OOWV

WATER BOARD OF OLDENBURG AND EAST FRISIA (OOWV)

A1.4 METHODOLOGY TO COLLECT SUCCESSFUL PRACTICES IN MONITORING, ASSESSING AND ENSURING COMPLIANCE WITH WATER REUSE STANDARDS

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AQUARES
Interreg Europe

AQUARES - WATER REUSE POLICIES ADVANCEMENT FOR RESOURCE EFFICIENT EUROPEAN REGIONS

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Executive summary

AQUARES activity 1.4 aims to evaluate existing water reuse monitoring practices used in the territories of the partnership. The objective is to assess and identify the best practices that ensure compliance with various sector-dependent water reuse standards. The outcomes of the activity will be discussed among partners, as well as with relevant stakeholders, contributing to the development of the action plans of the project.

This document provides the thematic background, guidelines, and tools for the implementation of the activity, to streamline project partners' data collection efforts. To this end, Water Board of Oldenburg and East Frisia (OOWV) conducted desk research on the monitoring frameworks and practices that exist in the field of water reuse in the EU. The results of this research were the following:

- Monitoring water reuse refers to the procedures and tools used for safeguarding the quality of water and for ensuring that there are adequate mechanisms for mitigating the health, environmental, or biological risks involved.
- Monitoring the compliance of actors (wastewater treatment plants) and beneficiaries (e.g. businesses, individuals) across various sectors (e.g. agriculture, industry) is commonly included in the definition of the water reuse standards. Essentially, water reuse standards often are a risk management framework, and monitoring procedures are a part of this framework.
- Although water reuse is commonly and successfully used in other countries for several years, there is not a coherent EU framework for water reuse; minimum water reuse requirements are now being developed by the European Commission. However, a number of EU states have established their own water reuse standards in the last few years. Currently all the Mediterranean states in the EU, except Malta, have established new criteria or have revised the existing ones.

1 The AQUARES project

1.1 Issues addressed

"AQUARES – Water reuse policies advancement for resource efficient European regions" is a project under the INTERREG Europe programme[1] that aims to improve the implementation of regional development policies and programmes in the partnership regions, to increase resource efficiency, green growth, and environmental performance management in the water reuse sector. Accordingly, the project will accelerate policy work to lift water reuse barriers and boost technological, administrative and policy eco-innovations that have the capacity to further green growth in EU territories. AQUARES will assist the participating EU regions to:

- Achieve considerable water savings through improved policies and better planning;
- Promote new business models that involve revenue streams from reusable water resources;
- Attract investments in more innovative and efficient water management technologies;
- Mitigate the risks associated with the volatile global economy and resource depletion.

Water reuse requires policy exchanges among EU regions and countries because public authorities have introduced different (in scope and pace) water management practices in issues such as planning, infrastructures, and licensing. For this reason, AQUARES brings together 10 partners from 9 countries to cooperate, exchange best practices, and address territorial problems such as inefficient surface and groundwater protection, adaptation to climate change, flood protection, and high WEI.

AQUARES contributes to EU 2020 strategy targets, for which water reuse is an essential part; it is one of the 5 priority areas of work of the European Innovation Partnership on Water which aims to increase the uptake of innovative water solutions by 2020. Additionally, water reuse will be a key aspect of the EU Water Framework Directive (to be reviewed in 2019) and the Drinking Water Directive (under revision).

[1] For more information, visit https://www.interregeurope.eu/.

1.2 Expected results

AQUARES will employ a transnational cooperation approach involving public authorities, water reuse businesses, water agencies, and relevant stakeholders with the aim to:

- Increase the capacity of public administrations to plan and implement policies that promote innovative technologies and business models for water reuse, to strengthen efficient water management and green growth.
- Promote knowledge and raise awareness on the benefits of water reuse and water efficiency solutions for environmental sustainability and the agricultural and industrial businesses of EU territories.
- Facilitate the integration of water reuse techniques and processes in businesses when producing goods and/or providing supplies, services, and works.
- Unlock regional investments that can lead to the incentivisation and advancement of water reuse projects.
- Improve coordination and collaboration among public administrations to promote and support the harmonisation of their policies and quality standards about water reuse.

1.3 Foreseen outputs

In the framework of AQUARES, the outputs will be:

- An online free toolkit designed to help territorial authorities evaluate aspects of water reuse, such as best management practices, investments, financing, and technologies, business models, and monitoring practices.
- 200 partners' staff members with increased capacity (knowledge/skills).
- 80 regional and local authorities considering the integration of AQUARES policy recommendations.
- 9 improved policy instruments in terms of management, especially for evaluating the implementation of measures and projects and streamlining selection processes
- New funding opportunities for projects relevant to water reuse, e.g. water filtration, water reuse awareness, setting up of water reuse markets.

1.4 Partnership

AQUARES brings together 10 partners from 9 countries (Table 1):

Table 1

Nº	Country		Partner
1)		ES	Regional Government of Murcia, Ministry of Water, Agriculture, Livestock and Fisheries – General Direction of Water (MURCIA-GDW)
2)		EL	Ministry of Environment and Energy, Special Secretariat for Water (SSW)
3)		PL	Lodzkie Region (LODZKIE)
4)		CZ	The Regional Development Agency of the Pardubice Region (RRAPK)
5)		MT	Energy and Water Agency (EWA)
6)		IT	Lombardy Foundation for the Environment (FLA)
7)		DE	Water Board of Oldenburg and East Frisia (OOWV)
8)		ES	Euro-mediterranean Water Institute Foundation (FIEA)
9)		LV	Association "Baltic Coasts" (Baltic Coasts)
10)		SI	The Municipality of Trebnje (TREBNJE)

2 Overview of activity 1.4

The objective of AQUARES activity 1.4 is to identify practices that monitor, assess, and/or ensure effectively the compliance of water reuse actors (water treatment plants) with relevant quality standards/requirements. The activity's scope will extend to all the sectors that water reuse requirements exist at the moment in the regions and regions of the partnership (e.g. requirements for agricultural, urban, industrial, recreational use and/or aquifer recharge).

