);
- Improve the control of IAS at local level, including through a systemic inventory of the IAS, regular inspections of the larger ones, an obligation of maintenance. This measure was rated 4.5 by academia, 3.6 by businesses, 3.8 by citizens, 4.1 by NGOs and 3.2 by public authorities.

5.2.4 N and P releases and eutrophication

Different options to reduce Nitrogen and Phosphorus releases were tested:

- A low ambition (Option 1) in which N/P removal would be systematically imposed only in larger facilities above 100.000 p.e.;

- A high ambition (Option 5) in which N/P removal would be systematically imposed in all facilities above 10.000 p.e. while N/P removal efficiency would be increased;

- A set of medium ambition (Options 2, 3 and 4) in which N/P removal would be imposed to different areas (from the whole territory to only 'sensitive' areas subject to eutrophication) for different size of facilities and with different levels of N/P efficiency. The most representative options are discussed in section 6 and more detail can be found in report 15, Annex 10.

These options are in line with the measures identified in the most advanced MS. Also, there was a consensus across the different stakeholder groups on the fact that current N/P standards could be adopted to the performance actually achieved in well operating facilities (data from the MS shows that well-functioning facilities can reach 85% reduction for N and more than 90% for P - see report 15 in Annex 10). In many cases, the plants can be upgraded with limited additional costs or only through better operation achieved with instrumentation, control and automation (ICA). In some limited cases, it would require infrastructural overhauls (all included in the cost assessment - see section 6.4).

Overall, stricter N/P emission requirements were supported by stakeholders. Introducing the obligation to remove N/P to a larger range of UWWTPs was supported by NGOs (4.0), academia (4.0), and businesses (3.1). However, businesses noted that such obligations should only be placed for plants above a certain threshold. Public authorities seemed least in favour of such an option (3.5), and generally showed more support for options on providing EU-level guidance on how to designate sensitive areas (3.8). Stakeholders also supported more clarity on the criteria for the designation of 'sensitive' areas subject to eutrophication but also more coherence with the Nitrate and the WFD. This measure was rated 4.5 by academia, 4.1 by citizens and businesses, 4.2 by NGOs, and 3.6 by public authorities.

5.2.5 Micro-pollutants

Based on the share of the load between the different facility sizes and on the dilution rates of the receiving bodies (see Annex 4), the following options were defined:

- a "low ambition" Option 1 requiring treatment only for large plants (> 100.000 p.e.);
- a "high ambition" Option 3 requiring treatment for all plants above 10.000 p.e. when the dilution ratio is 100 or less;
- other 'in between' options combining size and dilution rates (Option 2 in section 6).

There was a broad consensus amongst stakeholders on the necessity to address the issue of micro-pollutants from wastewaters. Contrary to some business (PCP's, Pharmaceuticals), citizens (4.0), NGOs (4.1), academics (3.8), public authorities (3.4) and water-related business support the requirement for larger UWWTPs to remove micro-pollutants based on EU-set performance standards.

Stakeholders were also insisting on the importance of measures to be taken at source but also on the need to **better apply the 'polluter pays' principle** by making the producers financially responsible for the costs linked to the additional treatment required to treat micro-pollutants. The EPR approach received a broad support (regarding feasibility and effectiveness) from the majority of stakeholders (academia (4.5), citizens (4.5), NGOs 4.8), public authorities (4.2), including businesses (3.9) except from the pharmaceutical and chemical industries globally not in favour of such a system, notably on the grounds that the financial responsibility should be either shared by all actors involved in the chain (from industry to consumers) or taken by the public authorities. The feasibility and impacts of a system of producer responsibility was assessed through a specific study (see Annex 10, report 2). To be noted that such a system will de facto lead to a shared financial responsibility as - depending on the decision to be taken by responsible industry - part of the costs will be supported by consumers (see section 6.5).

5.2.6 Non-domestic emissions

As detailed in section 2.1.17, the lack of knowledge of the quality of the incoming waters of the wastewater treatment plants prevents competent authorities to take additional actions to limit pollution at source. To improve the understanding of non-domestic emissions sent in the wastewater collection systems, the following actions were identified based on the consultation and best practices identified in MS:

- Expand the scope of pollutants to be regularly monitored at the inlet and outlet of the wastewater treatment facilities to improve the understanding on the presence of potentially harmful pollutants; the list of pollutants should be aligned with the existing and soon to be revised EQSD and with relevant parameters listed in the upcoming revision of the IED and E-PRTR Regulation;
- Incentivise competent authorities to better 'track' pollution at source based on improved monitoring, particularly when sludge and treated water are re-used;
- Ensure the involvement and access to information for wastewater operators in relation to the discharge permits given to business facilities connected to the treatment plants via the public collection network, and ensure full coherence between the IED and the UWWTD to prevent releases of not abated pollutants in the public network.

Stakeholders independently from their category, supported these measures and particularly as regards the necessity to better monitor/understand non-domestic pollution entering the treatment plants (one of the top ranked concerns that needs to be addressed).

5.2.7 Energy

Based on the experience of the most advanced MS (see Box 1) and the inputs provided during the stakeholder consultation, moving toward energy neutrality was identified as a promising avenue for the sector. The wastewater sector has indeed **specific characteristics** which would justify a specific sectoral target:

- The sector today accounts for **0.8% of the overall energy used in the EU** and **offers the potential** to significantly **reduce its own energy consumption**, but also to **produce renewable energy**;

- Wastewater treatment plants are indeed producing a **constant flow of sludge** which after digestion are producing **renewable biogas** which can be used as a <u>substitute to natural gas</u>;

- Wastewater treatment plants **occupy large surfaces** which could be made easily available for the **production of renewable energy** (notably solar and in a number of locations, wind and hydropower); this is highlighted in the recent RePowerEU package, in which wastewater facilities are identified as good candidates as "go-to-areas";[26]

- As shown in the Evaluation, due to its public/semi-public nature, the sector is **mainly** if not only **reacting to (EU) legal requirements**;

Fixing an EU energy neutrality sectoral target in the revised UWWTD ensures that the huge potential of this sector in terms of energy efficiency gains and self-production is effectively captured, in particular considering that this sector is mainly reacting to (EU) legal requirements. It will help MS to ensure that this potential is effectively captured even if this sectoral target, like targets decided for other specific sectors (including for instance car industry or buildings), will partly reduce the flexibility left to the MS to choose the sectors in which efforts should be accomplished. Nevertheless, the cost/benefit analysis displayed in section 6.7 shows that reaching energy neutrality in this sector is particularly relevant. Also, in compliance with the principles of subsidiarity and proportionality, the proposed energy neutrality target would be applied at national level but not for each facility: **flexibility would indeed be left to the MS** on the choice of the facilities where investments will take place so that an optimisation of the efforts could be achieved. The large facilities can indeed be net producers of energy which is not always the case for smaller facilities.

This specific target would complement and support the attainment of the objectives of the ongoing recast of the EED and revision of the RED (see below section 6.7 and 7.1). As shown in *Table 3* in section 5.1, without a specific target, part of the sector potential in terms of energy efficiency and of production of clean energy is expected to stay under-exploited over the next decades: in the baseline scenario it was assumed that energy use from the sector would be reduced by 25,5% by 2040 which is far below the potential of the sector. By encouraging the self-production of EU based biogas, it would also contribute to reduce energy dependency, one of the objectives of the recently adopted 'REPowerEU' Plan. This sectoral target would also help moving towards the EU objective of climate neutrality by 2050 and contribute to the implementation of the 'Fit for 55' and the ESR (see section 6.7 for more details). In that sense, there is no direct overlap between the existing and forthcoming legislations and this sectoral target, but on the contrary the energy neutrality target will complement the existing or planned legislation.

In practice, energy neutrality can be met through a specific mix of actions combining enhanced energy efficiency (new energy efficient pumps and aeration process, optimization of the process, energy recovery from water falls in the plants), production of renewable energy on site ("go to" areas for solar/wind energy production), and production of biogas from the digestion of residual sludge. The proposed target combined with the obligation of energy audits would push wastewater operators first to better assess their potential in terms of cost-effective energy savings and overall better energy management and then to develop tailored made solutions. As shown in section 2.1.2.1 and 2.1.2.2 each wastewater treatment facility is specific and therefore the optimal path to reach energy neutrality has to be defined for each wastewater treatment facility having regard to its specific process and opportunities.

[26] In the RePower EU Communication, "go-to areas" are limited and clearly defined land and sea areas available for renewable energy projects that do not have (as much as possible) environmental value.

***Denmark** intends to reach energy and climate neutrality by 2030. This will be accomplished through several actions agreed in an overall strategy:*

- *Investments in energy efficiency and sludge digestion – since 2006, € 22,65 million are invested each year to reach energy neutrality by 2030.*
- *Introduction of limit values for N_2O emissions from treatment above 30.000 p.e. (covering 65% of the wastewater volume and 75% of N_2O emissions from the process). The 30.000 threshold will be regularly reviewed.*
- *Monitoring, reporting and benchmarking of all wastewater companies on their energy consumption and production, GHG emissions and targets.*

*Under the Klimaatakkoord signed in 2010 (and confirmed by IBP in 2018 with the water competent authorities), **the Netherlands** intends to progressively reach energy neutrality already by 2025. To do this renewable energy sources (solar/wind) will be used but also measures to save and recover energy. 8 treatment plants have already become new producers of energy and another nine will follow soon. This is also the case in **Bulgaria** with the main facility of Sofia. **Scotland** intends to reach net zero emissions by 2040. GHG emissions from operations were already cut by 45% by using more efficient equipment, reducing leaks from pipes and using renewables.*

***Box 1 – Actions agreed to meet Climate/Energy neutrality by the wastewater and waste sector in Denmark, the Netherlands, Sofia (Bulgaria) and Scotland** – see Annex 10, report 19*

The impacts of following measures were therefore explored in section 6.7:

- Improve the sector's understanding of the level of energy use through new **monitoring obligations** and the requirement of regular **energy audits** (which are not required under the revised EED – see section 2.1.1.2). This can help wastewater operators to better understand the potential savings they can achieve and to identify cost effective measures for each facility;
- Progressively moving towards an EU **energy neutrality** objective (to be applied at national level) for the sector with interim targets up to 2040 to ensure regular progress towards the final objective of energy neutrality. The interim targets would start by 2030 to leave enough time to all MS to make the required investments. They would be identical for all MS as those MS having a less advantageous starting position would gain more benefits than the others. The potential financial direct savings are indeed more important in MS using more energy today for their wastewater sector (see section 6.7 for more details).

As mentioned in section 2.1, the avoidable part of GHG emissions of the sector amounts to 13.03 million tons of which around 46,45% is related to energy use.

The OPC results as well as inputs received during the specific workshops showed that all stakeholder categories broadly support the generalisation of energy audits. There was a general recognition on the necessity to better understand and monitor energy use of the treatment plants so that measures can be taken to reduce energy use and where possible produce energy. On average, the highest rated measure was related to introducing an obligatory energy audit in larger plants (average 3.8), academia (4.2), citizens (4.0), NGOs (4.2), businesses (3.6) and public authorities (3.6). Citizens, NGOs and to a lesser extent academia were supportive on introducing energy related targets while mixed views were expressed by public authorities and business. In terms of stakeholder response patterns, academics (4.3) indicated the most support for the measure relating to setting energy use reduction targets based on UWWTP sizes. This was, on the other hand, businesses least rated option (2.6), with a generally negative perception. Public authorities rated this measure 3.1, citizens 3.5 and NGOs 3.7. More recent contacts with the most important water industry representatives were clearly showing a willingness to improve energy efficiency for all wastewater treatment facilities above 10.000 p.e. and to reach climate neutrality targets for all facilities above 100.000 p.e. by 2035 et for all facilities above 10.000 p.e. by 2040. Some representatives from MS and business pointed out that these targets should be introduced for large UWWTPs only without specifying a specific size of the facilities. Targeting only facilities above 10.000 p.e. seems therefore reasonable and would partly answer to these comments. Most advanced MS were clearly supporting an EU wide target similar to their own target.

5.2.8 Sludge management and water re-use

Several actions considered in this IA will have an effect on sludge management. This is the case with the objective of climate and energy neutrality which will incentivise sludge digestion and production of biogas. Beyond this effect, the proposed actions to better monitor, track and reduce pollution at source (see section 5.2.6) will favour a safe use of treated water (water re-use) but also of sludge in line with the waste hierarchy.

Particular attention should be given to the possible presence of micro-plastics/pollutants and genes/bacteria promoting AMR in sludge, when used in agriculture. This aspect is being specifically tackled in the ongoing Evaluation - and possible subsequent legislative revision - of the Sewage Sludge Directive and in the announced Healthy Soil Directive. Finally, in line with the principle of circular economy, when sludge is incinerated, a minimum level of P recovery should be ensured.

The concept of source control, i.e. targeting substances such as micro-plastics and micro-pollutants at source, was widely supported by stakeholders in order to improve circularity in the wastewater treatment sector. As such, if sludge and/or water is to be reused, stakeholders highlighted that there is a need for tracking and preventing pollution at source.

5.2.9 Wastewater and health

Based on best practices in place in advanced MS notably for COVID-19 surveillance (see Annex 5) and on the March 2021 Recommendation by the Commission, the following measures would be taken:

- Ad-hoc surveillance of COVID-19 and its variants in larger wastewater treatment plants (representing a significant share of the population); the surveillance should be adapted according to the local but also timely needs of the health authorities;
- Regular monitoring of other pathogens with a view to define most effective actions to limit their dissemination;
- Regular monitoring of AMR and when relevant, actions to limit AMR dissemination.

A structural dialogue between health and wastewater competent authorities should also be setup with the aim to (1) ensure a timely transmission of the information to the national health competent authorities; and (2) define the health relevant parameters to be temporarily or permanently followed in wastewaters. Enough flexibility should be left to

MS so that health competent authorities together with wastewater competent authorities can decide together the parameters to be monitored, the frequency and the location of the samples to be taken depending on the public health situation in each MS.

Stakeholders stated that if wastewater surveillance were to take place, additional costs associated with it should be covered by several entities, for example health authorities. The preferred manner in which surveillance of wastewater should be incorporated in the Directive is through the means of guidelines for collaboration between UWWTPs and health authorities, as well as establishing EU-wide binding standards on implementation.

5.2.10 Transparency and Governance

Different measures are available to ensure a better transparency of the sector but also to improve the understanding on the actual performances of the operators:

- In line with the best practices already in place in some MS, require from the operators to monitor some key performance indicators in relation to their economic, social, environmental, energy and climate performances; these indicators would be included in the revised Directive on the basis of the OECD work (reference 6 in Annex 10);
- Make this information accessible to the public either via online access or for the most essential information, on the invoices sent to the consumers.

These measures are aligned to similar requirements recently adopted under the revised Drinking Water Directive. They will also help to better implement the principles of the Aarhus Convention notably on access to information and public participation. While expressing concerns regarding the administrative burden for authorities, stakeholders consider that the current provisions on public information and transparency do not reflect current desirable levels of public engagement.

5.2.11 Monitoring and reporting

While improved and simplified monitoring and reporting are one of the objectives of the revision of the UWWTD, the actual measures depend on the selections made under the other options discussed in this impact assessment. As further explained in sections 6.11 and 8, additional monitoring activities will be necessary to ensure compliance with the new proposed requirements: this is the case for instance for micro-pollutants, non-domestic pollution, GHG emissions or SWO/urban runoffs. The existing obligation would be also aligned to the current practices notably in terms of monitoring frequency: continuous monitoring of key parameters needed to check compliance should be envisaged for the larger facilities.

Reporting could be improved and where possible simplified by:

- Removing the obligation for all MS to report every two years to the Commission and for the Commission to publish bi-yearly reports, by replacing it with the requirement for MS to host national standardised data sets which would be regularly updated (at least annually) and to provide access to those by the EEA/Commission. This approach is similar to what was decided under the recently reviewed Drinking Water Directive but also with the recent efforts of the EEA and the Commission to automatize and simplify reporting. During the consultation it was mentioned that some MS are already using databases directly filled by operators;

- Adapt the existing reporting obligation to include actual releases on top to information on compliance (pass/fail) from wastewater treatment plants. To limit administrative burden, this new requirement would apply only for facilities above 10.000 p.e., representing 81% of the total EU load (see *Figure 12*);
- Include in the reporting obligations information on energy use, measures taken to reduce SWO/urban runoff, and to improve access to sanitation;
- Require MS to report if more than 2% of their load is collected/treated in IAS in their agglomerations, and to notify to the Commission summary information on the actions taken to respect the standards and ensure proper inspection of such IAS;
- Ensure a full coherence between the UWWTD and the revised Industrial Emissions Portal (former E-PRTR) Regulation to ensure best possible use of the same data, as well as full transparency;[27]
- Exempt compliant MS from reporting under current Article 17. For the others, ensure synergies and coherence between Article 17 and the 'water enabling condition' for EU funding under Cohesion Policy 2021-2027.

New monitoring obligations were clearly supported by NGOs, citizens and academics and to a certain extent by businesses and public authorities. NGOs noted that many of the substances urgently require monitoring (e.g. micro-pollutants). The importance of aligning new reporting requirements with other EU policies such as the new Industrial Emissions Portal (former E-PRTR) was highlighted. Generally, the pursuit for simpler and more harmonised reporting was supported by all stakeholder groups.

5.2.12 Access to sanitation

In order to improve access to sanitation, and in full synergy with existing measures to improve access to water under the revised Drinking Water Directive, the following measures are considered in this IA:
- Identify vulnerable and marginalised people and require MS to take action to improve their access to sanitation
- In line with the subsidiarity principle, encourage MS to take appropriate measures to improve access to sanitation in large cities based on local conditions and constraints.

The extension of the scope of the Directive to smaller agglomeration is expected to improve access to sanitation in rural areas (see section 5.2.2). In the OPC, stakeholders indicated that access to sanitation for vulnerable and marginalised groups should be required. Part of the respondents felt that flexibility should be left to MS on the way to improve access to sanitation.

5.3 Options discarded at an early stage

The Evaluation and stakeholder consultation results support the argument that **withdrawing the UWWTD** would have negative consequences. EU citizens would no longer enjoy the same level of protection, as MS would no longer apply the same high standards. Given the overall objective of protecting the environment and public health as well as the reasoning regarding subsidiarity provided in section 3, this option was

[27] E-PRTR includes an obligation for treatment plants above 100.000 p.e. to report their annual mass releases and transfers. It also requires other large industrial facilities to report their releases into UWWTP.

abandoned at the very beginning of the process. There was also no stakeholder support for this option.

Based on the stakeholder consultation, **several options** were considered at an early stage but rejected as either too vague or too prescriptive. Generally speaking, options based on guidance documents and soft approaches were not further considered in this IA. Their effects would be too limited and would not allow reaching the objectives described in section 4. As explained in the REFIT Evaluation, because of its specific market condition, this sector mainly adjusts to EU legal requirements. The clarity and relative **simplicity** of the Directive **making it highly enforceable** was recognised as one of its main success factors and this feature should be kept in the future.

Some flexibility should nevertheless be kept in order to ensure an optimal use of resources - including EU funding - to reach the objectives. In that sense, the option of **banning IAS** was rejected at an early stage, because this technique, if well used, might still be justified, depending on **local circumstances**. Similarly, and as explained in section 5.2.1, imposing detailed EU standards constraining the design of solutions for **SWO and urban runoff** was considered as not appropriate.

Imposing **individual energy efficiency targets** for each collection and treatment system was also discarded as this option would not lead to optimising investments at sector level. Similarly, imposing **resource efficiency objectives** such as **minimum percentages of sludge use** in agriculture or mandatory anaerobic digestion was rejected as well as the option of introducing minimum rates of water reuse. This is also in line with the subsidiarity and proportionality principles, since the conditions are varying from one MS to another and even from plant to plant. To better apply the '**polluters pays' principle**, different types of pollutants and related products were considered (see Annex 10, report 2). Possible Extended Producer Responsibility schemes were rejected for all other pollutants than micro-pollutants. Contrary to micro-pollutants, there are indeed at this stage no available technologies to better capture these pollutants in the treatment plants.

Imposing **access to sanitation for all and everywhere** seems unrealistic and too costly particularly in remote areas. The current scientific knowledge and technological capabilities for wastewater treatment do not support the definition of science-evidence-based threshold for AMR (ref in Annex 10, report 11), hence such an option was discarded too.

Drivers	Problems	Objectives	Operational Objectives	Contribution of the main options to the main specific objectives
Climate change and urbanisation	Increasing pollution from SWO/urban runoff	To protect EU citizens and ecosystems from the remaining sources of insufficiently treated wastewater	Further reduce pollution from the 'remaining sources' (SWOs)	**SWO and urban runoff** Reduction of the pollution sent to the environment from untreated water in case of heavy rains by: • Integrated management plans based on improved monitoring • Actions to be decided at local level to prevent rain water in the network (green infrastructures), optimise existing infrastructures (storage, treatment plants) and when needed new infrastructures
Small agglomerations out of the Directive, unclear requirements and overuse of IAS	Remaining pollution from small agglo and non-compliant IAS		Further reduce pollution from the 'remaining sources' (smaller agglomerations and IAS)	**Small agglomerations and Individual Appropriate System** Reduction of the pollution sent to the environment by: • Review of the thresholds above which the Directive applies (from 2.000 p.e. today to 500 or 1.000 p.e.) • Requiring MS to put in place systematic control of IAS combined with EU clear standards
Unclear criteria for 'sensitive areas' and outdated standards for N & P	High level of N & P releases leading to Eutrophication		Further reduce nutrient (N and P), pollution from urban sources	**Nutrients** Further reduction of N/P pollution sent to the environment by: • Establishing clear criteria where N/P treatment is required • Stricter standards for N/P removal
Ageing population and Increasing use of pharmaceuticals and personal care products	Increasing releases of micro-pollutants		Further reduce micro-pollutants pollution from urban sources	**Micro-pollutants** Reduction of micro-pollutants sent to the environment by: • Establishing new standards for micro-pollutants emitted by wastewater treatment plants • Establish an EPR scheme to incentive producers to put less toxic substances on the market **For all options: improved monitoring and application of a 'risk based' approach** • Integrated management plans for SWO/urban run-off to identify areas at risk and focus investments in areas at risk
Inadequate monitoring, lack of incentives to 'do better'	Lack of monitoring/understanding of some remaining sources and their impacts		Ensure that investments are taking place 'where it makes sense'	• Investments only required for large facilities and for smaller facilities based on an identification of areas 'at risk' for micro-pollutants and N/P (eutrophication) • Application of the Extended Producer Responsibility to cover new investments needs to treat micro-pollutants
No tradition of producer responsibility schemes for water pollution	Insufficient application of the 'polluters pays principle'		Better apply the 'polluter pays' principle Encourage investment and innovation in wastewater management.	• Innovation and investments encouraged by new standards for micro-pollutants, reinforced standards for N/P, improved management of SWO and urban run-off • Digitalisation/RTC needed for SWO/urban run-off management, N/P management and energy neutrality • New technologic development expected to reach energy neutrality while reinforcing water treatment

Figure 14: Links between drivers, problems, objectives, specific objectives and the main options

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS, HOW DO THEY COMPARE AND WHAT ARE THE PREFERRED OPTIONS?

As the policy options are quite different according to the identified problems, their potential impacts, their comparison and the choice of the preferred options are discussed together in this section. The assessment of impacts focuses primarily on the **economic** (costs) and **environmental impacts** (emission of pollutants). The **social impacts**, beyond access to sanitation, were addressed from the perspective of affordability of the wastewater services for the low-income households (see section 7).

When alternative options were available, **several criteria** were used to identify 'optimal' (preferred) options: on top of costs/benefits and costs/effectiveness, the contribution to the achievement of the main objectives, the enforceability as well as the potential administrative burden were considered. A summary of the selection criteria applied for each option is provided in *Table 12*, at the end of the present section whereas *Figure 14* above displays the main options, their contribution to solve the problems and their drivers while delivering on the specific objectives.

The costs and benefits were assessed and presented with a 2040-time horizon: this is indeed the time needed for a realistic implementation of the measures considered in this IA and for a sound planning of the underlying, required investments. Beyond 2040, there would be too many uncertainties on the expected costs and benefits of the envisaged measures. As detailed in section 4, **the main objective** of this initiative as well as the majority of its expected costs and impacts are related to **water collection and treatment** and to a lesser extent energy neutrality. This 2040 horizon takes into account the time required for the water-related investments. It also takes into account the lessons learnt from the application of the 1991 Directive (over ambitious deadlines leading to a multiplication of infringement cases – see the Evaluation for more details).

The time needed to achieve energy neutrality was also taken into account: most advanced MS (see Box 1) are indeed expecting to reach energy neutrality by 2025/2030, meaning 10 to 15 years before the proposed EU deadline which therefore would be realistic in the light of the potential gains and incentives related to better energy management but also the available technologies to move towards energy neutrality. The recent evolution of energy prices is providing another powerful incentive for the sector to accelerate its efforts toward energy neutrality. It is also in line with the REPowerEU Communication objective to become less dependent for its energy production. For all these reasons, the 2040 deadline appears to be both realistic and desirable. As detailed below (sections 6.7 and 7.1), reaching energy neutrality by 2040 will contribute to reduce GHG emission from the sector (around 33% of the 'avoidable emissions) which is compatible with the objectives of the Fit for 55 initiative and the 2050 objective of carbon neutrality.

For comparison purpose, a **maximum feasible scenario** was built showing what would be the effects of all technically feasible measures without taking into account their cost (see Annex 4). The effects on emissions in waters are summarised in *Figure 15* below and in *Table 1* above.

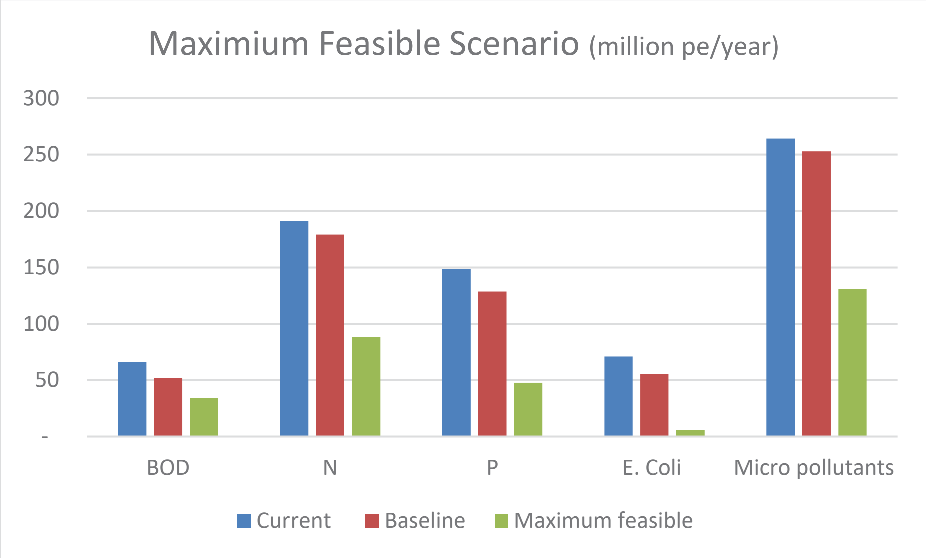

Figure 15: Impacts of the current situation, baseline, and maximum feasible scenario on the remaining load

As detailed in Annex 4, the costs were estimated based on reference cost functions (FEASIBLE functions). For the quantification of the benefits, the following shadow price were assumed: GHG emissions € 100 per t CO2e, and for 1 kg of BOD removed from the effluents € 0.05, € 20/kg for N and € 30/kg for P. Additional estimates of the benefits based on willingness to pay were used in the case of SWOs and urban run-off (see Annex 4). The cost and benefit methodologies were reviewed and improved by OECD (Annex 10, report 4).

6.1 Storm water overflows and urban runoff

The expected pollution reduction as well as the costs and benefits of the different options are summarised in *Table 3* and *Table 4* below. The costs and impacts of the additional investments needed will depend on the local conditions of each urban area. Nevertheless, the costs and effects of different measures were estimated using European hydrological and cost models (see Annex 4 for more details).

Two types of costs were estimated: (1) costs of establishing the urban water management plans including monitoring costs; (2) costs of actual measures included in the plans to limit untreated releases to 1% of the dry weather load (see section 5.2.1).

The average cost of establishing an integrated urban water management plan was estimated at € 0.09/year/p.e. (source: Annex 10, report 1).[28] These plans would allow optimising existing and planned infrastructures leading to potentially significant savings in terms of new investments. Such integrated plans are already in place in some MS (see Annex 5), therefore it was estimated that around 80% of the concerned agglomerations would have to establish such plans. Annual monitoring costs are estimated at € 0.05 per p.e. (including RTC).

[28] The actual cost will depend on the complexity of the systems, the pre-existence of relevant information and the size of the considered area.

The costs of actual measures were estimated assuming that overflows are treated in a constructed wetland before discharge. The effects of the greening of urban areas according to the objectives of the Biodiversity Strategy (Nature Restoration targets) were also taken into account in the modelling (see Annex 4). Potential savings (on average 21,4%) due to real time control, digitalisation and better planning/management of waters in the cities (see Annex 10, reference 21) were applied to the costs estimates.

Options	N removal t/year	P removal t/year	BOD t/year	Removal of Micro-pollutants (p.e./year)
1 - Low ambition – 30% of agglo >100.000 p.e.	3,476	512	17.262	3.826.925
2 - As above + 30% agglo > 10.000 p.e.	5,938	876	29.483	6.558.744
3 - High ambition - all agglo> 10.000 p.e.	19.795	2,919	98.276	21.862.481

Table 4: Annual pollution reduction by 2040 of actions to reduce urban runoff and SWOs *– source JRC, ref in Annex 10, report 17*

Options 1 and 2 include measures for all agglomerations respectively above 100.000 p.e. (Option 1) and 10.000 p.e. (Option 2) in areas 'at risk' where SWO releases represents a risk for the environment. For the calculations of the impacts of these Options, it was assumed that 30% of the agglomerations would require additional investments – which – according to available data from the WFD and the BWD appears to be a conservative approach (see section 2.1.1.2 and Annex 4 for more details).

Options	Costs €/year	Plans and monitoring €/year	Monetised benefits – water only €/year	10% of benefits – willingness to pay €/year	Total assumed benefits €/year
1 - Low ambition – 30% of agglo >100.000 p.e.	218.979.413	43. 100.000	85.753.164	365.537.530	451.290.694
2 - As above + 30% agglo > 10.000 p.e.	372.472.648	57.600.000	146.509.339	639.071.811	785.581.149
3 - High ambition - all agglo> 10.000 p.e.	1.241.575.494	77.200.000	488.364.462	2.130.239.369	2.618.603.831

Table 5: Annual costs and benefits by 2040 of actions to reduce urban runoff and SWOs *– source JRC, ref in Annex 10, report 17*

Like for the other options, a partial monetisation of the benefits was achieved on the basis of the avoided N, P and BOD pollution. In absence of credible shadow price for micro-pollutants and for micro-plastics (see Annex 4), the benefits related to water quality are nevertheless under-estimated, knowing that SWO and urban run-off are a significant source of these pollutants. Moreover, the monetisation does not account for the short duration, acute effects of pollution due to SWO/urban run-off, which may lead to fish die-off and temporary impairment of the aesthetics and safety of the receiving waters.

A recently published study (April 2022 – see Annex 10, reference 22) quantifies the willingness to pay (WTP) for improved ecosystem services due to a better management of SWO/urban run-off in the city of Berlin (around 100 €/year/person). Based on this, another estimate of the benefits was achieved for all options (more details in Annex 4).

In order to account for the fact that in many cases the perceived benefits can be smaller than in the Berlin case study, and to stay on a very conservative side in the estimation, it was assumed that the benefits would amount to 10% of the WPT as estimated in Berlin. Alternative extrapolation based on the GDP per inhabitant would also lead to an over-estimation of the benefits.[29]

The results of both methods are displayed in ***Table 4*** above. In the context of this IA and to compare the different options, the benefits linked to water quality were added to the estimations of the willingness to pay.

