Deliverable D6.2

Report on general context and regulatory constraints for water reuse in the greenfield demo site

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Deliverable lead:	VERI
Author(s):	Isabelle SAUDRAIS, Emmanuel SOYEUX, Marie-Pierre DENIEUL, with support of Thomas RENOULT (SETUDE)
Contact for queries	Marie-Pierre Denieul VEOLIA Recherche & Innovation Centre de Recherche de Maisons-Laffitte Chemin de la Digue, BP76 FR-78603 Maisons-Laffitte Cedex T +33 1 34 93 81 22 E marie-pierre.denieul@veolia.com
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Abstract	This report presents the results of Task 6.2 of the WP6 of DEMOWARE about the regulation constraints in France for reuse, the gaps to fill with a comparison with worldwide legislation and approaches on waste water reuse for drinking water production. Reuse of wastewater intended for drinking water production is currently not allowed in France and the foreseen reuse scheme in Vendée (greenfield site) would be the first reference in France of planned indirect reuse for drinking water production (IPR). This study aimed to identify the gaps to be covered and to propose an approach applicable to the local context to overcome the identified barriers.

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Glossary

ANSES	French national health safety agency
ARS	French local health authority
ATWF	Advanced Treatment Water Facility
CLE	Commission Locale de l'Eau, i.e. Local Water Committee
CODERST	Conseil Départemental de l'Environnement et des Risques Sanitaires et Technologiques - Local council for environment, health and technological risks.
DDTM	Direction Départementale du Territoire et de la Mer (Departmental Territory and Sea Directorate
DWTP	Drinking Water Treatment Plant
DPR	Direct Potable Reuse
GWRS	Groundwater replenishment system
IBI	Indice Biologique Invertébrés – French aquatic invertebrates index, scores range from 0 (worse) to 20 (best state of the aquatic system)
IBD	Indice Biologique Diatomées – French aquatic diatomae index, scores range from 0 (worse) to 20 (best state of the aquatic system)
ICPE	Classified Installations for Environmental Protection
IPR	Indice Poisson Rivière – French fish-based index, scores range from 0 (best) to infinite (worse). IPR measures a difference between a stream in a reference ecological status and the stream to assess. The more is the difference, the worse is the state of the aquatic system assessed
IMOL	Indice Mollusque – French biological index based on molluscs
IOBL	Indice Oligochètes de Bioindication Lacsutre – French biological index based on oligochaete
IPL	Indice planctonique – French biological index based on plankton
IPR	Indirect Potable Reuse
MF	Micro Filtration
MS	Member States
PAOT	Plan d'Action Opérationnel Territorialisé – Territorialised Operational Action Plan
RSadd	Additional program of analyses to RS (RS: analyses performed on resources, for surface water), performed on the resource, for surface water, whose gathered flow is greater than or equal to 100 m^3/day in average.
RSDE	Rejets de Substances Dangereuses dans l'Eau, i.e. discharges of hazardous substances to water
RO	Reverse Osmosis
SAGE	Schéma d'Aménagement des Eaux, i.e. Water Development Scheme
UBA	Umweltbundesamt (the German Federal Environment Agency)
UIE	Union Nationale des Industries et Entreprises de l'Eau et de l'Environnement, i.e. the French National Union of water and environment industries and companies
UWWTD	Urban Waste Water Treatment Directive
WFD	Water Framework Directive
WHO	World Health Organization
WP6	Work Package 6
WRSP	Water Reuse Safety Plan
WWTP	Wastewater Treatment Plant

Executive Summary

Vendée Eau is a greenfield site for planned indirect potable water reuse within the European project DEMOWARE. At this site we want to demonstrate the feasibility of using treated wastewater discharged upstream of a water reservoir, for the production of drinking water.

The intended reuse scheme in Vendée aims to augment the Jaunay reservoir, with reclaimed water from the WWTP of Les Sables d'Olonne, located 20 km away. This indirect potable reuse (IPR) project is an innovative approach toward integrated water resources management. Yet, it is not covered by the current French regulation on reuse of treated urban wastewater which only authorizes uses for irrigation purposes. The present report aims at identifying the regulatory constraints and gaps in the current French legislation related to such an undertaking. With the help of worldwide regulations and/or approaches and lessons learned from existing (direct and indirect potable) reuse schemes, legal procedure to follow and recommendations to be implemented are addressed.

- The local context and situation of Vendée is presented together with the issue of water transfer between two catchment areas (Water Planning and Management Scheme) in which the foreseen IPR project is located.
- The current French regulation is reviewed, linked with the foreseen IPR project, and put in relation with European regulations and other non EU ones on reuse, to identify how the legislative gap could be overcome for the greenfield,
- An inventory of legal procedures to follow for the greenfield site is then proposed. Additional key key issues to ensure project success are as well addressed on basis of a short inventory of existing projects (similar to the foreseen one in Vendée) and lessons learned from difficulties when implementing the project).

To overcome the gap of the French regulation on urban wastewater reuse, Vendée Eau will have to innovate by proposing, in addition to the legal procedure, a risk management approach that could be based on the WHO guidelines and Australian guidelines. Such approaches will be considered in Task 6.4 "Design of the reuse scheme" and Task 6.6 "Health and Environmental risk management" of WP6 of DEMOWARE.

The analysis of other water reuse schemes and case studies showed that the following issues are of importance and might constitute barriers that will have to be overcome:

- guarantee a high level of safety of the reuse scheme for health and environment, in order to demonstrate that there is no deterioration in comparison with the current state of the system and the safety for human health,
- assuring public acceptance and trust. Feedback has to be taken into consideration, particularly as shown for the USA where projects have demonstrated the importance of the communication approach (public education, stakeholder engagement…). The Vendée Eau foreseen IPR project should rely on successful examples as in the East Fork Raw Water Supply Project where the artificial constructed wetland is a positive point which contributes to limit the public opposition. Such return of experience will have to be considered in the public acceptance study to be done in Task 6.5.

1 Introduction

1.1 Vendée Eau as green field demonstration site within DEMOWARE

The coastal area of the department of Vendée (85), France, is prone to water shortage from May to October, due to the influx of tourists and intensified crop irrigation during this period.

The 2011 update of the drinking water management plan of the Vendée department reported a deficit of water for the production of drinking water from May to October in dry and canicular years of vingtennal dry type andvalued at 8 million m^3 in 2025 for coastal areas. 100 000 inhabitants are concerned in a raised risk of interruption of water supply, as was the case on three occasions between 2003 and 2009.

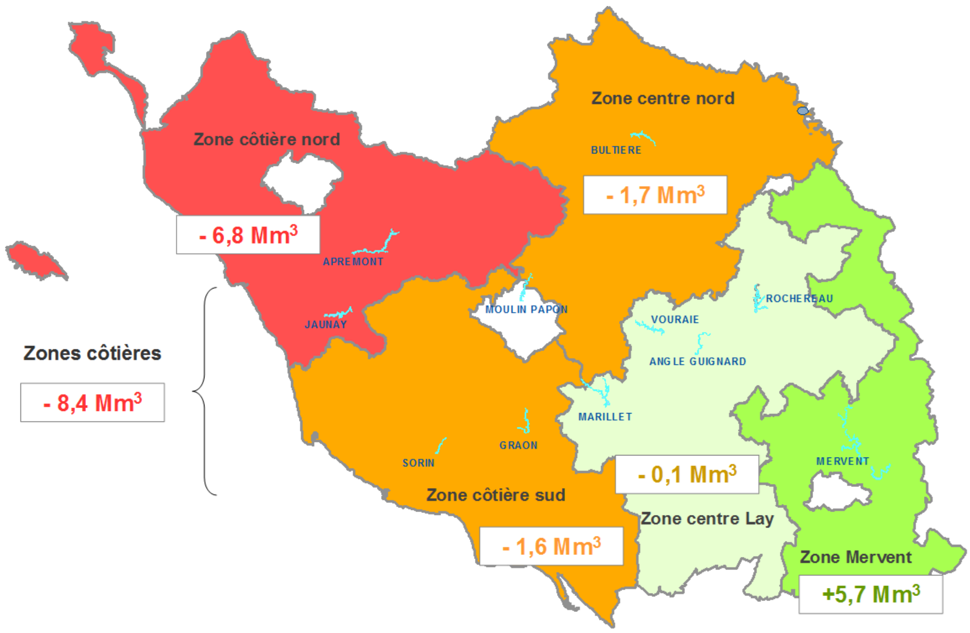

Figure 1 Vendée balance needs/resources in the inner, centre and coastal parts of the department

Water supply is mainly based on surface water and surface reservoirs. The groundwater resources are limited due to the geological nature of the basement.

As the water level in the reservoir depends on the precipitation occurring during fall and winter, additional water resource coming from reuse would contribute to secure the amount of water stored in those reservoirs and to avoid water shortage due to an increasing water demand forecasted for the next 10 years. Indirect reuse of treated urban wastewater from coastal WWTPs of this department could be indeed an additional resource to 2015-2020 horizon.