The policy goal of the activity is to facilitate among project partners an exchange of experience regarding successful water reuse monitoring practices; the results of the activity will be the focus of discussion with stakeholders in stakeholder group meetings (AQUARES activity 2.1), and will be used as to provide input for the development of the partners' action plans (which aim to improve the policy instruments addressed by the project).

The partner responsible for the coordination of the activity is the Water Board of Oldenburg and East Frisia (OOWV). The activity will unfold according to the following steps and time plan (Figure 1):

Figure 1

Methodology & input form (Semester 1 - November 2018)

- OOWV delivers the methodology and the input documentation form to project partners, to provide guidelines and tools for data collection.

Data collection (Semester 2 - May 2019)

- All project partners will fill-in the input forms according to the guidelines provided in the methodology on successful monitoring water reuse practices.
- They will conduct desk research at national level, except MURCIA-GDW, which will gather regional data, and LODZKIE, which will focus on the relevant practices of other EU-28 countries.

Evaluation report (Semester 3 - November 2019)

- OOWV will collect and analyse the data from all the input forms to draft an evaluation report on the best monitoring practices that safeguard compliance of relevant actors with water reuse standards.
- The final outcome of the activity will be a good practice guide titled ‘Evaluation report of best practices for monitoring, assessing and ensuring compliance with water reuse standards’.

3 Policy context of water reuse in the EU

One third of the EU territory is experiencing water stress due to the growing needs of populations, climate change, and over-abstraction. Deteriorating water quality and increasing water scarcity present a critical condition to growth in water-dependent economic sectors and EU society in general. For example, the immediate effects of droughts (such as damage to agriculture and infrastructure), as well as more indirect effects (such as a reluctance to invest in an area at risk), can also have a serious economic impact[2]. The increase of the frequency of droughts highlights the intensity of the situation: between 1976 and 2006 the number of areas and people affected by droughts went up by almost 20% and the total costs of droughts amounted to EUR 100 billion.[3] These trends are expected to persist in the future.

Water reuse, as the wastewater that after treatment has a quality that is appropriate for other intended beneficial uses, is both a necessity and an opportunity in the EU for two reasons: a) water scarcity has increased dramatically and affects 11% of the EU population and 17% of the EU territory, and b) the world water market will be worth 1 trillion by 2020, and a 1% increase in the growth of the EU water industry can create up to 20,000 new jobs.

Water reuse, as a strategic aspect of efficient water management in the EU, can help overcome a number of barriers to resource efficiency such as:

- The absence of flexible and differentiated policies for efficient water management in the agricultural, industrial, urban and recreational sectors of EU regions (e.g. the absence of sustainable procurement incentives);
- The slow rate of technological and managerial innovation adoption in water reuse (e.g. the lack of approaches focusing on treating the diffuse sources of residual medications);
- The absence of skills on green infrastructure and natural water retention measures;
- The lack of awareness about the suitability of reused water among the public.

For example, water reuse can advance resource efficiency in areas such as restoration of wetlands, aquifer recharge, irrigating crops, advancing industrial uses (aggregate washing, concrete making), soil compaction, and enhancing landscape use.

[2] The impact of the 2017 drought in EU regions is illustrative. The Italian farming sector alone was predicting losses of EUR 2 billion (European Commission, 2007).
[3] EEA, 2012.

To respond to water stress issues, EU regions should implement and promote efficient management of their water resources. An integrated water management approach is needed for ensuring water savings and increased water reuse plans. Reuse of treated waste water generally has a lower environmental impact than for example water transfers or desalination, and offers a range of environmental, economic and social benefits. Furthermore, it extends the water life cycle, thereby helping to preserve water resources and in full compliance with the circular economy objectives. Although water reuse alone could not solve water scarcity problems, the uptake of water re-use practices in the EU falls far below its full potential, with practices diverging widely across Member States.

More specifically, the potential for water reuse in the EU is very high. The percentage of water stress index (WSI, abstraction/availability ratio) is above “moderate” levels in 50% of the EU states, while in 25% of the EU states the WSI is above “high”.[4] More than 200 water reuse projects have been implemented in the EU with an estimated volume of 750 Mm3/yr (the relative volume for USA is 3,850 Mm3 /yr). Also a significant number of water reuse projects are in an advanced planning phase.

The water reuse status is quite different between northern and southern Europe. In southern Europe, water is reused predominantly for agricultural irrigation and for urban or environmental applications, while in northern Europe water is reused mainly for urban, environmental or industrial applications. Water reuse volume at the EU level in 2025 is estimated to reach 3,222 Mm3 /yr, which is estimated to save 0,9% of the total water abstraction in that year.[5] However, in southern states, e.g., Malta, Cyprus, Greece and Spain, reused water may cover up to 26%, 7.6%, 5%, and 3%, respectively, of their future water demand.[6]

3.1 EC initiatives for water reuse

Although water reuse is commonly and successfully used in other countries for several years, for example USA, Australia, Israel and Singapore, limited awareness of potential benefits among stakeholders and the general public, and lack of a supportive and coherent framework for water reuse prevent a wider spreading of this practice in the EU. To counter these issues, the European Commission is working on legislative and other policy instruments to boost water reuse when it is cost-efficient and safe for health and the environment.

[4] Angelakis & Gikas, 2014.
[5] Raso, 2013.
[6] Angelakis & Gikas, 2014.