Preferred option:

Requiring all agglomerations above 100.000 p.e. to produce an integrated plan and carry out proper monitoring should be done in any case: it would concern only a limited number of agglomerations (914) representing a significant part of the load. As for the agglomerations between 10.000 and 100.000 p.e., regular monitoring should be in place to identify whether additional action would be needed.

As shown in *Table 12*, the three options have similar benefits-costs ratios even if Options 2 and 3 performs slightly better than Option 1. More pollution would be captured with Option 3 but not always in areas where there is an actual risk for the environment. Administrative burden would be higher for Option 3 as more agglomerations would be covered. Option 1 has a slightly lower benefit/cost ratio than Option 2 and 3, while its administrative burden would be lower than for Options 2 and 3. The contribution of Option 1 to the main objectives of this initiative would be lower than with the other Options.

It is therefore proposed to consider Option 2 as the preferred Option. This Option offers the best combination between benefit/cost ratio, with limited administrative burden (around 2.966 agglomerations would be concerned - mainly where there is a real risk for the environment compared to 7.754 with Option 3). Option 3 entails significant investments in all agglomerations above 10.000 p.e. which might be excessive particularly when the receiving water bodies are not ‘at risk’. With Option 2, investments would take place only in areas where there is a risk for the environment as identified by the integrated water management plans leading to optimised measures to be decided at local level. Criteria to define the areas at risk would be included in the revised Directive[30] as well as an **indicative target** for the water management plans (1% of dry weather loads – see section 5.2.1). Applying an indicative (not legally binding) target would leave enough flexibility at local level on the decisions on actual actions to be taken depending on their local cost/benefit analysis and the local estimates of the ‘willingness to pay’ which differs from one city to another.

[29] According to Eurostat, the average GDP per inhabitant in the EU amounts to 27.830 €/year compared to 35.290 €/year in Germany. Based on the GDP/inhabitant, an extrapolation of the Berlin case would lead to WTP of 79 € per person which is considered by JRC experts as an over-estimation of the benefits. The same extrapolation in the MS having the lowest GDP/inhabitant (BG - 6.690 €) would lead to a WTP of 18,9 € per person which is still about the double of the WTP used in the context of this IA (10 € per person). In that sense the assumption used in this IA appears to be prudent but reasonable.

[30] Criteria would be linked to risks to the environment notably when monitoring results shows high levels of loads (more than 1% of dry weather loads) leading to risk of not achieving the objectives of other legislations such as the DWD, the BDW and the WFD.

With the preferred option, around **9% of micro-plastics** released in case of heavy rains would be further captured in treatment plants and as well as potentially significant additional number of larger pieces of plastic (see Annex 4 and report 8 in Annex 10). Finally, these measures are also aligned with the rationale underpinning the EU Climate Adaptation Strategy, the Biodiversity Strategy and the Zero Pollution Action Plan.

6.2 Individual or other appropriate systems (IAS)

The proposed measures are designed to ensure the full implementation of the existing Directive's requirements. An estimate of the additional administrative costs related to performing regular inspections of IAS and complying with new reporting obligations was based on the Austrian advanced experience: the annual cost of ensuring a regular inspection is estimated at € 82.6 million per year for the EU 27 (see in Annex 10, report 1). The Austrian system is considered as one of the most advanced, meaning that with this level of costs a real performant inspection would be in place in all MS.

As 26 MS have already a legislation in place on IAS and some form of inspection, the total additional cost of improving inspection was estimated at between 20 to 60% of € 82,6 million. Reporting costs would amount to 126.000 €/MS per year. To limit administrative burden, reporting obligation could be limited to MS reporting a high level of IAS in their agglomerations of above 2.000 p.e.: it would concern 13 MS reporting more than 2% (see *Figure 2*). Overall reporting costs would then amount to 1.64 million/year.

BOD reduction (Tons/year)	N reduction (Tons/year)	P reduction (Tons/year)	Micro-pollutants reduction (p.e./year)	*E. coli* reduction (p.e./year)	Administrative costs (million/year)	Monetised Benefits (million/year)
75.738	23.2820	32.480	4.900.263	4.190.288	16,52 to 49,56 +1.64 reporting	566,9

Table 6: Costs and benefits by 2040 of measures to ensure full implementation for IAS

As explained in section 5.1, the potential pollutant emission reduction was included in the baseline. Additional emission reductions can be expected if EU standards are developed for IAS, as theses would apply for all smaller facilities placed on the EU territory. As shown in Table 5, the monetised benefits are estimated at € 566,9 million which is exceeding the additional costs due to additional efforts on inspection and reporting.

6.3 Small Agglomerations

The impacts of reducing the existing threshold of 2.000 p.e. are summarised in ***Table 6***.

Options	Number of Agglomerations	BOD reduction Tons/y	N reduction Tons/y	P reduction Tons/y	Micro-pollutants (million p.e.)	Administrative Million €/year	Costs Million €/year	Benefits Million €/year
Option 1 - 1.000 p.e.	19.138	75.531	8.928	1.397	2,61	0,472	140,4	224,24
Option 2 - 500 p.e.	30.354	143.266	16.822	2.642	4,9	0,748	284,3	415,7

Table 7: Cost and benefits by 2040 of expanding the scope of the Directive to agglomerations of 500 and 1.000 p.e.

As shown in *Table 6*, for all options, the costs are lower than the monetised benefits. According to the MS answers to the questionnaire (see Annex 5), in 18 MS the majority of the small agglomerations are already connected to wastewater treatment plants – which was taken into account in the baseline. Therefore, additional reporting work would be needed only for around 40% of the agglomerations or € 747.923 per year[31] at EU level if the threshold is changed to 500 p.e. and € 471.560 for 1.000 p.e. (Annex 10, report 1).

Preferred option: As shown in *Table 13*, the benefit/cost ratio is slightly better if the thresholds are reduced to 1.000 p.e. (1,6 compared to 1,46) while administrative costs would be reduced by half. It is therefore proposed to consider this Option 1 as the preferred Option even if Option 2 would have delivered slightly higher pollution reduction. In terms of enforceability, the preferred option scores better as even if the thresholds are very clear for both options, targeting less agglomerations will ease compliance checking and limit administrative burden.

6.4 N and P releases and eutrophication

The impacts of several combinations of measures based on removal efficiency applied to different sizes of facilities were modelled (see Annex 4 and Annex 10, report 15). The impacts of the main following options are summarised in *Table 7* below.

Preferred option: As shown in *Table 12* and in *Table 7*, the benefit/cost ratio is positive for all options. Options 2 and 4 are nevertheless scoring better than the others. Option 4 will bring more N/P but also GHG reduction. In that sense, the coherence with the Green Deal as well as the effectiveness in terms of reduced water pollution is higher. Compared to other less ambitious Options, Option 4 will bring limited additional administrative burden as facilities above 10.000 p.e. are already subject to reporting while better contributing to the objectives.

It is therefore proposed to consider Option 4 as the preferred option. With this Option, the obligation to install additional tertiary treatment to remove N/P will be limited to areas subject to eutrophication or at risk of eutrophication as it is the case today but with more clarity and coherence with the WFD, the MSFD and the Nitrates Directive on the criteria to designate sensitive areas. Some areas incontestably subject to eutrophication consistently with the data generated by the MSFD, the WFD but also the Nitrates Directive could be included in the annex of the Directive.[32]

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[31] 0.5 day/operator based on cost of a FTE of 123,2 €/day – source: Eurostat – see Annex 10, report 1

[32] Parts of the North Sea, Black Sea, North of the Adriatic Sea, Baltic Sea

Options	N reduction (t/year)	P reduction (t/year)	GHG reduction (t/year)	Costs (€ million)	Benefits N/P removal in water (€ million)	Benefits GHG reduction (€ million)
1. Low ambition - N/P removal - all facilities above 100.000 p.e.	54.817	9.359	692.842	801	1.377	69,842
2. Medium – as above + N efficiency to 85% and P to 90%	168. 228	16.964	922.063	1.420	3.873	92,206
3. N/P removal for all facilities > 10.000 p.e.	84.603	15.288	1.228.372	1.395	2.151	122,84
4. N/P removal - all facilities > 100.000 p.e. + facilities between 10 and 100.000 in sensitive areas + N/P increased efficiency[33]	215.133	28.130	1.391.487	2.008,5	5.147	139,149
5. High ambition - As above + N efficiency to 85% and P to 90%	282.524	29.054	1.662.634	2.598	6.523	166,263

Table 8: Summary of the main impacts by 2040 of measures to reduce N/P

6.5 Micro-pollutants

Table 8 below summarises the model results for a selection of different options as regards the treatment of micro-pollutants (see Annex 4 for details).

Options	**Costs (Million €/year)**	**Toxic load avoided (p.e.)**	**Avoided toxic load in areas at risk (p.e.)**	**Additional GHG (Million t CO2e/year)**
1. Low ambition - all plants > 100 k p.e.	841	59.236	32.875	0 to 4,33
2. All plants >100 k p.e. + plants 10 k to 100 k in areas at 'risk' [34]	1.185,51	68,198	41.836	0 to 4,97
3. High ambition - all plants > 10k p.e.	2.651,82	103,431	41.836	0 to 7,58

Table 9: Impacts by 2040 of measures to reduce micro-pollutants, *source JRC - Annex 4 and ref in Annex 10, report 13 and 14*

As explained in the glossary, the lower the dilution rate, the higher the risks for the environment. Additional energy would be needed to treat micro-pollutants. In Table 8 an estimate of the related GHG emissions is provided. These additional emissions could be neutralised when energy neutrality will be met in the sector.

[33] For Option 4, it was estimated that around 50% of the facilities between 10.000 and 100.000 p.e. not yet equipped with N/P removal equipment are in sensitive areas and should be equipped by 2040

[34] In this IA, it was assumed that 70% of facilities between 10.000 and 100.000 p.e. with a dilution rate of 10 or less would be considered as 'at risk'- see Annex 4.

Preferred option:

As shown in *Table 8* and *Table 12*, there is a direct correlation between the reduction of the toxic load and the costs. Compared to Option 1, Option 2 delivers better results in terms of avoided load in areas 'at risk', where the dilution rate is below 10. Compared to Option 3, Option 2 is more cost effective as it will allow prioritising the efforts where the risk for the environment is higher.[35]

The administrative burden of Options 2 and 3 is slightly higher than Option 1 – which nevertheless delivers less reduction of the toxic load (both in and outside the areas 'at risk). All Options are similar in terms of enforceability even if Option 2 will require slightly additional efforts to check that MS did properly identify the areas at risk. Requiring an unconditional advanced treatment for facilities between 10.000 and 100.000 p.e. as in Option 3 would lead to disproportionally high cost when compared to expected reduction of polluting emissions. Balancing all the criteria, it is proposed to consider Option 2 as the preferred Option. With the preferred option, the toxicity of the released waters would be reduced by 44% against the current situation, of which more than 60% would happen in areas 'at risk'.

To give enough time to plan the required investments, advanced equipment would be installed within a sufficient time period by 2035 (more than 10 years) for all facilities above 100.000 p.e. and 5 additional years would be given for the others. These deadlines are realistic based notably on the experience from Switzerland.[36]

Monitoring costs for the preferred option are estimated around €11 million/ year based on monthly samples (Annex 10, report 1). Reporting costs are considered as negligible as all facilities above 10.000 p.e. are already subject to reporting obligations.

Producer responsibility, application of the 'polluters pays' principle:

The feasibility and impacts of covering the additional cost for advanced treatment through a system of producer responsibility was assessed (report 2 in Annex 10). According to the best available data today, and recognising uncertainties on the data gathered[37], substances used in pharmaceuticals and personal care products (PCPs) represent the majority of micro-pollutants inputs and toxicity in wastewater treatment plants justifying additional investments in advanced treatment for micro-pollutants (see Annex 10 reports 2, 15 and 16). Pharmaceuticals represent 59% of input quantities to wastewater treatment plants (14% for PCPs), 48% of the toxic chronic load (17% for PCPs) and 66% of the total toxic load PNEC- see Glossary (26% for PCPs).

In compliance with the "polluter pays" principle included in Article 191 of TFEU, these sectors should be financially responsible for the additional costs related to additional treatment needed to treat the pollution they generate (€ 1.186 million/year for all micro-pollutants). In practice, and similarly to the EPR schemes in place for several waste

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[35] On the basis of the outcomes of a risk assessment based on simple criteria such as low dilution rate, presence of bathing areas and/or where raw water is extracted for the production of drinking water.
[36] In Switzerland 100 'priority' facilities will be equipped with advanced treatment by 2040.
[37] There are uncertainties on the concentration of substances found in the treatment plants and on the toxicity of the substances – see also *Table 1*. As it was the case at the beginning of most EPR schemes, these uncertainties are expected to be rapidly limited with the introduction of the declaration on products placed on the EU market by the producers/importers.

streams, those placing PCPs/pharmaceuticals on the EU market would have to pay fees to a central organisation (PRO) based on the quantities and toxicity of their products. The funds would then be used mainly to finance the additionally required treatment through contracts with wastewater operators but also to cover the additional administrative costs. Such system will be in line with the concept of Extended Producer Responsibility as defined under Article 8 of the Waste Framework Directive. More details on the practical organisation, the responsibilities and roles of the different involved actors and their interactions is provided in Annex 9. On top of deciding on whether a producer responsibility system should be applied or not, the main choice to be done at this stage and in the EU legislation are related to the scope of the EPR scheme, the cost coverage of the scheme, the principles on how the fees to be paid will be applied and the level of transparency of the system. In this impact assessment it was assumed that:

- The **scope of the EPR schemes** would cover pharmaceuticals and PCPs. A review clause could be included in case new knowledge and understanding become available on the products placed on the market generating micro-pollutants and treated with the new advanced treatments.[31]

- The same principles in terms of fee modulation/transparency as defined in Article 8 of the Waste Framework Directive would be applied. In other terms, the fees to be paid by those placing PCPs and pharmaceuticals on the market would be linked to the quantities of the products they placed on the market and the potential toxicity of the related residues. This modulation of the fees paid by the producers/importers would be established so that substitution to most toxic substances could be incentivised.

- Similar requirements to those included in the Waste Framework Directive in terms of transparency would be requested from the producers/importers and for their PRO. These costs (administrative costs related to the EPR scheme but also to regular external independent audits were assesses in this IA – see below).

The **additional costs** related to an **EPR scheme** is due to administrative costs. These costs were estimated at € 16.6 million per year (less than 1.4%) mainly for the Producer Responsibility Organisation - PRO (€ 11.2 million) and to a lesser extent for the sectors (€ 5 million – declaration of what is set on the EU market). Costs for MS (control of the system – 0.06 million) and for wastewater operators (contracts with PRO – 0.34 million) are more modest. Depending on the decisions taken by each company in the two sectors, the additional costs due to the fees paid to the PRO would be covered either by an increase of products price (estimated at maximum 0,6%, of the annual expenses for PCPs and Pharmaceuticals) or by a reduction of the profit margins (estimated at maximum 0,6 to 0,9%) – see report 2 in Annex 10.

There are several advantages of an EPR scheme including:

- A **better application of the polluter pays principle** (in line with the recommendation of a recent Court of Auditor report), entailing an incentive for industrial producers to develop less toxic products;

- Reduced pressure on **public budgets** and **water tariffs** while ensuring a **stable and reliable financing** of the required investments needed to treat micro-pollutants;

- Expected **gains in governance** through new dialogue and contractual relations between wastewater operators and relevant industrial producers.

The **alternative to an EPR scheme** would consist in a 'classical' financing of the required investments: 1.186 € bn/year by 2040 would have to be covered by water tariffs (€ 0.83 bn/year[38]) and public budgets (€ 0,37 bn/year). These increases of water tariffs and public budget contribution would come on top of the expected increase due to the other measures identified in the preferred option (see section 7.1). Most of the advantages identified above linked with an EPR scheme would then be lost (incentives for less toxic products, gains in governance) while an occasion to better apply the 'polluters pays' principle would be missed despite the obligations included in the Treaty and the recommendation of the Court of Auditors (see section 2.1.3.2.).

6.6 Non-domestic discharges

The average cost of taking samples and make analysis of a large spectrum of substances in the inlets and outlets of the wastewater facilities is estimated at € 5.000 per sample (ref in Annex 10, report 1). At least two samples would be taken each year for the facilities above 100.000 p.e. and one every two years for the facilities between 10.000 and 100.000 p.e. – this would give an overview of the type of pollution coming in and going out the facilities, while keeping the number of samples proportional to the purpose of the exercise. This information can be used then to better 'track' non desirable pollution entering the plants and take further measures to limit at source this pollution. The total costs at EU level would amount to € 25,695 million per year.

The additional costs of ensuring more transparency and when required consultation of the wastewater operators on the permits given to facilities connected to the public network is difficult to assess in absence of data on the number of permits. The impact assessment for amending the IED concludes that a better alignment between the IED and UWWTD would result in reduced releases of polluting substance to water and may require a limited number of IED operators to invest into treatment equipment on site.

The benefits of this measure are multiple (but not quantifiable): (1) reducing pollution at source will improve the quality of the sludge but also of the treated water making it available for reuse notably in agriculture; (2) the functioning of the wastewater treatment could also be improved; (3) less pollutants will be released into the environment and more coherence will be ensured with the EQSD. This would help to achieve the objectives of preventing pollution at source and improving the 'circularity' of the whole sector. In order to improve the knowledge on micro-plastics releases, regular monitoring should be progressively put in place based on harmonised sampling and analytical methods.

6.7 Energy neutrality and GHG emissions

The estimated costs and benefits to move towards energy neutrality are summarised in *Table 9:* below. The average cost of establishing energy audit every 5 years was estimated at 4.000 € per audit (ref in Annex 10, report 1). In a first period (by 2030), the audits would be imposed only on the larger facilities above 100.000 p.e. (total costs at

[38] Assuming that 'historical' ways of funding water infrastructures would continue: 70% would be covered by water tariffs, the 30% remaining by public budgets – see ***Figure 10***

EU level of € 0.74 million per year). Average monitoring yearly costs are estimated at € 12 million at EU level (between 8.3 and 15,8 million per year).[39] To meet the 2040 energy neutrality target, audits and monitoring would also be needed by 2035 for all facilities above 10.000 p.e.: 81.4% of the total load (and energy use) would then be covered with 7.527 facilities. The total annual cost by 2035 for all audits would then amount to € 6 million per year and the monitoring costs would reach an average of € 98,7 million (between € 67,5 and 130 million per year). Imposing audits and systemic monitoring on facilities below 10.000 p.e. would be disproportionate (large number of facilities for a limited treated load and related energy use – see *Figure 12*).

	Costs (million €/year)	Expected savings (million €/year)	GHG emission reduction (tons CO_2e/year)	% of avoidable GHG emissions	Monetised benefits (million €/year)
Baseline	*410*	*510*	*1.188.477*	*11,85%*	*118,9*
Energy neutrality	1.560	2.000	4.660.695	45,46%	466,07
Energy neutrality target compared to baseline	1.150	1.490	3.472.218	33.61%	347,22

Table 10: Costs and benefits by 2040 associated to energy neutrality in comparison with the baseline - € million by 2040

In this IA, an estimate of the costs needed to move towards energy neutrality was calculated based on the solid experience of Denmark (annual cost of 22,65 million € per year to cover investments with between 10 and 40 years of amortization time). An extrapolation of the DK figures at EU level would lead to an annual cost of € 1,561 billion (EU capacity of 517 million p.e. compared to 7,5 million p.e. in DK). The main investments in Denmark were devoted to biogas production from sludge (around 85% of the investments) complemented by intelligent control and management, renew of heat pumps and aeration. No investments in other renewables like solar or wind production were included in the calculation. Reaching energy neutrality would represent a direct financial saving of 2 billion € per year for the whole sector – which is the actual costs of the energy used in wastewater treatment facilities. (ref in Annex 10, report 1). **The potential net saving linked with an energy neutrality target would therefore amount to € 0,439 billion per year for the sector.**

The data on the costs to reach energy neutrality provided by Denmark are based on a **successful and concrete experience**. Their extrapolation to the whole EU is most probably leading to an **over estimation of the costs** as digestion of the sludge would not always represent the most cost-effective solution to produce renewable energy: the potential for wind or mainly solar production could be more significant in other MS. At the same time, the potential savings (2 billion € per year) were calculated before the recent events in Ukraine having led to a significant increase in energy prices.

In the context of this IA, and in the light of the uncertainties mainly related to the evolution of the energy markets, **a very prudent and conservative approach** was taken:

[39] Annual operational and investment costs are estimated between € 12 and 21.000 per facility. It is was estimated that 75% of the facilities have already monitoring in place - see Annex 5.1

it was assumed that the costs of additional investments and related administrative costs to reach energy neutrality would be compensated by the financial savings due to increased energy efficiency and the production of renewables. By doing so, it can be assumed that potential savings are under-estimated with energy prices expected to increase in the short/mid- term. These potential savings will contribute to limit the potential increases of water tariffs and public budget intervention (see section 7.1).

Similarly, extrapolating the DK experience shows that the equivalent of **around 16.000 GW/h of biogas** (similar to the consumption of SE for instance) could be produced in the EU thanks trough sludge digestion. This biogas can be used as natural gas and substitute EU imports of gas which is one of the objectives of the REPower EU Plan.

Other advantages of such a target are summarised in *Table 10* below. The contribution of this target to the objectives of this IA (objective 3) but also to the implementation of key EU policies related to climate change, energy including EU independence are compensating the additional administrative burden mainly due to increased energy audits in the sector.

	Contribution to Objective 3 (EGD)	Contribution to RePower EU/energy independence	Contribution to ESR, REDII and EED targets	Administra tive burden
No action (baseline scenario)	+	+	+	0
Energy neutrality target	++++	++++	++++	--

Table 11: Comparison of the pros and cons of an energy neutrality target

The added value of the energy neutrality target is clearly demonstrated in *Table 10* and *Table 11*. Compared to the baseline, reaching energy neutrality by 2040 would lead to a reduction of GHG of 3.472.218 tons of CO2eq – representing a monetised benefit of € 347,22 million which compared to the baseline without an energy neutrality target represents a clear improvement. The costs to reach energy neutrality would be more than compensated by the expected financial savings due to energy savings and production of renewables. And the production of renewables in particular biogas would contribute to the independence of the EU in terms of energy production.

6.8 Governance – transparency

According to the OECD (see Annex 10, reports 5 and 6), additional costs can be expected at the beginning for operators not having in place a systematic monitoring of their key performance indicators. On the longer run, regularly monitoring of key performance indicators will provide a better understanding on potential operating improvements and savings. Making these key indicators publically available by digital means and on the water bills is expected to increase public willingness to pay but also collective awareness. A better empowerment of citizen might also lead to additional pressure on wastewater operators to improve their performances. The potential concrete effects are difficult to quantify, but as shown in Figure 9, the margins of progress might be significant.

In the absence of better estimates, it was assumed that the additional costs linked with the regular performance monitoring and with ensuring transparency would be more than compensated by the expected savings for wastewater operators. These new requirements will be fully aligned with the new requirements of the recently adopted Drinking Water

Directive in terms of transparency and follow-up of key indicators. This coherence is needed as water bills cover, in most MS, both water supply and sanitation.

The implementation of a possible EPR scheme for micro-pollutants will have a direct effect on governance: wastewater operators will be requested to negotiate and implement service contracts with PRO with clear objectives and performance requirements.

6.9 Wastewater and health

Ensuring a permanent dialogue between public health authorities and competent authorities for wastewater will bring multiple benefits in terms of public health. New pathogens could detected at early stage as well as the spread of different diseases but also other public health relevant parameters.

The potential costs for the establishment of a wastewater surveillance of SARS-CoV-2 virus was calculated on a basis of regular sampling and analyse (twice a week) for around 70% of the population. For the EU 27, the total cost would amount to 20 million € per year (JRC 2020 – estimate made in the context of the Recommendation to the MS). In 2021, the Commission has provided a financial support of € 20 million to MS having applied for a support (26 MS) to accelerate or intensify wastewater monitoring. In all cases, these costs would be by far exceed by the benefits for the society linked with an improved prevention and management of the pandemic.

The same reasoning would apply for other health related parameters including AMR surveillance. For the later, the cost of bi-annual sampling and analyse of AMR in larger water treatment facilities above 100.000 p.e. representing around 46% of the EU population would amount to € 9,74 million per year (€ 5.000 par sample/analyse).

6.10 Access to sanitation

Similarly to the requirements of the revised Drinking Water Directive, MS would be required to first identify marginalised and vulnerable people not having access to sanitation and then take measures to ensure/improve access to sanitation. MS would also be encouraged to ensure/improve access to public toilets in cities for all. The identification of the marginalised and vulnerable people lacking access to sanitation would be very similar to the requirements already in place under the revised Drinking Water Directive. Therefore, no additional major costs are expected.

The costs of the actual measures to improve access to sanitation would have to be defined at local level depending on local conditions. No EU target would be fixed, but just an obligation to take measures based on a proper identification of the concerned people. MS would also be ‘encouraged’ to improve access to public toilets in their cities including for vulnerable and marginalised people, but again without any specific EU target.

In order to enforce the new requirements on access to sanitation, MS would be required to regularly report (every 5 years as in the DWD for access to water) on the actions taken to improve access to sanitation. No estimate of actual benefits could be calculated, however it is likely that the benefits in terms of both public health and welfare would be higher than the costs.

6.11 Reporting

Compared to the baseline, and taking into account all preferred options, the yearly costs and savings related to reporting obligation are summarised in *Table 11* and detailed in the report in Annex 10, report 1.

Whilst the overall process of data gathering will be simplified, the revised UWWTD will require that MS collect more data. This would allow assessing compliance for the new requirements regarding SWOs and urban runoff, energy, GHG emissions.

At EU Commission and EEA levels, no major changes are expected: the savings linked with the abandonment of the two years reporting would be compensated by the efforts to regularly verify the national databases and the additional efforts to ensure compliance for the smaller facilities (between 1.000 and 2.000 p.e.).

Commission and EEA	Member States	Operators	Municipalities	EPR
Costs of € 10 million – once	Minor savings expected from reduced reports under Article 17	E-PRTR/UWWTD: limited savings Reporting small agglo: € M 0,471 GHG/Micro-pollutants monitoring: € 109,7 million	SWO/Urban runoff: € 57,7 million	Cost for PRO of € 11,2 million and for the concerned sectors € 5 million

Table 12: Reporting costs and potential savings by 2040

Adapting the existing reporting system using a common format would nevertheless imply a one-off IT cost – estimated at € 10 million for the EU. The EEA is already working on improving its reporting system following this approach. This is also the line taken in the revised Drinking Water Directive – which will increase the synergies and coherence between the reporting obligations, ultimately providing more accurate data for the overall Environmental Monitoring Framework as set up under the 8th Environmental Action Programme, and more specifically feeding the bi-yearly Zero Pollution Monitoring Report.

At **MS level**, the potential savings due to the simplification of the system (national databases directly accessible to operators combined with the abandonment of the 2 year reporting obligations) would be compensated by the additional reporting obligations on micro-pollutants, energy neutrality. 13 MS having less than 5% distance to target would not be obliged to report under Article 17 – representing another limited saving of € 32.032 per year; additional savings can be expected by better aligning Article 17 to the enabling condition under the Multiannual Financial Framework 2021 – 2027.

At Municipal level, additional costs will arise from the obligation to establish integrated plans on SWO/urban runoff (€37,03 million) plus costs of monitoring (€ 20,57 million). Part of these costs could be shared with operators. As explained in section 6.1, adequate planning and monitoring could save major investments.

At **Operators level**, additional administrative costs are expected for small agglomerations not currently covered by the Directive (€ 0,471 million). Reporting work for operators above 2.000 p.e. will broadly remain similar to the current work – gains in terms of digitalisation would compensate the additional efforts required to report more data notably on GHG, energy, micro-pollutants and other parameters. Enhanced coherence between reporting obligations under the E-PRTR and the UWWTD may result in limited savings in administrative burden. Monitoring costs are expected to increase for operators: € 11 million will be necessary to monitor micro-pollutants, € 98,7 million for energy and GHG. Assuming that (1) the monitoring costs for micro-pollutants would be covered by the EPR scheme; (2) 40% of the operators are either mixed or private companies (the others being 100% public), the addition administrative costs for the mixed/private sector would amount to € 39,29 million per year. These additional costs will be in any case passed on the competent public authorities having contracts with these operators and be compensated by the gains expected from the application of the energy neutrality target (see section 6.7).

Additional administrative costs of € 16.6 million per year are associated with the new EPR scheme (see section 6.5) mainly for the PRO (€ 11.2 million) and to a lesser extent for the sectors (€ 5 million – declaration of what is set on the EU market).

	Costs € million/year	Benefits € million/year	Benefits/Costs	Effectiveness - water pollution	Coherence with the Green Deal	Enforceability	Admin. burden - number of facilties/agglo	Admin. burden - Costs € million/year
Strom Water Overflow/Urban run off								
1. All agglomerations at risk > 100.000 p.e.	219	451,3	2,06	+	+	+++	914	43,1
2. All agglomerations at risk > 10.000p.e.	*372,5*	*785,6*	*2,11*	++	+++	++	*2.966*	*57,6*
3. All agglomerations > 10.000 p.e.	1.241	2.618,6	2,11	+++	+++	+++	7.754	77,2
Small Scale Agglomerations								
1. All agglomerations > 1.000 pe	*140*	*224*	*1,60*	++	+	+++	*19.138*	*0,472*
2. All agglomerations above 500 pe	284	416	1,46	+++	+	+	49.492	0,748
Nitrogen and Phosphorus Removal				N avoided (tons/year)				
1. Low ambition - N/P removal only for all facilities above 100.000 pe	801	1.447	1,81	54.817	+	+++	917	-
2. Medium – as above + N efficiency to 85% and P to 90%	1.420	3.965	2,79	168. 228	+++	+++	917	-
3. N/P removal for all facilities > 10.000 pe	1.395	2.274	1,63	84.603	++	+++	7527	-
4. N/P removal for all facilities above 100.000 pe + facilities between 10 and 100.000 in sensitive areas + N/P increased efficiency	*2.009*	*5.286*	*2,63*	*215.133*	++++	+++	*4.222*	-
5. High ambition - All facilities 10 kp.e. + N efficiency to 85% and P efficiency to 90%	2.598	6.689	2,57	282.524	+++++	+++	7527	-
Micro Pollutants		(Total Toxic load avoided p.e.)		(Toxic load avoided - areas at risk p.e.)				
1. Low ambition - all plants > 100 k pe	841	59.236		32.875	+	+++	917	-
2. All plants >100 k pe, + plants 'a risks' between 10 k and 100 k	*1.186*	*68.198*		*41.836*	+++	++	*5.544*	-
3. High ambition - all plants > 10k pe with dilution < 100	2.652	103.431		41.836	+++++	++++	7.527	-

Table 13: Summary of the selection criteria applied for each option – *the preferred Options are in green – all costs and benefits are estimated by 2040*

7. PREFERRED OPTION

7.1 Preferred Option – summary

The main actions included in the preferred option are summarised in *Table 14* below, which includes indicative deadlines. On top of the actions included in the Table, by 2025 additional monitoring activities would be in place: this concerns non-domestic releases (section 6.6), COVID-19 and AMR (section 6.9), key performance operator indicators together with actions to improve transparency (section 6.8). National and EU databases should be in place (section 6.11) and 'vulnerable and marginalised people' should be identified together with actions to improve access to sanitation (section 6.10).