The Jaunay reservoir is located about 20 km away from the coastal city of Les Sables d'Olonne in another catchment (see Figure 3). The drinking water treatment plant near the dam produces 4.5 million m^3 of drinking water. The drinking water supplies the municipalities nearby and, in summer period, the North of the Vendée and the Les Sables d'Olonne area (CLE du SAGE Vie et Jaunay, 2005).

The water management plan of the Vie and Jaunay rivers does not mention specific measures about water transfer between two catchments although it is considered as a matter of concern (Commission Locale de l'Eau (CLE) du SAGE Vie et Jaunay, 2011).

The Master Water and Management Plan of the Loire-Bretagne Basin has identified some major "issues" such as reducing the pressure of withdrawal on water resources. A program of measures has defined some actions to improve the water quantity management in the basin. The principal ones related to the IPR project of Les Sables d'Olonnes / Jaunay reservoir are:

- RES0701-Establish an alternative resource,
- RES0702-Develop a complementary water resource,
- RES0801-Develop a strategic management of the water transfer facilities (Comité de bassin Loire-Bretagne, 2015).

Thus, the foreseen Indirect Potable Reuse (IPR) project of Les Sables d'Olonne / Jaunay reservoir as depicted in Figure 2 complies with both local and regional water management plans by reducing the pressure of water abstraction on water resources and by transferring water in the same watershed that supplies the city of Les Sables d'Olonne during the critical period of summer.

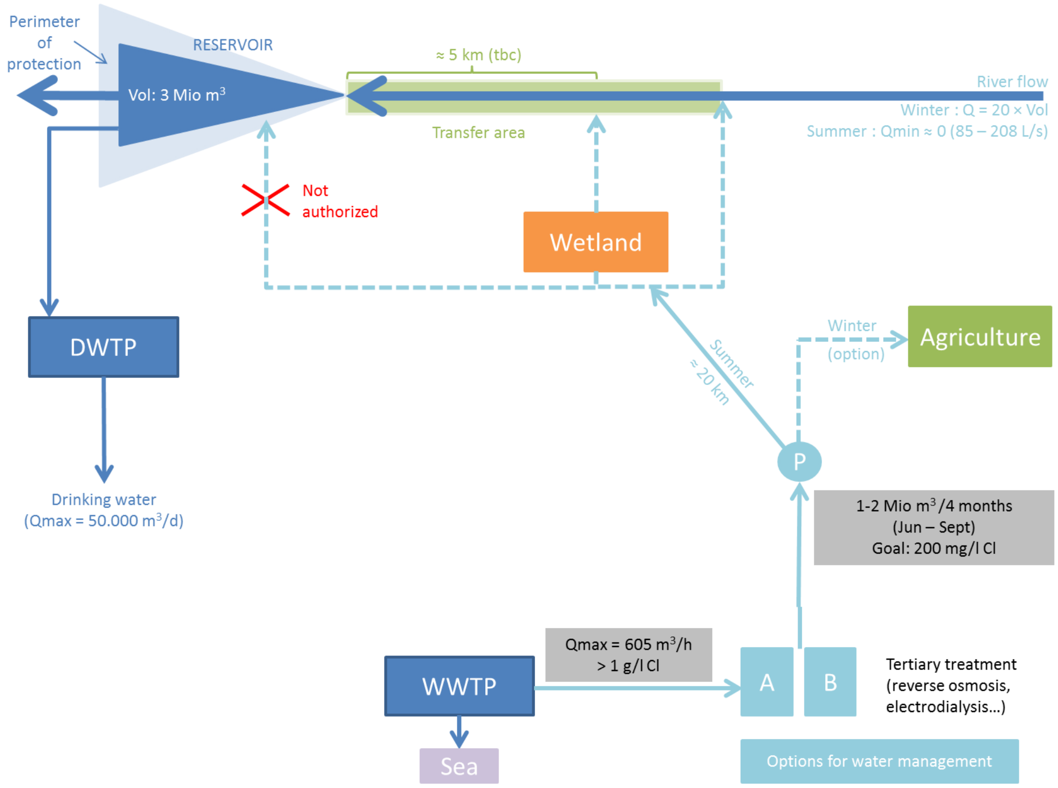

Figure 2 **Planned indirect reuse scheme: discharge of treated wastewater from Les Sables d'Olonne WWTP to Le Jaunay reservoir**

1.2 Starting points for our investigations

Vendée Eau is a green field site for planned water reuse. Vendée Eau wants to demonstrate within the European project DEMOWARE that the planned indirect reuse of treated wastewater discharged upstream of a water reservoir, used for the production of drinking water, is possible.

This includes the assessment of the existing dam of La Bultière which dams up the La Grande Maine river. This reservoir is located in the same area but more in the countryside (same meteorological and hydrological conditions, see Figure 3). The WWTP of Les Herbiers is discharging upstream in La Grande Maine river.

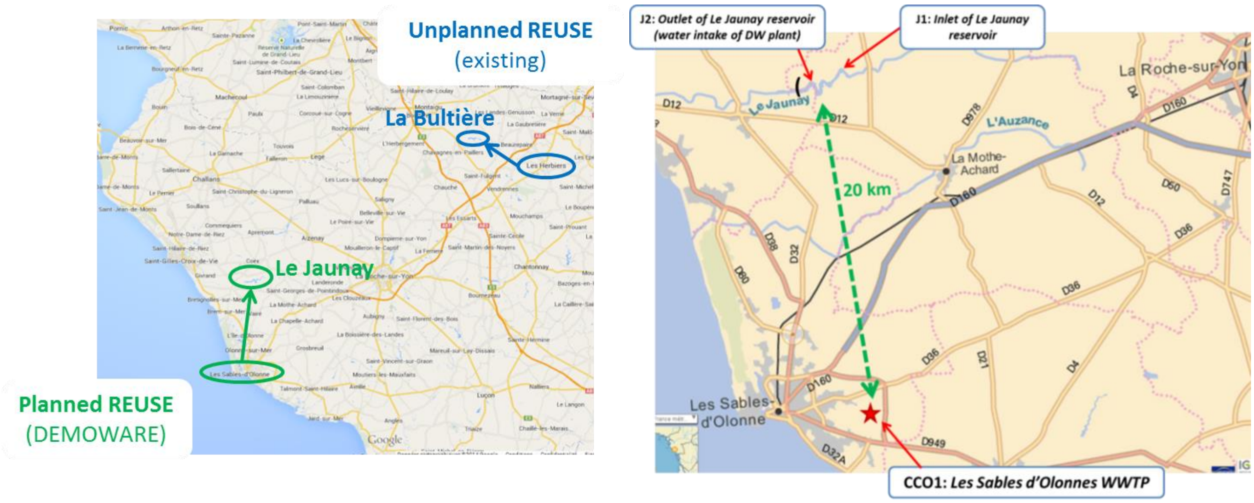

Figure 3 **From an unplanned indirect reuse scheme (Les Herbiers WTTP to La Bultière reservoir) to a planned indirect reuse scheme (Les Sables d'Olonne WWTP to Le Jaunay reservoir)**

In France, the current regulation is a barrier to reuse as it only authorizes uses as irrigation and watering with strong operational constraints (see Chapter 2). Most of the reuse projects in France are anterior to the regulatory framework established by the Decree of August 2nd, 2010 and modified by the Decree of June 25th, 2014. Since those Decrees, the number of operational reuse projects has decreased considerably in France (Laperche, 2015; David *et al.*, 2015), because:

- The complexity of the rules to comply with (see Chapter 2.5 for more details about French regulation on water reuse) is deterring,
- The additional costs of complying with the new regulations are prohibitive,

Thus, the Union Nationale des Industries et Entreprises de l'Eau et de l'Environnement (UIE, the French National union of water and environment industries and companies), has thus drafted a proposal for a by-law regarding all uses of treated wastewater to replace the current one. Their proposal, submitted to the Department of Ecology in April 2015, recommends to expand the authorized uses for reuse and to simplify administrative procedures. It also proposes:

- To set the bacteriological quality of the water after treatment as a criteria, and not the percentage of contamination reduction, as is the case today,
- Not to impose compliance with the new regulation to existing facilities that do not pose problems (UIE, 2015).

Direct potable reuse is neither authorized as Article R1321-6 of the French Public Health Code mentions that "unnatural water cannot be used to produce potable water".

The Vendée Eau project is then innovative toward the current regulation as it is addressing planned indirect reuse intended for human health consumption.

Another obstacle to reuse in France is that water scarcity is not, for the moment, a concern nationwide. There are local water supply problems that led to the implementation of reuse projects in the country, but the annual volume of reuse, which accounted for 20 000 m^3/d in 2007, is a proof that it is (or that it was?) a minor concern until very shortly. The increase of irrigated crop areas, the forecasts of climate change and recent events such as violent demonstrations against the controversial dam project in Sivens in 2015 (a dam on the course Tescou, a tributary of the Tarn, in the Garonne Basin) could change the perception of the public and of French authorities about this matter in the future.