The following points present the most relevant EU initiatives regarding water reuse:

- The most recent development is the proposal of the European Commission (May 2018) regarding the adoption of water reuse standards for agricultural irrigation.[7] To support this policy development, an impact assessment study was prepared and published in 2015; a public on-line consultation also took place in autumn 2014. The aim of the public consultation (involving both private citizens and stakeholders) was to evaluate the most suitable EU-level instrument/s to foster water reuse, while ensuring the protection of environmental and human health, and the free trade of food products. In addition to the online consultation, a stakeholders meeting was organised in December 2014 in Brussels. The public consultation led to a general agreement in support for the water reuse initiative, in particular concerning the development of EU-level common minimum quality requirements for reuse. The report on the public consultation includes the replies to the consultation itself and the feedback from the stakeholders meeting.[8]
- The need to address the problem at EU level has been acknowledged in the 2012 Commission Communication "A Blueprint to Safeguard Europe's Water Resources" (COM(2012) 673).[9] The Communication highlighted water reuse as a concrete and valid alternative supply option to address water scarcity issues. With maximisation of water reuse as a specific objective, the Commission identified the opportunity to develop a legislative instrument for water reuse.
- A Fitness check of EU Freshwater policy (SWD(2012) 393) published in November 2012 as a building block of the Blueprint, concluded that "alternative water supply options with low environmental impact need to be further relied upon" in order to address water scarcity.[10]
- A number of actions to promote water reuse were included in the Communication from the Commission "Closing the loop – An EU action plan for the circular economy" (COM(2015) 614), including an action to prepare a legislative proposal on minimum requirements for water reuse for irrigation and groundwater recharge.[11] This proposal has been included in the European

[7] COM(2018) 337 final; "Proposal for a regulation on minimum requirements for water reuse". For more information, visit http://ec.europa.eu/environment/water/pdf/water_reuse_regulation.pdf.
[8] One point of criticism on the EU proposal is that it focuses strongly on hygienic parameters, not taking into account micro-pollutants and trace substances (e.g. medicine residues).
[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0673.
[10] http://ec.europa.eu/environment/water/blueprint/pdf/SWD-2012-393.pdf.
[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614.

Commission's Work Programme of 2017 and 2018 as it contributes to the political priorities set by the Commission to promote a more circular economy.

- The intention to address water reuse with a new legislative proposal was noted with interest by the European Council, in its conclusions on Sustainable Water Management (11902/16). Furthermore, the European Parliament, in its September 2015 Resolution on the follow-up to the European Citizens' Initiative 'Right2Water' and the Committee of the Regions, in its December 2016 opinion on "Effective water management system: an approach to innovative solutions" encouraged the Commission to draw up a legislative framework on water reuse.
- The Commission is also carrying out regular consultations with Member States and stakeholders in the framework of the Common Implementation Strategy (CIS) for the implementation of the Water Framework Directive. Proceedings of this activity, including presentations on Member State experiences with water reuse, are available on CIRCABC.

3.2 Water reuse standards

A number of EU states have established their own water reuse standards in the last few years. Currently all the Mediterranean states in the EU, except Malta, have established new criteria or have revised the existing ones. The water reuse criteria have been issued as regulations. They focus mainly on agricultural and landscape applications, but additional uses, such as recharge for aquifers (not used for potable supply) and environmental uses are also covered in the cases of Greece, Italy and Spain.

The need to eliminate public health and environmental risks has led to the development and adoption of certain quality criteria, which govern the reuse of effluent water, depending on the intended application. Overall, based on the parameters' thresholds defined, water reuse criteria in the EU can be separated into three major categories:

(a) The French criteria, which are based on the revised WHO criteria and Australian guidelines.

(b) The Greek, and Italian regulations, which are more or less based on the Californian regulations.

(c) The Portuguese and Spanish criteria, which compared to the previous two types, follow an intermediate line.

To give an example, Greek regulations distinguish three basic effluent qualities:[12]

[12] Ilias et al., 2014.

- The highest quality refers to urban uses and groundwater recharge (for non-potable aquifers only) with direct injection, and defines a threshold of 2 cfu/100 mL for TC. [13]
- The intermediate quality refers to unrestricted irrigation and to industrial uses, except that of cooling water, and defines a threshold of 5 cfu/100 mL for E. coli.
- The lowest quality refers to restricted irrigation, aquifer recharge through basins and to industrial cooling, and defines the threshold of 200 cfu/100 mL for E. coli.

In addition to the effluent quality limits and treatment processes, Greek regulations include several barriers for each application. For example, monitoring of several heavy metals and metalloids is required and varies with the capacity of the wastewater treatment plant from 2 (<10,000 p.e.[14]) to 12 (>200,000 p.e.) times per year. In addition, a set of 40 organic compounds should be monitored two times per year in WWTPs serving more than 100,000 p.e. In conclusion, the Greek criteria as well as the Italian ones (which are similar to each other), impose a number of difficulties to the particularly strict limits and to the high number of parameters considered (74 and 62, respectively, for large wastewater treatment plants).

[13] [cfu]: Colony-forming unit; a unit used to estimate the number of viable bacteria or fungal cells in a sample. [TC]: Total coliforms; total coliform counts give a general indication of the sanitary condition of a water supply.
[14] [p.e.]: Population equivalent; it is the term most used to describe the size of package sewage treatment plants.

4 Monitoring water reuse standards

To avoid repetition and to harmonise the vocabulary with the relevant literature on water reuse requirements/standards, hereafter 'monitoring' includes the practices of assessment and of compliance as well. Additionally, for the purposes of this methodology, water reuse 'standards' and 'requirements' will be used interchangeably. 'Actors' that implement water reuse are considered to be water treatment plants. 'Beneficiaries' are all the businesses, individuals, or other entities that use the reclaimed water after it leaves the water treatment plant.

Within the context of water reuse, **monitoring** refers to the procedures and tools that exist for safeguarding the quality of the water and for ensuring that there are adequate mechanisms for mitigating the health, environmental, or biological risks involved.