	2025	2030	2035	2040
SWOs and Urban Runoff	Monitoring in place	Integrated Plans for agglo. > 100.k p.e. + areas at risk identified	Integrated Plans in place for agglomerations at risk between 10 and 100k p.e.	Indicative EU target in force for all agglomerations > 10.000 p.e.
Individual Appropriate Systems	Regular inspection in all MS + Reporting for MS with high IAS	EU standards for IAS		
Small scale Agglomerations	New thresholds of 1.000 p.e.	All agglo.> 1.000 p.e. compliant		
Nitrogen and Phosphorus	Identification of areas at risk (agglomerations 10 to 100k p.e.)	Interim target for N/P removal facilities > 100.000 p.e. + New standards for N/P	N/P removal in all facilities above 100k p.e. + Interim target for areas at risk	N/P removal in place in all areas at risk (between 10 and 100k p.e.)
Micro-pollutants	Setting up Extended Producer Responsibility Schemes	Areas at risk identified (facilities 10 to 100k p.e.) + Interim target for facilities above 100.k p.e. (50% of the facilities equipped)	All facilities > 100k p.e. equipped + interim targets for areas 'at risk'(50% of the concerned facilities between 10 and 100 k p.e. equipped)	All facilities at risk equipped with advanced treatment
Energy	Energy audits for facilities above 100k p.e.	Audits for all facilities above 10k p.e. (50% of the energy neutrality target met)	Interim target for energy neutrality (75% of the energy neutrality target met)	Energy neutrality met and related GHG reduction met

Table 14: Summary of the key actions included in the preferred option

By 2040, the impacts of the preferred options are summarised in *Figure 16* and in *Table 15* below. Compared to the baseline, the total pollution would be reduced by 4,8 million p.e. (or 105.014 tons) for BOD, 56,4 million p.e. for N (or 229.999 tons), 49,6 million p.e. (or 29.678 tons) for P, 77,4 million p.e. for toxic load of micro-pollutants and 24,8 million p.e. for *E. coli*. These reductions represent 27% of what is 'technically feasible' for BOD, 62% for N, 61% for P, 63% for the toxic load of micro-pollutants and 50% for

E. coli. Micro-plastics emissions would be reduced by 9% mainly through actions on SWO and urban run-off.

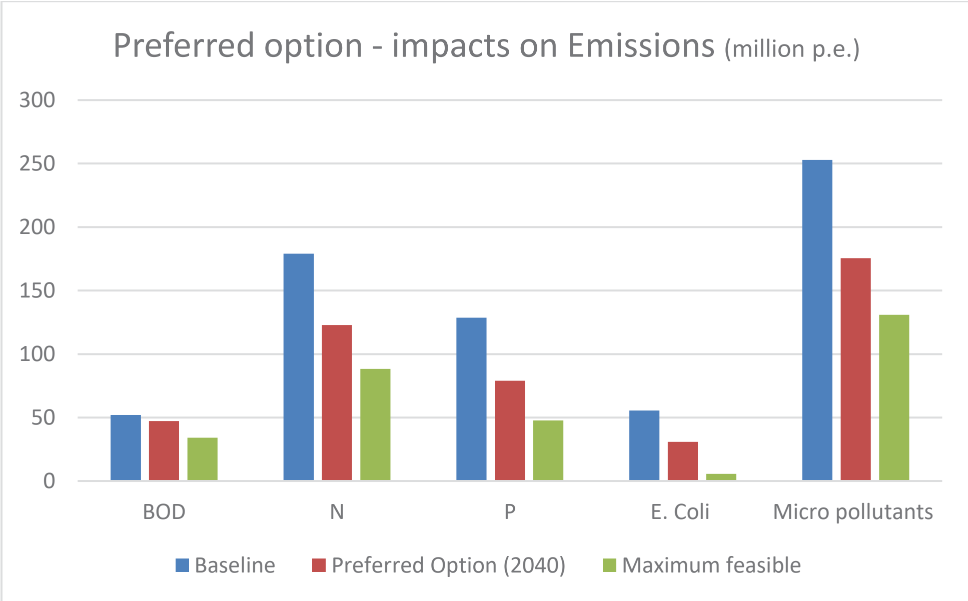


***Figure 15: Preferred option – impacts on emissions (p.e. per year in 2040) –** a breakdown per MS is provided in Annex 7, Table A7.7*

	BOD	N	P	*E. coli*	Micro-pollutants	GHG reduction
Storm water and urban runoff	1.346.247	1.455.249	1.427.839	2.160.989	6.558.744	
Small agglomerations	3.448.911	2.187.882	2.277.889	3.616.469	2.609.814	
Nutrients management	-	52.719.582	45.873.500	18.979.050	-	1.391.488
Micro-pollutants treatment	-	-	-	-	68.197.761	
Energy and GHG						3.472.218
Total reduction p.e.	4.795.158	56.362.713	49.579.228	24.756.508	77.364.162	
Total reduction tons/year)	105.014	229.999	29.678			4.863.706
Reduction as a % of maximum feasible	27%	62%	61%	50%	63%	

Table 15: Emission reduction by 2040 – preferred option

With the planed measures to reach energy neutrality, GHG emission would be reduced by 3,472 million tons by 2040 compared to the baseline, or 33,71% of the avoidable GHG emissions. Together with the baseline (assuming GHG emission reduction due to the application of the EED and ESR) and compared to 1990, this would represent a reduction of 62.51% of the GHG emissions - which is compatible with the EU Climate Law and the 'Fit for 55' climate package.[40]

The annual costs and the annual monetised benefits of the measures included in preferred options are presented in *Table 3* below. Investments costs are displayed in *Table 6*. The annual costs include operational and investment costs taking into account a lifetime of the investments of 30 years to which a discount rate of 2.5% was applied (see Annex 4 for more details).[41] As from 2040, the total cost would amount to € 3,793 bn per year (less than 2,76% of the costs of the maximum feasible scenario - € 13,870 bn). Overall, **the total costs at EU level (€ 3,848 bn/year in 2040)** are **below** the expected monetised **benefits (€ 6,643 bn per year by 2040 –** of which 6.157 bn are related to improvements to water quality and 0,486 bn to GHG emission reduction due to better N management and energy neutrality).

	Costs (€/year)	Administrative costs (€/year)	Total costs (€/year)	Monetised benefits (€/year)	Proportionality (Benefits/Costs)
Storm water and urban runoff	372.472.648	57.600.000	430.072.648	785.687.648	2.11
Small agglomerations	140.406.278	472.000	140.878.278	224.242.435	1,6
Nutrients management	2.008.825.659	0	2.008.825.659	5.285.693.790	2,63
Micro-pollutants treatment	1.185.512.586	27.600.000	1.213.112.586	0	Reduction of the toxic load of 68.198 p.e.
Energy and GHG		Note[42]		347.221.754	Energy neutrality
Others (AMR/Covid surveillance, non domestic waters)		55.700.000			
Total	3.707.217.171	141.372.000	3.848.589.171	6.642.845.627	1,726

Table 16: Summary of 2040 costs and benefits of the preferred option and summary of the investments needs between entry in force and 2040

Proportionality

The preferred option will allow emission reductions contributing to the achievement of the main objective of this review (Objective 1 in section 4) in a cost-effective way. As shown in ***Table 3***, the benefits are higher than the costs for each individual measure of the preferred option. For energy neutrality as the financial costs are expected to be more than compensated by the financial savings (see section 6.7), only monetised benefits due

[40] According to the EEA, GHG emissions from the sector amounted to 49,2 million tons of CO_2eq in 1990 of which 18,6 can be considered as 'avoidable'.

[41] In the context of this IA, a net present value analysis was not applied as the investments and most of the related benefits will occur progressively and in a linear way between the entry in force and 2040 (no major time gaps between investment time and appearance of the benefits).

[42] As detailed in section 6.7, administrative costs related to energy audits (6 million/year) and monitoring/reporting energy and GHG emissions (98,7 million/year) as well as investments costs needed to reach energy neutrality are expected to be compensated by the financial savings due to improved energy efficiency and increased production of renewables.

to GHG emission reduction are taken into account leading to a positive benefit/cost ratio. For micro-pollutants, in absence of monetisation of the benefits (see section 6.5), the preferred option is the most cost effective, leading to the highest reduction of the toxic load in particular in sensitive areas compared to the costs of the action. In summary, the preferred option includes a **proportionate package of measures** representing the **best 'value for money'** of all possible options: as displayed in Table 10 and in section 6, careful attention was given to find an **optimal solution** based on:

- **the costs and the benefits** analysis (or the cost effectiveness analysis in the case of micro-pollutants in absence of monetised benefits): **the benefits are higher than the costs** for all measures and all MS;

- **administrative burden/enforceability -** by targeting only a limited number of facilities/agglomerations, significant results can be obtained on key parameters such as pollution reduction, energy use and GHG emissions while keeping administrative burden at a reasonable level and ensuring a high level of enforceability;

- the introduction of a **risk-based approach** will help ensuring that investments are taking place where they are needed – this is the case for N/P and micro-pollutant reduction, but also for SWOs/urban run-off.

When necessary to reach local optimal solutions**, flexibility** was left at national or local levels. This is the case for instance to achieve the objective of energy neutrality or to reduce emissions from SWOs.

If the costs are relatively well known and quantified, this is less the case for some benefits: reliable monetised values are only available for a limited set of parameters such as direct savings from energy use, GHG emissions, BOD, N and P emission to water but also recent estimates of the benefits from improved management of SWO and urban run-off (see section 6.1). Some benefits can be quantified but not monetised: this is the case for instance for micro-pollutants and micro-plastics (no available shadow prices) but also reduction of *E.coli* in waters (leading to more possibilities of bathing areas for instance). Other significant benefits were impossible to quantify due to the lack of proper methodologies: this is the case for access to sanitation and health related parameters (COVID-19 and its variants and AMR surveillance) but also the benefits linked treatment cost reduction for drinking waters producers due to improved quality of surface water.

Costs coverage

The total costs by 2040 would represent an increase of 3,85% of the current total expenditures for water supply and sanitation (around 100 bn € - OECD (2020) – Annex 10, report 5). These additional expenses would be partly covered by the new EPR system – € 1,213 billion/year. The remaining part – 2,64 billion/year - would be covered by a mix of water tariffs and public budgets, depending on the financing strategies applied by each MS. On the basis of the current financing strategies of the MS (see *Figure 10)*, it can be assumed that on average 30% (or € 0,791 billion/year) of the additional costs would be covered by public budgets. 70% (or € 1,848 billion/year) would then be covered by water tariffs. This would represent an average modest increase (2,3%) compared to the overall water billing on the EU (80 billion for water supply and sanitation in 2018 – source OECD, Annex 5, report 6), even if local/national difference might be excepted. EU funds (around 2 bn/year for the water sector) would remain indispensable to cover adjustment costs needed to cover the new requirements including energy neutrality.

Impacts at MS level

The total 2040 cost and benefits for each MS is displayed in Annex 7, Table A7.8 and 9. *Figure 2* shows that – even without taking account of the non-monetised benefits from micro-pollutants reduction - **the benefits largely outweigh the costs in all MS**.

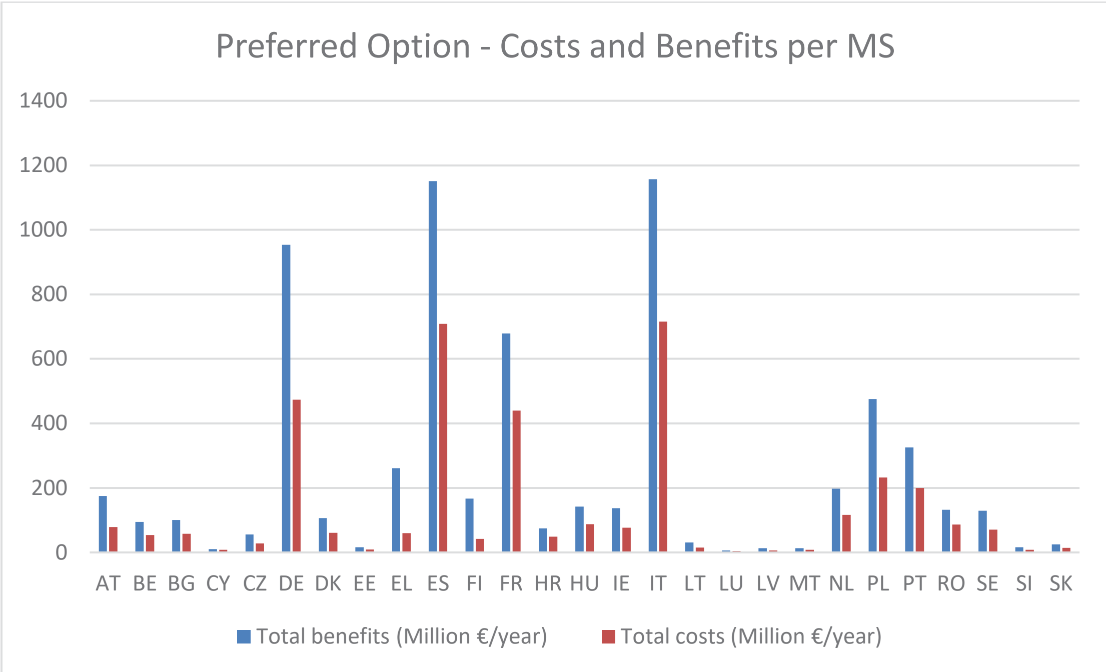


Figure 16: Costs and benefits of the preferred option

As displayed in *Figure 16*, some MS (e.g. DK, IT, MT, CY and PT) would have to make comparatively more efforts per inhabitant (more than 7 €/year/inhabitant by 2040). This is due to a combination of objective factors including the lack of past investments in more advanced water treatment for Nitrogen and Phosphorus, but also geographical circumstances (low dilution rates across freshwater streams increasing the areas 'at risk'). Although the costs for these MS are expected to be slightly higher, the benefits are nonetheless expected to remain higher than costs in all cases.

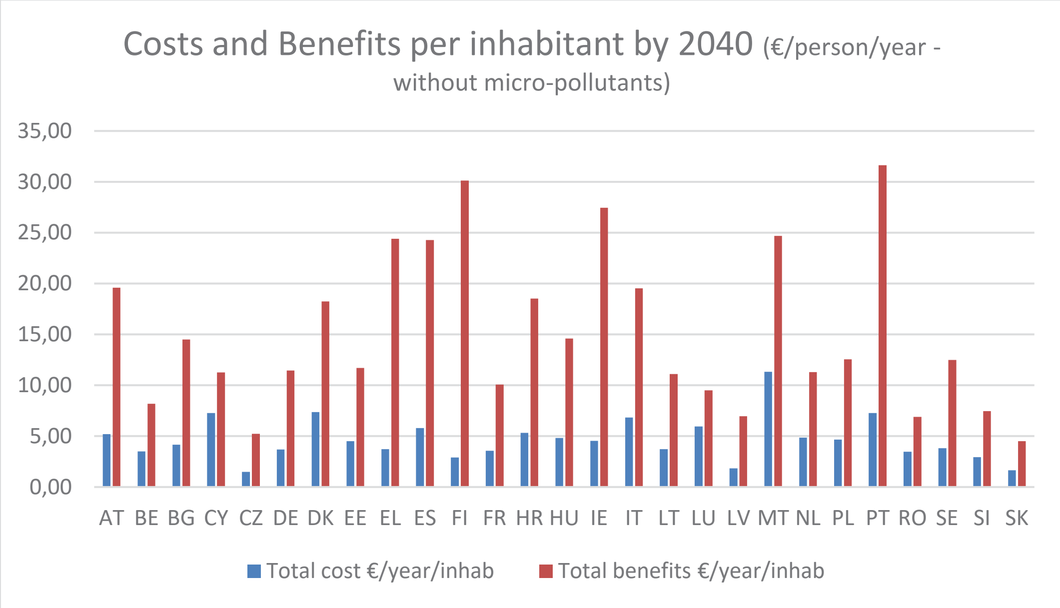


Figure 17: 2040 Annual costs and benefits per inhabitants per Member State *(excluding costs for micro-pollutant treatment to be covered by the proposed EPR scheme*)

Figure 18 displays the 2040 costs of advanced treatment per MS in relation to the reduction of the toxic load from wastewater treatment plants. Differences between MS in terms of additional investment needed can be explained by the presence of more areas considered 'at risk' for micro-pollutants (with lower dilution rates).

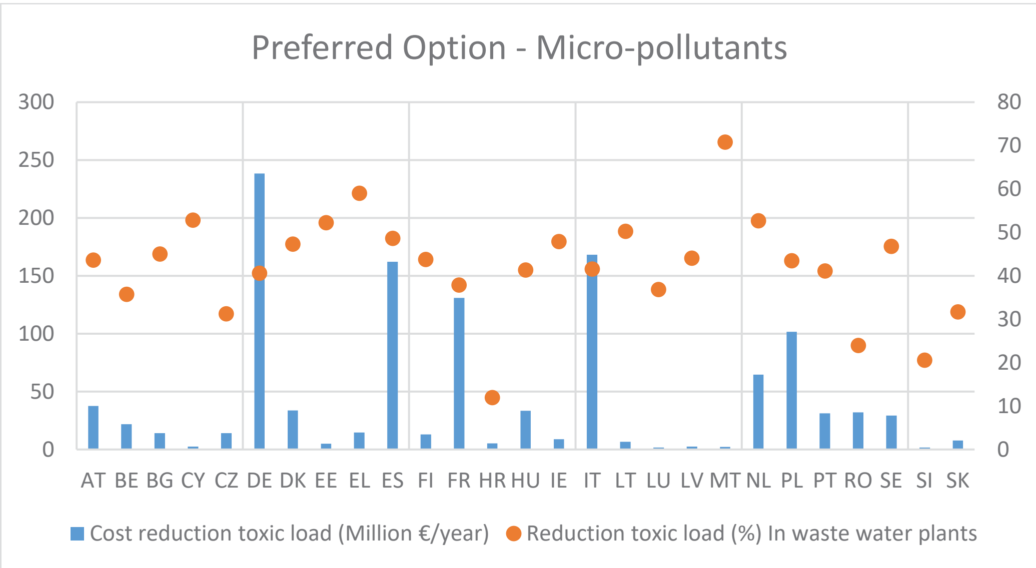


Figure 18: 2040 costs of advanced treatment vs toxic load reduction (micro-pollutants in waste treatment plants)

Social impacts - Affordability

According to OECD, today the general affordability of water services is not at risk in any country, though in some countries, such as RO and BG, the burden borne by lower income households is slightly higher than in other MS, being above 5% of the disposable household income – see ***Figure 19***.

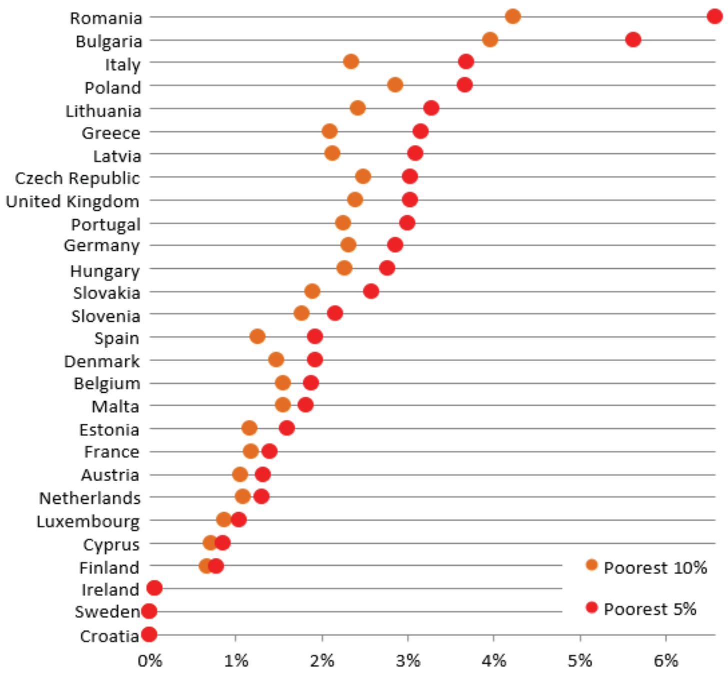


Figure 19: Share of water supply and sanitation expenditures in households' disposable income (2011-2015 average) *Source: OECD based on Eurostat*[43]

Social measures to accompany lower income households are in place in several MS – but not systematically in the whole EU. Nevertheless, particular attention should be paid to some MS (DK, IT, MT, CY and PT) in which annual costs per inhabitants are expected to be higher see *Figure 18.* Affordability is not expected to become an issue in any of these MS: the average expected increase of water tariffs by 2040 due to the preferred option would amount to 1,6 €/year/inhabitant (CY) to 7,26 €/year/inhabitant for DK. As shown in *Table 17* below and based on OECD data as displayed in *Figure 19*, compared to the lowest 5% income in each country, this would represent a small increase of the budget devoted to water supply and sanitation (between 0,02% for CY and 0.19% for PT). Therefore, the share of expenditures due to water supply and sanitation for households with poorest revenues, **would remain below 5%** - which is the ceiling considered as acceptable by OECD.

Practical measures to ensure affordability is mainly a competence of the MS but the Commission can organise further exchange of best practices notably on social measures in the water sector in continuation of the seminars co-organised with the OECD and the MS (see report 5 in Annex 10).

[43] Note: Lack of household expenditure data for Croatia and Sweden.

	Total additional cost €/year/inhab	Water tariff coverage %	To be covered by water tariff	5% lowest income (€/year)	Tariff increase as % of the 5% lowest income	Cost to lowest 5% income	New total
CY	7,29	21,80%	1,59	6860	0,02%	0,86%	0,88%
DK	7,36	98,60%	7,26	11998	0,06%	1,92%	1,98%
IT	6,84	82,40%	5,64	4421	0,13%	3,68%	3,81%
MT	11,34	55,60%	6,3	5461	0,12%	1,81%	1,93%
PT	7,29	75,00%	5,46	2819	0,19%	3,00%	3,20%

Table 17: analyse of affordability in MS with highest cost per inhabitant *(source: OECD reference5 in Annex 10 and Figure 25 of the REFIT Evaluation*

Implementation

As it was the case with the existing Directive (refer to the REFIT Evaluation), there will be risks of slow or bad implementation of the revised Directive in some MS. These risks would nevertheless be mitigated with the following measures:

- Contrary to the initial Directive, **enough time** (2040) would be given to meet the targets of the revised Directive. This time horizon will provide **legal certainty** so that investments can take place on the basis of **proper long term planning;**

- **Interim targets** will be included in the legislative proposal for the most important measures. These interim targets are summarised in *Table 1* and will be applied for all MS. They will help MS to plan their investments sufficiently in advance and avoid a situation were most of the actions are taken few years before 2040; the interim target for energy neutrality and for tertiary treatment will take into account the starting position of each MS;

- The expected **effects on public budgets and water tariffs** (and therefore affordability of the water tariffs) are **modest** while **EU funds** would remain **available** (average of 2 bn/year based on past experience);

- The Commission intends to continue its **mixed approach** (enforcement combined with EU funds) which has shown its effectiveness in the past;

- Several aspects of the Directive will be clarified with the revised Directive ('sensitive areas', measures on SWO/urban run-off, better control of IAS) while the simplicity of the text would be kept (**clear and simple requirements with clear deadlines**).

In addition, and like it was the case for MS having joined the EU after 2004, those Member States still having difficulties to reach full compliance today will have the opportunity to invest directly in most advanced techniques.

Coherence and added value of the initiative

Implementing the preferred option would contribute either directly or indirectly to the attainment of the objectives of several EU strategies and legislations – see Annex 8 for more details. This is the case for the **Zero Pollution** ambition (reduction of pollutant releases in the waters), the 2050 **EU Climate neutrality objective** and the related **EU Climate law (**reduction of GHG emissions due to energy neutrality**)**, the **Circular Economy** (better use of resources/sludge, better conditions for water reuse), the **Biodiversity Strategy** (green infrastructures) and the **Pharmaceutical and the Chemical strategy** (less releases of pharmaceuticals in the environment, financial incentive for substitution of harmful substances). Reducing nutrient emission will directly contribute to the **preservation of the Biodiversity**. In addition, direct synergies can be excepted withy the **Biodiversity strategy** and the application of nature restoration targets in urban areas (nature based solution for better water management in urban areas).

As it was already the case with the existing Directive (see the Evaluation), the revised Directive would directly contribute to achieving the objectives of the **Water Framework Directive** – namely reaching the good ecological and chemical status of water bodies by 2027. It would also contribute to the planned revision of the **EQS Directive**: the additional treatment of micro-pollutants would allow the attainment of more stringent EQS in the environment. This also the case for the ongoing review of the **Bathing Water Directive**: reinforcing the standards of the UWWTD particularly for SWO and urban runoff would contribute to the improvement of the quality of the bathing water. Better controlling pollution at source would help to ensure a safe use of sludge in agriculture and thus support the ongoing review of the **Sewage Sludge Directive** and the **Soil Strategy and the proposal for the Soil Health Law.** It will also provide an incentive for **more and better re-use** of treated water contributing to improve **water resilience**. Synergies will be fully exploited with the ongoing review of the **E-PRTR Directive** notably for what relates to reporting for the larger facilities. Coherence between the revised IED and UWWTD will be improved to avoid non desirable industrial releases in public networks.

The energy neutrality target would act in synergy and complement with the revised RED and recast EED by contributing to meet the targets of each of these directives in an optimal way for each wastewater treatment facility combining energy efficiency, use of renewable energy and production of biogas. By encouraging the self-production of EU based biogas, it would also contribute to reduce energy dependency, one of the objectives of the recently adopted Communication ‘Repower EU’. Last but not least, this sectoral target would help moving towards the EU objective of climate neutrality by 2050 and contribute to the implementation of the ‘Fit for 55’ and the ESR (expected GHG emission reduction of 3,472 million tons (33,71% of the avoidable GHG emissions) by 2040 compared to the baseline which assumes the application of the revised EED.

Regular monitoring of COVID-19 and its variants and other health related parameters will help to improve the preparedness of the EU for future possible outbreaks – as detailed in the related Communication and in the Commission recommendation on virus surveillance in wastewaters.

Uncertainties

The main uncertainties are summarised in *Table 18*. More details on model uncertainties are provided in Annex 4.

Uncertainty	Measure taken to identify/limit uncertainties	How it was taken into account in policy development?
Baseline – lack of understanding of MS existing actions on rain water, small agglo., IAS	In depth consultation of the MS on their starting positions – Annex 5.	No major influence. Costs and benefits per MS might be slightly different but are linked (if costs for a MS increase or decrease, benefits will also increase or decrease).
Baseline – lack of information on how MS will apply the EED, RED and ESR	Prudent assumption taken in the baseline based on the best existing available information (strict application of the energy use reduction target from the EED proposal for the public sector across all MS)	Applying the proposed energy neutrality target will generate more savings, benefits and GHG reduction in MS not having initially the intention to act in the wastewater sector to reach their targets under the RED, EED and ESR. The reverse impacts are expected in MS having already targeted this sector. Overall at EU level it would not change the analysis neither the conclusions on the added value of the energy neutrality target.
Unknown starting positions of the MS in terms of energy neutrality	Very conservative assumptions were taken on the cost and benefits of reaching energy neutrality	Interim targets were fixed by 2030 to allow MS with a less favourable starting position to align themselves with the others. MS starting with a less favourable position are expected to gain more benefits from the energy neutrality target.
Different starting situations for SWO and urban runoff.	Development of an EU scale model calibrated on known situations.	Flexibility left to MS and their local authorities to design optimal solutions at local level.
Lack of reliable to monetise micro-pollutants benefits.	The preferred option was identified on the basis of cost-effectiveness.	Options were decided on the basis of lowering the costs while maximising the toxic load reduction.
Lack of data on the actual toxicity of micro-pollutants, as well as their removal efficiency by standard techniques.	The best available data and scientific knowledge was used to make estimates – see Annex 10 reports 2, 13 and 14. More than 1.300 representative chemicals were assessed giving a fair representation of the toxic load and how it can be reduced.	Advanced treatment is required to reduce toxicity, independent of the specific chemicals. The comparison of policy options is robust with regard to the variation of chemical properties driving toxicity. The introduction of a possible EPR scheme will help to gather precise data. The scope of the EPR scheme can be adapted to improved knowledge on micro-pollutants.

Table 18: Main uncertainties and their potential consequences

The sector is relatively well known, reliable databases are in place on all treatment facilities above 2.000 p.e. including on their level of treatment. The estimation of conventional pollutant loads under the various scenarios, and the related costs are relatively well established and show relatively low variability across Europe. The main uncertainties are related to the estimation of toxic loads conveyed by wastewater and to the sources of pollution not addressed by the current Directive. There are also uncertainties related to the application of the ESR, the RED and the EED current and revised legislations.

7.2 REFIT and "One in, One out"

In line with the Evaluation, several elements of the existing Directive will be **clarified and simplified** in the legislative proposal on the basis of the elements discussed in this IA. This concerns notably the requirements for SWO and urban runoff and small scale agglomerations (clear thresholds and deadlines), the designation of 'sensitive' areas (list of basins placed in the Annex of the revised Directive), clearer obligations to ensure full compliance for IAS, and improved follow-up and transparency of operator' performances. For the new requirements, a lot of attention has been paid to establish simple, clear, enforceable and affordable deadlines and objectives – the Evaluation has demonstrated the importance of clarity and enforceability of this Directive.

Apart from the expected increase in water tariffs, no additional obligations are expected for **EU citizens.** This is also the case for **business (water industry** providing wastewater equipment's**)** which will mainly benefit from new business opportunities. The new requirements will represent a driver for **innovation and research** contributing to maintain and improve the **competitive position** of the EU water industry. The Pharmaceutical and PCPs sectors would nevertheless be required to organise and finance the new system of producer responsibility to cover the costs related to advanced additional treatment for micro-pollutants (1,185 bn € per year) and the related administrative costs (11,2 million per year – see section 6.5).

The revised Directive will introduce **new obligations mainly for wastewater operators. They cannot be considered as 'business'** as all operators have strong direct links with the public competent authorities – either they are public companies (60% of the operators) or private/mixed companies directly acting for public entities (concessions).

Measure of the preferred option	Storm water and urban run-off	Small agglomerations	Nutrients management	Micro-pollutants treatment	Total
Total investment up to 2040	6.446.657.281	1.141.228.243	12.129.508.400	8.891.344.396	28.608.738.319

Table 19: Total investments costs linked with the preferred option between entry in force and 2040. *To calculate annual costs, a lifetime of the investments of 30 years was applied with a discount rate of 2.5% (see Annex 4 for more details).*

Adjustment costs to cover the required investments needed to meet the new standards and to reach energy neutrality will be progressive in time (see *Table 14* and *Table 16*): total investment costs are estimated at € 28,6 billion between the entry in force of the revised Directive and 2040 – see *Table 19*. In absence of sufficient data on the baseline situation in each MS on energy neutrality, it was not possible to provide a reliable estimation of the investments needs for this measure.

To cover these investments, MS and local competent authorities are expected to continue using a blend of different sources of financing:

- Public budgets, including from the **EU** (e.g. around 2 billion € per year of EU funds are devoted to water infrastructures, particularly under EU regional policy);

- **Loans** from commercial or institutional banks (such as the European Investment Bank) – wastewater projects are **typically 'bankable'** as they are covered by stable revenues from water tariffs and/or energy savings;

- Private/public partnerships and/or concessions in which the private partner is financing the infrastructures.

- The investments needed for the additional treatment for micro-pollutants (9 billion € up to 2040 from the total 28,6 billion €) will be covered by the EPR scheme, and more precisely by the **Producer Responsibility Organisations** (PROs) managing them. As detailed in section 6.5, the PROs will have to establish a solid financing strategy to cover such costs based on the funds gathered thanks to the fees paid by its members.

- The recently adopted REPowerEU Plan will also boost existing funding possibilities to cover the investments needs to reach energy neutrality. This concerns the cohesion policy, large scale innovation calls, loans under Recovery and Resilience Facility. MS already have and will have several possibilities to cover the investments needed to meet energy neutrality target through these EU funds as they all aim at increasing the independence of the EU in terms of energy supply by encouraging energy savings and developing renewables – which is also one of the purpose of the energy neutrality target.

8. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

As shown in the Evaluation, proper monitoring and reporting is key to ensure the compliance of the Directive. It is therefore crucial to maintain and improve where possible the existing monitoring and reporting obligations so that it will be possible to assess to what extent the general and specific objectives are achieved.

The existing Directive has established a reporting system based on a 2-year report from the MS to the Commission via the EEA. Based on this information the Commission is publishing implementation reports every two years (often based on more than 4 years old data). The Commission is also using this information to launch infringement procedures.

As detailed in sections 5 and 6, this system will be modernised and simplified: national databases to be updated at least once a year will be hosted in each MS with permanent access for the EEA and the Commission. These databases will include actual monitoring results for the parameters covered by EU standards not only for the quality of the treated water but also for the new parameters to be followed such as energy use and GHG emissions. Monitoring frequencies will also be adapted to ensure an appropriate follow-up of the implementation of the Directive but also to simply align the frequencies to current best practices.