The barriers to overcome in the green field site concern mainly the Health Authority acceptance as well as public acceptance (Understanding and Trust). For both stakeholders it will be key that it can be demonstrated that the reuse scheme will not pose a risk to public health. Another challenge will be to ensure that the reuse scheme does not have a significant impact on the status of water bodies (Water Framework Directive)

1.3 Scope of investigations

Reuse of wastewater intended for drinking water (direct and indirect) production is currently not allowed in France and the foreseen reuse scheme would be the first reference in France for planned indirect potable reuse (IPR).

Within the DEMOWARE project, Vendée Eau wants to demonstrate in Work Package 6 (WP6) the feasibility of the reuse of treated wastewater to secure drinking water reservoir levels and to avoid water shortage due to an increasing water demand forecasted for the next 10 years. Considering the local context, the stakes, the context of reuse in France and the obstacles exposed before, this proof of demonstration will be addressed by various tasks organised in WP6:

- The assessment of environmental and health impacts of an existing unplanned indirect reuse scheme located in the same area but in La Grande Maine water catchment, where Les Herbiers urban WWTP discharges in the upper catchment of the river which then flows to La Bultière reservoir. The objective of this study done in ***Task 6.1*** is to demonstrate that the planned reuse scheme can be envisaged thanks the study of this existing system (→ deliverable D6.1)
- A comprehensive study of the current situation at Les Sables d'Olonne WWTP and Jaunay reservoir (→ done in Task 6.3) to assess the chemical and biological quality of the existing WWTP discharge (Les Sables d'Olonne) and the water quality of the water resource used as reservoir (Le Jaunay).
- The design of the reuse scheme and assessment of its potential impacts (Task 6.4). This will be done by extrapolation of results from Task 6.1 and Task 6.3. (→ Deliverable D6.3)
- A study of public acceptance of the envisaged reuse scheme, done in Task 6.5. (→ Deliverable D6.4)
- Proposing a method to control and manage the sanitary and environmental risks in the operation phase of the project (« Reuse Safety Plan »). This will be done in Task 6.6 through a "Health and Environmental risk management" study. (→ Deliverable D6.5)
- Identifying the legal issues to follow for the greenfield site and addressing recommendations in Task 6.2 on basis on current legislation in France and reuse schemes worldwide (→ deliverable D6.2).

Thus the present Deliverable D6.2 "General context and regulation constraints, focusing on a greenfield demo site", which covers the Task 6.2, intends:

- to present an overview of the current water legislation in France and its relevance for the foreseen IPR project in Vendée in order to identify the legislative gaps to be filled.
- to summarise regulations on water reuse in European countries as well as non-EU approaches, to identify how the legislative gap could be overcome for the greenfield, *(NB: detailed survey is done in WP5 and presented in DEMOWARE deliverable D5.2)*

- to describe the inventory of legal procedures to follow to implement reuse in the greenfield site, including recommended guidelines very recently issued by the ANSES (French National Health Safety Agency);
- to recommend on implementation issues based on experience and lessons learned from existing projects similar to the one foreseen in Vendée.

2 Regulatory frames for water reuse

This chapter will look into French, European and pan-European approaches to govern the safe use of treated wastewater. In the context of indirect potable reuse it also analyses more general approaches of how to deal with health and environmental risks, especially for thus far unregulated compounds of concern.

2.1 French water (reuse) related regulations

There is currently neither a dedicated regulation in French law nor a generally accepted blueprint for the concept of indirect potable reuse (IPR). However, the foreseen reuse scheme has to be in line with the objectives and requirement of existing French legislation in the water and health sector which are detailed in this chapter. Figure 4 relates the different steps of the IPR Vendée Eau scheme to the current regulations that are further detailed in this chapter.

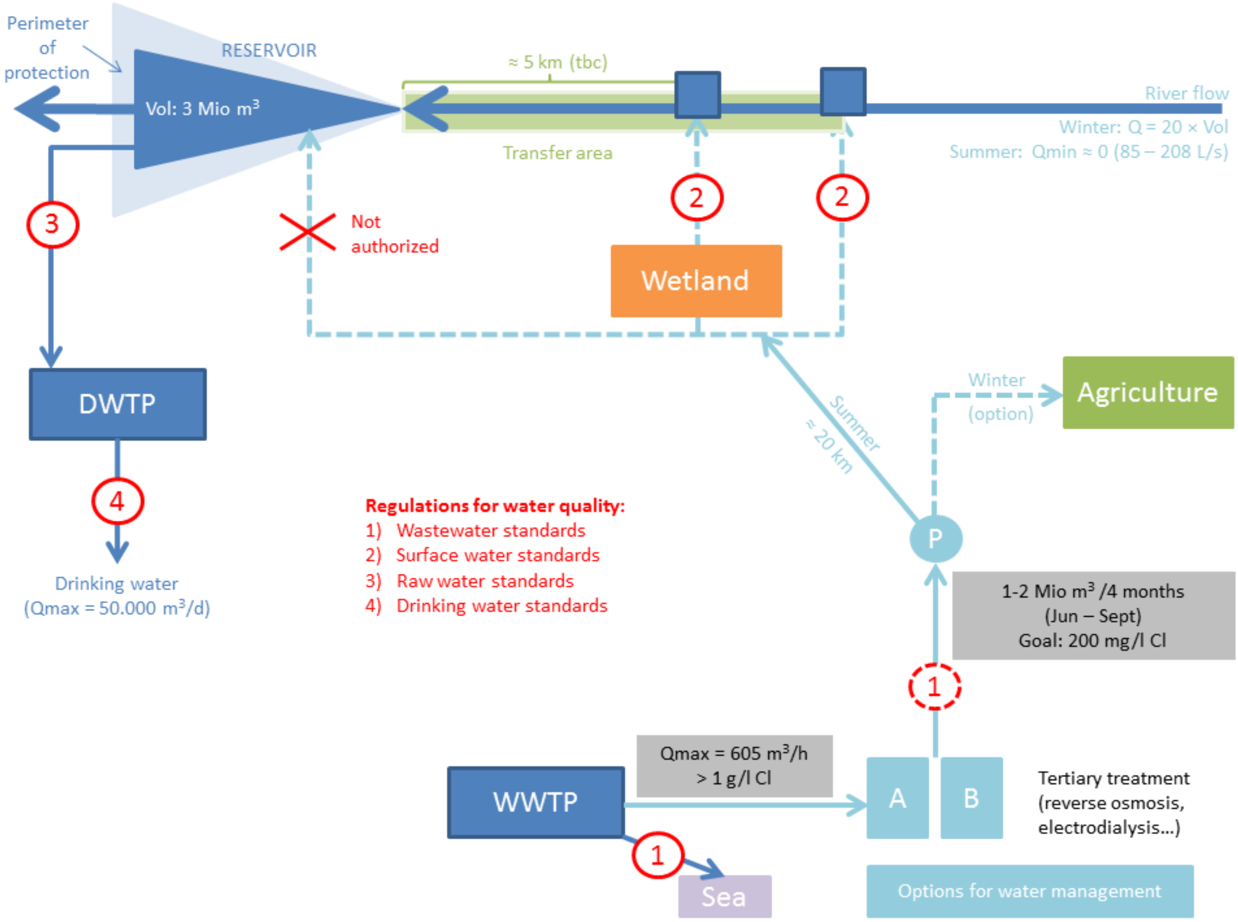

Figure 4 Current French regulations for water quality relating to the foreseen IPR scheme

2.1.1 Overview of French regulation

Table 1 presents a summary of the French regulation on (drinking) water, waste water and ecological status with which Le Jaunay reservoir and the WWTP of Les Sables d'Olonne have currently to comply and its application to the different items of the IPR scheme that is envisaged in Vendée:

Table 1 Summary of French regulation on water, waste water and ecological status

Field of application	Type of regulation	Name of regulation		Comment	Vendée Eau reuse scheme
GENERAL FRAME	European directive	No. 2000/60/EC Water Framework Directive	establishing a framework for Community action in the field of water policy	Transposition into French law: Law No. 2004-338 (21/04/2004)	Apply to the **natural aquatic environment**. They regulate parameters as priority substances and also define standards to **assess the ecological status of water bodies** such as lakes and rivers. → Quality of rivers/lakes and ecological status may be impacted by the quality of discharged treated waste water of an advanced treatment plant as in the one in the Vendée Eau IPR project
		http://www.ineris.fr/rsde/doc/docs%20rsde/directive_cadre_eau.pdf *http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000418424*			
	European directive	No. 2013/39/EU amending 2000/60/EC	amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy	Transposition in French law: legislation coming before the end of 2015	
		http://www.ineris.fr/aida/consultation_document/26932			
	Ordinance	January 25th, 2010 (modified by Ordinance of July 27th, 2015)	Standards for ecological status of the water bodies	Integrated in the Code of Environment, Articles R212-10 to R212-18	
		https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000021865356			
Drinking Water	European directive	No. 98/83/EC	on the quality of water intended for human consumption	Integrated in the Code of Health, Articles 1321-1 to 1321-63	Apply to the **health sector**. They define the standards to comply with in the **drinking water sector**. → In the Vendée Eau project, they apply to the Drinking Water Treatment Plant of Le Jaunay. The parameters concerned are the pathogens and hazardous chemicals that may be brought in raw water by the discharge of treated wastewater (→ toxic effects).
		http://www.ineris.fr/aida/consultation_document/1017 *http://legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000006072665*			
	Ordinance	January 11th, 2007	Limits and reference quality of raw water and drinking water		
		https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000465574			
	Ordinance	January 21st, 2010	Program of samplings and health control analyses for waters supplied by the distribution network	Including additional RSadd monitoring	
		http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000021923970&dateTexte=&categorieLien=id			
Urban Wastewater	European directive	No. 91/271/EEC **DERU (UWWTD)**	Obligations for the collection and treatment of wastewater		Apply to the **receiving environment** and the uses that may be impacted downstream the discharge point of Les Sables d'Olonne WWTP → Discharge of **current** treatment processes and as well in the foreseen IPR scheme
		http://www.ineris.fr/aida/consultation_document/1059			
	Law	92-3 of January3rd, 1992 **Loi sur l'Eau**		Cf. Article 35	
		http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000173995&dateTexte=&categorieLien=id			
	Decree	94-469 du 3 Juin 1994	Collection and treatment of wastewater	Cf.Article 24	
		http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=LEGITEXT000005615953			
	Decree	July 21th, 2015	Collection, transport and treatment of wastewater stemming from urban areas	Cf. Article 8	
		http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000276647			
	Law	2009-967 of August 3rd, 2009 **Grenelle 1**	Implementation of the « Grenelle de l'Environnement »	Cf. Article 27	

Field of application	Type of regulation	Name of regulation		Comment	Vendée Eau reuse scheme
	http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000020949548&categorieLien=id				
	Decree	August 2nd, 2010	Reuse of waters stemming from an urban WWTP for irrigation of agricultural crops or green space		REUSE Not applicable for treated wastewater recycled for indirect DW production
	http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000022753522				
	Modifying decree	June 25th, 2014	Reuse of waters stemming from an urban WWTP for irrigation of agricultural crops or green space		
	http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000029186641&dateTexte=&categorieLien=id				
RSDE	Circular	January 5th, 2009	Implementation of Phase 2 of the National Action Plan for searching and reducing hazardous substances in the aquatic environment coming from ICPE discharges (Classified Installations for Environmental Protection) subjected to authorization		Apply to the **receiving environment**. → The parameters concerned are hazardous substances that may be discharged in surface water such as Le Jaunay reservoir and its tributaries
	http://www.ineris.fr/aida/consultation_document/7149#7150				
	Circular	September 29th, 2010	Monitoring of presence of micropollutants in water discharged into the natural environment by WWTPs		
	http://www.ineris.fr/aida/consultation_document/7003				

2.1.2 General water management framework

The Directive 2000/60/EC of the European Parliament and of the Council of October 23rd, 2000 referred to as Water Framework Directive (WFD, Directive "Cadre sur l'Eau") establishes a framework for Community action in the field of water policy and aims at organizing all the previously voted texts in a coherent set. It was transposed into French law by the law No. 2004-338 of April 21st, 2004 and was modified by the Directive 2013/39/EU of August 12th, 2013, in particular the Appendix I (initially Appendix X; see Annex 1 of this document) which defines environmental quality standards for the list of priority substances in water. The Member States are required to transpose the latter into national law by September 14th, 2015 the latest. It was transposed into French law by the Decree of July 27th, 2015, that modifies the previous decree of January 25th, 2010. This WFD directive strengthens the Community guidelines relative to the good status of the aquatic ecosystems. In particular, the Article 16 of the WFD aims at strengthening the aquatic environmental protection by specific measures designed to progressively reduce discharges, emissions and losses of priority substances, and the cessation or the phasing-out of discharges, emissions and losses of priority hazardous substances in water.

2.1.3 French regulation about ecological status of surface waters

The discharge of treated wastewater into the environment should not lead to degradation of water quality in the receiving environment. In accordance with the WFD, every water body should be classified in a "Good status" that means that each water quality parameter has to comply with the environmental standards for the ecological status. The standards to meet depend on the type of the water body concerned as detailed below.

For example:

- For river water bodies, dissolved oxygen should not be less or equal to 6 mg/l O_2 for 90% of the values.
- For lake water bodies, the annual average in the euphotic zone for maximum total phosphorus should not be more or equal to 0.03 (mg P/l).

The **Decree of January 25th, 2010** defines standards to assess the ecological status, i.e. good state of the aquatic ecosystem, for the different types of water bodies: [1] rivers, lakes and closed water bodies, transitional waters (like estuaries), coastal waters and artificial or heavily modified water bodies. The assessment is based on 3 groups of parameters: biological parameters, physicochemical parameters and specific pollutants. For each parameters and each type of water bodies, the Decree sets maximum, minimum or gap limits values.

The ecological status of a water body is defined by combining the assessment from the biological, physicochemical parameters and specific pollutants. The biological parameters are dominant in describing the ecological status and a single parameter is sufficient to downgrade the quality of a body of water: the aggregation rule of quality elements in classification of ecological status is based on the principle of quality element downgrading. Figure 5 presents the aggregation rules to define the ecological status of a water body. The standards and rules to assess ecological status of a water body are detailed below.

In the foreseen IPR scheme project of Vendée Eau, the Jaunay reservoir and its tributaries upstream that will receive the discharge of Les Sables d'Olonne WWTP are subject to this regulation. It has however to be noticed that all these receiving environments are currently subject to this regulation. According to the ANSES, the SAGE (water management scheme) of the Vie and Jaunay indicates that the quality of the Jaunay reservoir is already worrying (ANSES, 2016) and the ecological status is qualified of poor quality in the PAOT (Territorialised Operational Action Plan) of Vendée (DDTM de la Vendée, 2016). SAGE reported a derogation regarding the achievement of good environmental status set by the Framework Directive (WFD) in 2027, against its major eutrophication problems due to high concentrations of macropollutants (nitrogen, phosphorus, etc.). The ecological status of the Jaunay river is as well qualified of poor quality in upstream the Jaunay reservoir (DDTM de la Vendée, 2016).

Therefore, reference state of this system will be more thoroughly assessed within Task 6.3 "Comprehensive study of the current situation at Les Sables d'Olonne and Jaunay reservoir".

[1] on methods and criteria to evaluate the ecological status, chemical status and ecological potential of surface water, modified by the Decree of July 27th, 2015, taken pursuant to Articles R. 212-10, R. 212-11 and R. 212- 18 of the French Environmental Code,

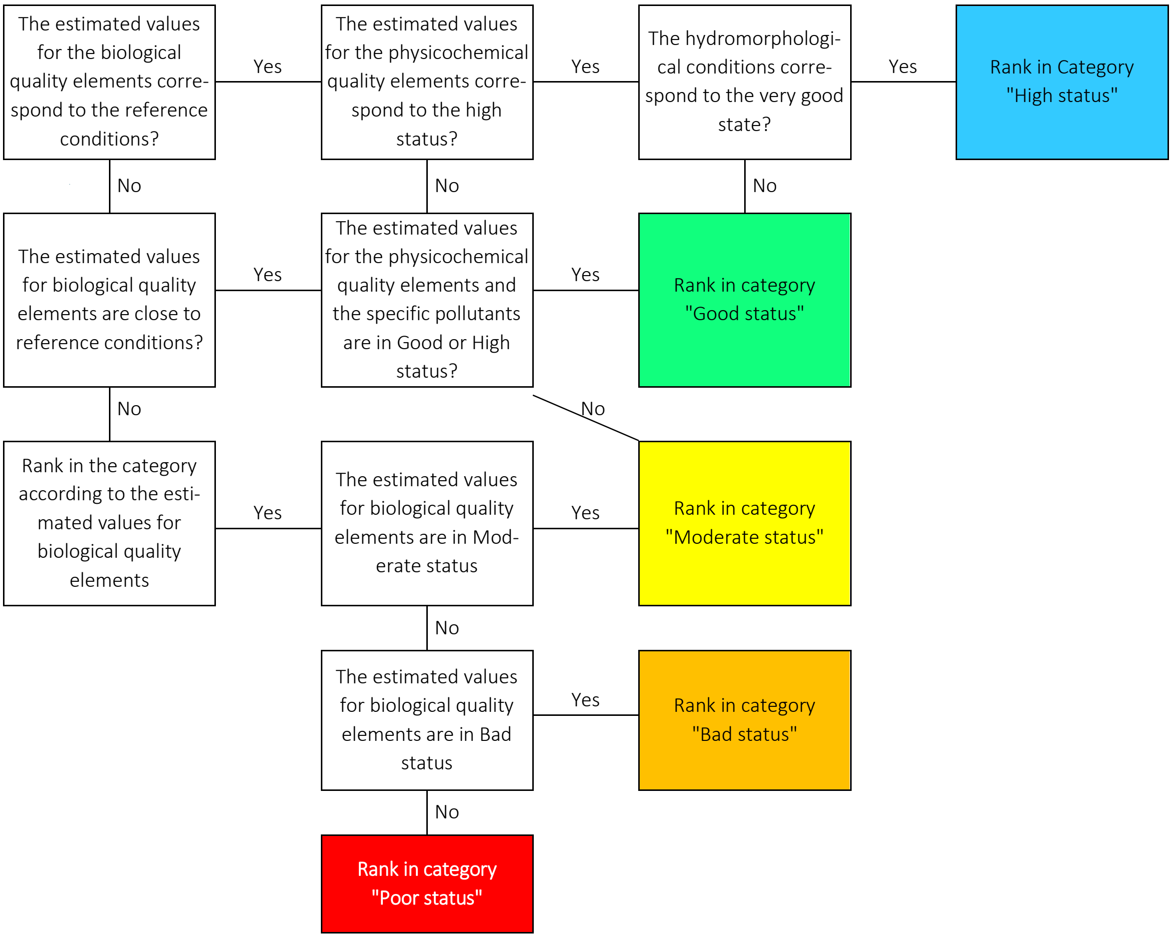

Figure 5 Aggregation rules for quality parameters and elements of ecological status for surface water