In practice, monitoring is part of the framework that defines water reuse standards. Since the most common approach for the development of water reuse standards is establishing a risk management framework, monitoring is part of such frameworks. A **risk management framework** is a systematic management tool that consistently ensures the safety and acceptability of water reuse practices. A central feature is that it is sufficiently flexible to be applied to all types of water reuse systems, irrespective of size and complexity.

The risk management framework approach is proposed by the EU Commission on the development of minimum water reuse requirements for agricultural irrigation (COM(2018) 337 final) and it is included in the Directive 2015/1787 that amends Directive 98/83/EC on the quality of water intended for human consumption; it is also the approach recommended by the World Health Organization and it is also used in Australia and the US.

Overall, a risk management framework incorporates several elements, spanning from the assembly of a risk management team and the description of the water reuse system (some of the initial steps to establish the framework) to the validation of procedures and the management of incidents and emergencies (some of the final steps to establish the framework). The following steps are commonly followed for establishing a risk management framework for water reuse (Figure 2):

Figure 2

Indicative steps of developing a risk management framework	**1) Assembly of a risk management team.**
	2) Description of the water reuse system.
	3) Identification of hazards and hazardous events, and risk assessment.
	4) Determination of preventive measures to limit risks.
	5) Development of operational procedures.
	6) Verification of the water quality and the receiving environment.
	7) Validation of processes and procedures.
	8) Management of incidents and emergencies

For the purposes of this activity, the focus is only on the parts of a risk management framework that are relevant to monitoring (steps 5, 6, 7). For example, although the identification of possible hazards and hazardous events or conducting a risk assessment are essential elements of a risk management framework and a prerequisite for the proper implementation of monitoring, they are not monitoring procedures per se. However, there are many elements from steps 1, 2, 3, 4, and 8 that support monitoring in an indirect way, and therefore should be included in the scope of the activity. Both main and supporting elements are presented in detail in the next section.

4.1 Monitoring elements

Within the context of a risk management framework for water reuse, monitoring can be separated into three general procedures: a) operational, b) verification, and c) validation monitoring. There is an additional element to monitoring that includes the elements that support it but are not directly involved in monitoring. The following sections present in detail these four categories:

1) **Operational monitoring**

Operational monitoring includes the procedures that assure water safety, i.e. the delivery of the requested quality level of reclaimed water quality. These procedures apply to the whole water reuse system (from the moment that raw wastewater enters the system to end use) and, apart from quality control procedures, include the management of incidents, emergencies, and advanced additional mitigation measures regarding treatment. Operational monitoring is described in various water reuse and quality protocols (e.g. WHO guidelines).

To provide an example of operational monitoring, if measuring a certain pathogen in the water (parameter) **https://www.health.qld.gov.au/public-health/industry-environment/environment-land-water/water/risk-management/plan/glossary - legionella**requires to control temperature (indicator), operational monitoring should include scheduled real-time monitoring (method & frequency) of temperature at specific points (CCPs) in the water reuse system to ensure that the water is heated to the required temperature. Should operational monitoring indicate results outside the critical limits set for the parameter (for example, temperature), it should trigger a corrective action.

The most important elements of the operational monitoring are the following:

(a) Definition of critical control points (CPP): CPP is a point, step or procedure in the water reuse system where failure of standard operation could cause deterioration to the quality of the water. It is also the point at which control can be applied and a hazard can be prevented, eliminated, or reduced to acceptable levels. Definition of CPPs are crucial for monitoring, since they are the focus of the operational monitoring. For example, the intake point, the sedimentation and middle disinfection with chlorine and ozone procedure, and the final disinfection procedure can be CCPs.

(b) Parameters being monitored (indicators): The operational monitoring protocol has to include indicators that monitor biological, chemical, and physical parameters of the water. The indicators can be measurable and/or observational, providing immediate evidence of water quality performance. Some common indicators in water reuse are: flow rate, nitrates, BOD_5, suspended solids, pH, total organic carbon (TOC), and others. For each parameter/indicator there are critical limits established that signal –when exceeded– if corrective measures are needed.

(c) Method of monitoring & frequency: The method of monitoring refers to the techniques used to monitor the indicators. Together with the frequency that these techniques are applied to the water, they ensure that an effective operational monitoring system is in place to detect variations in performance. For example, on-line monitoring with real-time data reporting is usually recommended when technologically feasible since it provides immediate results and triggers more rapid response to hazards. Observational manual checking of preventive measures is also part of the operational monitoring, but it is generally around four days slower to produce results that the on-line, real-time monitoring. Sometimes physical monitoring is required, when for example, checking for leaks.

(d) Corrective actions: An operational monitoring protocol need to include procedures for corrective actions to be implemented when parameters deviate from the critical limits. Depending on the nature of the parameter that exceeds the predefined limit, actions range from restricting water supply to emergency repairs. Usually, a series of steps are followed to identify the source of the problem and initiate a matching corrective action. After a corrective action is implemented, follow-up monitoring of the problem is required (e.g. amendments to operational monitoring's functioning).

(e) Documentation: Monitoring data of various parameters and all actions performed in the critical control points should be recorded accurately and completely. Transparency and access to information is a critical aspect for promoting trust among users and also the general public as regards the safety of the reclaimed water. Also, documents should be maintained for a period of time, to be used for validation. Documentation usually happens with ICT tools.

(f) Audits: Audits ensure that the water reuse system continues to function properly, thereby checking the quality and effectiveness of monitoring. Auditing can be done by internal, regulatory or independent auditors. It should demonstrate that the monitoring framework has been properly designed, is being implemented correctly and is effective. In general, audits can assist implementation by identifying opportunities for improvement such as the accuracy, completeness, and quality of monitoring, the better use of limited resources and identifying training and motivational support needs. Auditing frequencies should be commensurate with the level of confidence required by the regulatory authorities.