As it is the case today, regular compliance checking will be made by the Commission on the basis of the information reported by MS.

Different indicators to **measure success** can be extracted from MS reports and would be related to:

- The existing compliance rate and distance to target per MS and per treatment level - which provide an excellent overview on the implementation of the Directive;
- The number of facilities equipped with additional treatment for N/P and micro-pollutants; and the related reduction of N/P releases and toxic load at MS and EU levels;
- The energy use by MS and the related GHG emissions;
- The number of agglomerations covered by integrated management plans for stormwater overflows and urban run-off and their compliance with the EU objective;
- The measures taken by MS to improve access to sanitation and better control individual appropriate systems (IAS) and a summary of the main health indicators surveyed in the MS.

Like it was the case in the context of the evaluation of the Directive, other data notably on the water quality of the receiving waters (rivers, lakes and seas) coming from the Water and the Marine framework Directives will be used to concretely measure the impacts of the UWWTD.

More details on possible parameters to be reported for assessing compliance and measure the success of the Directive are provided in Annex 10.

A first **in depth evaluation of the revised Directive** can be foreseen by 2030 when most investments should have been made in larger facilities (see *Table 1*). This first evaluation would allow assessing the success and remaining challenges linked with the implementation of the revised Directive. If need be, corrective measures could be envisaged to ensure the full implementation of the revised directive. Another evaluation could be considered before 2040 to prepare a possible review of the directive.

ANNEX 1: PROCEDURAL INFORMATION

1. LEAD DG, DECIDE PLANNING/CWP REFERENCES

The preparation of this impact assessment was led by Unit C2 Clean Water Services and Marine Environment within DG Environment (ENV) with support from DG Joint Research D2 Water and Marine Resources. The file concerns the revision of the Urban Wastewater Treatment Directive. This Directive was evaluated according to Better Regulation guidelines in 2019. The Decide planning number is Plan/2020.7347 – Revision of the Urban Wastewater Treatment Directive.

2. ORGANISATION AND TIMING

The revision of the Urban Wastewater Treatment Directive (UWWTD) is a direct consequence from its REFIT evaluation. It was announced in a number of strategies published under the European Green Deal, such as the Circular Economy Action Plan (CEAP) and confirmed more recently in the Zero Pollution Action Plan. The Inception Impact Assessment Roadmap for the revision of the UWWTD was published on 21 July /2020 with a feedback period until 8 September 2020.

The inter-service steering group (ISSG) for the impact assessment is the same one as for the Evaluation. It is a shared group with other water and pollution related files: the revision of the pollutant lists under the EQSD and Groundwater Directive, the Evaluation of the Sewage Sludge Directive and the back to back Evaluation and impact assessment of the Bathing Water Directive. The ISSG includes members from the following DGs: AGRI (Agriculture), CLIMA (Climate Action), ENER (Energy), FISMA (Financial Stability, Financial Services and Capital Markets Union), GROW (Internal Market, Industry, Entrepreneurship and SMEs), HOME (Migration and Home Affairs), JRC (Joint Research Centre), JUST (Justice and Consumers), MARE (Maritime Affairs and Fisheries), RTD (Research and Innovation), REGIO (Regional and Urban Policy), SANTE (Health and Food Safety), SG (Secretariat General), SJ (Legal Service), TAXUD (Taxation and Customs Union) as well as the EEA (European Environment Agency).

Meetings were organised between June 2020 and January 2022, the final meeting being held on 31st January 2022. The ISSG has been consulted on all major deliverables for this file, including the inception impact assessment, the open public consultation questionnaire, key deliverables for the support study prior to the its submission to the Regulatory Scrutiny Board. The same ISSG has followed the while process having led to the adoption of the REFIT Evaluation of the Directive.

3. CONSULTATION OF THE RSB

The Regulatory Scrutiny Board (RSB) was consulted on the Evaluation of the Directive.

On 17 July 2019 the RSB meeting on the draft SWD Evaluation was held. The RSB gave a positive opinion on 19 July 2019 and suggested a few improvements which were taken on board before the finalisation and publication of the evaluation.

An informal upstream meeting with the RSB took place on 23 September 2020 on the IA. During the meeting ENV explained that the options will be built into packages that range from less ambitious to more ambitious. The costs and benefits of each package will be assessed as far as possible. They should all aim to meet all objectives of the initiative. RSB suggestions and answers provided in this IA are summarized in *Table 7*.

After final discussion with the ISSG, a draft IA was submitted to the RSB on 15th February 2022 and discussed at a meeting with the RSB on 16th March 2022. Following the opinion of the RSB from 18th March 2022, a revised IA was submitted to the Board on 2nd of May. A second 'positive opinion with reservations' was issued by the RSB on 3rd of June. Table A1.1 presents an overview of the RSB's comments and how these have been addressed.)

RSB Comment – second Opinion	How the comment has been addressed
(1) The report does not present a fully developed and dynamic baseline scenario. It is neither sufficiently clear how the measures expected from the Member States to meet their national 'Fit for 55 targets' nor how the recent actions under the Repower EU package have been incorporated and which overall energy saving gap would remain in absence of further sector specific action and targets.	Section 5.1 has been improved to better explain that all possible efforts have been made to build a dynamic baseline and why the only reliable mandatory quantitative target applicable for this sector is the legally binding target on energy efficiency for public entities (reduction of energy use of 1,7% per year for the public sector). This target was included in the calculations of the baseline scenario as displayed in the new Table 3 of section 5.1. It was also better explained that no quantified precise information is available on Member States intended efforts to reduce GHG emissions from the wastewater sector in order to reach the objectives of the Fit for 55 and the ESR regulation. The potential effects of the REPowerEU Plan (adopted after the submission of this report) are discussed in section 5.1 on the baseline scenario and in sections 7.1 and 7.2. The REPowerEU plan does not include specific objectives for the wastewater sector as such therefore only its qualitative effects on the baseline scenario are presented in section 5.1. Nevertheless, the preferred option will contribute to achieve the objectives of the package by reducing energy use and increasing the production of renewables including biogas. This is better explained in section 7.2.
(2) The report does not sufficiently demonstrate the need for and value-added of new sector specific energy neutrality targets over and above the already envisaged obligations for Member States.	The need and the added value of this specific target are better explained respectively in sections 5.2.7 and 6.7 - Tables 10 and 11. The contribution of this target to the attainment of different EU objectives is better discussed in section 7.1 while the flexibility on Member States choices are discussed in section 5.2.7. More details are provided on how the costs to reach energy neutrality were estimated and why the extrapolation made on the basis of the Danish concrete and successful experience is reliable and provide a robust base to justify the target in the context of this impact assessment. It is also better explained why the recent increase in energy prices makes the assumptions taken in this report (expected costs will be covered by the expected financial savings) even more realistic and probably too prudent. More details on stakeholder views are provided in the same section - recent information and contributions from industry were also included. More explanations in section 5.2.7 and 7.1 (Table 14 and section on implementation) are provided to

	justify how the interim target would be fixed while the Table 18 on uncertainties was completed to discuss the possible effects of different starting positions of MS as regards energy neutrality.
(3) The report does not sufficiently justify the proportionality of individual measures as well as of the preferred option considering the estimated investment needs. Expected overall investment needs seem to substantially outweigh monetised benefits. The report should explain whether it can be reasonably assumed that all Member States will cover these in a timely manner (including those less reliant on water tariffs). It should be explicit about whether there are any risks for the implementation of the measures and for benefits materialising. The report should better demonstrate the proportionality of the preferred option, preferably on the basis of a net present value analysis. When it comes to the proportionality assessment of the stormwater overflow options, the report should better justify why it did not choose, as preferred option, the one, which provides the highest net benefits overall, performs best in terms of effectiveness and enforceability and has the most favourable benefit-cost ratio. When assessing the proportionality of imposing energy neutrality targets, the report should better reflect the relative small contribution to the overall monetised benefits and the uncertainty that the targets will be the most costefficient measure among those available for the Member State The report should better explain the robustness and validity of the used evidence on the willingness to pay. It should justify why, in order to extrapolate to EU level, it assumes 10% of the value determined for the case study of Berlin in terms of public willingness to pay for ecosystem services associated with drainage. As willingness to pay depends on income, the report should explain why it did not consider a comparison of Germany's GDP and the EU average or other means of extrapolating.	Table 16 and section 7.1 were improved to show that for each of the proposed individual measure in the preferred option the annual benefits are systematically higher than the annual costs (except for micro-pollutants for which a cost/effectiveness approach was used). In that sense, all individual measures are justified in terms of proportionality. In section 7.1 (implementation), more details are provided on the measures taken to limit the risks of non-timely implementation of the preferred option by the MS. Those MS less reliant on water tariffs are also those having more margins to increase their water tariffs without affecting affordability. A footnote (41) was added to explain an NPV analysis is not relevant in this context and the justification for the preferred option on stormwater overflow (most cost effective) was clarified in section 6.1. The uncertainties related to the energy neutrality target were better identified in Table 18, section 7.1. More details are provided in section 6.1 on why the 10% assumption applied the willingness to pay from the Berlin case is reasonable in the context of this IA.
The report provides more information in an annex regarding the proposed extended producer responsibility scheme. It should be explicit about whether there are any choices for policy makers in this regard and if so, present them in the main report.	The main choices to be done by policy makers were explicitly summarised in section 6.5.
The report provides stakeholder views without any numbers (either percentages or 3 absolute numbers). This presentation may be misinterpreted as a representative survey which is not the case. The report should be more specific on the views of particular categories of stakeholders and Member States, including by explaining why certain academics, business or Member States authorities	More efforts were achieved in the report to better summarise and quantify where possible stakeholder views. It was not always possible to verify during the consultation some more precise assumptions or issues like the calculations made on the costs and the financial benefits of reaching energy neutrality. There was nevertheless a broad consensus on the need to act with a combination of measures

were less supportive on some issues.	including better monitoring, audits, energy efficiency with less overall support for EU based targets.
RSB Comment – first Opinion	**How the comment has been addressed**
(1) The report should be clearer about how the initiative fits in the context of existing legislation and initiatives. It should explain the coverage of each of these and identify the remaining gaps that the revised Directive would be expected to address.	Sections 1 (introduction) and 7.1 (preferred options) were improved and completed by a summary Table in a new Annex 8 displaying the main interactions with other legislations. In addition in each ad hoc section the gaps of the existing legislation are discussed as well as the potential added value of the initiative.
(2) The report should explain clearly the evidence base for considering sector-specific Energy Neutrality Targets and further measures related to Green House Gas emissions. It should be specific on the scale of the identified Green House Gas emission reduction and energy savings gaps under the dynamic baseline, fully reflecting the impacts expected from the requirements of the Effort Sharing Regulation, the Energy Efficiency Directive and other relevant 'Fit for 55' initiatives. It should explain how the new targets and measures are expected to interact with the 'Fit for 55' initiatives, how double regulation will be avoided and flexibility for Member States on the choice of the best measures in reaching their overall reduction targets will be ensured. It should better justify the 2040 time horizon used for the baseline, given the need to ensure coherence with the 2050 climate neutrality objectives and the envisaged measures in the adopted 'Fit for 55' package.	On GHG emissions, sections 5, 6 and 7.1 have been clarified to better explain the interactions with the exiting initiatives (Climate Law and by the Effort Sharing Regulation). It was clarified that the revision of the UWWTD does not have the ambition to set any additional legally binding target for GHG reduction. The justification of a sector based energy neutrality target is further detailed in the IA in sections 1 (introduction), 2.1.2.2 (problem definition), 5.1 (baseline), 5.2.7 (options), 7.1 (preferred option) and further detailed in a new annex 8. This includes an analysis of the added value of a sectorial target compared with the baseline including the application of the EED and ESR (additional reduction of energy use and related reduction of GHG emission from the sector but also development of local optimal solutions combining energy efficiency, renewables and bio-gas production). The contribution of this target to the EED and ESR is better explained as well as its added value in the context of the recently adopted 'Repower EU' Communication in section 6.7. The justification for the 2040 horizon (the main objective and main investments of this initiative are related to water quality improvement) is better explained in the introduction of section 6.
(3) When it comes to micro-pollutants, the report should further elaborate on the Extended Producer Responsibility scheme it considers. It should set out the main elements and present the key policy choices to be made by policy makers (e.g. scope, progressive expansion) and assess the costs and benefits of available alternatives.	More detailed explanations on the envisaged EPR system (scope, policy choices, possible alternatives, costs and benefits) were included in sections 5.2.5 and 6.5 although more details on the functioning of the EPR scheme were provided in a new Annex 9. The possible impacts of an alternative based on a 'classical' financing system is discussed in section 6.5.
(4) The report needs to strengthen its narrative significantly and the argumentation in support of the proportionality of the preferred set of measures, in particular on SWOs and urban runoff. It should make an effort to further quantify the expected, most significant, benefits. Where this is not possible, the report should explain why and provide qualitative analysis to support the conclusion that the benefits overweigh the costs. It should provide more convincing arguments to show how the intervention is expected to bring	New evidence based on recently published articles were included in section 6.1 showing (1) how costs could be reduced with good integrated management plans and digitalisation and (2) new estimates of the potential benefits based on 'willingness to pay' beyond water quality of improved storm-water overflows management. In addition, more flexibility was introduced (EU objective would become indicative leaving more flexibility at local level while focusing actions only in areas 'at risk') so that optimal solutions would be decided at local level

about the non-monetised benefits and the extent to which this will happen. It should show the order of magnitude (e.g. case studies, expert estimates, literature) of the benefits expected to materialise. It should present a more balanced analysis of benefits and costs, fully reflecting the recurring and the (quite high) one-off investment costs. For 'one in one out' approach, it should only include the costs to businesses and citizens.	based on decentralised analysis of the costs and the benefits. This has reduced the investment needs while increasing the benefits leading to an improvement of the proportionality of the measure. In consequence, the proportionality of the whole package has improved and is better demonstrated in section 7.1 (preferred option). The benefit/cost ratio is largely positive for all MS. Section 7.2 (One in, One out) was adapted to only focus on costs for citizens and businesses.
(5) The report should show more transparently where the impact is expected to be different across Member States. It should explain how the financing of the investment costs will be ensured. In this context, it should be more explicit about the expected use of EU funding to support the measures envisaged. It should also be more explicit about possible affordability issues for low-income households and whether this poses any risk for implementation.	Additional information on the impacts on MS were extracted from annex 7 and included in section 7.1. More details are provided in section 7.2 on the financing of investment costs based on OECD analyse. Additional detailed analysis on affordability was included in section 7.1.
(6) The analysis should report more systematically on the different views expressed by the consulted stakeholders.	More details on stakeholder point of views were extracted from the consultation process and from the Evaluation to the main text.
(7) The report should specify when the initiative will be evaluated, and how success will be measured.	Section 8 and Annex 10 were completed to better explain when evaluations would be undertaken and what success indicators will be used.
Some more technical comments have been sent directly to the author DG.	All suggestions were taken on board.

Table A.1.1: RSB comments and how comments have been addressed

4. EVIDENCE, SOURCES AND QUALITY

Besides the stakeholder consultation, the following main sources of information were used to build this impact assessment:

1. **Models developed by the JRC**: The JRC has developed for several years' models on water quality and quantity in the EU. These models were adapted to the policy questions related to the impact assessment and to the review of the Directive. They were also used in the context of the REFIT Evaluation of the Directive.

2. **Consultation of ad hoc experts**: under the co-lead of JRC and DG ENV, a small consortium of experts were consulted on specific policy questions. For each issue, a report was prepared and used directly in the IA or to improve the JRC model. All reports are annexed to this IA (see Annex 7). In particular, the JRC cooperated with experts to assess which micro-pollutants are the most typical to be found in wastewater and what treatment technologies exist to deal with these micro-pollutants. In addition, individual experts provided input through the drafting of short analytical peer-reviewed studies, financed under an administrative agreement with the JRC on the following topics: individual and other appropriate systems, antimicrobial resistance, combined sewer overflows and urban runoff, nutrients, micro-plastics, and greenhouse gas emissions from the wastewater sector.

3. Support from the **Organisation for Economic Cooperation and Development** (OECD): DG ENV cooperated with the OECD to develop a benefit methodology for the UWWTD IA. This was done, among others, to address methodological shortcomings uncovered in the Evaluation of the UWWTD. Furthermore, the OECD re-assessed the

investment gap to reach full compliance with the current UWWTD. OECD also provided analysis of the issues related to transparency and governance.

4. **In depth consultation of the Member States**: in order to establish a solid baseline scenario but also to gather evidence on the best practices in place in the Member States, a specific consultation of each Member State was organised in 2020. For each country a fiche was pre filled with the hypothesis JRC intended to use in the context of the modelling. Each fiche was about 50 pages long and contained tentative assumptions on how far advance the Member State is in implementing policy measures that go beyond the current Directive. Member States had a 4-6-week period of time to comment on the information and the assumptions. The main assumptions taken per MS are summarised in Annex 5.

5. To support the analysis of the different options, the European Commission awarded two support contracts to **external consultants**:

- for the general Impact Assessment Support Study, a consortium of consultants comprised: Wood E&IS GmbH (consortium lead) with Trinomics, Ricardo, IMDEA, ELLE and Tyrsky.

- another consortium led by BioInnovation in association with RDC Environment, AirQuality Consultants, VVA Economics & Policy and CETAQUA Water Technology Center assessed the feasibility of an Extended Producer Responsibility System for micro-pollutants.

Further evidence was compiled from the Evaluation report of the UWWTD (2019), the OECD water investment needs study (2020) and a vast variety of background information submitted by stakeholders over the course of the IA. Further information regarding the evidence used is included in each section via footnotes as well as in Annex 10 (references). In addition, extensive consultation of stakeholders was carried out, as detailed in Annex 2. The data used in this IA are those that were available when the calculation model was developed (data from 2016). Data for 2018 were in the meantime available. The difference between the 2016 and the 2018 data set is minimal (less than 0,5% of distance to target) due notably to the long time period needed for the investments to produce their effects. These differences have no influence on the conclusions related to the main and the preferred options detailed in this impact assessment.

ANNEX 2: STAKEHOLDER CONSULTATION (SYNOPSIS REPORT)

The impact assessment accompanying the revision of the Urban Wastewater Treatment Directive was subject to a thorough consultation process that included a variety of different consultation activities, as set out in the Consultation Strategy. The methods selected for consulting stakeholders consisted of semi-structured interviews (speed dates), interactive workshops with the option to send additional feedback after workshop, a broad online public consultation (OPC) to reach a large range of stakeholders on a variety of topics as well as written consultation on factual information and assumptions for modelling. A final stakeholder conference was held to have their views on the different policy options proposed by the Commission and was divided into three main sessions.

1. CONSULTATION STRATEGY & ACTIVITIES

The consultation strategy identified groups of stakeholders and consultation activities. The consultation strategy was developed at the start of the study by DG Environment, assisted by its consultants.[44] The strategy identified groups of stakeholders, consultation activities and mapped these as presented below. **Table A2.1** below presents the different groups consulted and the consultation approaches:

Stakeholder groups	Consultation activity				
	Open public consultation	Member State overviews	Interviews	Stakeholder workshops	Final conference
EU Member States and their public authorities	x	x		x	x
Industrial/economic actors, including small and medium sized enterprises, represented through EU level association.	x		x	x	x
Non-Governmental Organisations	x		x	x	x
International organisations	x			x	x
Academia, research and innovation	x			x	x
Citizens	x				

Table A2.1 below presents the overview of the stakeholder activities:

Consultation activity	Attending Stakeholders	Main discussion points and results
29/01/2020-30/01/2020 Making water fit for life – LIFE and the Urban Waste-Water Treatment Directive	Over 100 participants: technical experts from 53 EU LIFE and 7 H2020 projects representing 14 member states.	Key discussions outcomes included: 1) Circular economy aspects need to be included in the new UWWTD. Harmonised EU Regulatory Framework is required to facilitate the secondary use of raw materials. Particular focus should be on energy and nutrient recovery. 2) Contaminants of emerging concern are generated through pharmaceuticals and other products, which therefore require a shared (extended) responsibility to be applied. Raising awareness to change attitudes and behaviour in society is key. But lack of financial resources present barriers to develop technologies.

[44] European Commission (2021) UWWTD Consultation strategy

		3) SWOs ad CSO need more precise and more ambitious regulation. Potential solutions included NBS and green infrastructure, and sustainable drainage systems. 4) Legislation/ regulation needs to drive the development of improved technologies, especially in relation to online, real-time monitoring.
21/07/2020-08/09/2020 Roadmap feedback	57 replies from business associations (35%), NGOs (14%), individual companies (25%), public authorities (14%), EU citizen (9%) and research institutes (2%) from across the EU.	General support for the revision of the Directive Important topics to consider in the revision: micro-pollutants, energy consumption, sludge and water reuse management, address SWOs, climate neutrality and coherence with other EU legislation.
14-16/10/2020 Speed dates with selected stakeholders	10 stakeholders representing the wastewater sector or related sector and interests (e.g. env. NGOs). All stakeholders received a background document with draft policy ideas in advance.	Overall general agreement on the topics identified for the revision. New topics: access to sanitation and water reuse. Divergent views between those preferring a risk-based approach compared to those in favour or stricter standards. Audits for energy and climate neutrality generally supported.
22/10/2020 UWWTD Member States expert meeting.	100 participants from all EU MS. A background document with draft policy ideas was circulated in advance.	Informal meeting to present preliminary ideas for policy measures to the MS providing room for feedback (orally and in written format). Though problems with remaining pollution are acknowledged, MS are cautious regarding the cost and benefits of addressing them. Support regarding better management of energy use.
26-27/11/2020 Joint DE/EC UWWTD Revision conference on nutrients and micro-pollutants.	About 200 participants from Member States and stakeholder associations. A background document was circulated in advance of the conference.	There is room for improvement regarding nutrient management (min. targets and definition of sensitive areas) under the UWWTD Few MS already address micro-pollutants in wastewater, control at source, monitoring and addressing micro-pollutants in hotspots is needed. EPR could be a solution to deal with additional costs.
19/02/2021 Expert workshop on a computational scheme for GHG from wastewater.	About 20 experts. A draft computational scheme was circulated in advance among the experts.	Different methods to monitor and calculate GHG emissions for the wastewater sector were discussed.
23-24/03/2021 Joint workshop with the EEA on reporting. 11th reporting cycle, 12th reporting cycle, Treatment Plant under the E-PRTR and the Industrial Emissions Portal, streamlining of monitoring and reporting.	127 participants from all 27 Member States and observers from the UWWTD Expert Group. A background document was circulated in advance.	MS appreciated focus on simplification of reporting. QA/QC is a major burden. Art. 15: some MS already use datasets that can be filled by operators directly. Art. 16: general agreements that this Article is outdated and information should be more tailored to what is location-specifically interesting. Art. 17: agreement that this Article needs to be simplified with a focus on access to EU funding.
20-21/04/2021 Joint workshop on sludge and urban wastewater in light of climate change and the circular economy.	Day one: 323 participants from 15 Member States. Day two: 290 participants from 16 Member States. A background document was circulated in advance of the workshop.	Key discussions outcomes included: 1) Participants indicated the need for more data to be collected on WWTP processes for better quantification of energy consumption/production. 2) Energy auditing and the tracking of energy use was portrayed as a key area to fill data gaps. 3) Participants were concerned about GHG emission targets since the data gap to set a well-informed baseline was missing.
28/04/2021-21/07/2021 Online Public Consultation (12 weeks)	A total of 285 responses and 57 position papers were received from stakeholders in 22 Member States.	The OPC consisted of introductory questions related to respondent profiles, followed by a questionnaire divided into two parts: the general questionnaire and the targeted expert survey. The OPC included questions to examine the general public's perception of the success and needed improvements of the UWWTD, as well as an expert section that targeted those with more expertise to elaborate on their views regarding specific measures to be taken in the impact assessment of the directive. The survey was made available in all EU languages on the Have Your Say Portal and uploaded to the EU Survey tool.
04/05/2021 Cost and benefits workshop.	80 participants from all Member States and	Key discussions outcomes included: 1) to identify all uncertainties and be transparent about these, 2) synergies and

	stakeholder associations.	trade-offs between policy measures should be considered and 3) a revised Directive will lead to additional cost while some MS are still “catching up” with the current Directive. For these MS it is expected that the revised Directive will lead to efficiencies in implementation.
29/04-21/05/2021 Member State overviews and targeted questionnaires.	25 out of 27 Member States replied to the written consultation.	For all Member States detailed factsheets on topics related to urban wastewater management were prepared to reflect the current situation in the country in particular identifying where the current practices are going beyond the UWWTD requirements. All factsheets included tailored assumptions for the Member States that would be used for the modelling of the baseline. Member States were asked to validate and add to the information provided.
22/06/2021 Workshop in approaches for integrated management of collecting systems in the revision of the UWWTD.	177 participants from 27 MS and 6 from third countries, stakeholder associations and local authorities.	Key discussions outcomes included: 1) NBS and green infrastructure need more knowledge sharing and financial support for further implementation, 2) Targets for SWOs and urban runoff need to be set at EU level while still allowing MS control to account for local conditions, 3) Collection systems need to deliver sustainable solutions to urban environments while maintaining/achieving good/high status of water bodies, 4) Modelling and regular water quality monitoring systems may be costly and time intensive but provide necessary information for developing collection systems.
August 2021 Interviews	A few selected EU-level stakeholder associations were contacted for further information on specific topics.	A series of targeted interviews was organised in the final stage of the data collection. A list of questions was sent to them ahead of the interviews which were then discussed. Interviews focused on remaining gaps including costs and benefits of the various options considered.
26/10/2021 Stakeholder conference	312 participants from 226 organisations and all 27 MS. There were a total of 9 non-EU participants from Iceland, Morocco, Norway, Scotland and Serbia.	Key discussions outcomes included: 1) Industrial pollution needs to be addressed up-stream using the polluter pays principle, 2) NBS and green infrastructure to be considered in addressing SWOs and IAS, 3) UWWTD should be aligned with existing legislation (e.g. WFD), 4) facilities must contribute to climate-change mitigation (energy efficiency audits were welcomed as a first approach), 5) improving resource recovery and water reuse, 6) apply risk-based approaches for advanced treatments, and 7) participants recognised that interventions at different levels of governance are necessary (proportionate and require clarity on the roles of the stakeholders).

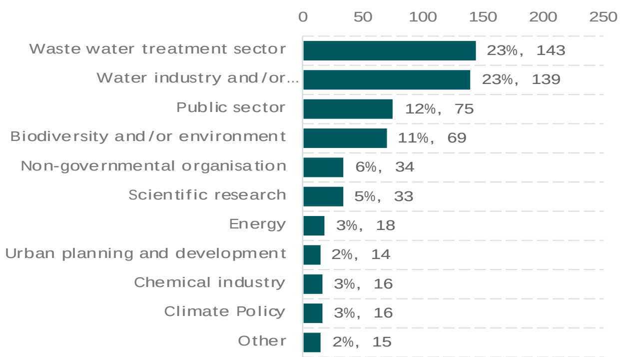
2. STAKEHOLDER GROUP

Overall, the consultation activities have been successful in reaching the identified stakeholder groups as defined in the consultation strategy. All Member States and the vast majority of industrial/economic actors were represented. For citizens, the OPC was the primary approach for engagement. While citizens were the second highest group of respondents in the OPC, the number was overall low when considering it in the context of the entire project.

A wide range of stakeholders groups were involved throughout the activities, for example the split of groups involved in the OPC is presented in the figures below. **Figure A2.1** below shows the share of the 228 participants by stakeholder type for the OPC.

Although 285 stakeholders participated in the OPC, only 228 of those answered the question about the stakeholder type they represented. In the OPC, stakeholders were asked to indicate the sectors which they represented (by selecting three subjects that were relevant to the representation of their organisation).

Figure A2.2 below illustrates the representation of different sectors in the OPC:



Stakeholders from all EU Member States and third countries were involved in the consultation process. For example, the final conference saw participants from 226 organisations across all 27 Member States. In addition, there were a total of nine non-EU participants representing Iceland, Morocco, Norway, Scotland and Serbia.

3. METHODOLOGY AND TOOLS USED TO PROCESS THE DATA

All feedback submitted through different consultation activities was collated and taken into account in the analysis presented in the impact assessment. Questionnaire responses from the OPC were obtained from the European Commission Survey system. For the final OPC data download, no significant update of formatting/data structure was required. The steps followed were: the raw data was imported and cleaned in an Excel template; no campaigns were identified, but small series of duplicated responses were noted. There were three sets of duplicated responses which were not removed but it has been ensured duplicates are not double-counted the statements in the open-response analysis. It is considered that these duplicates have no impact on the overall results.

Graphics presenting the details of the responses, distinguishing stakeholders' categories and Member States were created via Excel. Respondents had the option of elaborating on their answers in open text fields or responding to stand-alone open-ended questions. Responses in all languages were analysed after having been translated to English using machine translation. Survey data was then analysed and coded. The aim of the coding exercise was to identify the keywords and themes mentioned by respondents and then attribute these as established "codes" for which a consensus can be built and counted. For instance, if one respondent mentions a need for more transparency, "more transparency" can be coded and then used to count further responses that communicated the same need.

Finally, any attachments, links, or other materials submitted by stakeholders were analysed and incorporated throughout. Qualitative and quantitative data obtained from workshops, interviews and the conference were summarised in respective reports (available on CIRCABC) and included into the analysis of individual measures in the impact assessment. Feedback from consultation activities has been integrated into the assessment of policy measures per area of improvement, informing recommendations for each area. The MS overviews have been integrated into the final report through a horizontal analysis as well as informing detailed assessment of policy measures per area of improvement.

Overall, the evidence collected throughout the consultation has been compared with other evidence gathered, namely with results of individual consultations as well as the results of the literature review, modelling and data analysis. This triangulation of several research methods helped to identify whether there were any major divergences between different sources of evidence.

4. OPC – GENERAL VIEW

The OPC was divided into five sections. After some initial questions regarding the profile of respondents, sections 2-3 were addressed to all respondents and covered respondents' understanding of the UWWTD, their views on the problems relating to wastewater pollution, and how to best address water pollution through wastewater treatment processes. Section 4 was targeted at expert respondents and included more in-depth questions on specific measures to address in the revision of the Directive. Finally, respondents could share additional relevant materials/publications and/or information in section 5. As most of the questions were not mandatory, the total number of responses for each question varies throughout the report.

A high number of respondents agreed that wastewater was correctly treated before discharge in their country of residence, particularly respondents from Germany (n=64/77, 83%) and Austria (n=7/8, 87%) who overall showed the most agreement. When asked whether urban wastewater was an increasing source of pollution, stakeholders mostly disagreed with that statement, with 59% (n=159) disagreeing (particularly respondents from Germany, Austria, Spain, and Sweden with 75%, 100%, 79%, and 84% of respondents disagreeing, respectively).

When asked about the risk perception of pollution from untreated wastewater, almost all risks were rated by more than half of respondents (n=152), as a significant concern. The topic ranked of the highest importance to be addressed in the upcoming revision was the improved implementation of the polluter pays principle; where 68% of respondents felt that this was a very important topic. On the importance of monitoring and removal of contaminants, there was consensus among respondents that all contaminants listed required stronger efforts to be addressed. Respondents also indicated that there was a need for receiving more information (e.g. informing the public).

Open text answer analysis showed that businesses/companies and the public authorities were mainly concerned with the details of implementing proposed measures and the potential additional cost burdens. Lastly, the OPC showed all stakeholder groups' support for measures related to access to sanitation, access to information and more coherence and alignment of the UWWTD with other policies.