2.1.3.1 Assessment of the ecological status for rivers

Table 2 present the limits values of the principal parameters for rivers and the corresponding ecological status. In the Vendée Eau IPR scheme project, the parameters that may be concerned are all the parameters that would lead to a deterioration of the ecological status. For example, the Phosphorus content of the treated wastewater could contribute to exceed the limit value of the good state, and then lead to declass the ecological status of the receiving environment.

All parameters of Table 2 are potentially concerned but particularly the parameters of the oxygen balance and nutrients. Chloride is as well of importance parameter for the discharge in Jaunay River, as there is salt intrusion in Les Sables d'Olonnes collection system. However, as for other salinity parameters there is no regulatory limit value at the moment.

Table 2 Biological and physicochemical parameters for the ecological assessment of stream water body

For each biological parameter, the limit values will vary according to the size of the stream and hydro-ecological zone to which it belongs. Limit values presented below are specific to the Grand Maine river water body.

Limits values of ecological status classes	High	Good	Moderate	Bad/poor
IBI[1)]	15	13	9	6
IBD[2)]	16.5	14	10.5	6
IPR[3)]	5	16	25	36

Limits values of ecological status classes	High	Good	Moderate	Bad/poor
Oxygen balance				
Dissolved oxygen (mg/l)	8	6	4	3
Dissolved oxygen (%)	90	70	50	30
Biochemical oxygen demand (mg/l)	3	6	10	25
Dissolved organic carbon	5	7	10	15
Temperature – salmon context	20	21.5	25	28
Temperature – cyprinids	24	25.5	27	28
Nutrients				
Orthophosphate (mg PO_4/l)	0.1	0.5	1	2
Total phosphorus (mg P/l)	0.05	0.2	0.5	1
Ammonium (mg NH_4/l)	0.1	0.5	2	5
Nitrite (mg NO_2/l)	0.1	0.3	0.5	1
Nitrate (mg NO_3/l)	10	50		
Acidification				
Minimum pH	6.5	6	5.5	4.5
Maximum pH	8.2	9	9.5	10
Salinity				
Conductivity	(*)	(*)	(*)	(*)
Chlorides	(*)	(*)	(*)	(*)
Sulfates	(*)	(*)	(*)	(*)

1) IBI : Indice Biologique Invertébrés – French aquatic invertebrates index, scores range from 0 (worse) to 20 (best state of the aquatic system)
2) IBD: Indice Bilogique Diatomées – French aquatic diatomae index, scores range from 0 (worse) to 20 (best state of the aquatic system)
3) IPR: Indice Poisson Rivière – French fish-based index, scores range from 0 (best) to infinity (worse). IPR measures a difference between a stream in a reference ecological status and the stream to assess.
(*) Current knowledge does not allow to set reliable thresholds for this limit

2.1.3.2 Assessment of the ecological status for lakes

The following tables present the limits values of the principal parameters for lakes and the corresponding ecological status.

In the case of the Vendée Eau IPR scheme project, the phosphorus is the more relevant parameter because it is particularly involved in the eutrophication process of lakes. The eutrophication leads to algae blooms that complicate the production of drinking water which then becomes more expensive. This parameter will have to be particularly monitored and the advanced tertiary treatment of Les Sables d'Olonne WWTP tailored with an enhanced treatment for phosphorus: it is indeed known that Le Jaunay reservoir is currently subject to eutrophication phenomena.

Furthermore, some cyanobacteriae, a specific genus of phytoplankton, may appear when the phosphorus content in water is high. The phosphorus threshold depends on many factors, including the residence time, the depth, the presence of a thermocline, the presence of other nutrients such as nitrogen or the inter-specific competition in phytoplankton. Some species of cyanobacteriae produce toxins that are found in raw water and then potentially in drinking water.

Table 3 Biological and physicochemical parameters for ecological assessment of lake water body

Limits values of ecological status classes	High	Good	Moderate	Bad	Poor
Phytoplankton					
a-chlorophyll average summer (mg/l)	mathematical formula based on average depth of the lake				
IPL[1)]	25	40	60	80	
Phytoplankton					
IMOL[2)]	8	7	4	1	
IOBL[3)]	15	10	6	3	
Nutrients*					
Maximum mineral nitrogen (NO_3 + NH_4) (mg N/l)	0.2	0.4	/	2	
Orthophosphate maximum (mg P/l)	0.01	0.02	0.03	0.05	
Maximum total phosphorus (mg P/l)	0.015	0.03	0.06	0.1	
Transparency					
Transparency	5	3.5	2	0.8	
Oxygen balance					
Deoxygenation of the hypolimnion in% deficit observed between the surface and the bottom during the summer	8	6	4	3	

[1)] IPL: Indice planctonique – French biological index based on plankton
[2)] IMOL: Indice Mollusque – French biological index based on molluscs
[3)] IOBL: Indice Oligochètes de Bioindication Lacsutre – French biological index based on oligochaete

For the nutrients, the measurement period depends on the mean residence time:

Table 4 Concentration of the nutrients to be considered depending of mean residence time

Parameters	Mean residence time > 2 months	Mean residence time <= 2 months
Nutrients		
Maximum mineral nitrogen (NO_3 + NH_4) (mg N/l)	Winter value in times of total water mixing	Maximum value during summer for 3 sampling campaigns at least
Orthophosphate maximum (mg P/l)	Winter value in times of total water mixing	Maximum value during summer for 3 sampling campaigns at least
Maximum total phosphorus (mg P/l)	Annual average in the euphotic zone or winter value in times of total water mixing	Maximum value during summer for 3 sampling campaigns at least

2.1.3.3 Specific pollutants for the ecological status

The rules for assessing the chemical status (based on specific pollutants) of river water bodies and lakes are the same. As for biological and physicochemical parameters, the assessment of chemical status for specific pollutants is based on the principle of quality element downgrading: one single parameter is sufficient to downgrade the quality status.

There are 45 specific pollutants of the chemical status: pesticides, metals, polycyclic aromatic hydrocarbons (see Annex 3). For each pollutant, the annual average concentration and the maximum allowable concentration should not be exceeded. **The revised standards for these substances** were **included in 2015 in the new SDAGE of Loire Bretagne water district** which includes the targets quality for the substances of concern (see Annexe 8) and **should be taken in account in the foreseen reuse scheme of Vendée Eau.**

2.1.4 French regulations on water and aquatic environments

The French Water Law of January, 1992 and the Decree of February, 1993 have established a nomenclature of installations, structures, works and activities that may impact water bodies and wetlands and are thus subject to administrative authorization (beside the installations Classified for the Environmental Protection regulation). Those activities or installations are e.g. wastewater treatment plants, abstraction of surface water or groundwater, works in river beds… are classified in rubrics of the nomenclature. They **need an authorization demand based on an environmental risk assessment study**.

Each heading of the nomenclature is subject to a **specific environmental risk assessment study**. The study content is fixed by a by-law of the Ministry of Ecology. The rubrics concerned by the implementation of Reuse in the Sable d'Olonne / Le Jaunay reservoir project scheme are described in Chapter 3.

→ An environmental and health risk assessment study is thus planned within the Task 6.6 "Health and environmental risk management" in WP6 of the DEMOWARE project.

2.1.5 Drinking water

The Directive 98/83/EC of the Council of November 3rd, 1998 fixes requirements at European level on the quality of water intended for human consumption. This directive was transposed into French law in the French Public Health Code (Code de la Santé Publique), in Articles R.1321-1 to R.1321-63.

The **Article R1321-6 of the French Public Health Code** defines the content of the application for a permit to use water as a ressource for drinking water production: minimum information for the evaluation of the water quality, risks of degradation of the water quality, description of the watershed, vulnerability study of the resource, monitoring program... This Article mentions that **"unnatural water cannot be used to produce potable water"** (« L'utilisation d'une eau ne provenant pas du milieu naturel ne peut être autorisée »). **Direct potable reuse (DPR) is thus currently not allowed** as there is no definition of what is "unnatural water".

The term of "unnatural water" will then have to be highlighted at some point with the authorities and addressed to get the authorization.