2) Verification monitoring

Verification monitoring confirms that the operational monitoring is effectively performing its tasks and manages the risks associated with water quality within the water reuse system.

In effect, verification monitoring is the use of methods, procedures, or tests in addition to those used in operational monitoring, to assess the overall performance of the treatment system, the compliance with regulatory requirements of the ultimate quality of the reclaimed water being supplied, and the quality of the receiving environment. It consists of collecting water samples from selected locations from the water reuse system and testing for the hazards (parameters) that are being controlled. For example, in the case of reclaimed water used for irrigation, a monitoring program for soils, crops, groundwater and surface water, and dependent ecosystems has to be established, on a case-by-case basis, according to the identified risks[15].

Verification monitoring does not generally occur in real-time or as frequently as operational monitoring. However, verification monitoring measures more parameters that operational monitoring, and tests are conducted at an analytical laboratory accredited for the analytical test method used to ensure the highest level of accuracy.

As with operational monitoring, details of the verification monitoring program (locations, frequency, parameters) should be documented in the risk management framework. If verification monitoring results show that operational monitoring measures are not effectively controlling the hazard (a parameter), an appropriate corrective action which brings the hazard back under control should be put in place. This may also require changes to the functions of the operational monitoring procedures.

3) Validation monitoring

Validation aims to ensure that processes and procedures control hazards effectively and that the water reuse system is capable of meeting its design requirements. One of the objectives of validation monitoring is to prove that the water reuse system can deliver the expected water quality specified for the intended use. Therefore, validation monitoring includes also operational and verification monitoring parameters discussed above. Validation monitoring has to be conducted when a reclamation system is established (commissioned) and put in operation when equipment is upgraded or new equipment or processes are added. Once the setup of the whole water reuse system has been validated, it is generally sufficient with the operational and verification monitoring.

[15] Recommendations for monitoring programs of environmental matrices when reclaimed water is used for agricultural irrigation are described in the ISO guidelines (ISO 16075: 2015). Analytical methods used for monitoring shall comply with the requirements included in the related Directives (i.e. WFD (2000/60/EC), DWD (98/83/EC), GWD (2006/118/EC) to conform to the quality control principles, including, if relevant, ISO/CEN or national standardized methods, to ensure the provision of data of an equivalent scientific quality and comparability.

4) Supporting elements

There are risk management framework elements ancillary to monitoring that are indirectly involved in monitoring. However, since elements of a risk management framework are highly interrelated, procedures and functions supporting monitoring should be taken into consideration. These are:

(a) Skilled personnel: The level of expertise of the people involved in monitoring ensures that procedures are followed in a precise and scientific manner. The monitoring team should include people with a mix of health and technical skills so that members are collectively able to understand the nature of the monitoring system and the water quality issues as a whole, and to understand how the risks can be controlled (it should include, for example, relevant agricultural expertise). Depending on the scale of the monitoring it may be appropriate to include independent members (e.g. universities and research institutes). Alternatively, they may be included separately in the verification or validation stages by health authorities and external assessment.

(b) Adequate laboratory equipment: To adequately measure quality parameters, available methods vary from basic water laboratory equipment to very sophisticated, state-of-the-art laboratory set-up. Laboratory equipment is an element that supplements the expertise of the personnel and it is a prerequisite for conducting proper monitoring. Without it, measuring water quality becomes impossible.

(c) Cooperation among actors & beneficiaries: Given the inter-sectoral nature of safeguarding water quality and reuse operations, the process of setting up a risk management framework and relevant monitoring procedures may require prolonged policy discussion to achieve sector-wide endorsement and inter-sectoral cooperation.

5 Instructions for data collection

Based on the objective and the thematic background of the activity, as these have been defined previously, this study seeks to address the following questions:

- What are the monitoring elements that project partners' regions, countries, and the rest of the EU-28 use to ensure compliance with water reuse requirements?
- What are is the most effective way to implement monitoring practices in the water reuse sector in project partners' countries, regions and the rest of the EU-28?

To cover adequately the activity's thematic scope, this activity will make use of the desk research method for data collection (identification of effective monitoring practices). The tool for desk research is an input documentation form. It is addressed to project partners since they have the proper institutional standing and capacity to gather information on this issue.

5.1 Desk research

Desk research data is data collected from existing studies (i.e. primary research – for example surveys, interviews, case studies) or it is a literature review. There are many sources for this type of data, notably government agencies, educational institutions, companies, non-profit institutions, libraries, and the Internet. This method was chosen for its efficiency and cost-effectiveness, capitalising on already existing knowledge without requiring primary data collection. It can help project partners' data collection efforts by offering already analysed and validated data. Desk research can be divided into two categories according to their source: external or internal.

Internal desk research refers to the collection of data by members of an organisation within their own organisation. The accessibility of this kind of data is the reason AQUARES project partners should consider internal desk research as one of the starting points of their research. Internal desk research starts with internal documents (e.g. policy frameworks, reports, studies, memos, and others). Considering the nature of information required for this activity (water reuse monitoring practices), there is a high possibility that AQUARES project partners have already available water reuse monitoring data and/or may have participated in projects concerned with water reuse and recycling.