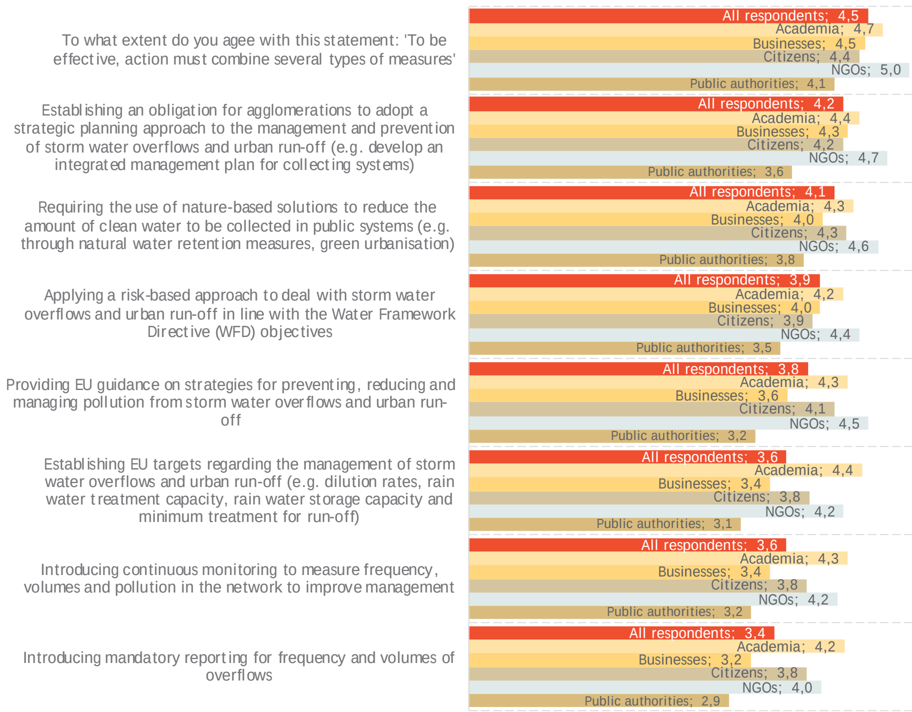
Two topics that stood out as particularly important to experts were the introduction of an extended producer responsibility (EPR) scheme to further implement the polluter pays principle and the need to better tackle pollution at-source. However, businesses were the most critical about the feasibility of the EPR, where all votes for 'not at all' effective (n=16, 7%) came from this stakeholder group.

5. STAKEHOLDERS' VIEWS ON THE DIFFERENT AREAS[45]

5.1 Storm water overflows and urban runoff

Issues relating to the improved management of SWO and urban runoff were considered of high importance to all stakeholders.

During the workshop, strong support from participants for the increased use of Integrated Management Plans was identified, whilst support for target values for SWOs and urban runoff received the lowest support from participants. Similarly, the OPC results indicated that a strategic integrated planning approach for management and prevention was highly supported. OPC respondents were also strongly supportive of NBS playing an increased role in managing urban wastewater, with 71% of respondents (n=185) rating this as either very important (5) or important (4). Expert stakeholders were asked about the appropriateness of various measures to minimise pollution through SWOs and urban runoff. The most positive response from all respondents was for the statement that a combination of measures is required to achieve the needed results. Mandatory reporting of overflows was considered the least appropriate measure, particularly by public authorities and businesses (average scores 2.9 and 3.2, respectively).



OPC Targeted consultation: How appropriate are the following proposed measures for minimising pollution through storm water overflows and urban run-off? Please rate on a scale of 1 to 5 (1 = not at all; 5 = very appropriate). (n= 260).

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[45] For more details, please refer to Appendix F Views of the stakeholders by area of improvement from the WOOD report – report 1 in Annex 10

5.2 Smaller agglomerations

The need for several types of measures to address the issue was highlighted by stakeholders. Results from the OPC show that introducing a risk-based approach for urban wastewater management in agglomerations below a certain size (requiring more treatment where their discharges can cause problems) was rated the most appropriate individual measure across all stakeholder groups. Respondents noted that the risk-based approach was already covered under the WFD. Redefining agglomerations scored an appropriateness score of 3.6 (1-low and 5-high), however three respondents highlighted that they were not able to propose a better definition. Suggestions made included considering size and distance to sewer system. It was highlighted that there is a need to improve the centralisation and the connection rates of smaller agglomerations to larger treatment plants in order to reduce pollution impacts.

5.3 IAS

Overall, a flexible system, was favoured and stakeholders also indicated that guidance was needed on IAS technologies, registration, monitoring, and inspections. From the OPC, the option to require agglomerations to report to the EC if an IAS is used to collect more than a set amount of the load was generally perceived as inappropriate to address the problem. Academics were most supportive of reviewing the EU-wide standards for IAS (4.8) and generally felt that the measures presented were appropriate. Businesses were particularly in favour of ensuring connection to public sewer systems (4.1), providing guidance on IAS technologies (4.0), and reviewing the definition of IAS (4.0).

Citizens were generally supportive of the measures presented but showed a lower average response for reporting to the EC (3.4) and requiring countries to keep an IAS registry. NGOs were particularly critical on requiring agglomerations to report to the EC (3.0). Public authorities, on the other hand, only showed an average positive response for ensuring connection to the public sewer system (4.0). Measures relating to a risk-based approach, consumer awareness campaigns, keeping an IAS registry, and limiting IAS use generally had more support from academia and citizens than from other stakeholder groups. One NGO respondent also noted the difference that consumer awareness can create and how education of the general public on these issues can widely encourage an EU-wide change in behaviour over time. Overall, there was quite a varied interest and response between stakeholder groups, but also within the different groups themselves.

Several of the position papers submitted addressed the topic of IAS. EurEau supported the use of a database to record the use of IAS under the responsibility of the local authority. EurEau and AquaPublica both raised the fact that some flexibility should be kept so that the cost of connection, and the associated emissions with building networks are considered.

5.4 Sensitive areas

Overall, stricter N/P emission requirements were supported by stakeholders. While an obligation for additional treatment where there is a bathing site, shellfish water or a drinking water catchment downstream (and abandoning criterion b and c in Annex II of the Directive) was widely supported, a more general stringent standard for N/P treatment for all large UWWTPs was less popular with OPC respondents. Moreover, with regard to sensitive areas, the most highly rated measures was providing EU-level guidance (score 4.2/5). Measure 1 on improving the ways ‘sensitive areas’ are designated by requiring the same methodology and criteria to be used and aligning them with the Nitrates Directive and the WFD (score 4.1/5). Also the less rated one abandon the possibility for MS to designate less ‘sensitive areas’.

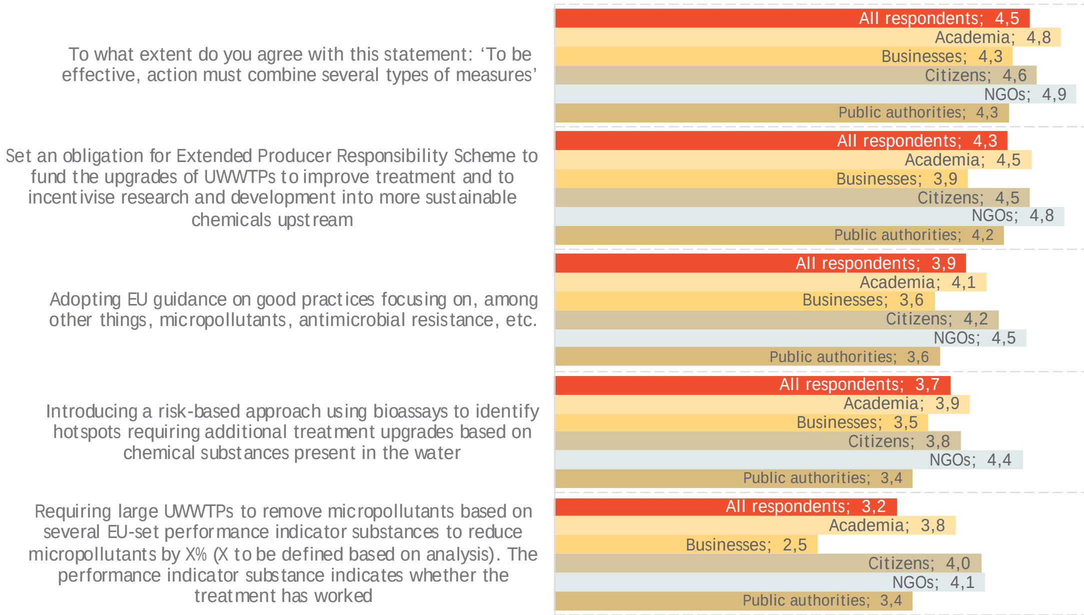
5.5 Micro-pollutants

Across all stakeholders’ categories, increasing consumer awareness on releasing micro-pollutants and on safely using and disposing products was a widely supported approach to the issue. Stakeholders generally supported the idea that micro-pollutants are the responsibility of manufacturers and producers and the concept of source control was widely supported. From the OPC, on average, all contaminants were ranked with similar importance. Respondents also commented on the need to prevent pollution at source and the greater need for the polluter pays principle to be implemented. The results of the OPC highlight the general desire from respondents for the UWWTD to increase monitoring and improve the removal of contaminants in wastewater. The responses show that predominantly respondents felt that manufacturers and producers were responsible for addressing pollution of most contaminants.

The exception is for urban runoff, where 69% of respondents felt the responsibility lies with the municipalities (n=71). Industrial wastewater contaminants had the highest rate of agreement with 91% (n=97) of respondents indicating that this is the responsibility of manufacturers and producers, which further reflects earlier results on the importance of tracking industrial contaminants and the importance of the polluter pays principle.

To address micro-pollutants, setting an obligation for EPR to fund upgrades of UWWTPs had by far the most positive response across all stakeholder groups (4.3) whereas the introduction of a risk-based approach (3.7) and requiring larger UWWTPs to remove micro-pollutants based on EU-set performance indicators (3.2) ranked lowest. While academics, citizens, and NGOs generally felt measures were appropriate, businesses felt particularly negative towards requiring larger UWWTPs to remove micro-pollutants based on EU-set performance indicators. Despite there being a lower overall ranking for the risk-based approach, a number of open responses highlighted their support for bioassays and their suitability to identify hotspots or effluent toxicity. However, all respondents noted that there are some challenges in the application of bioassays that need to be taken into account when identifying the correct bioassay to use under specific circumstances (n=4). Regarding the position papers, it was commonly mentioned that substances of emerging concern should be better considered under the revised Directive text (n=3) and that the list of substances covered should be revised (n=5) and, furthermore, that this list should be an open and/or live list that can be updated when new substances of concern emerge (n=2).

OPC Targeted consultation: How appropriate are the following proposed measures for addressing micro-pollutants under the UWWTD? Please rate on a scale of 1 to 5 (n=258)



5.6 Industrial Emissions

Views from stakeholders confirmed that there is a need for action to enhance coherent legislative requirements, as identified in the recent UWWTD evaluation. This would include alignment of monitoring and reporting requirements under different sets of legislation. A generalised comment across all stakeholders was the need for coherence of the UWWTD with other Directives, especially with the IED.

From the OPC, a very positive response across all stakeholders was recorded for the measure requiring pre-treatment at industrial installations before wastewater is discharged into UWWTP. Regarding the type of contaminants that should be prioritised for removal, on average all contaminants were ranked with similar importance. Endocrine disruptors and other pollutants from industrial installations had the highest score, closely followed by pharmaceutical residues, excess nutrients, and pesticides.

Micro-plastics as well as nutrients and pharmaceuticals had a wider spread of responses resulting in the lowest average rate of importance. Overall, respondents felt that stepping up monitoring and removal of all listed contaminants was at least somewhat important. Industrial wastewater contaminants were considered for 91% of respondents as being the responsibility of manufacturers and producers, which further reflects the importance of tracking industrial contaminants, and the importance of the polluter pays principle.

Targeted interviews drew several conclusions regarding industrial discharges including: the need for policy coordination, especially with the WFD, but also with the IED, SSD and Nitrates Directive; mixed views on the added value of IED/BREF process for wastewaters; a need for further reflection on industrial releases in the urban networks; a short-list of selected indicators of groups of substances that should be monitored in treated wastewater and trigger more targeted source control if thresholds are reached; and a general principle in the Directive in relation to industrial releases could be useful although it is acknowledged that it is difficult to enforce because of resources constraints.

5.7 Energy efficiency, generation and climate neutrality

Stakeholders indicated that more data is required on WWTP processes to enable better quantification of energy consumption/production. Energy auditing and the tracking of energy use were highlighted as being key activities which could be used to fill these data gaps.

The OPC results as well as inputs received during the specific workshops showed that all stakeholder categories broadly support the generalisation of energy audits. There was a general recognition on the necessity to better understand and monitor energy use of the treatment plants so that measures can be taken to reduce energy use and where possible produce energy. Citizens, NGOs and to a lesser extent academia were supportive on introducing energy related targets while mixed views were expressed by public authorities and business. Some representatives from MS and business pointed out that these targets should be introduced for large UWWTPs only, and, despite the importance of the 2050 energy neutrality targets, these should not hamper the primary objectives of UWWTPs; wastewater treatment. Other representative of business were in favour of both climate and energy neutrality targets. Most advanced MS were clearly supporting an EU wide target similar to their own target.

In the targeted consultation component of the OPC, proposed measures to address energy use and emissions were generally not as highly rated as other measures in previous sections. On average, the highest rated measure was related to introducing an obligatory energy audit in larger plants (3.8), which was rated highest by academia, citizens and NGOs. In terms of stakeholder response patterns, academics indicated the most support for the measure relating to setting energy use reduction targets based on UWWTP sizes. This was, on the other hand, businesses least rated option, with a generally negative perception. Overall, none of the stakeholder groups felt particularly positive about introducing energy efficiency targets at a national level (average 3.0) – in particular, public authorities did not seem supportive of the measures (2.6).

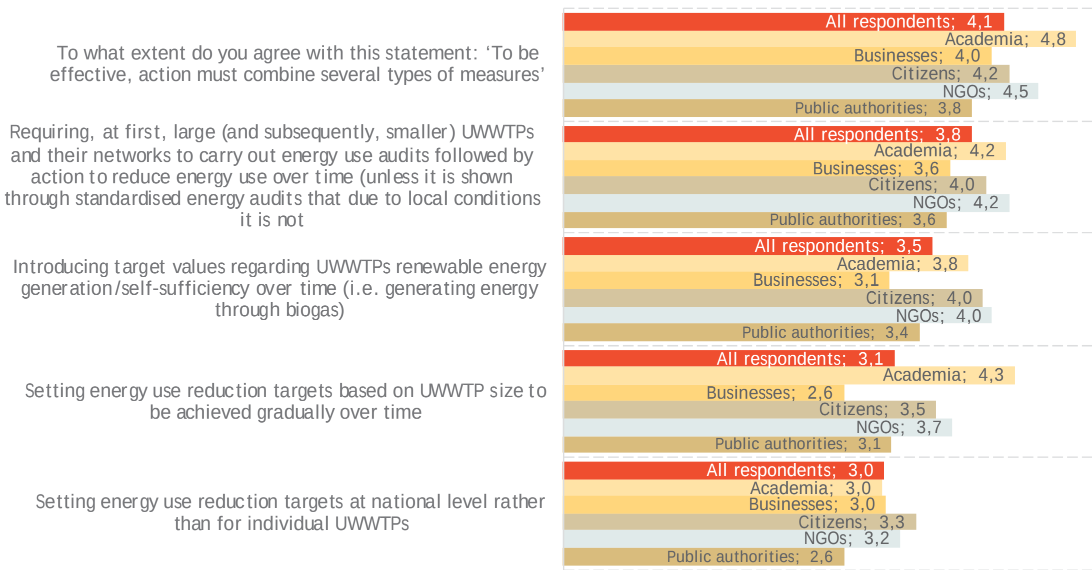
Academics noted in the open text questions for suggestions that energy efficiency and regulation of emissions must consider other additional emissions as a consequence, for example nitrous oxide and nitrogen dioxide (n=2). Public authorities generally expressed their support for the implementation of energy audits and improved energy management (n=4), however they also expressed that the best possible purification of wastewater must not be lost from sight when trying to implement rigid energy efficiency classes (n=1). The respondents also noted that energy efficiency and management should be strictly addressed during the design and renovation phases of plants and suggested that the Directive’s wording should not go beyond suggesting energy efficiency be considered during these steps (n=2).

Business respondents showed support in particular for energy audits (n=4) but expressed concerns regarding target setting. Similar to Public authorities, Businesses expressed the importance of efficient cleaning producers and set it as a higher priority than energy efficiency, which thus spoke against setting firm targets (n=4).

During workshop on wastewater and sludge, the overall feedback of the participants was that it should be up to MS to decide which interventions to apply to which treatment plants to achieve the best efficiency results based on local data from operators, treatment stages and applied technology. The challenge of setting a target across such local variability without proper baseline remains too significant in absence of energy audits.

In relation to GHG emissions including methane, overall views from stakeholders confirm that there is a need to better understand the baseline of GHG emissions generated by UWWTPs in the EU. On the OPC results, stakeholders appeared to be more interested in energy efficiency investments than in actions to reduce GHG emissions. This could stem from the fact that many respondents had previously noted that GHG benefits could be achieved from improvements in energy efficiency. Respondents generally believe that benchmarking and specific targets should only be set once sufficient data is collected from audits that would allow a well-informed baseline to be set. Respondents preferred, if required, that any limits set should be based on plant size and highlighted the need to go beyond the UWWTP and incorporate the sewer collection system and other sectors too. Similar conclusions were made during the workshops.

OPC targeted consultation: Response to: How appropriate are the following proposed measures for improving UWWTPs' energy use and emissions intensity to help achieve energy use reduction? Please rate on a scale of 1 to 5 (n=258).



5.8 Circular economy

The concept of source control, i.e. targeting substances such as micro-plastics and micro-pollutants at source, was widely supported by stakeholders in order to improve circularity in the wastewater treatment sector. Others also highlighted the need for tracking and more stringent requirements to prevent pollution at source when sludge is used in agriculture. From the OPC, the most highly rated measure in relation to circular economy (sludge reuse) was preventing pollution at source (Measure 4: Member States to adopt strategies for tracking and preventing pollution at source, in particular when sludge is reused in agro-industrial activities. Track and trace of pollution if sludge reused in agriculture (consistent for industrial emission requirements above. (4.4/5)), with a less preferred option setting minimum levels for recovery phosphorous and other resources

(Measure 2: Setting minimum levels for recovering phosphorous and other materials, such as cellulose, from wastewater and sludge. All valuables in sludge (e.g. materials and energy) need to be recovered and recycled / Measure 1: Setting minimum levels for recovering phosphorous and other materials, such as cellulose, from wastewater and sludge, P recovery mandatory for large UWWTPs > 100.000 p.e. (Score: 3.6/5)).

5.9 Monitoring and reporting

The concept of providing EU-wide guidelines to operators on 'normal operating conditions' in UWWTPs to support comparability of monitoring data received strong support. Clarifying the requirements on sampling conditions and sampling frequency were also identified on the OPC as supporting the comparability of monitoring data.

As part of the OPC, the measures proposed relating to sampling frequency and monitoring did not receive particularly high scores, with the majority scoring below 4 on average. Providing guidelines for normal operating conditions was generally considered the most feasible measure (average 4.0). The least rated option was to replace COD measurements with total organic carbon across all stakeholder groups (average 2.6). All stakeholders rated very low the deletion of COD monitoring requirements (2.3), which reflects their willingness to maintain the monitoring standard, rather than removing it entirely.

Public authorities were less supportive of measures relating to additional parameters and increasing sampling frequencies. This is likely because such measures would cause additional burdens for the authorities. NGOs were most in favour of adding additional parameters. Academics and NGOs generally were supportive of more options than other stakeholder groups, rating half of the options above 4.0. NGOs noted in particular that many of the substances that urgently require monitoring (e.g micro-pollutants) often occur at low limits. The respondents noted that there is a need for establishing analytical methods for low detection limits in order to monitor these pollutants. This was linked both to the acknowledgment of the water body condition and, therefore, the coherence with the WFD, as well as to decisions on water reuse, bathing sites and drinking water sources. A few businesses also mentioned the need for new monitoring parameters that should stimulate the use of innovative technology and integration with existing efforts to improve monitoring practices such as the use of satellite data (n=3). OPC respondents rated the use of EEA data availability as the highest option overall, indicating that the interest in providing further information to the public is supported by all stakeholder groups

Some respondents also noted that harmonisation of data reporting is not the only factor making comparisons difficult but that diversity in analysis methods and the related frequencies prevent environmental data from being effectively compared (n=3).

Respondents also noted the importance of new reporting requirements to be aligned with other EU policies such as the E-PRTR (n=3). In this respect, respondents mentioned that identifying chemical classes to compare across countries with existing PRTRs and creating a global PRTR for all relevant policies should be considered. Generally, the pursuit for simpler and more harmonised reporting was supported by respondents but there seems concern regarding the increasing ambitions in the other sub areas and the possible additional reporting costs that this may cause.

The conclusions from the workshop on reporting specifically highlight that regarding Art. 15, some MS already use datasets that can be filled by operators directly; on Art. 16, there are general agreements that this Article is outdated and information should be more tailored to what is location-specifically interesting, and finally, on Art. 17, there is an agreement that this Article needs to be simplified with a focus on access to EU funding.

5.10 Wastewater surveillance

Recent developments have indicated that wastewater surveillance can be used as an early warning signal for the current coronavirus pandemic and further viral outbreaks that could occur in the future. These are aspects that are not covered by the existing legislative framework. Stakeholders preferred the provision of guidelines for collaboration between UWWTPs and health authorities compared to other measures.

Regarding the OPC, respondents generally felt that the additional costs of wastewater surveillance should be covered by different groups / entities, but health authorities received the highest number of total votes (48%, n=122), followed by the general public (37%, n=93). When asked about measures on how to incorporate wastewater surveillance in the UWWTD, stakeholders preferred the provision of guidelines for collaboration between UWWTPs and health authorities, as well as establishing EU-wide binding standards on implementation. Respondents noted that the characteristics of local conditions need to be taken into account and, therefore, national rather than EU-level targets would be more appropriate. Nonetheless, a number of respondents mentioned that standardization for water surveillance was important.

5.11 Information to the public

Stakeholders appeared to widely support improvements to accessing information from UWWTPs although accessing real-time information on water quality after treatment was of least interest.

Results from the OPC show that quality of rivers, lakes, and seas where wastewater is discharged and the compliance of the UWWTP with the EU, national and regional laws were the two most highly yes-voted information subjects at 77% (n= 205) and 72% (n=192), respectively. The least interesting information appeared to be real-time information on water quality after treatment as well as sources for funding, which had more respondents voting no or did not know/no opinion than yes.

In the targeted part of the questionnaire, stakeholders were of the opinion that regardless of what measures are to be taken, there is a strong need to improve the level of communication and information provided to the public. The highest support among stakeholders was for the use of the EEA website, providing information relevant to the public (57% respondents marked this option as ‘appropriate’ or ‘very appropriate’).

5.12 Late implementation

Member States perceive Article 17 as burdensome and many stakeholders supported its improvements. The OPC drew attention to several observations: over 50% of respondents agreed with the measure to adjust planning/reporting under Art. 17 to link better with obligations/reporting with enabling conditions to access EU funds. Respondents felt mostly quite negative towards the idea that planning and implementation obligations should be set for those EU countries that receive significant EU funding. Only 19%

agreed with the measure as an effective way to improve implementation. A high number of respondents (at least 30%) did not know or had no opinion on the matter. This may be because the subjects were outside their area of expertise or that the questions were too broadly formulated for respondents to give confident answers. Respondents noted a general lack of funding and a need for better investment planning to be adjusted for incorporation of other obligations, such as under the WFD, which may increase the costs of effective treatment and procedures. There were also requests on improving transparency on investment needs in countries to anticipate future requirements. Overall, those that provided a response felt political willpower needed to be improved across the EU and that this could come through pressure, such as infringement and sanctions, from the EC.

5.13 Access to sanitation

Sanitation is not yet accessible to all EU citizens to the same extent. There was general support among stakeholders for improved access to sanitation for vulnerable and marginalised groups.

5.14 Access to justice

Currently, the UWWTD contains no provisions concerning access to justice. Therefore, this area of improvement and the associated measure are aimed at improving social justice for both individuals and organisations. Consultation activities aimed to establish stakeholder views on the issue as well as on potential measures to address the problem.

The majority of the position papers provided recommendations for the revision of the UWWTD and touched upon the topic of 'Transparency, governance and justice'. Very few details were provided on ways this should be improved / strengthened.

6. POSITION PAPERS[46]

In addition to the response to the online public consultation, a total of 57[47] position papers were received, mostly from business associations (n=25) and companies / business organisations (n=11). The majority of position papers submitted touched on the following areas of revision: 'Fit for the Future' (n=33), 'Remaining loads and pollution of the environment' (n=12), 'New pollution' (n=6) and 'Transparency, governance and justice' (n=5). Overall, there was a particular interest in circular economy, with strong focus on recovery and reuse of materials from sludge (n=17). There was also support for addressing energy efficiency and standardising audits (n=12). The EPR also stood out as an important measure (n=15), particularly as a tool to address pollution at source rather than end-of-pipe. There was interest expressed in addressing issues from storm water overflows (n=19) and urban run-off (n=13).

20 additional contributions were received in 2021. The position papers can be divided into 2 main categories, either providing direct reflection on the stakeholder conference (n=3, public authorities and one NGO) or providing general inputs and suggestions

[46] The list of all the position papers received in 2021 is detailed in Appendix G Position papers from the WOOD report
[47] In total 59 position papers were submitted alongside the OPC submissions, two of which were duplicates

regarding the revision of the UWWTD (n=17, public authorities, business association, NGO and a company).

Annex 3: Who is affected and how?

5. Practical implications of the initiative

The following table summarise the main implications for the affected stakeholders.

Category affected	Possible effect
National and regional authorities	The EU Member States and national/regional authorities (in Federal States) will be involved in the implementation and enforcement of the revised directive, like it is the case for the existing Directive. Additional investments in wastewater infrastructure and the necessary operation and maintenance of such equipment will be required. As shown in section 7, the additional yearly costs required to implement the preferred option represents on average an increase of the 3,85% of the yearly expenditures of the sector. These costs will be covered by a combination of additional budgets, water tariffs and the new system of producer responsibility for micro-pollutants. On the basis of the existing financing strategies in the water sector, additional required annual public budgets were stimulated at € 0,791 billion/year (see section 7.1). Part of these budgets could be covered by EU funds which will also be essential to cover adjustment costs. In that sense, National/Regional authorities will have to make sure that EU funds are made available and used for the water sector - when it is necessary. Also they should maintain/intensify accompanying social measures in case water tariffs are increased. An appropriate control of the new system of producer responsibility should be put in place, representing minor additional administrative costs compared to the expected financial contribution from the sector (€ 1,185 bn per year). Even if the IT tools will be provided by the EEA and the Commission, National/regional authorities will have to adapt their reporting system to the revised directive which will include new requirements but also key simplifications. Overall, National/Regional authorities will benefit from the proposed simplification and digitisation of reporting even if part of these benefits might be cancelled by additional reporting requirements on access to sanitation, GHG emissions or new pollutants (see Table 11). The application of the revised Directive will result in better protection of the aquatic environment and maintaining these assets is of critical importance to protecting human health and the environment in Europe. With potential significant economic impacts – for instance in regions/countries where tourism is a key source of revenues.
Water/wastewater operators	Wastewater operators are first in line for compliance with existing national and European legislations related to water quality standards. They are responsible for collection, treatment,

	monitoring and proper discharge of different waste streams. Wastewater operators are public, mixed or private companies working for the local competent authorities (municipalities or group of municipalities). Changes to the UWWTD will have direct impacts on this sector. Additional investments will be needed notably to better manage N and P but also to treat micro-pollutants where it makes sense. Investments will also be needed to meet energy neutrality - even if these investments will be profitable on the long run. Additional monitoring efforts will be required notably to better understand GHG emission and energy use and to monitor the achievements on the micro-pollutant reduction (see Table 11). On top of their existing contractual obligations with their municipalities or group of municipalities, wastewater operators will have to establish contracts with the new organisations in charge to implement the producer responsibility schemes for micro-pollutants (administrative burden estimated at € 5 million/year). At the same time, they will be funded for the additional investments required to treat micro-pollutants (1,185 € bn in total). New efforts will be also asked in terms of transparency but also to monitor of key performance's indicators (economic, social but also environmental, energy and GHG) which in the mid-term is expected to contribute to optimise their operations and reduce their costs. Operators are expected also to be better involved in the permitting process in case of industrial release in their facilities. They will also be a key player of the future integrated management plans aiming at reducing releases from storm water overflows and urban runoff.
Local competent authorities (municipalities)	The local competent authorities (mainly municipalities or group of municipalities) will have to ensure that enough resources are given to their wastewater operators to ensure the implementation of the measures included in the preferred option. They will have to make sure that national/EU budgets are reserved for their investments, but also that water tariffs are adapted when necessary. Local authorities will also play a key role in establishing and implementing the integrated water management plans (see section 6.1) aiming at reducing SWO and urban runoff : their coordination role between different services (urbanism, wastewater collection and treatment, floods, urban greening etc) is essential to ensure the success of such plans.
Citizens	Citizens are affected in that they pay water tariffs and taxes to support the wastewater treatment sector. Citizen on the other side benefit from clean drinking and bathing water, improved environmental and ecological status of the waters, preserved biodiversity and improvement to the public health reactiveness to possible outbreaks. Environmental protection, clean and safe bathing waters and access to sanitation are essential aspects of human health and wellbeing and contribute both socially and economically to EU citizens. The implementation of the preferred option will contribute to

	improve the aquatic environment while reducing the risks associated with new emerging pollutants. Citizen will also directly benefit from health-related measures notably the surveillance of COVID-19 and its variants in wastewaters but also the better control of AMR. Citizen will also benefit from a better access to sanitation but also to key information on their operators' performances – which is important as they can't choose their operators. Depending on the financing strategies of their local and national authorities, increases in water tariffs can be expected (estimated on average at 2,3% - see section 7.1). In case the whole additional cost linked to the implementation of the new producer responsibility schemes is included in the product prices, PCPs and pharmaceutical prices would slightly increase (0.6% on average see section 6.5).
Water Industry sector	The water and treatment technology industry will directly benefit from a reinforcement of the standards, but also from measures aiming at expanding the scope of the Directive to smaller agglomerations and optimising the operations and reducing energy use and GHG emissions. New business opportunities to develop new treatment techniques while reducing GHG emissions will emerge from the preferred option. Innovation will be boosted maintaining a comparative advantage for EU water industry. At the time of the Evaluation, eight out of the top 15 worldwide water businesses were based in the EU, showing clearly the global business leadership of this sector. The total gross value added (GVA) of the water industry (collection, treatment, supply and sewerage) reached € 43.84 billion, or 0,35% of the total EU28 value added in 2010 (Eurostat, 2013). In the context of changes to the UWWTD, additional jobs could be created as well as new skills (digitalisation, advanced treatment).
Pharmaceutical and PCP's industries	PCPs and the Pharmaceutical industry will have to set up new 'Producer responsibility' organisations and finance their operations. As explained in section 6.5 and further detailed in Annex 9, these industries will have the choice to either pass these new costs in the price of their products (max increase of 0.59%) or reduce their profit margins on these products (average maximum impact of 0.7).
Other industrial sectors	Inefficiencies in wastewater treatment and subsequent pollution have direct negative impact on the EU economy and industry. Multiple industry sectors are highly dependent on sufficient treatment of wastewater, and clean water quality. For example, water for the food industry or for irrigation in agriculture, provision of drinking water, tourism and recreational industry. Improved water quality as a result of the application of the preferred option will positively affect these sectors. Since micro-pollutants are not entirely biodegradable, they can pose a risk to drinking water resources and aquatic ecosystems. The application of the preferred option will avoid putting additional

	burdens on drinking water providers who must rely on sufficient clean water resources (surface and groundwater) so that they can fulfil their task to ensure healthy and safe drinking water. Water quality and security affects agriculture as well, which can use up to 80% of water in Southern regions (EIB, 2016[48]). Given that the dominant use of water is for agricultural irrigation (global average is 70%[49]), the economic consequences of poor water quality and water scarcity are most pronounced in agriculture-dependent economies.
Environment	Protection of aquatic ecosystems and water resources is a key ambition of the UWWTD and in coherence with the WFD, targets treating water for pollution to enable favourable conditions for aquatic life. With the preferred option, the expected reduction of organic matter and other pollution in treated wastewater will improve water quality throughout the European Union. Water quality improvements lead to an increased provision of ecosystem services such as recreational benefits of improved bathing waters and tourism. The impacts include direct and indirect impacts on fisheries, recreation (including human health), biodiversity and the production of drinking water.[50] According to a report published by the EEA, the effectiveness of national water policies and many years of investment in better wastewater treatment and sewerage systems has led to Europe's bathing water being much cleaner today than it was decades ago. As shown in the Evaluation of the UWWTD, the implementation of the Directive has almost doubled the river length with at least good quality, from 43.5% in the pre-Directive scenario to 82,9% under full compliance. The implementation of the UWWTD is estimated to have increased the length of coastlines with at least good quality from 73,5% in the pre-Directive scenario to 95,2% under full compliance which would be a direct benefit for citizens using these waters. These percentages are expected to further increase with the implementation of the preferred option (% to be added). Differences in the implementation and interpretation of the UWWTD principles and procedures across Member States can limit the protection of the environment, creating transboundary issues and directly affecting the functioning and effectiveness of the Directive in reducing pollution with subsequent impacts on EU society. Approximately 60% of the EU's rivers run across borders of Member States (and non-Member States). If waters are of poor quality in an upstream Member State, this may have impacts on any downstream Member State. Action taken by all Member States is therefore required so that cross border environmental problems can

48 European Investment Bank, (2016), Restoring European Competitiveness, Luxemburg
49 OECD, (2020), Financing Water Supply, Sanitation and Flood Protection: Challenges in EU Member States and Policy Options
50 Milieu and COWI, (2016), Study to assess the benefits delivered through the enforcement of EU environmental legislation

be mitigated and water quality improved.