2.1.5.1 Raw water

The decree of January 11th, 2007 concerning the limits and quality references of raw water and water intended for human consumption, as mentioned in Articles R.1321-2, R.1321-3, R.1321-7 and R.1321-38 of the French Public Health Code, sets quality standards s for a number of substances.

Table 5 presents the parameters with their maximum limit value that should not be exceeded for the raw water of Le Jaunay reservoir used to produce potable water in the foreseen IPR project in Vendée (from the decree of January 11th, 2007 on standards and guidelines for the quality of potable water and raw water used to produce potable water).

Table 5 Limit values valid for quality parameters of all sources of raw water intended for the production of drinking water (From Appendix II of the decree of January 11th, 2007)

Group of parameter	Parameters	limit value	Unit
Organoleptic	Color (Pt)	200	mg/l
Physico-chemical linked to natural conditions	Chlorides (Cl^-)	200	mg/l
	Sodium (Na^+)	200	mg/l
	Sulphates (SO_4^{2-})	250	mg/l
	Saturation level of dissolved oxygen (O_2)	< 30	%
	Temperature (°C)	25	°C
Parameters linked to un-desired substances	Surfactant reacting with methylene blue	0.5	mg/l
	Ammonium (NH_4^+)	4	mg/l
	Barium	1	mg/l
	Total Organic Carbon	10	mg/l
	Dissolved or emulsified hydrocarbons	1	mg/l
	Nitrates (NO_3^-) Surface water Groundwater	 50 100	mg/l
	Phenol index (C_6H_5OH)	0.1	mg/l
	Zinc (Zn)	5	mg/l
Toxic substances	Arsenic (As)	100	µg/l
	Cadmium (Cd)	5	v
	Cyanides (CN^-)	50	µg/l
	Total chrome (Cr)	50	µg/l
	Cyanides (CN^-)	50	µg/l
	Polycyclic aromatic hydrocarbons	1	µg/l
	Mercury (Hg)	1	µg/l
	Lead (Pb)	50	µg/l
	Selenium (Se)	10	µg/l
Pesticides	Pesticides : single molecule	2	µg/l
	Pesticides : addition of substances	5	µg/l
Mirobiological parameter	Enterococci	10000	cells / 100 ml
	Escherichia coli	20000	cells / 100 ml

Some further parameters are mentioned in the Appendix III of the decree specifically for water abstracted from surface waters (see Annex 2 of this document) such as

- Boron;
- Fluorides;
- Coliform bacteria;
- Salmonella…

These parameters are used to classify surface raw water according to quality in A1, A2 and A3 according to criteria of the Appendix III of the decree (see Annex 2):

- A1: water is subject to a simple physical treatment and disinfection
- A2: water is subject to a physical and chemical hormonal treatment and disinfection
- A3: water is subject to an advanced physical and chemical treatment with polishing and disinfecting operations.

Limit value for the parameters have to be met in 95% of the samples and have to comply with 90% for the guideline values.

The decree of January 21st, 2010 (RSadd)[2] concerning the "program of samplings and analysis for health control of waters supplied by a distribution network, taken in application of Articles R.1321-10, R.1321-15 and R.1321-16 of the French Public Health Code" requires the control of additional parameters (10 substances or groups of substances, see Annex 2) on water resources,

The decree of June 20th, 2007 concerning the establishment of the permit to use raw water for human consumption, mentions the minimal information necessary to assess the water quality of the resource.

2.1.5.2 Potable Water

The quality of drinking water produced by the Le Jaunay treatment plant has to comply with the requirements of the decree of January 11th, 2007, which fixes in its Appendix I:

- limit values for 32 parameters and
- reference values for 26 parameters (see Annex 1).

When the characteristics of the water deviate from these reference values, investigations and special checks must be conducted to understand the situation and assess possible health risks. Where applicable, the situation must be remedied.

2.1.6 RSDE regulation (Rejets de Substances Dangereuses dans l'Eau, i.e. discharges of hazardous substances to water)

In France, WWTPs are submitted to the RSDE regulation that considers that hazardous substances discharged to water can have irreversible consequences on aquatic environments and human health.

The circular of January 5th, 2009 aims at regulating discharges of hazardous substances into water from Classified Installations for Environmental Protection (ICPE) submitted to authorization.

Installations falling under this law are:

- Industrial WWTPs;
- WWTPs which receive only industrial wastewater. WWTPs are collective, which means that two industries are at least connected to it, among which one at least is submitted to authorization (Section 2750 of the list of the ICPE)
- Dual WWTPs (receiving domestic wastewater and industrial wastewater) has a nominal treatment capacity of at least 10 000 p.e. (population equivalent), where the COD of industrial wastewater coming from authorized classified installations is up to 70 % of the capacity of the plant.

WWTP intended to treat only urban wastewater are not in the scope of the list of Classified Installations.

[2] RSadd: additional program of analyses to RS (RS: analyses performed on resources, for surface water), performed on the resource, for surface water, whose gathered flow is greater than or equal to 100 m^3/day in average.

- The **Circular of September 29th, 2010** specifies the appropriate procedures to implement the monitoring of specific micropollutants in waters discharged into the natural environment by urban WWTPs of more than 100 000 p.e. (≥ 6 000 kg BOD_5/day) and between 10 000 and 100 000 p.e. (between 600 and 6 000 kg BOD_5/day).

  The general principles of the implementation of this monitoring for the **WWTPs of more than 100 000 p.e.** are described below. **The WWTP of Les Sables d'Olonne (125 000 p.e.), which is part of the Vendée Eau reuse project, is currently subject to this regulation:**

  - From the national list of 104 pollutants (substances listed in the Annex 3 of the aforementioned circular, see Annex 9), a first monitoring campaign is conducted.
  - The list of pollutants can then be reduced as part of regular monitoring following the initial assessment made for each WWTP, if certain pollutants from the national list are not found in significant amounts in this initial monitoring phase. 6 campaigns per year have to be conducted in the case of the WWTP of Les Sables d'Olonne.
  - A complete campaign of measurements of 104 substances is to be scheduled every 3 years and the regular monitoring has to be updated by taking in account this complete new campaign.

  A reduced monitoring program is required for the WWTPs between 10 000 and 100 000 p.e.[3]

2.1.7 Wastewater and wastewater reuse

Since 1975, about thirty Directives and Community decisions were adopted at European level and implemented. They aim mainly at regulating water uses or discharges in the aquatic environment.

The Directive 91/271/EEC of May 21st, 1991, referred to as DERU (Directive sur les Eaux Résiduaires Urbaines, i.e. Urban Wastewater Directive - UWWTD) is related to the treatment of urban wastewater and sets obligations of the collection and treatment of wastewater. The required treatment levels and compliance deadlines are set according to the size of the urban areas and the sensitivity of the receiving environment to the final discharge.

It is indeed noted in paragraph 1 of Article 12, that "**Treated waste water shall be reused whenever appropriate.**"

These obligations were transposed in French law by:

- the law No. **92-3 of January 3rd, 1992** on the water (Article 35: " The municipalities or their groupings circumscribe, after public inquiry the zones of collective purification where they have to ensure the collection of domestic wastewater and the treatment and discharge or re-use of all the collected waters "),
- the Decree No**. 94-469 of June 3rd, 1994** concerning wastewater collection and treatment, particularly Article 24: " **Treated wastewater can be used for agronomic or agricultural purposes, for watering or for irrigation**, provided that their characteristics and their methods of use are compatible with the requirements of protection of the public health and the environment ",
- the **Decree of July 21st, 2015** on collective sanitation systems and on-site sanitation facilities, with the exception of individual sewerage systems receiving a gross load of organic pollution less than or equal to 1.2 kg BOD5/d (2 000 p.e.) with Article 8: " The treated wastewater is preferably discharged into surface water or reused in accordance with the regulations."– Article 9 mentions

[3] The WWTP of Les Herbiers is 25,000 p.e.

that "in case of reuse of treated wastewater" the application for a permit should include "the demonstration of compliance with the current regulation".

The law **2009-967 of August 3rd, 2009** related to programming and implementation of the Environment Round Table (Grenelle de l'Environnement), referred to as "**Loi Grenelle 1**" makes a reference to water reuse in its Article 27: "**Rainwater and wastewater recovery and re-use will be developed in accordance with sanitary constraints** *by taking into account the necessity of satisfying the priority needs for the population in a crisis. The second objective in this domain is to guarantee the sustainable supply of good quality water appropriate to satisfy the essential needs of citizens. As such, the State promotes actions to limit withdrawals and water consumptions...*"

Finally, the sanitary and technical requirement for "the use of wastewater from urban WWTPs for purposes of crop irrigation or watering of green spaces" are regulated by the Decree of August 2nd, 2010, and modified by the Decree of June 25th, 2014. The French standards and limitations of use are presented in Table 6 to Table 8 and compared with European regulations in Chapter 2.2.