Indicatively, during internal desk research AQUARES partners should focus on gathering data from the following categories of their internal documents:

- Policy work conducted within own organisation for water reuse
- Internal reports & studies on water reuse

- Wastewater and water reuse
- Impact assessments for water reuse
- Proposals or communications on wastewater and water reuse
- Emails, memoranda, letters with water reuse stakeholders

External desk research draws from documents produced outside the organisation, i.e. documents that are publicly available either online or in libraries, delivered by other organisations other than AQUARES partners. In external desk research, project partners need to read and examine various texts/documents that contain data congruent with the purposes of activity 1.4. The data will be collected from relevant secondary sources of information. Indicatively, possible sources of information can be:

1. **Policy frameworks for developing water reuse requirements:**
   a. EC - Proposal for a regulation on minimum requirements for water reuse (http://ec.europa.eu/environment/water/pdf/water_reuse_regulation.pdf)
   b. WHO – Sanitation safety planning manual for safe use & disposal of wastewater, greywater and excreta

      (http://apps.who.int/iris/bitstream/handle/10665/171753/9789241549240_eng.pdf;jsessionid=5798650EF8539BB9E8C8B9703BD7F137?sequence=1)

2. **ISO for water reuse**
   a. ISO 16075 (2015) - Guidelines for Treated Wastewater Use for Irrigation Projects (https://www.iso.org/obp/ui/#iso:std:iso:16075:-1:ed-1:v1:en)

3. **National regulations specifying water reuse**
   a. NP (2005) NP 4434 2005 Guidelines for Reuse of reclaimed urban water for irrigation. Portugal Quality Institute.
   b. RD (2007) RD 1620/2007 Legal framework for the reuse of treated wastewater. Government of Spain.

c. JORF (2014) JORF num.0153, Order of 2014, related to the use of water from treated urban wastewater for irrigation of crops and green areas. Government of France.

d. KDP (2015) Law 106 (l) 2002 Water and Soil pollution control and associated regulations KDP 772/2003, KDP 379/2015, Government of Cyprus.

e. CMD (2011) CMD No 145116 2011 Measures, limits and procedures for reuse of treated wastewater. Government of Greece

f. DM (2003) DM185/2003 Technical measures for reuse of wastewater. D. Lgs 152/06 - art. 74, art.124 DGR 1053/03. Government of Italy.

4. Journals and other academic sources:

a. Journal of water reuse & desalination (https://iwaponline.com/jwrd)

b. Water (https://www.mdpi.com/journal/water)

c. Desalination and Water Treatment (https://www.tandfonline.com/loi/tdwt20)

d. Water Utility Journal (http://www.ewra.net/wuj/)

e. Water Policy (https://www.sciencedirect.com/journal/water-policy)

f. Process Safety and Environmental Protection

(https://www.sciencedirect.com/journal/process-safety-and-environmental-protection)

g. Journal of Environmental Sciences (https://www.journals.elsevier.com/journal-of-environmental-sciences)

h. Agricultural Water Management (https://www.sciencedirect.com/journal/agricultural-water-management)

i. Ecological Engineering (https://www.sciencedirect.com/journal/ecological-engineering)

5. Water reuse research reports:

a. BIO (2015) Optimising water reuse in the EU. Final Report - Part 1. EC/DG-ENV, 116. Paris: Bio by Deloitte, Paris, France.

(http://ec.europa.eu/environment/water/blueprint/pdf/BIO_Water%20Reuse%20Public%20Consultation%20Report_Final.pdf)

b. CAC (Codex Alimentarius Commission) (2003) Hazard analysis and critical control point (HACCP) system and guidelines for its application. Annex to CAC/RCP 1–1969, Rev 4. FAO/WHO, Rome, Italy.

(https://www.mhlw.go.jp/english/topics/importedfoods/guideline/dl/05.pdf)

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d. EC (2014) Technical report on aquatic effect-based monitoring tools. Technical Report 2014-077. Office for Official Publications of the European Communities, ISBN 978-92-79-35787-9. (https://circabc.europa.eu/sd/a/0d78bbf7-76f0-43c1-8af2-6230436d759d/Effect-based%20tools%20CMEP%20report%20main%2028%20April%202014.pdf)

e. WHO (2006) Guidelines for the safe use of wastewater, excreta and greywater. Volume 2: Wastewater use in agriculture. World Health Organization, Geneva, Switzerland. (https://www.who.int/water_sanitation_health/publications/gsuweg2/en/)

6. Similar EU projects

a. iWATERMAP - Water Technology Innovation Roadmaps

(https://www.interregeurope.eu/iwatermap/)

b. SWARE - Sustainable heritage management of WAterway Regions

(https://www.interregeurope.eu/sware/)

c. TANIA - TreAting contamination through NanoremedIAtion

(https://www.interregeurope.eu/tania/)

d. LAND-SEA - Sustainability of the land-sea system for eco-tourism strategies. (https://www.interregeurope.eu/land-sea/)

6 Data collection tool

To guarantee that all results are documented in a consistent and clearly structured manner, the methodology prescribes a common approach for reporting results. An input documentation form, presented in this section, provides a tool for data collection.

The tool has three sections (A, B, and C):

- **Section A** aims to gather information on the overall water reuse policy framework that exists in partner's territories and countries, the elements included in the framework, and the number of treatment plants, sectors, and actors benefiting from it.
- **Section B** focuses on the monitoring procedures that are in place to ensure compliance with water reuse standards; the section asks project partners to document the elements that comprise monitoring, its effectiveness, and its reporting mechanisms.
- **Section C** inquires about the elements that support monitoring indirectly; the section includes questions on the adequate laboratory equipment, adequate personnel for monitoring, and cooperation among stakeholders.

The suitable personnel to conduct the desk research and fill-in the input documentation forms are members or staff of the organisations represented in the project consortium or relevant experts.