6. SUMMARY OF COSTS AND BENEFITS

The annual overall costs and benefits of the preferred option by 2040 are presented below.

I. Overview of Benefits (total for all provisions) – Preferred Option - A breakdown per MS is provided in Annex 7, Table A7.6 (total costs and benefits).		
Description	***Amount***	***Comments***
Direct benefits		
Improvement of water quality	€ 6.156.474.955 /year	Monetised benefits due to reduced emissions of Nitrogen, Phosphorus and BOD in the environment and willingness to pay for SWOs/urban run off
Reduction of the toxic load in receiving waters	44% reduction of the toxic load rejected to receiving waters of which 64% happening in areas at risk (with low dilution rates)	Benefits mainly for the environment and public health (notably bathing and drinking water), for biodiversity (protection of fauna)
Reduction of GHG emissions and energy neutrality	€ 486.370.454 /year (GHG reduction) € 0 (2 bn /year savings due to energy neutrality compensated by the costs to reach energy neutrality - see section 6.7)	Monetised benefit due to GHG emission reduction from improved process (N_2O emissions) and energy neutrality Direct savings due to energy neutrality
Indirect benefits		
Improved bathing water quality	Significant reduction of *E. coli* emissions (key parameter for bathing water quality), impacts on tourism, well-being in the cities	
Improved raw water for drinking water	Improved protection of the raw water used for drinking water, reduced health risks, reduced treatment costs for water operators	
Biodiversity	Cleaner water is essential to preserve biodiversity on the rivers, lakes and coastal areas. Actions on SWO and urban runoff will incentivize actions to 'green' the cities	
Public Health	Monitoring COVID-19 and its variants as well as Anti-Microbial resistance is providing precious information for public health	
EU water industry	New business opportunities. Push for innovation, modernisation and transition towards climate neutral industry. Maintain/amplify of the worldwide leadership of the EU water industry	
Innovation	Energy and Climate neutrality as well as micro-pollutant treatment are new and will drive innovation. Same for improved N and P efficiency	
Administrative cost savings related to the 'one in, one out' approach		
National digitalised database for reporting	Potential savings for operators compensated by additional costs due to reporting more parameters	
Better coherence reporting		Modest savings

with E-PRTR		

II. Overview of costs – Preferred option - A breakdown per MS is provided in Annex 7, Table A7.6 (total costs and benefits) and in Table A7.5 (detailed costs per MS). Costs are annual costs by 2040 including capex and opex.							
		Citizens/Consumers		**Wastewater operators/ municipalities**		**National/regional administrations**	
		One-off	**Recurrent €/year in 2040**	**One-off**	**Recurrent €/year in 2040**	**One-off**	**Recurrent €/year in 2040**
SWO and urban run -off	Direct adjustment costs			6.446.657.281	372.472.648		
	Administrative costs				57.600.000		
Small scale agglomerations	Direct adjustment costs			1.141.228.243	140.406.278		
	Administrative costs				472.000		
Nutrients removal	Direct adjustment costs			12.129.508.400	2.008.825.659		
	Administrative costs				0		
Micro-pollutants removal	Direct adjustment costs			8.891.344.396	1.213.112.586		
	Administrative costs				27.600.000		
GHG and energy neutrality	Direct adjustment costs				0 (1.560.000 €/year compensated by direct savings – see section 6.7)		
	Administrative costs				Audits – (6.000.000 and monitoring -		

					98.700.000 compensated by direct savings – see section 6.7)		
Other actions	Direct adjustment costs		Average increase of water tariffs of 2,26% - or € 1.806.000 /year				Average increase in public budget of 774 million
	Administrative costs		No changes		55.700.000 million AMR + COVID-19 + non domestic waters		Neutral
Costs related to the 'one in, one out' approach (PCP's and pharmaceutical industry) [51]							
Total	Direct adjustment costs			8.891.344.396 € for PROs to cover investments for micro-pollutants advanced treatment between entry in force and 2040			
	Indirect adjustment costs						
	Administrative costs (for offsetting)				16,2 million €/year to be shared between PRO (11,2 million) and industry (5 million)		

[51] As explained in section 6.11 the private and mixed private/public companies will face additional administrative costs (€ 39,29 million per year). These additional costs will nevertheless be passed on the competent public authorities having contracts with these operators and/or compensated by the expected gains due to the application of the energy neutrality target.

7. RELEVANT SUSTAINABLE DEVELOPMENT GOALS

Relevant SDG	Expected progress towards the Goal	Comments
SDG no. 6 – 'Ensure availability and sustainable management of water and sanitation for all' Targets 6.2, 6.3, 6a and 6b.	Increased population connected to sanitation systems by actions to improve access to sanitation but also extending the scope to smaller facilities.	The Directive directly contributes to the implementation of the requirements of SDG 6. The level of treatment as well as the collection rate of the EU is one of the most advanced worldwide. With the revision of the Directive, this will be intensified (reinforcement of the standards, new parameters to be treated, more agglomerations covered by the Directive). The scope of the Directive could also be expanded to ensure access to sanitation.
SDG no 3 – 'Ensure healthy lives and promote well-being for all at all ages' Targets 3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases. and 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Monitoring of health relevant parameters in wastewater will contribute to improved public health (Covid 19, AMR others). Increased removal of pollutants in wastewater released to water bodies will contribute to reduce hazards due to water pollution (bathing-g waters, drinking water).	The Directive directly contributes to the implementation of specific parts of the targets of SDG 3, in particular targets 3.3 and 3.9.
SDG no 14 – 'Conserve and sustainably use the oceans, seas and marine resources for sustainable development' Target 14.1 "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution"	Increased removal of pollutants including contaminants, plastics, nutrients in wastewater will reduce pollution going to seas.	The Directive directly contributes to the implementation of specific parts of target 14.1 of SDG 14

ANNEX 4: ANALYTICAL METHODS

In line with previous assessments in the context of the Evaluation of the Directive[52], the JRC has developed ad-hoc model calculations tailored for the policy questions of this impact assessment.

1. *Quantification of emissions reduction and costs for current and scenario conditions*

Addressing the questions required mainly the quantification of costs of action and changes in water pollutant and greenhouse gas (GHG) emissions following from the implementation of a set of measures at selected wastewater treatment plants. Pollutants addressed include organic matter (as biochemical oxygen demand, BOD), nutrients (as total N and total P), faecal coliforms, and micro-pollutants. GHG emissions are represented as carbon dioxide equivalent (CO2e) emissions.

All calculations ground on the database of wastewater treatment plants (WWTPs) from the 10th UWWTD Implementation report. For each WWTP, we assume an emission factor expressed as:

- mass of BOD, N or P per population equivalent (pe) per day;
- coliforms colony-forming units (CFU) per p.e. per day;
- normalized toxic units (TU) of micro-pollutants per p.e. per day;
- GHG emissions as kg CO2e per p.e. per day.

The emission factors are attributed on the basis of the level of treatment and the treated population equivalents of the plant.

For each policy scenario, we modify one or more of the emission factors (depending on the measures foreseen in the policy) for those WWTPs to which the policy applies. The product of an emission factor by the treated population equivalents of the plant yields the emissions from the plant. The sum of emissions from plants within one Member State (MS) or the total for the EU indicate the aggregated effect of a policy scenario on emissions. In a similar way, for each plant we calculate the cost of implementing a measure based on appropriate assumptions, and consequently the MS and EU total costs.

Therefore, the quantification of present conditions and scenarios in this impact assessment is based on simple Excel calculations that are all similar in structure, but differ for the issue addressed each time in terms of emission factors and costs.

The emission factors for coliforms, BOD, N and P, based on Pistocchi et al., 2019[13] but slightly adapted for N and P, are summarized in **Table A4. 1**.

[52] https://publications.jrc.ec.europa.eu/repository/handle/JRC115607

Substance	Emission factor (g/p.e./day)	Removal efficiency of primary treatment	Removal efficiency of secondary treatment	Removal efficiency of tertiary treatment
BOD	60	50%	94%	96%
N	Varies slightly by country, average 11.18	25%	50%	75%
P	Varies slightly by country, average 1.34 (excreta) and 0.34 (detergents)	30%	55%	85%
Faecal coliforms	1.23×10^{10} (*)	40%	90%	99% (**)

Table A4. 1– *Emission factors for N, P, BOD and coliforms.* *After treatment, the emission factor is multiplied by (100 – removal efficiency)/100. (*) for coliforms, units of the emission factor are CFU/PE/day ; (**) for N removal : if only P removal, efficiency is 90%.*

The emission factors for micro-pollutants are estimated as the sum of concentrations of a list of several representative micro-pollutants, each divided by an appropriate threshold indicative of toxic risks. For the modelling of micro-pollutant removal in wastewater treatment plants we use the SimpleTreat model[53], used for risk assessment within the European Union System for the Evaluation of Substances (EUSES)[54]. For advanced treatment, we refer to measured removal efficiency in ozonation and adsorption on activated carbon for a set of representative substances.

All details of the analysis, including an in-depth discussion of assumptions and limitations, are presented in Pistocchi et al., 2022a[55] containing also all the data on micro-pollutant properties used for the estimation. **Table A4. 2** summarizes the emission factors adopted in the impact assessment. This representation of emission factors is equivalent to assigning "weights" to the discharges of wastewater subject to different treatments, so that the results appear as "untreated wastewater equivalent discharges".

Level of treatment	Emission factor (normalized TU)
Untreated wastewater	1.0000
Primary treatment effluents	0.6595
Secondary treatment effluents	0.3148
Tertiary treatment effluents	0.2955

[53] https://www.rivm.nl/en/soil-and-water/simpletreat
[54] https://echa.europa.eu/support/dossier-submission-tools/euses
[55] Supporting Report 13 in Annex 10

Advanced treatment effluents	0.0783

Table A4. 2– *Emission factors for micro-pollutants,* *expressed as dimension less toxic units and normalized by assigning a unit value for untreated wastewater.*

A specific model of GHG emissions has been developed for this impact assessment (Parravicini et al., 2022[56]) drawing on the 2019 refinement of the IPCC Guidelines for national GHG inventories. The emissions of a WWTP depend on various design and operational parameters that are not known for the plants included in the database used for the assessment. Therefore an emission factor was estimated for a set of typologies of plant configurations. For each plant, we considered the average of emissions from the typologies compatible with the plant's size and level of treatment. ***Figure A4. 1*** plots the emission factors for the typologies considered in Parravicini et al., 2022[17].

[56] Supporting report 9 in Annex 10

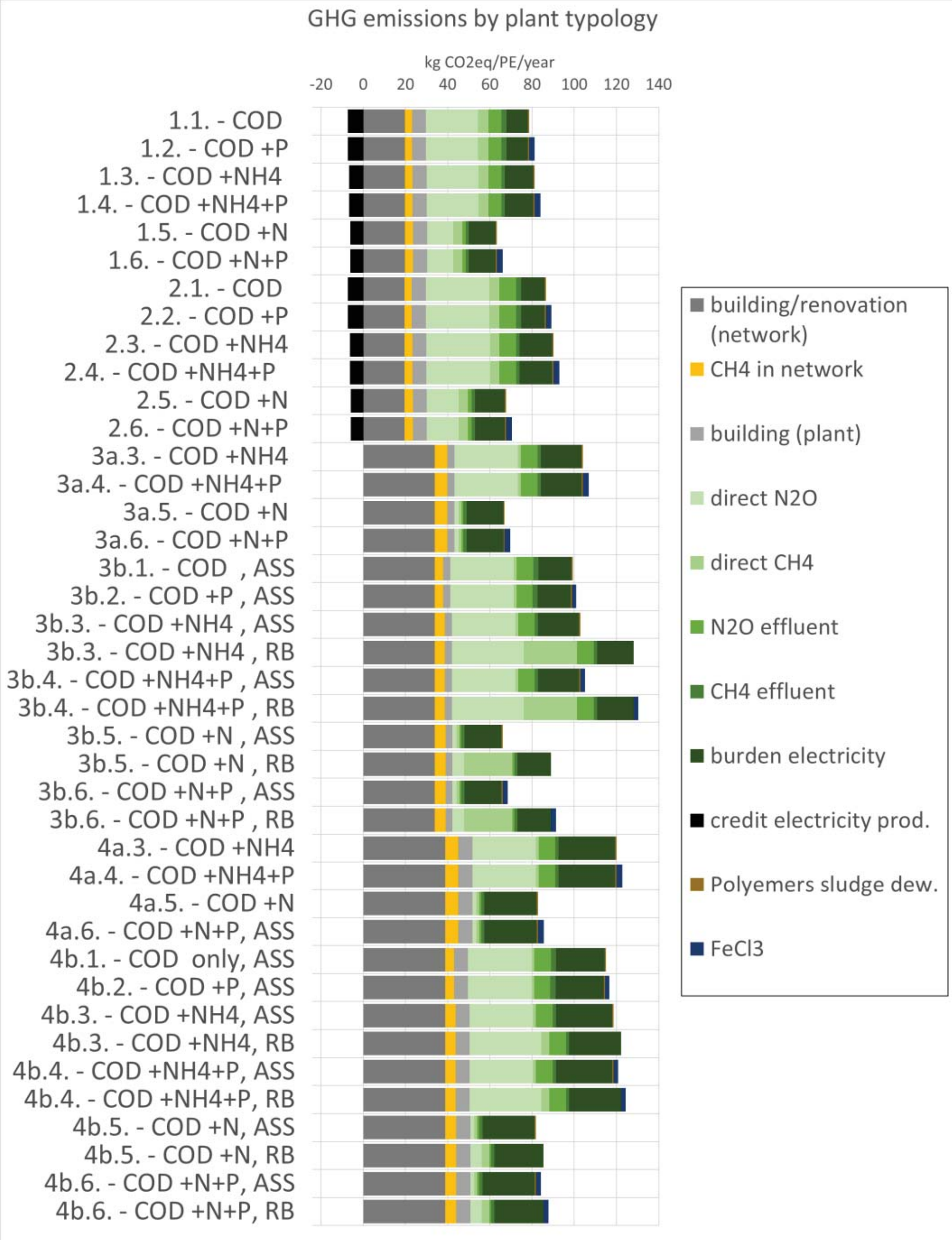


Figure A4. 1– Emission factors for the typologies of plant configurations considered in the IA.

For the Evaluation of costs of conventional wastewater treatment we used the OECD-endorsed FEASIBLE model[57] to quantify the costs of upgrading a WWTP from secondary to tertiary treatment. In particular, we refer to the expenditure functions described in Appendix 3 of the model documentation[58], as updated more recently in a study on the costs of compliance with the UWWTD[59].

[57] https://www.oecd.org/env/outreach/methodologyandfeasiblecomputermodel.htm
[58] https://www.oecd.org/env/outreach/36227787.pdf
[59] https://ec.europa.eu/environment/water/water-urbanwaste/info/pdf/Cost%20of%20UWWTD-Final%20report_2010.pdf

For the costs of advanced treatment for the removal of micro-pollutants, we used the simple expenditure function proposed and discussed in Pistocchi, 2022b[60]. For the costs of treatment of small agglomerations, we used a combination of costs from the FEASIBLE expenditure functions and the expenditure functions proposed in a study on the Danube region (Pistocchi et al., 2020)[61].

All details on the calculation of costs of upgrade for nutrient removal, as well as micro-pollutant removal, are presented in Pistocchi et al., 2022b[62], and in Pistocchi et al., 2022c[63]. Details on the costs of extending the scope of the UWWTD to smaller agglomerations are provided in Pistocchi et al., 2022d[64]. For the quantification of the benefits, we have assumed a shadow price of avoided BOD emissions of 50 €/t, and a shadow price of 1 kg of avoided N or P equal to 20 and 30 €, respectively[24]. For GHG emissions, we assume a shadow price of 100 Euro/t CO2e.

For coliforms, micro-pollutants and micro-plastics, it was not possible to identify a valid shadow price. The benefits of removing these pollutants are therefore not quantified.

2. Modelling impacts of policy scenarios at the level of the whole stream network

While most of the policy options are evaluated on the basis of the above calculations, for nutrients and micro-pollutants we quantified the change in the conditions of the receiving water bodies through appropriate indicators. For nutrients, we used the GREEN model (Grizzetti et al., 2021[65]) to compute the discharges of N and P to the EU regional seas taking into account also other sources of nutrients (agriculture, atmospheric deposition etc.). For micro-pollutants, we computed the distribution of toxicity, both at the discharge point for individual WWTPs, and for the whole stream network taking into account the accumulation of contaminants from upstream to downstream. These calculations are further discussed in detail in Pistocchi et al., 2022a[16] and Pistocchi et al., 2022c[24].

3. Modelling costs and impacts of policy scenarios on storm water overflows (SWO)

SWO are a potentially significant source of pollution in Europe. However, we lack data and knowledge about their current occurrence and existing management practices. In order to support the analysis of policy options, we have developed a dedicated hydrological model (Quaranta et al., 2022a[66]) that was reality-checked with satisfactory results (ibid.). The model was then used to appraise the impacts and costs of various action strategies, representative of policy scenarios. The results are discussed in detail in Quaranta et al., 2022b[67].

4. Model uncertainties

The main uncertainties linked with the use of the models are concisely recalled here for each area of model application. When feasible and relevant, a sensitivity analysis was performed to better understand the limits of the model. In general terms, it should be stressed that:

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[60] See Annex 10, report 14
[61] https://publications.jrc.ec.europa.eu/repository/handle/JRC115606
[62] Supporting report 15 in Annex 10
[63] Supporting report 14 in Annex 10
[64] Supporting report 10 in Annex 10
[65] https://www.sciencedirect.com/science/article/pii/S0959378021000601
[66] Supporting report 17 in Annex 10
[67] Supporting report 18 in Annex 10

- Cost estimates are uncertain at least within a factor 2 in absolute terms. Costs of all policy measures depend on local conditions warranting for a high variability and specificity of costs.

- The quantification of impacts varies with the emission factors in a linear way, so the uncertainties on emission factors reflect directly in uncertainties on impacts.

- The uncertainties on individual emission factors are high and (in some cases) difficult to even quantify. However, for the impact assessment the relative change in emission factors among scenarios is most important, and is expected to be much less uncertain.

- In order to make sure that uncertain emission factors do not yield misleading conclusions for policy, we have complemented the more "technical" sensitivity analysis and discussion of uncertainty with a qualitative assessment of the "safety" of assumptions, where we show that even stretching the assumptions to the limits of plausibility would not significantly affect the conclusions of the impact assessment. Further details are provided in the following sections.

5. *Detailed analytical methods – micro-pollutants*

Quantification of policy impacts[68]

The impact of implementing of advanced treated is evaluated by analysing how two indicators of water pollution change under different policy scenarios.

The first one (L) is an indicator of aggregated toxic loads with reference to a set of *m* WWTPs and *l* agglomerations in the EU:

$$L = w_0 \sum_{k=1}^{l} P_k\, \delta_{0,k} + w_I \sum_{k=1}^{l} P_k\, \delta_{I,k} + w_I \sum_{j=1}^{m} P_j\, \delta_{I,j} + w_{II} \sum_{j=1}^{m} P_j\, \delta_{II,j} + w_{III} \sum_{j=1}^{m} P_j\, \delta_{III,j} + w_{IV} \sum_{j=1}^{m} P_j\, \delta_{IV,j} \qquad \text{(Eq 1)}$$

Where:

- $w_0, w_I, w_{II}, w_{III}, w_{IV}$ are the emission factors (normalized toxic units) for untreated wastewater and wastewater treated at primary, secondary, tertiary or advanced level (),
- P_k is the wastewater load, expressed in population equivalent (pe), in the k-th agglomeration,
- P_j the wastewater load treated by the j-th WWTP in pe,
- $\delta_{0,k}$ and $\delta_{I,k}$the fractions of P_k that are untreated or treated mechanically,
- $\delta_{I,j}$, $\delta_{II,j}$, $\delta_{III,j}$ and $\delta_{IV,j}$ are Boolean variables equal to 1 if the j-the WWTP provides mechanical, biological carbon removal or denitrification or advanced treatment, respectively, and 0 otherwise.

The data on agglomerations and wastewater treatment plants are drawn from the 10th UWWTD implementation report database. Indicator L is expressed in units of population equivalents (p.e.).

[68] All details of the modelling summarized here are presented and discussed in Pistocchi, 2022a[55]

The "population equivalents" of an emission represent the discharge of pollutants expressed in terms of the number of persons that would generate the same discharge (before any treatment). So for instance a WWTP treating 100 thousand p.e. with a removal efficiency of BOD of 95% corresponds to a discharge of 100 x (1-0.95)= 5 thousand p.e. for BOD. The same plant would correspond e.g. to 20 thousand p.e. for total N if its N removal efficiency were 80%. p.e. of discharges must be always interpreted with reference to a specific contaminant, as highlighted by the above example with BOD and N. Referring to p.e. instead of more physical units (e.g. tonnes per year) enables presenting results on the same scale for all pollutants of concern (BOD, N, P, coliforms, micro-pollutants).

Converting p.e. to tonnes/year is always possible, provided that we know the emission per capita. This is the case for BOD (60 g/PE/day), N (roughly 11-12 g/PE/day) and P (roughly 1.5 g/PE/day). In certain cases (e.g. micro-pollutants), we do not know the emission per capita. In these cases, we can still compute p.e. if we know the removal efficiency of different types of treatment. These are the reasons why the results are presented in terms of p.e. A practical advantage is also that p.e. are relatively easy to visualize: for instance, if we say that EU CSO convey 9 million p.e. of pollution, we can imagine them as the total load (before any treatment) of the population of Austria.

The second one (CT) takes the form of a map accounting for the accumulation of all toxic loads from their point of release along the stream network. At a point (x,y) in the stream network the map is computed as:

$$CT(x,y) = w_0 \frac{\int_{A(x,y)} P_{0(\xi,\zeta)} d\xi d\eta}{Q_{(x,y)}} + w_I \frac{\int_{A(x,y)} P_{I(\xi,\zeta)} d\xi d\eta}{Q_{(x,y)}} + w_{II} \frac{\int_{A(x,y)} P_{II(\xi,\zeta)} d\xi d\eta}{Q_{(x,y)}} + w_{III} \frac{\int_{A(x,y)} P_{III(\xi,\zeta)} d\xi d\eta}{Q_{(x,y)}} + w_{IV} \frac{\int_{A(x,y)} P_{IV(\xi,\zeta)} d\xi d\eta}{Q_{(x,y)}} \quad \text{(Eq 2)}$$

Where:

- $P_{0(x,y)}, P_{I(x,y)}, P_{II(x,y)}, P_{III(x,y)}, P_{IV(x,y)}$ are the wastewater discharges at location (x,y) (expressed in PE) subject to no treatment, mechanical, biological treatment for carbon removal, for nitrogen removal and advanced treatment, respectively,
- $Q_{(x,y)}$ is the diluting discharge at (x,y), A(x,y) is the drainage area at point (x,y).

Wastewater discharges accounted for include not only WWTPs and releases from IAS and untreated wastewater in agglomerations, but also discharges from other European countries not reported under the UWWTD, as well as smaller agglomerations outside the scope of the UWWTD. The map CT(x,y) is computed at the cells (x,y) of a regular grid of 5 km resolution over Europe in a GIS using standard map-algebraic operations with flow accumulation operators as described in detail in Pistocchi, 2014[69].

Indicator CT is expressed in the rather abstract units of p.e. m^{-3} s, but can be interpreted in a more informative way if we assume a certain emission rate per p.e. For the sake of illustration, we refer to the example of diclofenac, a drug commonly considered of

[69] https://onlinelibrary.wiley.com/doi/book/10.1002/9781118523667

concern for which we can assume an environmental quality standard (EQS) of 100 ng/L (Ort et al., 2009; EC, 2012). If we assume that a p.e. corresponds to an emission of 240 ug/day of diclofenac to wastewater (ibid.), then 1,000, 10,000 and 50,000 p.e. m-3 s correspond to a concentration of about 3 ng/L, 30 ng/L and 150 ng/L, respectively. These concentrations are estimated assuming an annual average discharge, and may be higher during low flow, or lower during high flow conditions.

Therefore our thresholds may be regarded as discriminating situations where concentrations are low (<1,000 p.e. m^{-3} s), medium-low (1,000-10,000 p.e. m^{-3} s), medium-high (usually below EQS but at risk of exceedance in case of low flows: 10,000-50,000 p.e. m^{-3} s) and high (usually above EQS: > 50,000 p.e. m^{-3} s). This categorization is based on diclofenac, and would be valid for any other micro-pollutant having a similar ratio between emission rate (ER) and EQS. For micro-pollutants with higher ER/EQS, a lower amount of p.e. could be conveyed per m3 s-1 of streamflow before exceeding the EQS, and the other way around for micro-pollutants with lower ER/EQS.

The calculation of indicator L is performed in MS Excel, while CT is computed using ArcGIS 10.7 (Spatial Analyst extension).

The analytical structure is simple and transparent, and calculations can be followed in details (e.g. by inspecting Excel formulas and ArcGIS command scripts).

The indicators are used as proxy of the toxic pollution associated with wastewater under the following key assumptions, limitations and simplifications:

1. The chemical mixture composition of wastewater is constant across the EU and in time.

2. The assumed concentrations of individual micro-pollutants, on the basis of available measurements, are representative.

3. Advanced treatment is assumed to consist of ozonation, activated carbon or a combination of the two in different process configurations. The latter are assumed to be largely equivalent to each other in terms of aggregated toxicity reduction.

4. The removal of micro-pollutants in conventional wastewater treatment is represented by the SimpleTreat model using the partitioning and degradation properties of the substances that can be inferred from the available data.

5. For advanced treatment, the removal efficiency is represented by measured removal efficiencies of the known chemicals. In the case advanced treatment removal efficiency for a substance is not known, we assume the substance is removed as the average of the known substances. This assumption is particularly critical as the available data on removal are limited, and in practice the majority of chemicals is removed as the average.

6. Additionally, for indicator CT we consider only toxicity caused by wastewater (neglecting e.g. urban runoff, agricultural pesticides, industrial chemicals and other emissions potentially overriding the effect of wastewater. Moreover, we consider the micro-pollutants as conservative in the stream network after discharge.

The above assumptions are apparently crude approximations laden with limitations (see Pistocchi et al., 2022a, for more details). However, their introduction leads to the estimation of the toxicity emission factors shown in **Table A4. 2**, which is reasonably in line with the expectations: the toxicity of untreated wastewater is reduced by a factor > 3 with conventional treatment, which may allow meeting environmental quality standards in many cases, but advanced treatment is needed to reduce toxicity by one order of magnitude or more. Measurements suggest that advanced treatment may reduce toxicity even more, but this would only strengthen the recommendations deriving from this modelling exercise. Therefore, it can be concluded that the representation is acceptable insofar as not misleading. For indicator CT, neglecting other sources of contamination may be appropriate for those chemicals (such as pharmaceuticals) for which urban wastewater is expected to be a key driver. For other classes of pollutants, wastewater may be a minor, or anyway a secondary source.

In addition to the impacts in terms of toxicity indicators, we have quantified the greenhouse gas (GHG) emissions of advanced treatment, assuming an average emission factor of 0.225 kg CO2e/m3 of wastewater treated, and a wastewater volume to treat of 200 L/PE/day[21].

The approach has been developed in collaboration with a network of leading experts in Europe, presented at specific workshops and meetings with stakeholders and subject to scientific peer-review in fully open access form (including supporting material with all the data used in the calculation)[16].

Quantification of policy costs[70]

The cost of advanced treatment (€/PE/year including investments and operation) is described by the following simple expenditure function:

$$C_{adv}=1000\ PE^{-0.45} \qquad (Eq\ 3)$$

This function corresponds to the available evidence and is accurate within a factor 2 (Pistocchi et al., 2022b[21]). In addition to the costs of advanced treatment, in some scenarios certain WWTPs might be required to implement advanced treatment even if not currently required to perform nitrogen removal (tertiary treatment). In this case, we calculate also a cost of upgrading the plant from secondary to tertiary treatment. To this end, we assume the costs of upgrade to correspond to the difference between costs of new tertiary and secondary plants, plus 50% of the costs of a new secondary plant to account for the potentially significant infrastructural overhaul. The costs of upgrade are described with the FEASIBLE expenditure functions[19, 20]. This cost is likely overestimated and provides a “worst case” bound to the overall costs. In the calculation, we assume a lifetime of the investment of 30 years, and a discount rate of 2.5%.

The method has been designed in order to explore the trade-offs between costs and effectiveness of advanced wastewater treatment for micro-pollutant removal. The calculation is quick and transparent and enables comparing several scenarios in order to define precisely the Pareto front of trade-offs.

[70] Supporting report 15 in Annex 10

As a starting point, we compute the indicators L and CT for the present conditions ("baseline") and the conditions of full compliance with the current directive, not yet achieved although quite close in reach.

We also assume that, in the absence of a specific provision, advanced treatment will not be implemented. This is a "pessimistic" assumption, because some initiatives are already being undertaken notably in Germany, Sweden, Denmark and the Netherlands. However, stakeholder consultations and Member State surveys (see Annex 5) have highlighted how in most of the EU there is no appetite for advanced treatment, and even within the above mentioned countries the subscription to advanced treatment is not always enthusiastic due to the relatively high costs entailed.

We then compare the baseline and full compliance scenarios with scenarios of advanced treatment implemented at all plants above a certain treatment capacity (expressed as PE), and when the dilution ratio (annual average flow of the receiving water body divided by the effluent discharge) is less than a minimum value. Pistocchi et al., 2022a[16] and Pistocchi et al., 2022b[21] present a systematic exploration of all combinations of capacity thresholds between 0 and 1 million PE, and dilution thresholds between 2 and infinity.

For each scenario, the calculated indicator L is compared with those under baseline and full compliance scenarios. Moreover, for each scenario we can compute the costs of advanced treatment (and the additional costs of upgrading conventional treatment from secondary to tertiary), and the value of L plotted as a function of the corresponding costs indicates the cost-effectiveness of the scenario. While L is a scalar number, indicator CT is a map. In order to compare CT maps for the baseline/full compliance and the various scenarios, we refer to the percentage of the stream network (on which CT is computed) under conditions of "high", "medium", and "low" toxicity as discussed above. While the reader is referred to the supporting reports[16, 21] for the full exploration of scenarios, here we focus on representative scenarios:

- "low ambition": all plants with a treatment capacity of 100,000 p.e. or more, discharging in water bodies with any dilution are required to implement advanced treatment;

- "high ambition": advanced treatment at all plants above 10,000 p.e. and with dilution of 100 or less;

- "medium option": advanced treatment at all plants above 100,000 p.e. irrespective of dilution, and between 10,000 and 100,000 p.e. only when justified by the environmental risks caused by the toxicity of the effluents, which we expect to be the case when the dilution is 10 or less. For scenario modelling purposes, we assume that risks occur in 70% of the cases when effluents are discharged with a dilution of 10 or less, excluding discharges to seawater.