Table 6 Health quality levels of treated wastewater for reuse
Four levels of sanitary quality of treated wastewater (A, B, C and D) are defined as follows:

Parameters	Health quality levels of treated wastewater (*Niveau de qualité sanitaire des eaux usées traitées*)			
	A	B	C	D
Total Suspended Solids (mg/L)	< 15	Comply with the regulation on treated wastewater at the outlet of the plant outside the irrigation period		
Chemical oxygen demand (mg/L)	< 60			
Escherichia coli (CFU/100 mL)	≤ 250	≤ 10 000	≤ 100 000	-
Fecal enterococci (log removal)	≥ 4	≥ 3	≥ 2	≥ 2
RNA F-specific phages (log removal)	≥ 4	≥ 3	≥ 2	≥ 2
Spores of anaerobic sulphite reducing bacteria (log removal)	≥ 4	≥ 3	≥ 2	≥ 2

Table 7 Use categories and required water quality

Type of use	Level of sanitary quality of treated wastewater			
	A	B	C	D
Vegetable crops, fruit and vegetable that are not transformed by industrial and suitable heat treatment (except cressiculture) (1)	+	-	-	-
Vegetable crops, fruit, vegetable transformed with a suitable industrial heat treatment	+	+	-	-
Pasture (2)	+	+ (3)	-	-
Green spaces open to the public (4)	+ (5)	-	-	-
Flowers sold cut	+	+ (6)	-	-
Shrubs and other nursery and flower crops	+	+	+ (6)	-
Fresh fodder	+	+ (3)	-	-
Other cereal crops and fodders	+	+	+ (6)	-
Fruit trees	+	+ (7)	+ (8)	-
Short rotation coppice with public access controlled	+	+	+ (6)	+ (6)

Type of use	Level of sanitary quality of treated wastewater			
	A	B	C	D
Forest, except short rotation coppice, with public access controlled	-	-	-	-

+ authorized / -: forbidden.
(1) The reuse of treated wastewater for cressiculture is prohibited.
(2) In case of spraying, the animals must not be to the field at the time of the operation and waterers, should they be watered, should be rinsed before use.
(3) Subject to compliance with a deadline of 10 days after irrigation in the absence of abattoir linked to the treatment plant wastewater and 21 days otherwise.
(4) The term green space, including: motorways, cemeteries, golf courses, racetracks, parks, public gardens, common areas of housing estates, roundabouts and other embankments, squares, stadiums, etc.
(5) Irrigation outside the opening hours to the public or closed to users during irrigation and irrigation two hours in the case of closed green spaces; Irrigation during hours of low frequentation and denial of access to passerby during irrigation and irrigation two hours in the case of green areas open permanently.
(6) Only by drip irrigation, as defined in Article 2.
(7) Forbidden during the period from flowering to harvest for unprocessed fruits, except where irrigation drip.
(8) Only drip.

Table 8 Distance constraints

Nature of activities to be protected	Level of sanitary quality of treated wastewater		
	A	B	C et D
Lake [(1)]	20 m	50 m	100 m
Aquaculture pond (except shellfish fliter feeders). Fish farming including recreational fishing.	20 m	50 m	100 m
Shellfish farming, beach fisheries of filter-feeding shellfish	50 m	200 m	300 m
Bathing and watersports	50 m	100 m	200 m
Watering cattle	50 m	100 m	200 m
Watercress cultivation	50 m	200 m	300 m

[(1)] Except for the lake being used as an outlet to the discharge of the WWTP discharge system and the private lakes where the access is regulated and where no activity such as swimming, boating and water sports, fishing or watering of the cattle is practiced.

The Decree also fixes specific technical requirements for spray irrigation of treated wastewater as wind speed constraints: *Sprinkler Irrigation should be implemented only during periods when the average wind speed is below 15 km/h or 20 km/h when using a low pressure spray. This average speed is to be measured by an anemometer located 2 meters above the ground, in an open area, within or near the periphery of the plot. A speed mean wind measured over a 10 minutes period exceeds this value automatically trigger the shutdown of irrigation.*

In addition these standards specify following prohibited uses:

- irrigation with raw sewage,
- irrigation with treated wastewater from WWTPs connected to certain animal by-products processing installations,
- irrigation with treated wastewater from WWTPs whose sewage sludge does not comply with applicable limit values,
- irrigation with treated wastewater on soils that do not comply with limit values specified by the national legislation on agricultural use of sewage sludge,
- irrigation with treated wastewater within the close protection perimeters of drinking water abstraction points (with some exceptions).

The current French regulation on waste water reuse does then not apply to the Vendée Eau reuse project and as seen before there is no specific regulation for direct and/or indirect potable reuse in France, which is currently not permitted as "unnatural water unnatural water cannot be used to produce potable water" .

2.2 Water reuse standards in other EU Member States

In view of the lack of dedicated guidelines to indirect potable reuse in France, advice could be sought at other countries approaches to water reuse.

Some European countries have developed specific regulations and standards for water reuse practices as reviewed in Alcade Sanz et al. (2014), JRC (2014) and BIO Deloitte (2015, see Annex B and D therein). Most of the regulated uses deal with agricultural, urban and industrial applications, but **no country has established standards for potable reuse.** Only Spain and Italy have standards that concern aquifer recharge. Nevertheless, in both countries reuse of urban wastewater intended for human consumption is not allowed.

In general, the **approaches are based on limit values** defined for a range of parameters of the reclaimed water. By complying with these numerical limit values, health and/or environmental risks are deemed to be minimised. The limit values may be applicable at different points, depending on the standards (e.g. at the reclaimed water delivery point or at the outlet of the WWTP).

Cyprus, France, Greece, Italy, Portugal and Spain have thus defined standards that include part or all of the following criteria:

- Intended uses,
- Analytical parameters,
- Maximum limit value permitted for each parameter,
- Monitoring protocols,
- Additional preventive measures for health and environment protection.

In all these EU MS where standards exist, they have a legally-binding status, except in Portugal. In Portugal, however, water reuse permit conditions (which are legally-binding) are based on standards described in a technical norm.

Thus, one way to proceed for the foreseen IPR reuse scheme could then be based on other type of approaches implemented in other countries.

2.3 Californian guidelines for treated wastewater reuse

At the national level in the U.S., the Environmental Protection Agency (USEPA) produced the 2012 Guidelines for Water Reuse, which has become a global reference document for reuse guidance. These guidelines are not legally binding, as actual regulation of water resources occurs primarily at state level. However, the guidelines establish a national supportive framework to guide state regulations around reuse, including establishing a comprehensive set of water quality targets for a wide range of reuse applications, as well as guidance on treatment options, risk management, and public engagement measures. A number of U.S. states have adopted specific regulatory measures for reuse (with California, Texas, Arizona and Florida having the most mature regimes).

California has adopted **an approach based on wastewater treatment requirements and limit values** (Title 22 of the Code of Regulations). Statutes and regulations regarding the use of recycled water in California can be found in the California Water Code (CWC), the California Health and Safety Code, and the California Code of Regulations (CCR). The State Water Resources Control Board (SWRCB) and nine Regional Water Quality Control Boards (collectively, "Regional Water Boards") regulate the water quality and quantity aspects of water reuse under the CWC, while the California Department of Public Health (CDPH) regulates the public health aspects.

Title 22 establishes uniform state-wide recycling criteria for the various uses of recycled water to assure protection of public health where recycled water use is involved. These regulatory criteria include specified approved uses of recycled water, numerical limitations and requirements, treatment method requirements and performance standards. Articles 5.1 and 5.2 of the Chapter 3, division 4 of Title 22 are dedicated to the recycling criteria for IPR groundwater replenishment with surface or subsurface application.

Recycled water guidelines include both monitoring and performance requirements. The California Department of Public Health (CDPH) released first draft criteria for IPR *via* groundwater recharge in 1986. These guidelines were revised in 2008, 2011 and 2013 and include monitoring requirements related to nitrogen compounds, unregulated emerging chemical contaminants (such as endocrine disrupters and pharmaceuticals), and TOC limits. The latest groundwater recharge reuse draft released by the CDPH in March 2013 includes annual monitoring for endocrine disrupting chemicals and pharmaceuticals.

To achieve the goal of increasing the use of recycled water, the State Water Resources Control Board has adopted an updated recycling policy in 2009 (Resolution No 2009-0011) which has been integrated as chapter 7.3 "Direct and Indirect Potable Reuse" of the Water Code. It has established deadlines for the adoption of criteria for the recycling of water for groundwater recharge to 31 December 2013, for surface water augmentation and direct potable reuse area increase to December 31, 2016.

The basic advantage of the Californian approach is its 'safety first' philosophy, but it is oversight-heavy and carries a high administrative cost. Nonetheless, the water quality requirements it establishes have become a global benchmark.

(see as well Annex 4 of this document)

2.4 Risk assessment and management approach

Another type of approach is based on the implementation of a risk management system for each reuse project. This approach is the one adopted by the Australian and the WHO guidelines.

This approach identifies and manages risks in a more proactive way, rather than relying on post-treatment testing and reacting when problems arise. It is also more flexible as it may be applied to a wide range of situations. First, the main health and environmental risks need to be identified and assessed, and then measures to prevent and control the risks have to be implemented, followed by the implementation of monitoring procedures to check the risks are effectively reduced to an acceptably low level.