Table 2

<table>
<tr><td colspan="4" align="center">AQUARES – Activity 1.4</td></tr>
<tr><td colspan="4" align="center">Documentation form</td></tr>
<tr><td>A.</td><td colspan="3">General information</td></tr>
<tr><td>1)</td><td>Partner</td><td colspan="2"></td></tr>
<tr><td>2)</td><td>Country*
*where [country], hereafter [region] for MURCIA-GDW</td><td colspan="2"></td></tr>
<tr><td rowspan="2">3)</td><td rowspan="2">Does your country implement water reuse standards?</td><td>☐</td><td>Yes</td></tr>
<tr><td>☐</td><td>No*
*If your country does not implement water reuse standards, please use the policy framework most relevant to water reuse to fill-in the rest of the form (e.g. risk management framework for wastewater treatment).</td></tr>
</table>

4)	**Name of the standard (or most relevant framework)**		
5)	**Developed by**		
6)	**Implementing authority / (-ies)**		
7)	**Geographical coverage**	☐	**National**
		☐	**Regional**
8)	**Purpose/use of the standard**	☐	**Agricultural**
		☐	**Industrial**
		☐	**Urban**
		☐	**Recreational**
		☐	**Other (please specify):**
9)	**a) Please briefly describe the main aspects of the standard.** *(No more than 15 lines)*		
	b) Is it standalone or part of a wider policy framework for water reuse?	☐	**Standalone**
		☐	**Part of a wider policy framework (please specify which):**
		☐	**Other (please specify):**
	c) What types of stakeholders are involved in providing feedback and implementing the standard?	☐	**Public authorities**
		☐	**Water supplier company / organisation**
		☐	**Operator/owner of the reuse plant and system**
		☐	**End-users (e.g. farmers)**
		☐	**Public health organisations**
		☐	**Consumer representatives**

		☐	NGOs (e.g. environmental)	
		☐	Local communities / citizen initiatives	
		☐	Other (please specify):	
	d) How intensely are stakeholders involved in the implementation of the standard?	☐	1	The standard is implemented without any stakeholder involvement.
		☐	2	Stakeholders are informed about the implementation process of the standard, without providing their opinion.
		☐	3	Stakeholders are consulted in the process of implementing the standard, providing opinions and information.
		☐	4	Stakeholders are involved in the implementation of the standard, providing (further to option 3) resources and data.
		☐	5	Stakeholders collaborate with public authorities in the implementation of the standard, having (further to option 4) increased managerial responsibilities and co-shaping the policy direction of the standard.
10)	Please provide data on the number of treatment facilities that implement the standard, including data (if available) on the type and number of end users served by those facilities. *(No more than 10 lines)*			
11)	Is the water reuse standard embedded in or accompanied by a risk management framework?	☐	Yes	
		☐	No	

12)	**Which of the following elements comprise the water reuse standard?**	☐	**Operation of a (risk) management team**
		☐	**Description of the water reuse system**
		☐	**Processes to identify hazards and hazardous events, and risk assessment**
		☐	**Determination of preventive measures to limit risks**
		☐	**Operational procedures for monitoring**
		☐	**Verification procedures of the water quality and the receiving environment**
		☐	**Validation of processes and procedures**
		☐	**Procedures to manage incidents and emergencies**
		☐	**Other(s) (please describe):**
13)	**a) Does the water reuse standard define:**	☐	**Provisions for granting permits to treatment plants**
		☐	**Steps for managing non-compliance**
		☐	**Regulations defining compliance checks procedures**
	b) If existing, please briefly describe the steps followed for 1) granting permits, 2) coping with non-compliance issues, and 3) compliance checks. *(No more than 15 lines)*	**1**	
		2	
		3	
		1) Granting permits to treatment plants	

	c) How effective do you consider the processes of:	☐	1	Not effective: There are a lot of delays and bureaucratic drawbacks for granting permits.
		☐	2	Moderately effective: There are some delays and bureaucratic drawbacks, sometimes hindering the process of granting permits, but it is overall operational.
		☐	3	Very effective: The process of granting permits does not have any delays or administrative setbacks.
		2) Managing non-compliance issues		
		☐	1	Not effective: Most non-compliance issues are not treated in time and are not resolved.
		☐	2	Moderately effective: Around half of the non-compliance issues are treated in time and resolved.
		☐	3	Very effective: Most non-compliance issues are treated in time and resolved.
		3) Compliance checks procedures		
		☐	1	Not effective: Compliance checks rely solely on on-spot checks.
		☐	2	Moderately effective: Compliance checks use both on-spot checks and monitoring checks defined in EU regulations (Directives 91/271/EEC and 2000/60/EC)
		☐	3	Very effective: Compliance checks use on-spot checks, monitoring checks defined in EU regulations (Directives 91/271/EEC and 2000/60/EC), and include additional physio-chemical parameters (e.g. micro-pollutants, trace residues from medicine).
B.	**Monitoring water reuse**			

1)	**Are monitoring procedures defined within the water reuse standard?**	☐	**Yes**		
		☐	**No (please describe the framework under which they are defined):**		
2)	**Do the monitoring procedures follow / are based on an established approach?**	☐	**No**		
		☐	**World Health Organisation approach (WHO)**		
		☐	**ISO 16075:2016**		
		☐	**Other (please describe below):**		
3)	**Does the monitoring procedures include one of the following (select all that apply):**	☐	**Identification of critical control points (or similar monitoring points)**		
		☐	**Definition of water quality parameters & indicators**	☐	**Health**
				☐	**Biological**
				☐	**Physical**
		☐	**Definition of critical limits for parameters & indicators**		
		☐	**On-line real-time monitoring**		
		☐	**Manual monitoring**		
		☐	**Other type(s) of monitoring method (please specify):**		
		☐	**Procedures for initiating corrective actions**		
		☐	**Verification monitoring**		
		☐	**Validation monitoring**		
		☐	**Audits on the overall monitoring procedures**		

<table>
<tr><td rowspan="3">4)</td><td rowspan="3">In documenting monitoring data, do you (select all that apply):</td><td>☐</td><td colspan="5">Release the data to the public / regular public reports</td></tr>
<tr><td>☐</td><td colspan="5">Use ICT methods to document data</td></tr>
<tr><td>☐</td><td colspan="5">Other(s) (please describe below):</td></tr>
<tr><td>5)</td><td>Please provide information regarding the implementation of the monitoring procedures. Does the implementation run into any kind of <u>problems</u>?

(For example, is there a frequent need to take corrective actions?)