Table A4. 3 shows a comparison of indicator L among the 4 scenarios, as well as the current and baseline scenarios, for all Member States and the EU. ***Table A4.4*** shows the corresponding costs of advanced treatment.

The results of this scenario analysis suffer from the uncertainty in the calculation of the toxicity emission factors discussed above, while costs can be considered uncertain within a factor of 2. On the other hand, the uncertainty in the *difference* among scenarios is arguably much smaller, although it is not possible to quantify it.

As all the WWTPs in Europe under a full compliance scenario have a biological (secondary or tertiary) treatment process, obviously the value of indicator L normalized by the value under full compliance is approximately proportional to the following quantity:

$$L \sim 1 - (1 - a)b$$

where a is the ratio between the emission factors of advanced treatment and of biological (secondary or tertiary) treatment, and b the fraction of the treated load undergoing advanced treatment.

Parameter a is assumed to be about 0.3 (see ***Table A4. 4***) in our assessment, but could be in principle any value between 0, meaning that advanced treatment removes toxic emissions completely, and 1, meaning advanced treatment is not effective at all. Measurements at European WWTPs suggest, however, that an advanced treatment may reduce toxicity more than we assume in this analysis, meaning the ratio could be lower than the assumed value of ca. 0.3 (see Pistocchi et al., 2022a[16], for a more detailed discussion).

	Current	Baseline	Low ambition	High ambition	Preferred Option
AT	6,119,085	6,108,046	3,546,436	4,016,808	3,438,856
BE	2,742,273	2,723,002	1,969,469	1,295,348	1,738,730
BG	2,414,676	2,120,715	1,192,954	818,890	1,097,659
CY	247,404	247,404	128,582	71,756	109,705
CZ	2,606,374	2,592,882	1,890,969	1,452,995	1,782,165
DE	32,754,448	32,722,942	21,240,721	17,977,985	19,424,388
DK	3,434,246	3,427,488	2,059,544	1,160,506	1,803,292
EE	467,417	467,092	224,967	179,905	218,287
EL	3,169,802	3,169,656	1,429,615	1,036,919	1,299,737
ES	19,548,256	18,865,567	9,962,682	7,227,673	8,784,926
FI	1,558,348	1,542,112	970,737	708,047	859,729
FR	21,239,621	21,212,684	13,736,729	12,803,272	13,025,377
HR	1,259,648	831,086	655,425	501,687	583,036
HU	3,621,328	3,507,410	2,188,519	2,074,575	1,786,917
IE	1,564,034	1,528,949	807,688	656,659	780,328
IT	23,550,204	22,136,548	14,511,265	10,524,659	12,991,187
LT	835,613	835,021	451,115	346,437	415,460
LU	189,550	187,892	146,144	85,375	118,943
LV	459,302	455,703	291,351	226,829	279,275
MT	233,874	233,874	68,377	96,973	68,377
NL	5,750,272	5,745,852	3,317,420	2,071,206	2,717,265
PL	11,492,932	11,277,713	7,154,561	5,588,834	6,231,897
PT	4,117,119	3,741,518	2,151,928	1,577,466	1,993,711
RO	4,388,110	3,758,579	2,074,170	1,624,079	1,883,691
SE	3,750,202	3,730,919	2,159,454	1,798,495	1,976,559
SI	417,493	392,153	297,248	279,597	293,388
SK	1,066,615	1,050,489	749,180	640,810	712,648
EU total	***158,998,247***	***154,613,295***	95,377,249	76,843,786	86,415,534

Table A4. 3– indicator L under the 5 representative scenarios. Values in pe.

	Low ambition (€)	High ambition (€)	Preferred option (€)
AT	33,210,752	46,218,522	37,634,807
BE	11,707,932	41,768,823	21,949,684
BG	10,684,777	27,658,707	14,110,021
CY	2,221,470	4,047,861	2,527,273
CZ	9,510,998	29,613,650	14,178,119
DE	163,933,461	395,431,303	238,477,441
DK	25,743,637	61,573,612	33,680,164
EE	4,145,769	6,576,343	4,926,170
EL	12,527,860	27,840,446	14,622,260
ES	117,778,928	233,330,473	162,112,160
FI	8,422,797	19,358,750	13,046,187
FR	100,866,076	205,704,604	130,822,544
HR	2,593,678	11,240,852	5,292,965
HU	17,815,481	43,511,578	33,482,887
IE	7,139,764	14,036,162	8,965,060
IT	115,125,309	284,333,910	168,242,744
LT	5,321,231	9,394,797	6,565,971
LU	805,524	2,930,275	1,683,707
LV	1,633,313	4,373,038	2,510,885
MT	2,101,382	1,477,121	2,101,382
NL	42,911,706	93,937,353	64,774,361
PL	64,718,529	148,376,715	101,748,705
PT	26,269,579	49,993,994	31,301,446
RO	24,670,642	43,627,782	32,114,988
SE	21,925,166	44,336,138	29,257,162
SI	1,697,477	2,870,358	1,697,477
SK	5,869,996	12,018,361	7,686,018
EU	841,353,236	1,865,581,530	1,185,512,586

Table A4. 4– costs of advanced treatment under the 3 representative scenarios. Values in €.

Figure A4. 1 shows that, for very different values of a, L changes much less as per the above linear relationship with b, so a large error on a would reflect in a smaller error on L.

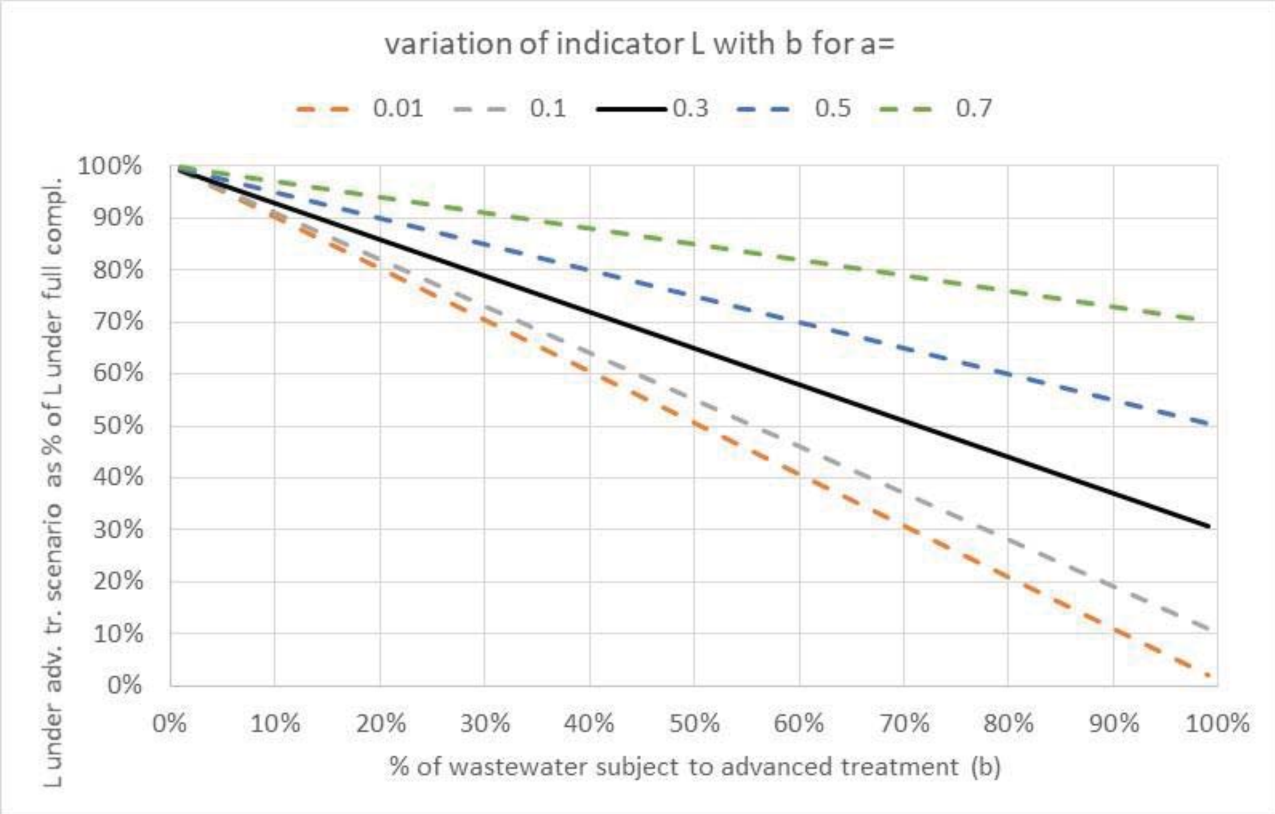

Figure A4. 2–variation of indicator L (*represented here as a percentage of the value of L under full compliance) to the % of wastewater subject to advanced treatment (b), for values of a from 0.01 to 0.7 (a value a=0.3 (continuous black line) represents the assumption made in this analysis).*

6. Detailed analytical methods - Nutrients

General description of the methods

In order to appraise the costs and benefits of nutrient removal, we calculate the discharge of total N and total P under the various policy scenarios, as:

$$D_x = (1-\eta_{Ix})\sum_{j=1}^{m}\varepsilon_{x,j}P_j\,\delta_{I,j} + (1-\eta_{IIx})\sum_{j=1}^{m}\varepsilon_{x,j}P_j\,\delta_{II,j} + (1-\eta_{IIIx})\sum_{j=1}^{m}\varepsilon_{x,j}P_j\,\delta_{III,j}$$

Where:

- x=N, P,

- $\varepsilon_{x,j}$ is the emission factor for N or P at the j^{th} WWTP,

- $\eta_{Ix}, \eta_{IIx}, \eta_{IIIx}$ are the removal efficiencies for N and P at primary, secondary or tertiary level of treatment, respectively,

- P_j the wastewater load treated by the j-th WWTP in PE

- $\delta_{I,j}$, $\delta_{II,j}$, $\delta_{III,j}$ are Boolean variables equal to 1 if the j-the WWTP provides primary, secondary or tertiary treatment, respectively, and 0 otherwise.

The WWTPs considered in the analysis are the same described under the previous section, and were characterized on the basis of the data from the 10th Implementation report of the UWWTD. The removal efficiency for N and P is given in A4.1 The emission factors for N and P are assumed to vary by country as per ***Table A4. 5***.

Country	N (g/year per capita)	P in excreta (g/year per capita)	P in detergents (g/year per capita)
Austria	4443	515	95
Belgium	4033	471	82
Bulgaria	3399	430	100
Switzerland	3923	445	11
Cyprus	3695	457	100
Czechia	3581	421	100
Germany	4235	490	100
Denmark	4653	516	100
Spain	4345	496	100
Estonia	4181	474	100
Finland	4785	541	100
France	4432	521	100
Greece	4232	510	100
Croatia	3623	431	100
Hungary	3511	420	100
Ireland	4498	530	100
Italy	4161	512	60
Lithuania	5066	590	100
Luxembourg	4514	514	95
Latvia	4177	491	100
Malta	4596	541	100
Netherlands	4383	483	82.1
Poland	4189	503	100
Portugal	4596	522	100
Romania	4370	541	100
Slovakia	2803	339	100
Slovenia	3966	481	100
Sweden	4344	484	100

Table A4. 5 – Emission factors for N and P assumed in this study.

The policy options entail the upgrading of certain plants from secondary to tertiary treatment. We assume the corresponding costs to equal the difference between costs of new tertiary and secondary plants, plus 50% of the costs of a new secondary plant to account for the potentially significant infrastructural overhaul. The costs of upgrade are described with the FEASIBLE expenditure functions[19,20]. This cost is likely overestimated and provides a "worst case" bound to the overall costs. In the calculation, we assume a lifetime of the investment of 30 years, and a discount rate of 2.5%.

Under some policy options, the removal efficiency of N and P is increased above current standards, from 75% to 85% for N and from 85% to 90% for P. In both cases, we assume the additional costs to be 10% of the annualized cost of a tertiary treatment plant (capital repayment, operation and management), the latter evaluated using the abovementioned FEASIBLE model expenditure functions.

The changes in GHG emissions under the various policy options have been evaluated using the approach discussed in a dedicated section below. All calculations are implemented in MS Excel © as discussed in detail in Pistocchi et al., 2022[24].

For the quantification of the benefits, we have assumed a shadow price of GHG emissions of 100 €/t CO2e, and a shadow price of 1 kg of N or P removed from the effluents equal to 20 and 30 €, respectively[24].

How the method has been applied in the impact assessment?

The approach has been broadly discussed with experts involved in the development of supporting scientific work[24], and presented and discussed at conferences and workshops during the preparation of this IA. The approach has been designed specifically to provide a simple and transparent quantification of the policy options.

7. *Detailed analytical methods - Stormwater overflows (SWO)*

For the modelling of SWO, we developed and applied an urban-scale hydrological model simulating combined sewer flows using an input time series of precipitation at the resolution of 3 hours. The model is described in detail in Quaranta et al., 2022a[27], and was developed by the JRC in the form of an Excel © workbook. The model itself is available as supplementary electronic material with the cited paper. It was developed with the contribution of various European experts, initially convened at a technical workshop organized by the JRC in 2019. Some of the contributing experts were also involved in the verification and calibration of the model as well as the analysis of scenarios as described in details in Quaranta et al., 2022b[28].

The model is applied to describe a unit-area (1 hectare) urban hydrological response unit (HRU) of impervious ground connected to a combined sewer receiving the wastewater generated by a population equal to the average population density of an urban area. The lumped, conceptual hydrological model has the analytical structure of a cascade of 3 linear reservoir models with 6 parameters reflecting the rate constant of the reservoir and the volume filling threshold triggering an overflow (see Quaranta et al., 2022a[27], for details).

The model has been applied to 671 HRUs each with the precipitation time series and population density of one of the 671 functional urban areas (FUA) of Europe, as detailed in Quaranta et al., 2022a. The parameters of the model were assigned in order to reflect a realistic "average" condition of European combined sewer networks, and were found to yield an acceptably realistic description of the initial situation in a specific model verification exercise (see Quaranta et al., 2022a[27], for details).

Both SWO volume, and the volume of dry-weather wastewater flow (DWF) released with the SWO, computed for a 1 ha urban HRU for each FUA were then multiplied by the impervious area of the FUA and summed by EU member state. The resulting sums were multiplied, for each country, by the % of population assumed to be serviced with combined sewers in each country, and by a correction factor representing the ratio of the total impervious urban area in a country, divided by the total impervious area of the FUAs in the country (see ***Table A4. 7***).

The model parameters were then changed to simulate the various measures that can be in principle taken to reduce SWO. The scenario chosen for reference, representing a condition where SWO is managed so that they meet the proposed standards (SWO not discharging more than 1% of the yearly dry-weather wastewater generated in the catchment), includes:

- greening measures in line with the Biodiversity strategy, ensuring an additional surface storage volume of 5 mm in combined-sewer urban areas, combined with

- constructed wetlands (CW) removing 50% of the pollution of SWO before discharge.

The CW are sized in order to detain SWO for 1 day (24 hours). The volume of the required CW is calculated as the average of the 50^{th} and 75^{th} percentiles of the cumulative SWO over 24 hours. The total volume required for CW is shown in ***Table A4. 8***. This is calculated on the basis of the impervious urban area in the FUA within each country, and the percentage of this area that is served by CS. In this case, we do not correct for the ratio of the total impervious urban area in a country, divided by the total impervious area of the FUAs in the country. This accounts for the potential of inexpensive solutions, particularly in less densely populated zones. Inexpensive solutions include the buffering of overflows in marginal land, effectively avoiding most of the discharge directly to water bodies, as well as the simple disconnection of stormwater drainage from sewers by allowing runoff dispersion directly on land.

The cost of a CW is estimated from an investment cost of 500 Euro/m3, a discount rate of 2.5%, a lifetime of 30 years, and an operation and maintenance cost (O&M) of 1% per year. The costs of urban greening are not included in the assessment, as they pertain to other specific initiatives and deliver benefits much beyond SWO control.

The various policy options considered in this assessment differ for the size threshold of agglomerations for which SWO management is required. The cost of CW, as well as the avoided volumes of overflow and of DWF in overflow, are computed under the assumption that SWO management applies to all agglomerations, and then multiplied by the population in agglomerations subject to measures as a fraction of the total population. Information on the factors used for the calculation are provided in ***Table A4. 8***. Particularly, the policy options shown in Table 3 in Section 6.1 of this assessment are evaluated considering the population in agglomerations above 100,000 PE (option 1), the population above 100,000 PE and 30% of that between 10,000 and 100,000 PE (option 2), and the sum of population above 100,000 PE and between 10,000 and 100,000 PE (option 3).

The impacts and benefits of the policy options considered in the IA were evaluated by multiplying the results obtained for each EU Member State, by the percentage of the population equivalents covered with different thresholds of agglomeration size (10 and 100 thousand PE) as for the costs. Impacts are meant here as the reduction of pollutant loads discharged through overflows.

To this end, we convert the volumes of overflow assuming that 1 PE corresponds to 73 m3/year (200 l/day) of DWF, 60 g BOD/day, 11.18 g N/day and 1.68 g P/day. Runoff in overflows is converted to PE assuming the concentrations shown in Table A4. 6, or equivalently considering the volumes of overflow as volumes of sewage subject to a treatment with a given removal efficiency, as shown in the table.

Pollutant	Concentration mg/L	Equivalent removal efficiency
BOD	7.77	97%
N	2	96%
P	0.27	97%
Toxicity(*)	0.50	50%

Table A4. 6 – assumed concentrations in runoff, and corresponding removal efficiency that would make treated sewage equivalent to runoff. (*) Toxicity (dimensionless) of runoff is assumed to be 50% of that of untreated sewage.

For the quantification of the benefits, we have assumed a shadow price of avoided BOD emissions of 50 €/t, and a shadow price of 1 kg of avoided N or P equal to 20 and 30 €, respectively[24].

Additional benefits not included in the above monetization are those from the removal of micro-pollutants and micro-plastics, as well as those related to the reduction of fish die-offs and impairment of the water bodies as a consequence of reduced pollution episodes. Johnson and Geisendorf, 2022[71] quantify the willingness to pay (WTP) for the latter in about 100 Euro/person/year for the case of Berlin. For a given policy option, we extrapolate this WTP by multiplying, for each country, the total number of population equivalents in the agglomerations of the size range affected by the policy (Table A.4.8) by the assumed % of agglomerations implementing specific measures for SWO reduction, and the assumed % of urban areas served by combined sewer networks (Table A.4.7) and by the WTP of 100 Euro/PE/year. This represents a likely upper limit to the benefits expected from SWO management. In order to avoid overestimations of the benefits, we assume for Europe a WTP equal to 10% of the one in Berlin, on average.

[71] https://www.sciencedirect.com/science/article/pii/S0301479722000810?via%3Dihub#

EU Member State	***Population served by combined sewers***	***Correction factor (Total to FUA impervious area)***
AT	28.0%	2.00
BE	92.3%	1.99
BG	0.0%	2.12
CY	100.0%	1.77
CZ	0.0%	1.80
DE	46.1%	1.49
DK	50.0%	1.70
EE	50.0%	2.07
EL	39.0%	2.38
ES	13.0%	2.26
FI	17.5%	2.52
FR	32.0%	1.83
HR	59.0%	2.83
HU	32.5%	2.24
IE	24.0%	2.10
IT	70.0%	2.34
LT	50.0%	2.62
LU	90.0%	1.00
LV	50.0%	3.03
MT	100.0%	1.12
NL	73.0%	1.59
PL	92.0%	2.00
PT	34.0%	2.41
RO	0.0%	3.03
SE	12.0%	2.47
SI	59.0%	3.01
SK	7.5%	3.00

Table A4. 7– EU Member State factors used for the calculation of SWO

	Overflow volume Mm3/y, current conditions	Volume of DWF in overflows Mm3/y, current conditions	Reduction of DWF in overflows with measures, Mm3/y	Reduction of overflow with measures, Mm3/y	Volume of CW required for overflow treatment (m^3)	PE in agglo 10-100 k PE	PE in agglo > 100 k PE	PE in agglomerations, total
AT	59	2	0.48	11.57	571,255	7,417,950	11,493,783	20,670,206
BE	259	27	6.57	55.78	2,717,920	3,854,900	4,287,600	9,231,350
BG	0	0	0.00	0.00	-	2,481,677	4,043,148	7,448,278
CY	27	2	0.58	6.08	597,602	381,000	400,000	849,500
CZ	0	0	0.00	0.00	-	4,152,849	3,258,497	9,348,994
DE	773	35	7.76	133.53	6,525,214	48,938,729	53,011,623	112,009,321
DK	104	11	2.63	21.85	1,055,605	4,906,031	5,452,145	11,598,945
EE	8	1	0.24	1.80	101,507	504,117	923,961	1,589,716
EL	63	4	1.26	14.88	1,446,670	19,425,222	39,135,381	65,207,923
ES	92	8	1.88	19.84	2,056,473	2,083,050	2,386,500	5,057,300
FI	27	3	0.71	6.12	309,888	26,750,168	35,178,994	72,482,923
FR	841	68	21.61	233.24	10,797,463	2,845,037	7,270,546	11,021,837
HR	86	6	1.31	15.80	1,063,079	2,532,958	1,661,154	4,999,712
HU	42	4	1.09	9.68	785,497	4,982,145	6,833,741	13,588,976
IE	34	3	0.92	8.38	297,335	1,439,948	3,146,478	5,080,615
IT	1287	90	23.66	290.12	20,141,349	30,696,516	37,108,985	77,187,042
LT	15	2	0.49	3.77	223,036	946,880	1,796,720	2,905,700
LU	42	4	0.83	7.70	373,767	259,190	231,359	637,438
LV	6	1	0.14	1.10	99,210	706,183	673,670	1,611,113
MT	12	1	0.38	4.09	310,741	52,313	736,726	789,039
NL	135	6	2.17	35.23	2,234,155	7,349,318	11,623,761	19,444,506
PL	414	43	11.03	91.69	6,314,024	13,903,757	20,035,549	38,542,418
PT	164	11	3.07	41.28	2,334,196	3,902,270	6,959,400	12,250,540
RO	0	0	0.00	0.00	-	5,105,297	8,431,853	16,169,845
SE	22	2	0.65	5.55	272,739	4,114,260	7,148,200	12,517,265
SI	57	4	0.66	8.49	611,116	502,032	436,270	1,462,223
SK	6	1	0.11	1.05	87,887	1,904,850	1,255,500	4,088,385

Table A4. 8– factors used for the calculation of SWO. DWF = dry weather flow.

8. Detailed analytical methods - Small agglomerations

Small agglomerations are not covered by the current scope of the UWWTD, and systematic data are not available at European scale concerning agglomerations below 2000 PE. Hence, a key issue with the assessment of policy options concerning small agglomerations is the estimation of the number of agglomerations and cumulative population living therein. This assessment is based on a model simulation of agglomerations smaller than 2000 PE, as presented in Pistocchi, 2022[72].

[72] Supporting report 10 in Annex 10

The simulation is based on the spatial distribution of population available for Europe according to the Global Human Settlements Layer (GHSL)[73], and compares favourably with information available on small agglomerations in the different MS gathered in a study in support to the IA[74]. The simulation suffers from an overestimation of population living in small agglomerations as discussed in Pistocchi, 2022. In order to correct this bias, we considered the average between the simulation and a previous estimate used in the GREEN model[75].

The latter was based on the difference between the population of each member state, and the population corresponding to the population equivalents reported for agglomerations above 2000 p.e. under the UWWTD, and appears to be underestimating. The two estimates differ by a factor of about 3, and their average is still compatible the information gathered in the different MS. The loads from small agglomerations remain affected by a significant uncertainty, close to a factor 2, as further discussed in Pistocchi, 2022. The dataset of simulated agglomerations is publicly available as supplementary electronic material of the cited paper.

Table A4. 9 summarizes the assumed population in the various EU MS living in agglomerations between 50 and 2000 PE. This is assumed to undergo a given level of treatment, based on the information gathered in each MS concerning the current practice[35].

Based on the estimated population in small agglomerations, we compute the costs and pollution reduction due to improving the treatment level from current conditions to policy scenario standards. The policy options considered entail enforcement of a secondary (biological) treatment for all agglomerations above a certain population size. When a MS has a level of treatment already equivalent to secondary or more stringent, the policy does not cause any change. Also, agglomerations below the size assumed for the policy scenario do not change their assumed current level of treatment. When small agglomerations have a level of treatment less stringent than secondary, we represent the cost of upgrade to a secondary system as (Pistocchi, 2022):

Annualized Cost = $218.36 * P^{-0.37}$ (€/PE/year)

This cost corresponds to assuming that (1) agglomerations are initially equipped with septic tanks, (2) a sewer network does not exist in the agglomeration; and (3) the secondary treatment plant is a constructed wetland.

The reduction of pollution achieved by expanding the scope of the UWWTD to smaller agglomerations is evaluated as the difference between loads emitted under baseline and under policy scenario conditions. To this end, we assume the emission factors for conventional pollutants as shown in **Table A4. 1**. For the quantification of the benefits, we have assumed a shadow price of avoided BOD emissions of 50 €/t, and a shadow price of 1 kg of avoided N or P equal to 20 and 30 €, respectively[24].

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[73] https://ghsl.jrc.ec.europa.eu/

[74] Annex 10, report 1

[75] Vigiak, O., Grizzetti, B., Zanni, M., Dorati, C., Bouraoui, F., Aloe, A., Pistocchi A., Estimation of domestic and industrial waste emissions to European waters in the 2010s, EUR 29451 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97297-3 , doi:10.2760/08152, JRC113729.

	Untreated	Mechanical	Biological	More stringent	Total
AT	-	-	1,009,259	-	1,009,259
BE	-	-	-	924,016	924,016
BG	-	1,008,806	-	-	1,008,806
CY	-	-	247,538	-	247,538
CZ	-	-	2,120,496	-	2,120,496
DE	-	-	6,923,236	-	6,923,236
DK	-	-	-	489,605	489,605
EE	-	-	99,698	-	99,698
EL	-	-	1,341,030	-	1,341,030
ES	-	2,256,118	-	-	2,256,118
FI	-	-	-	722,561	722,561
FR	-	-	9,667,829	-	9,667,829
HR	-	511,990	-	-	511,990
HU	-	-	1,042,439	-	1,042,439
IE	-	-	575,845	-	575,845
IT	-	3,468,576	-	-	3,468,576
LT	-	655,136	-	-	655,136
LU	-	-	64,439	-	64,439
LV	-	-	460,709	-	460,709
MT	-	-	2,180	-	2,180
NL	-	-	-	572,870	572,870
PL	8,419,068	-	-	-	8,419,068
PT	-	-	959,706	-	959,706
RO	-	2,799,874	-	-	2,799,874
SE	702,693	-	-	-	702,693
SI	-	626,849	-	-	626,849
SK	-	-	1,616,210	-	1,616,210
total	9,121,761	11,327,349	26,130,613	2,709,052	49,288,776

Table A4. 9– Assumed load of wastewater (PE) from agglomerations smaller than 2000 PE, at different levels of treatment. Estimations are based on detailed results from Annex 5

9. *Detailed analytical methods - Greenhouse gas emissions*

General description of the method

Greenhouse gas (GHG) emissions are computed for each wastewater treatment plant on the basis of its size and level of treatment, using the emission factors described in Parravicini et al., 2022[76], based on a specific improvement of the IPCC 2019 Guidelines to account for the state of current knowledge of GHG emissions from the wastewater sector. The emissions of all WWTPs were summed by country and at EU scale, to yield the total emissions from the sector. Under an energy neutrality scenario, we assume electricity to come at zero emissions. For a climate-neutral scenario we assume the emissions corresponding to the average of two scenarios, namely:

- A scenario with systematic implementation of simultaneous aerobic stabilization of the sludge, yielding the lowest possible N2O emissions;
- A scenario with systematic implementation of anaerobic digestion with delivery of bio-methane to the gas grid, thus displacing fossil methane, yielding low emissions of CH4 and credits from the displaced fossil fuel.

The model calculations are all implemented in an Excel © workbook, provided for open access as supplementary electronic material to Parravicini et al., 2022[37]. The JRC developed the model with leading European experts after thorough consultation of additional experts from the sector (in government, academia and industry).

Although the validation of GHG emissions from the wastewater sector is problematic for various reasons also due to the difficulty of measurements and their generalization, the results of the calculation were found in line with the current literature, as discussed in Parravicini et al., 2022[37].

10. Micro-plastics

Under all policy options, we quantify the change in microplastics emissions with effluents and runoff. For runoff, we assume an amount of Tire wear particles (TWP) generated in Europe equal to 1,327,000 t/a according to Wagner et al. (2018). Of this amount, we assume 10% (132,700 t/a) ends up in urban runoff, uniformly distributed across the EU. With 57.7 billion m3/a of urban runoff (Pistocchi et al., 2019), this results in an average concentration of 2.3 mg/L TWP. Plastics in WWTP effluents are assumed to equal 560 mg/PE/a according to Simon et al. (2018), as the result of a 95% removal in WWTPs. This is not the average removal rate of a WWTP, but a representative value for the plants Simon et al., (2018) refer to. Hence in untreated sewage the plastics amount to 560 / (1-0.95) = 11200 mg/PE/a. The concentration in untreated sewage, assuming 200 l/PE/day of sewage, is 11200 / (365*0.2) mg/m3 = 0.157 mg/L. when comparing the various policy options, we consider a removal efficiency of microplastics in WWTPs equal to 70% for primary treatment, 85% for secondary, 90% for tertiary and 99% for advanced treatment.

Additional details can be found in Obermaier and Pistocchi, 2022[77] .

[76] Supporting report 9 in Annex 10.

[77] See Annex 10, report 15

11. Definition of the reference maximum technical feasibility scenario

In order to appraise the impacts of the preferred policy options, we compare them with the scenario corresponding to the “maximum technical feasibility” option for each specific problem. This is summarized in the following table.

Specific problem	Maximum technical feasibility scenario	Reasoning
Storm water overflows (SWO)	Doubling of the removal under the preferred option	Result of combining the most extensive preventive measure with the treatment of overflows as in the preferred option.
Micro-pollutants	All plants above 5,000 p.e. discharging with a dilution ratio of 100 or less are treated	An upper limit of advanced treatment requirements.
Nutrients	All plants above 2000 p.e. are required to remove N and P with higher efficiency than current	The maximum removal that can be achieved before regulating smaller agglomerations as well.
Small agglomerations	All agglomerations above 100 p.e. are required to have at least a secondary treatment	Assumed upper limit of regulation.

12. References of supporting reports - see Annex 10 documents 8 to 18.

Annex 5: Summary of Member State Situation

On top of the core consultation activities, Member States were consulted on the basis of pre-filled overviews. MS had the opportunity to comment, provide their feedback and validate on these pre-filled overviews. The Member State overviews were filled in, consolidated with the inputs from the EPR Feasibility study, reviewed by the Commission and sent to the Member States for the opportunity to complete the information, comment on the content and any assumptions made, notably for the modelling.

Member States have had 4-6 weeks to verify their national information presented in the overview and to challenge the assumptions made by the project team on likely impacts of possible change to the legislative framework for their country.

The EC has received 25 Member State responses to the overviews.

Member State overviews cover all areas of intervention considered as part of the impact assessment. The overviews are mostly descriptive and present the current practices in Member States, including where practices go beyond the requirements of the UWWTD. It also included the main assumptions used in the context of the modelling.

Section	Summary
Storm water overflows and urban runoff	• Urban runoff management differs significantly between Member States. • 12 of 21 reporting Member States have mainly separate sewers with the minority combined. However, there is a wide variety of combinations among Member States and differences between older and newer urban areas. • Several Member States report that new additional urban areas are serviced by separate sewers. • 2 Member States reported a reference to treatment requirements for ‘first rain’. • Several Member States reported treatment of overflows and several Member States also reported explicit dilution rates. • 5 reported the use of Integrated Management Plans.
Smaller agglomerations	• Evidence collected from 21 Member State authorities suggests that there may be more than 85.000 agglomerations below 2.000 p.e. across these countries. • For 15 Member States, the majority of small agglomerations are connected to an urban wastewater treatment plant. • In 2 Member States, individual and appropriate systems are most commonly used to manage urban wastewater from small agglomerations.
Individual or other Appropriate Systems	• 26 Member States have national legislation on IAS in place but there are a few that do not have specific regulatory frameworks for IAS either for smaller agglomerations or for all agglomerations independent of size. • 17 Member States reported that the connection to the public

	sewer system is mandatory where available (sometimes facilitated by financial incentives). • The predominant types of IAS installed are cesspools and septic tanks. At least 9 Member States do not report the use of IAS in agglomerations < 2000 p.e. (not required by the UWWTD). • At least 14 Member States require a permit for the use of IAS. • At least 13 Member States do not centrally record use of IAS through a national database. • The inspection and monitoring schemes across the Member States vary to a great extent.
Sensitive areas (in combination with nutrient removal)	• Only 9 Member States apply stricter measures than those set in the Directive. • 10 countries apply more stringent standards for certain pollutants or for smaller agglomerations or include new agglomerations size range. • The majority of Member States have a nitrification requirement. • The majority of the Member States have designated part of their territories as sensitive areas; only 11 Member States go beyond UWWTD by classifying their whole territory as Sensitive Areas. Drivers mentioned include orthophosphate/phosphorous compound levels, vulnerability, the status of water bodies according to WFD, eutrophication, poor status of receiving waters. • A specific national definition for eutrophication often does not exist and only 3 Member States use a methodology aligned with the Nitrates Directive. • 13 Member States do not apply a nutrient balance calculation. • Only 9 Member States are entirely designated as Nitrate Vulnerable Zones (NVZ). • 5 Member States identified a link when designating NVZs with sensitive zones under the UWWTD.
Micro-pollutants	• Each Member State has different approaches to the monitoring and treatment of micro-pollutants, and the predicted future uptake of 4th stage treatment technologies varies widely between Member States.
Industrial discharges	• 11 Member States have mandatory pollutant-specific treatment level for UWWTPs receiving industrial discharges (from either IED installations or SMEs). • 9 Member States have specific provisions in their legislation regarding the specification for pre-treatment of wastewater from industrial sites as mandatory. • The setting of limit values for industrial wastewater discharges to UWWTP is performed differentially based on prescriptive provisions in regulations or permits or based on operational agreements.

Energy efficiency, generation and climate neutrality	•	In 10 Member States, no legislation in relation to energy efficiency requirements is in place. • There is legislation and/or guidance, to various extents, in place in 8 Member States. • There are 9 Member States with a requirement to carry out energy audits in UWWTPs. • In most cases, Member States have taken no action in relation to the energy efficiency of UWWTPs (only 2 Member States have concrete legislative measures in place).
Greenhouse gas emissions, including methane	•	12 Member States do not have any information available on average emissions of greenhouse gases. • Another 8 Member States have information available on average emissions of greenhouse gases.
Circular economy (sludge reuse)	•	Sewage sludge is not used in agriculture in several Member States due to concerns related to contaminants. Alternatives such as incineration (with or without energy recovery) are often used. • Pre-treatment of industrial discharges is mandated in several Member States. • Assessment of micro-pollutants is being undertaken by several Member States. • Of the information that was identified, 4th stage treatment is not planned to be widely used in the near future by Member States.
Monitoring and Reporting	•	All Member States have adopted sampling frequencies that comply with the requirements of the UWWTD. • 6 Member States have not set any other sampling frequencies than those set in the Directive. • 11 Member States have set additional frequencies for sampling of UWWTPs below 2.000 p.e. • 5 Member States have set frequencies taking into other parameters than the size of the WWTPs (e.g., sampling per parameters). • The sampling process and sampling parameters vary between Member States and are covered within Appendix B in detail. • 12 Member States have indicated that continuous monitoring is a common practice in wastewater treatment plants (and an addition 5 Member States have continuous monitoring the largest WWTPs) and that data from continuous monitoring is available to water authorities. • Member States show some diversity on the monitoring of TOC. • All Member States (who responded to this topic) indicated that exact measurements, including concentrations are made available to authorities. • In many instances, the monitoring requirements are detailed in the permit of the UWWTPs.
Wastewater	•	A Europe-wide Umbrella Study was conducted to monitor the

surveillance		presence of the SARS-CoV-2 virus (that causes COVID-19) in the population. On 17/03/2021, the EU Commission published a Recommendation on a common approach to establish a systematic surveillance of SARS-CoV-2 and its variants in wastewaters in the EU. • The Umbrella Study involved 17 Member States.
Information to the public	•	Requirements for public consultation and participation are in place in 5 Member States and are primarily in place in relation to EIAs for new UWWTPs. • Additional requirements in relation to reporting (made available to the public) is in place in 13 Member States.
Access to sanitation	•	The specific recognition of the right to sanitation is only subject to the national legislation of 1 Member State. • Other countries have made attempts to different extents.
Access to justice	•	Of the Member States for whom information was identified, 2 Member States identified specific legal provisions for access to justice and 2 Member States identified their transposition of the Aarhus convention. Furthermore, several Member States identified that no additional requirements on access to justice beyond the UWWTD are applied.

Source: Wood report Section 3 p.21-22, see Annex 10, report 1

ANNEX 6: ASSESSING COMPLIANCE

To assess compliance, the following examples of organisation of the data to be gathered can be considered:

I. Agglomerations

II. Population of each municipality/agglomeration

III. Individual and other Appropriate Systems

a. Data on exceedances

b. Type of IAS applied

c. Measures in place to ensure inspection

IV. Storm water overflows and urban runoff

a. Existence of integrated management plan

b. % of system that is combined / separate

c. Results of data monitored notably for what relates to the % of pollutants releases compared to dry weather conditions or equivalent data

d. Information on separate sewer discharges

V. Access to sanitation

a. Identification of the vulnerable/marginalised people and measures taken to ensure/improve access to sanitation

b. Measures taken to improve access to sanitation in the cities

VI. Treatment Plants

a. Volume of urban wastewater treated by each treatment plan and design capacity

b. Parametric values of effluent at UWWTPs discharge point

i. Data on concentrations

ii. Data on percentage of reduction (for secondary, tertiary with stricter P & N thresholds and fourth treatment for micro-pollutant removal)

iii. Data on toxicity (e.g. from bio-assays)[78]

[78] As included in Commission Implementing Decision (EU) 2016/902) establishing best available techniques (BAT) conclusions for common wastewater and waste gas treatment/ management systems in

iv. Other parametric values (e.g. Environmental Quality Standards Directive parameters)

b. Energy use and reduction over time; and energy production

i. If an audit system is in place and date of last audit

ii. Baseline of last 3 years of energy use in kWh/p.e[79]

iii. % reduction over X years achieved.

c. Greenhouse gas emissions and reduction of emissions over time

i. Report on performance indicators (see IPCC 2006, 2019)

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the chemical sector: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016D0902&from=EN

[79] Baseline should account for the energy consumption for new treatment technologies applied to reduce micro-pollutants in treated urban wastewater

ANNEX 7: ADDITIONAL DETAILED INFORMATION

	Collection - Article 3	Secondary - Article 4	More stringent - Article 5
AT	0%	0%	0%
BE	0%	0%	1%
BG	5%	18%	20%
CY	15%	15%	16%
CZ	0%	0%	21%
DE	0%	0%	0%
DK	0%	0%	1%
EE	0%	0%	0%
EL	0%	4%	1%
ES	0%	9%	16%
FI	0%	1%	2%
FR	0%	6%	6%
HR	11%	67%	89%
HU	3%	12%	10%
IE	0%	50%	75%
IT	1%	12%	6%
LV	0%	0%	0%
LT	0%	0%	0%
LU	0%	0%	1%
MT	0%	98%	100%
NL	0%	0%	0%
PL	0%	1%	4%
PT	0%	6%	15%
RO	36%	66%	59%
SE	0%	1%	3%
SI	1%	26%	36%
SK	1%	1%	2%

Table A7.1: Distance to target per MS in 2018, source: Annex 10, report 7

	BOD	Nitrogen	Phosphorus	*E. coli*	Micro-pollutants
SWO	9.497.956	9.497.956	9.497.956	9.497.956	9.497.956
Urban runoff	3.021.652	4.178.561	4.655.970	11.669.055	58.345.277
Non Compliant IAS	9.761.177	8.437.746	8.437.746	10.328.361	8.860.309
Compliant IAS	653.509	4.901.318	4.356.727	1.089.182	3.428.287
Small Agglo	16.461.634	30.143.614	28.044.961	18.639.594	25.634.454
Non compliant load from wastewater plants	4.420.871	3.601.479	11.541.423	5.272.255	2.312.323
Remaining compliant load treated in wastewater plants	22.332.023	130.366.051	82.065.999	14.614.358	156.048.652
Total remaining load	66.148.823	191.126.725	148.600.784	71.110.762	264.127.257

Table A7.2: Remaining loads sent to the environment - source JRC, See annex 4

	Treated load (pe)	Treated load (%)	Cumulative load (%)	Number of facilities	Number of facilities(%)	Cumulative number (%)
<1000	24.644.388	4,32%	100,00%	30.354	41,51%	100,00%
1001-2000	24.644.388	4,32%	95,68%	19.138	26,17%	58,49%
2001-10.000	56.691.407	9,94%	91,36%	16.102	22,02%	32,31%
10.001-100.000	199.793.943	35,02%	81,42%	6.610	9,04%	10,29%
100.001-1.000.000	165.897.806	29,08%	46,41%	864	1,18%	1,25%
> 1.000.000	98.865.557	17,33%	17,33%	53	0,07%	0,07%
Total	570.537.489	100%		73.121	100%	

Table A7. 3: Treated load, number of treatment plants per category size (source – JRC 2021)

Agglomeration	Treated load (pe)	Treated load (%)	Cumulative load (%)	Number of agglomerations	Number of agglomerations(%)	Cumulative number tions (%)
< 1000	24.644.388	4,15%	100,00%	30.354	42,63%	100,00%
1001 - 2000	24.644.388	4,15%	95,85%	19.138	26,88%	57,37%
2001 - 10.000	63.626.959	10,72%	91,70%	13.954	19,60%	30,49%
10.001 - 100.000	202.455.997	34,10%	80,98%	6.840	9,61%	10,89%
100.001 – 1M	216.413.317	36,45%	46,88%	876	1,23%	1,28%
> 1.000.001	61.891.051	10,43%	10,43%	38	0,05%	0,05%
Total	593.676.100	100%		71.200	100%	

Table A7.4: Treated load, number of agglomerations (based on MS reports for agglomerations above 2.000 p.e. and on JRC below 2.000 – see Annex 10, report 7 and 10)

	BOD	Nitrogen	Phosphorus	E. Coli.	Micro-pollutants
AT	982.988	4.841.959	2.591.978	569.588	7.269.045
BE	1.335.367	3.213.281	2.219.618	1.569.320	6.932.759
BG	1.200.409	2.761.572	2.186.688	1.213.787	2.942.393
CY	132.994	378.495	286.978	165.853	699.318
CZ	645.548	3.136.876	2.199.997	533.381	3.545.495
DE	6.045.065	27.373.203	16.335.408	4.269.852	43.559.047
DK	793.354	2.876.336	1.614.096	636.738	4.920.322
EE	109.766	407.577	243.584	82.476	633.860
EL	867.769	3.293.870	4.409.166	801.879	4.897.692
ES	6.224.028	24.792.808	19.527.424	7.427.139	24.235.427
FI	370.575	1.973.909	807.885	504.821	2.289.153
FR	5.892.901	24.048.613	18.930.021	6.342.548	36.055.353
HR	2.903.371	4.912.404	4.567.034	3.674.225	5.683.355
HU	2.139.098	5.278.430	4.196.803	2.249.799	6.120.729
IE	554.087	2.611.671	2.100.435	837.615	2.402.121
IT	11.698.165	30.222.485	27.497.639	14.944.615	48.568.544
LT	556.669	1.204.833	889.115	583.722	1.626.472
LU	101.079	253.551	180.764	130.651	525.712
LV	149.437	565.518	404.267	149.434	721.932
MT	50.921	188.181	337.330	42.372	332.704
NL	1.017.682	4.350.802	2.417.517	660.753	7.470.835
PL	11.881.413	19.508.154	16.023.586	11.954.366	26.443.195
PT	1.791.299	6.381.166	5.769.058	2.638.153	7.439.871
RO	6.146.977	9.379.433	8.166.039	6.366.004	9.683.748
SE	1.300.473	3.975.096	2.060.985	1.214.548	4.870.822
SI	709.482	1.241.119	1.110.856	945.243	2.201.401
SK	547.903	1.955.381	1.526.514	601.881	2.055.954
Total	66.148.823	191.126.725	148.600.784	71.110.762	264.127.257

Table A7.5: Starting position - remaining total pollution per MS *(p.e. per year)*

	BOD	Nitrogen	Phosphorus	E. Coli	Micro-pollutants
AT	982.712	4.776.459	2.587.832	546.008	7.264.004
BE	1.305.155	3.124.313	2.095.212	1.517.803	6.903.582
BG	830.195	2.718.057	2.100.757	875.145	2.787.322
CY	119.700	365.201	273.684	152.559	686.024
CZ	512.585	3.049.183	1.961.037	387.226	3.444.735
DE	6.030.528	27.313.726	15.632.341	4.246.324	43.564.031
DK	792.313	2.864.136	1.596.993	632.346	4.919.383
EE	100.572	398.545	232.128	73.444	624.827
EL	726.442	3.197.615	4.310.627	641.453	4.787.093
ES	4.463.935	23.347.879	16.544.830	5.502.645	22.850.725
FI	348.909	1.959.779	779.625	481.271	2.272.917
FR	5.860.178	23.875.125	17.034.481	6.280.093	36.042.001
HR	956.981	3.553.503	3.208.133	1.476.053	4.136.872
HU	817.798	4.190.002	3.104.480	820.218	4.966.007
IE	428.232	2.514.022	2.010.150	691.295	2.303.401
IT	9.140.615	28.943.614	24.393.328	12.102.546	47.165.347
LT	520.846	1.180.826	855.909	543.711	1.598.889
LU	98.239	242.233	166.729	124.799	523.383
LV	126.268	628.487	403.443	133.166	756.559
MT	50.921	188.181	337.330	42.372	332.704
NL	1.015.153	4.295.523	2.312.854	640.852	7.466.581
PL	11.413.974	18.760.109	13.940.937	11.403.368	26.111.479
PT	1.229.235	5.992.623	5.299.321	2.003.827	7.001.877
RO	1.911.616	4.903.262	3.275.387	1.900.529	5.625.198
SE	1.300.473	3.900.146	2.060.985	1.187.566	4.865.055
SI	584.185	1.044.244	856.609	787.973	2.090.006
SK	299.015	1.760.707	1.246.470	315.554	1.864.623
Total	51.966.775	179.087.499	128.621.614	55.510.146	252.954.625

Table A7.6: Full implementation - remaining total pollution per MS *(p.e. per year)*

	PE (BOD)	PE (N)	PE (P)	PE (coli.)	PE (tox)
AT	973.984	3.224.208	1.665.054	27.261	4.528.605
BE	1.209.235	2.438.914	1.652.186	1.167.253	5.538.284
BG	661.450	1.768.241	1.184.964	382.876	1.632.070
CY	111.726	289.076	222.510	115.771	511.584
CZ	512.585	2.531.274	1.640.524	200.779	2.634.019
DE	5.928.573	19.502.774	10.887.951	1.287.057	29.611.873
DK	759.590	1.978.244	1.054.752	278.307	3.167.187
EE	97.388	266.098	150.665	22.483	364.488
EL	705.892	2.267.789	2.403.258	281.297	2.814.172
ES	4.121.344	11.910.806	5.191.524	1.070.721	12.377.161
FI	336.300	1.250.743	453.216	212.271	1.539.761
FR	5.607.007	17.070.757	11.198.073	3.528.963	26.663.693
HR	865.910	2.928.612	2.461.106	1.157.893	3.671.634
HU	800.686	2.990.945	1.959.827	369.689	3.175.191
IE	415.898	1.285.630	637.899	235.380	1.503.459
IT	8.112.554	19.592.485	14.875.127	7.663.326	35.339.851
LT	461.895	915.395	682.866	394.405	1.109.306
LU	91.646	197.602	137.537	101.350	426.589
LV	123.037	522.994	338.644	91.812	568.102
MT	48.621	106.644	150.587	10.280	156.396
NL	988.001	2.758.223	1.401.863	49.112	4.270.128
PL	9.745.509	15.090.633	11.243.121	8.786.994	19.368.415
PT	1.175.483	3.124.260	1.917.666	901.137	4.960.512
RO	1.395.384	3.591.525	2.354.828	968.387	3.345.888
SE	1.115.151	2.671.245	1.323.520	603.183	2.941.002
SI	510.509	911.032	751.431	667.741	1.856.563
SK	296.257	1.538.638	1.101.687	232.432	1.514.533
EU 27	47.171.616	122.724.787	79.042.386	30.753.638	175.590.463

Table A7.7: Preferred option - remaining total pollution per MS by 2040 *(p.e. per year)*

	SWO	Advanced treatment	N removal	P removal	Small agglomerations
AT	3.560.329,31	37.634.807	32.379.268	5.291.899	-
BE	16.330.626,78	21.949.684	12.952.199	2.116.851	-
BG	-	14.110.021	29.355.506	6.456.473	8.219.939
CY	3.742.600,63	2.527.273	1.514.832	259.727	-
CZ	-	14.178.119	11.435.666	1.869.953	-
DE	40.457.861,96	238.477.441	167.387.373	27.364.710	-
DK	6.421.552,56	33.680.164	17.792.156	2.908.121	-
EE	621.158,85	4.926.170	2.692.551	440.598	-
EL	8.850.101,31	14.622.260	20.164.361	16.206.301	-
ES	12.380.600,66	162.112.160	433.509.361	79.209.160	20.951.645
FI	1.803.587,45	13.046.187	25.749.799	1.249.958	-
FR	67.504.427,91	130.822.544	199.545.499	41.598.903	-
HR	6.074.831,94	5.292.965	27.095.418	6.384.738	3.767.257
HU	4.652.621,94	33.482.887	39.995.041	8.904.487	-
IE	1.828.429,24	8.965.060	54.094.724	11.983.135	-
IT	120.526.543,74	168.242.744	310.661.745	76.238.048	40.257.269
LT	1.434.560,68	6.565.971	4.657.565	761.559	1.615.957
LU	1.959.380,80	1.683.707	821.998	134.039	-
LV	578.808,45	2.510.885	2.216.124	362.289	-
MT	2.116.764,86	2.101.382	1.818.724	1.632.185	-
NL	14.850.045,72	64.774.361	31.792.349	5.192.741	-
PL	37.874.231,11	101.748.705	56.357.670	9.214.379	27.484.957
PT	14.097.828,85	31.301.446	124.114.881	29.627.744	-
RO	-	32.114.988	20.130.685	3.291.664	31.165.876
SE	1.671.644,53	29.257.162	30.846.067	3.175.212	5.464.910
SI	2.671.321,25	1.697.477	1.868.410	322.912	1.478.466
SK	462.787,78	7.686.018	4.880.057	797.844	-
EU 27	372.472.648	1.185.512.586	1.665.830.029	342.995.630	140.406.278

Table A7.8: Detailed costs of the preferred option per Member State (€ per year by 2040)

	Total benefits (€/year)	Total costs (€/year)
AT	174.914.995	78.866.303
BE	94.494.053	53.349.360
BG	100.232.620	58.141.939
CY	10.082.786	8.044.433
CZ	56.105.349	27.483.738
DE	953.191.567	473.687.386
DK	106.556.866	60.801.994
EE	15.582.780	8.680.477
EL	260.765.336	59.843.024
ES	1.150.729.864	708.162.927
FI	166.668.941	41.849.532
FR	678.512.609	439.471.374
HR	74.757.636	48.615.210
HU	141.983.549	87.035.037
IE	137.425.378	76.871.348
IT	1.157.375.180	715.926.350
LT	31.024.455	15.035.613
LU	6.040.250	4.599.125
LV	13.156.919	5.668.106
MT	12.747.036	7.669.056
NL	197.125.498	116.609.496
PL	475.052.545	232.679.943
PT	325.829.876	199.141.900
RO	132.592.302	86.703.213
SE	129.501.116	70.414.996
SI	15.757.529	8.038.587
SK	24.638.474	13.826.707
EU 27	6.642.845.627	3.707.217.171

Table A7.9: Total costs and benefits of the preferred option per MS by 2040

	Total cost €/year/inhab	Total benefits €/year/inhab
AT	5,20	19,58
BE	3,49	8,17
BG	4,16	14,49
CY	7,29	11,25
CZ	1,50	5,24
DE	3,68	11,46
DK	7,36	18,25
EE	4,50	11,72
EL	3,71	24,41
ES	5,80	24,28
FI	2,91	30,12
FR	3,56	10,06
HR	5,33	18,52
HU	4,83	14,59
IE	4,55	27,45
IT	6,84	19,53
LT	3,71	11,10
LU	5,95	9,52
LV	1,82	6,95
MT	11,34	24,70
NL	4,85	11,28
PL	4,66	12,55
PT	7,29	31,64
RO	3,47	6,91
SE	3,81	12,48
SI	2,93	7,47
SK	1,64	4,51

Table A7.10: 2040 costs and benefits of the preferred option per inhabitant

ANNEX 8: MAIN RELATIONS BETWEEN ONGOING INITIATIVES AND THE PRESENT INITIATIVE

Initiative	Brief description of the initiative	Potential interactions and added value of the preferred option	Sections in the IA were interactions are described
Evaluation of the Sewage Sludge Directive	This Directive regulates the use of sludge in agriculture and includes limit values (mainly for heavy metals) when sewage sludge is used in agriculture. The Directive is under evaluation before deciding on its possible revision.	Measures aiming at better controlling pollution at source notably for non-domestic pollution will contribute to improve the quality of the sludge making it more suitable for agriculture. Actions to better capture and treat SWOs and urban run-off are expected to allow capturing more micro-plastics and increase their presence in sludge. Moving towards energy neutrality will only happen if more sludge is digested (production of biogas).	The potential consequences on sludge management of the proposed measures are identified in the IA (sections 1, 7.1, 5.2.8 and 6.6).
Revised Industrial Emission Directive	The Industrial Emission Directive (IED) regulates water and air emissions from large industrial facilities.	Most of the large facilities are located outside the cities and are not connected to the urban collection system. When they are connected, the ongoing revision of the IED will contribute to better control wastewater emissions from large industrial facilities notably for what relates to non-domestic pollution. Reversely, actions aiming at better controlling the incoming waters in the wastewater treatment plants will help reducing possible emissions from IED facilities connected to the public network.	The interactions between the IED and the proposed revised UWWTD are identified in sections 1, 2.1.1.7, 5.2.6 and 7.1.
Revised Energy Efficiency Directive (EED) and Renewable Energy Directive (RED)	The proposal for a revised EED requires MS to further reduce their energy consumption by 9% by 2030 (compared to 2020). Energy audits are imposed for enterprises consuming large amounts of energy. The exemplarity of the public sector is highlighted and a specific objective is included in the EED for the public sector (1,7% reduction per year). The proposal for a revised Renewable Energy Directive set a binding target of 40 % for the overall share of energy from renewable sources in the EU's gross final consumption of energy in 2030.	Moving towards energy neutrality for the wastewater sector by 2040 will directly contribute to reach the objectives of the RED and the EED as combination of measures will be necessary to meet energy neutrality (more energy efficiency, production of bio-gas and installation of renewables). The optimal combination of measures needs to be defined at each plant level based on in depth energy audits - which are not required for wastewater treatment plants under the EED. Fixing a specific energy neutrality objective for the sector will help capturing the specific potential from this sector while promoting the development of optimal solutions at local level.	The interactions with the RED and EED as well as the necessity of a specific target of energy neutrality for the sector is explained in section 2.1.2.2 (problem definition), 5.1 (baseline), 5.2.7 and 7.1
Climate Regulation, Effort sharing regulation and 'Fit for	The Climate Regulation includes a legally binding objective of climate neutrality for the EU by 2050. The Efforts Sharing Regulation (ESR) request MS to reduce GHG emissions from the sectors not covered by the EU Emission Trading Scheme - including wastewater treatment. Binding national emission reduction targets are included in the ESR. The 'Fit for 55'	Moving towards energy neutrality by 2040 of the wastewater sector will directly contribute to reduce its GHG emissions (around 46,45% of the 'avoidable' emissions of the sector). It will help to achieve the objectives of the ESR, the Climate regulation and the "Fit for 55" package (62,5% reduction compared to 1990 levels).	The impacts of energy neutrality on GHG emissions are discussed in section 5.1, 5.2.7 and 7.1

55' package	package includes different measures ailing at reaching a reduction of GHG emissions of 55% by 2030 (compared to the 1990 levels).		
RePowerEU	The plan aims at rapidly reduce dependence on Russian fossil fuels and fast forward the green transition	The preferred option through the energy neutrality objective will directly contribute to the objectives of the REPowerEU plan: more biogas and more renewables are expected to be produced while at the same time efforts will be achieved to reduce energy use. The REPower plan will on the other side help achieving the energy neutrality objective for the sector notably by promoting the 'to-go areas' which could include wastewater treatment plants and offering new funding opportunities for renewables and energy savings.	The potential influence of the REPowerEU plan is discussed in section 5.1 (Baseline scenario)) and 7.1 (preferred option).
Proposal for Nature Restoration Regulation (NRR)	The proposal of NRR aims at ensuring that there is an increase in the total national area of urban green space in cities and towns and suburbs of at least 3 % of the total area of cities and towns and suburbs in 2021, by 2040, and at least 5 % by 2050.	The NRR will directly contribute to increase the green areas in the cities and therefore the capacities of urban soils to absorb rain water. In case heavy rains, less 'clean' rain water will be mixed to polluted waters in the urban collecting systems and less untreated water will be sent to the environment. The precise effects on water absorption of Nature Restoration targets will depend on the very local circumstances, but both legislation will act in a synergetic way. The NRR was taken into account in the modelling (see annex 4).	The influence of the Nature restoration targets on the SWOs and urban run-off management is detailed in sections 1, 7.1 and 6.1.
Initiative on micro-plastics	The Micro-plastics initiative is expected to reduce non-intentional micro-plastics emissions from some sources such as the textile, tyre or plastic pellets.	With the planned initiative and in the mid-term, less emissions of micro-plastics from these sectors could expected in urban wastewaters. But even if all possible measures are taken to reduce emissions at source, there will always be residual emissions. Micro-plastics are well captured in wastewater treatment plants (between 80% up to 99% when tertiary treatment is in place). The proposed set of measures (notably measures to better manage urban run-off and SWOs, to impose more tertiary treatment for N/P but also to improve IAS and cover smaller agglomerations from 1.000 p.e.) will improve the abilities of capturing more micro-plastics in the collecting and treatment system. This will complement the envisaged measures under the micro-plastic initiative.	The expected interactions between the initiative on micro-plastics and the review of the UWWTD are discussed in sections 1, 2.1.1.6, and 7.1.

ANNEX 9: ACTORS INVOLVED IN AN EPR SCHEME AND THEIR RESPECTIVE ROLES

The roles and responsibilities of the main actors involved in the possible EPR scheme is displayed in Figure 9.1 below and summarised in the following Table (main source: report 2 in Annex 10).

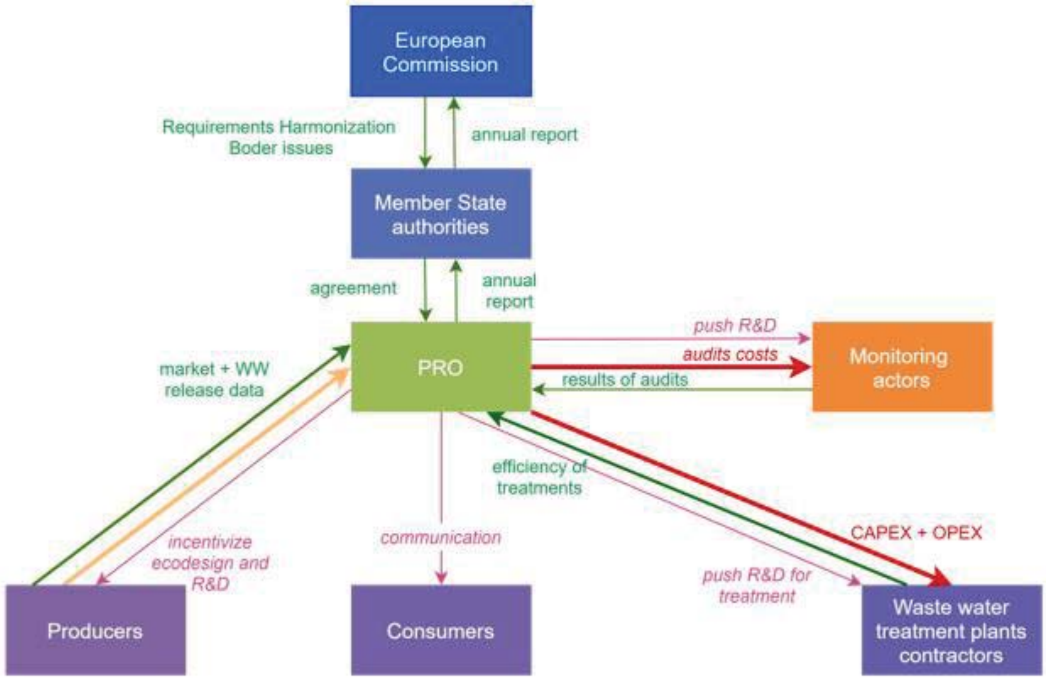

Figure 9.1: Roles, responsibilities and relationship between the different actors involved in the EPR scheme *(source: report 2, Annex 10).*

Main actors	Main role and responsibilities of the actors
European Union	• The EU in its Directive will define minimum objectives, the scope and common principles for the EPR scheme to be complied by Member States, in line with the generic principles of an EPR defined in the Waste Framework Directive (including modulation on fees, full cost coverage, transparency).
Member States	• Member States would be responsible mainly for overseeing the detailed and proper implementation of EPR (transposition compliance) • More specifically, MS should ensure that: ➢ a reporting system is in place to collect data on products placed on the market and on wastewater treatment; ➢ PROs have the financial and organisational means to meet the EPR obligations (procedure to recognise the PRO's) and proper self-control mechanisms (regular

	independent audits for financial management and quality of data collected and reported); ➢ Fee modulation is applied by the PRO's; • MS will also put in place a control system to ensure that all importers/producers are fulfilling their obligations by being member of a PRO's.
Producers/Importers	• They will have to adhere (have a contract) with PRO's, declare what they are placing on the EU market and pay fees to PRO's depending on the quantities and toxicity of the products they place on the market. • They will take decisions on cost allocation (either product cost increase or reduce profit margins) and on product composition (less toxic if possible).
Producer Responsibility Organisations (PRO's)	• PRO's will implement the financial responsibility for the treatment of micro-pollutants for their members; • PRO's will collect statistics on products placed on the EU market by their members, and collect their financial contributions according to fees to be established by the PRO's; • The funds collected will be used to finance additional treatment (4th treatment) via contracts to be established with wastewater operators while respecting the deadlines and the objectives fixed in the Directive.
Wastewater operators	• They will have to progressively install additional treatment for micro-pollutants in line with the deadlines included in the Directive and with the financial support of the PRO's (contract to be established). • They will report on the performances met to PRO's and competent authorities.
Auditing Companies	• External control by independent auditing companies will concern the quality of the reported statistics on products placed on the EU market and on financial streams; • Results of the audits should be made available to MS competent authorities.

Table A9: Summary of the roles and responsibilities of the main actors involved in the possible EPR scheme.

ANNEX 10: LITERATURE REFERENCES

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