(No more than 20 lines)</td><td colspan="6"></td></tr>
<tr><td rowspan="2">6)</td><td rowspan="2">With 1 being not effective at all and 5 being absolutely effective, how good (overall) do you assess (according to your own judgement) the quality of monitoring?</td><td colspan="2">1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td colspan="2">☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>C.</td><td colspan="7">Elements supporting monitoring</td></tr>
<tr><td rowspan="3">1)</td><td rowspan="3">How would you assess the quality of the personnel that implements the monitoring?</td><td>☐</td><td>1</td><td colspan="4">Not adequately qualified: The personnel does not include specialised chemists, engineers or technicians.</td></tr>
<tr><td>☐</td><td>2</td><td colspan="4">Qualified: The personnel includes specialised chemists, engineers or technicians.</td></tr>
<tr><td>☐</td><td>3</td><td colspan="4">Qualified and up-to-date: The personnel includes specialised chemists, engineers or technicians, who undergo additional training regularly.</td></tr>
</table>

2)	**How would you assess the lab equipment used for monitoring?**	☐	**1**	**Basic equipment: Can measure microorganisms, pathogens.**
		☐	**2**	**Adequate equipment: Can measure microorganisms, pathogens, water quality parameters (e.g. BOD5, TSS).**
		☐	**3**	**Advanced: Can measure microorganisms, pathogens, water quality parameters (e.g. BOD5, TSS), and additional parameters such as micro-pollutants, trace residues, heavy metals, and/or other physio-chemical parameters.**

7 Roadmap for data collection

After project partners have received the methodology, to be delivered by OOWV until the end of November 2018, feedback is expected within two weeks. Any comments and feedback will be incorporated into the final methodology report.

The deadline for AQUARES partners to provide territorial data (by filling-in the 'input documentation form') is semester 2 (May 2019). OOWV will review the collected evidence and a final round of fine-tuning will take place before the end of the month. All responses should be gathered and delivered in an integrated format.

Finally, the data gathered will be analysed and used for drafting the final report, which is to be delivered by OOWV until the end of November 2019.

8 Evaluation criteria

After the collection of data has been completed by project partners, all data will be evaluated by OOWV, who is the partner responsible for drafting the Evaluation report (final deliverable). OOWV will use the criteria presented in the following table (Table 3) to perform the evaluation.

To identify the most effective monitoring practices for ensuring compliance with water reuse standards, the evaluation of data will happen according to a point system; for each criterion there are certain points awarded. The monitoring framework with the most points will be classified as best, according to the classification in Table 4.

Table 3

Overview of evaluation criteria		
A. Monitoring framework		
Criteria	**Relevant question**	**Points awarded**
Integration with other water reuse regulations	A9b	For option a): 10
		For option b): 5
		For option c): 5
Stakeholders' involvement in the development of the standard	A9c	N*1 (e.g. if three boxes checked, 3*1=3)
	A9d	N*2 (e.g. if option 4, then 4*2=6)
Inclusion of a risk management approach	A11	For option a): 10
		For option b): 0
Inclusion of essential elements of a water reuse monitoring framework	A12	For each option: 10
		For each extra option: 5
Inclusion & effectiveness of provisions on permits, compliance checks, and non-compliance procedures	A13a	For each option: 5
	A13c	For option 1: N*1 (e.g. if option 3, then 3*1=3)
		For option 2: N*1
		For option 3: N*1
B. Quality & elements of monitoring		
Criteria	**Relevant question**	**Points awarded**
	B2	For option a): 2

<table>
<tr><td>Follows established approach/uses best practices</td><td></td><td colspan="3">For all other options: 5</td></tr>
<tr><td rowspan="2">Includes essential elements of water reuse monitoring</td><td rowspan="2">B3</td><td colspan="3">For all options apart b): 10</td></tr>
<tr><td colspan="3">For option b): 5 each</td></tr>
<tr><td rowspan="3">Data transparency & Administrative efficiency</td><td rowspan="3">B4</td><td colspan="3">For option a): 5</td></tr>
<tr><td colspan="3">For option b): 5</td></tr>
<tr><td colspan="3">For each extra option: 2</td></tr>
<tr><td rowspan="5">Effectiveness of implementation</td><td rowspan="5">B5</td><td>Unsurmountable problems were encountered during the implementation of the monitoring practice. The monitoring practice was not implemented fully due to these problems.</td><td>1</td><td rowspan="5">*5
(e.g. 3*5=15)</td></tr>
<tr><td>The monitoring practice had major problems that hindered its implementation, but in the end they did not hinder its full implementation.</td><td>2</td></tr>
<tr><td>The monitoring practice occasionally encountered significant problems, which were treated in time and did not pose a problem for its implementation.</td><td>3</td></tr>
<tr><td>The monitoring practice faced minor difficulties and had an overall smooth implementation.</td><td>4</td></tr>
<tr><td>The implementation of the monitoring practice had no problems or difficulties whatsoever, outperforming implementation expectations.</td><td>5</td></tr>
<tr><td colspan="5">C. Supporting elements</td></tr>
<tr><td>Criteria</td><td>Relevant question</td><td colspan="3">Points awarded</td></tr>
<tr><td>Skilled personnel</td><td>C1</td><td colspan="3">N*2 (e.g. if option 3, then 3*2=6)</td></tr>
<tr><td>Adequate lab equipment</td><td>C2</td><td colspan="3">N*2</td></tr>
</table>

The following table provides the classification that will be used to rank monitoring practices in order of effectiveness, based on the total number of points.

Table 4: Classification system of cases & points

Classification system of cases	Points
Poor	0-121
Promising	121-180
Good	181-220

Best	>221

Please note: OOWV holds the right to review parts of the evaluation criteria to incorporate unanticipated data from project partners that may come up in the input documentation forms. Final adjustments to the evaluation criteria will be documented in the final deliverable of the activity (Evaluation report).

9 References

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