2.4.1 World Health Organisation (WHO)

The WHO has produced two sets of guidelines that are relevant for water reuse (WHO, 2006; WHO, 2011):

- *Guidelines for the Safe Use of Wastewater, Excreta and Greywater* (2006 – to be updated by 2019) – These guidelines apply to reuse for the **purposes of agricultural irrigation and aquaculture**, and are principally concerned with the protection of farmers and their families from the health hazards associated with wastewater (mainly in developing countries).
- *Guidelines for Drinking Water Quality* (2011) – These guidelines outline an integrated approach to protect drinking water quality, and are implemented in both developed and developing countries. They do not directly address reuse, but are applicable to reuse schemes that produce water for potable purposes.

Both sets of guidelines outline comprehensive and systematic risk assessment and risk management approaches, drawing on the Hazard Analysis and Critical Control Point (HACCP) method, initially developed for the food industry. The *Guidelines for the Safe Use of Wastewater, Excreta and Greywater* are operationalized through the development of Sanitation Safety Plans, and the drinking water guidelines through the development of Water Safety Plans. Though widely referred to, both approaches are limited in the extent to which they address reuse schemes. This has led some to propose a new approach – the Water Reuse Safety Plan (WRSP) – to fill this gap. A key feature of the WRSP is that it should be flexible enough to accommodate all forms and applications of water reuse. While not yet implemented in any regulatory frameworks, the WRSP approach has a growing number of proponents (WHO, 2006; NRMMC-EPHC-AHMC, 2006) - see as well Annex 5 of this document.

2.4.2 Australian guidelines (EPHC, 2006)

The National Guidelines for Water Recycling: Managing Health and Environmental Risks mean to be an authoritative reference for the supply, use and regulation of recycled water schemes. This document provides guidance on how recycling can be safely and sustainably achieved.

An important feature of these guidelines is that they use a risk management framework, rather than simply relying on post-treatment testing as the basis for managing recycled water schemes.

As it is essential to protect the health of both the public and the environment, the guidelines consider that a risk management approach is the best way to achieve this. This type of approach has been used in the food industry for many years, through application of the hazard analysis and critical control point (HACCP) system.

The first step is to look at hazards in the recycled water that could potentially affect human or environmental health. The next step is to estimate the risk from each hazard by assessing the likelihood that the event will happen and the consequences if it did. After characterizing the risks, preventive measures to control hazards are identified. The approach also includes monitoring to ensure that the preventive measures operate effectively, and verification to ensure that the management system consistently provides recycled water of a quality that is fit for its intended use.

Monitoring is essential to determine baseline, to validate systems, for operational purposes and to verify that the processes used in recycling are effective. All types of monitoring should be used in relation to both human and environmental health risks. For human health risks, validation monitoring is essential because of the magnitude of potential health risks from use of recycled water. This means that log reductions assured by designers and manufacturers of treatment systems, or by user group representatives, cannot be assumed to be valid — some objective empirical evidence of the log reductions is required. The precise nature of the evidence depends on the nature of the barriers.

"The guidelines specify target log removals of enteric pathogens for different treatment processes as well as target log removals for particular categories of water reuse application. The guidelines also provide an indicative list of water quality parameters that may be relevant for monitoring.

The guidelines that cover indirect potable reuse applications recommend the definition of health-based targets to manage health risks. Such targets measure the gap between current health status and an ideal health situation using DALY per year and per person units (Disability-Adjusted Life Year: one DALY can be thought as one lost year of 'healthy' life).

The approach is to identify major health risks and the preventive measures needed to reduce those risks to an acceptably low level. Sources of recycled water can contain a wide range of agents that pose risks to human health, including pathogenic (disease-causing) microorganisms and chemicals. Microbial hazards include bacteria, viruses, protozoa and, to a lesser extent, helminths. Chemical hazards include inorganic and organic chemicals, pesticides, potential endocrine disruptors, pharmaceuticals and disinfection by-products." (see as well Annex 6 of this document)

2.5 Approaches to cope with unregulated or unassessed substances

Even treated wastewater still contains numerous chemical compounds stemming from industrial production, the use of household chemicals as well as pharmaceuticals and personal care products. This mix of micropollutants constitutes a concern in relation to indirect potable reuse.

Improvements in analytical chemistry achieved in the past decades and still ongoing resulted in the detection of many new contaminants but as well of known contaminants. These new contaminants, named as emerging contaminants/pollutants are most of the time still not yet regulated in drinking water and questions are arising about how to maintain a good / impeccable drinking water quality. These two approaches have thus been developed in order "to answer to the question of what concentration(s) are considered safe and acceptable/tolerable, when (i) toxicological data are lacking, or (ii) toxicological information indicates that the emerging compound has no adverse health effect, but the compound is not regulated as of yet."

Approaches to deal with this uncertainty are applied in the drinking water sector Germany and in the Netherlands to fix limit values for micropollutants in drinking water, as described below.

2.5.1.1 Health-based parametric values (German approach):

Next to tables with standards for several parameters the Drinking Water Ordinance in Germany states that drinking water quality should be such that it is acceptable for human health for lifelong consumption (TrinkwV, 2001). The German Federal Environment Agency (UBA, for Umweltbundesamt) has issued recommendations for situations where a toxicological evaluation is not, or only partially, possible. The adopted **health-based parametric values (HPV)** or **health-related indication values (HRIV)** approach is a method for coping with not assessed substances in drinking water that focuses solely on human health issues in an area of precaution (Dieter, H.H., 2014, UBA, N.N.). The guideline values are defined for groups of toxic compounds as summarised in Table 9.

Table 9 Health-based precautionary values (HPV) (UBA, 2003)

HPV	Compound group and explanation of application	Substances (examples)
< 0.01 µg/L	Highly genotoxic compound.	NDMA
< 0.1 µg/L	No toxicological data available.	2-Chloroethane, Phenazone, Propylphenazone, halogenated ethers
≤ 0.3 µg/L	Only genotoxic data available, indicating that substance is not genotoxic. No other toxicological data available.	Carbamazepine, Diclofenac
≤ 1 µg/L	Substance proven non genotoxic. Data on neurotoxicity and germ cell damaging potential available, not indicating a value < 0.3 µg/L.	Iopamidole, Lanthan, Ibuprofen, Metformin, Tetrahydropyran
≤ 3 µg/L	Substance neither genotoxic nor germ damaging nor neurotoxic. In vivo data on sub-cronic oral toxicity available, not indicating a value < 1 µg/L.	Trichlorethane, Clorfibrat
> 3 µg/L	At least one chronic oral study is available enabling (almost) complete toxicological information and not indicating a value < 3 µg/L.	EDTA

"A pragmatic health-based parametric value (HPV) of 0.1 µg/L has been defined as a precautionary value, which should allow lifetime consumption (i.e. 70 years) of drinking water (UBA, 2003). The value of 0.1 µg/L applies to both non-genotoxic compounds and the majority of genotoxic compounds. For highly genotoxic compounds it is indicated that this value cannot be used for lifetime exposure, but only for a shorter duration (70 years/(measured concentration/HPV)). And a value of 0.01 µg/L should be used for longer durations. Depending on the amount of toxicological information available, the UBA indicates that higher levels can be used as HPV. For non-genotoxic compounds in drinking water, for which toxicological data exist, HPVs can be up to, or even over 3 µg/L, depending on the quality of the available information. The HPVs are recommendations for situations where a toxicological evaluation is not or only partially possible and are not mandatory" (UBA, 2003).

2.5.1.2 Method based on "Threshold of toxicological concern" (TTC) - Nederland

Dutch water utilities have developed the Q21 approach (Drinking Water Quality for the 21st Century), which is drinking water of impeccable quality. As part of this approach target values (i.e. acceptable/tolerable concentrations) have been proposed as an addition to the regulatory standards. These target values are based on the Threshold of Toxicological Concern (TTC) approach and provide guidance in those situations where contaminants are detected in drinking water, but toxicological data are lacking (Van Der Kooij et al., 2010). **The target values apply to organic contaminants that have not been formally regulated in drinking water legislation as well as substances that are already included in drinking water quality regulations.** This can be seen as a precautionary approach.

The TTC method categorizes chemicals into different structural classes (cramer classes) and derives their potential toxicity (not applicable for high potency carcinogens, inorganics, metals, radioactive compounds, nanomaterials, organometallics, and proteins). It defines level targets for each compound group (see Table 10 below). Additional safety factors are applied for highly genotoxic and steroid compounds.

Other than the German approach described above the Q21 approach implements as an ethical component by defining that the sum of all chemicals in drinking water should be below 1.0 µg/L. These sum values are intended to prevent possible effects from mixture of contaminants in drinking water.

Table 10 Threshold of Toxicological Concern (TTC) (Mons et *al.*, 2013)

Compound group	Target value in drinking water
Single genotoxic organic chemical	0.01 µg/L
Single (synthetic) steroid hormones	0.01 µg/L
All other single organic chemicals	0.1 µg/L
Total sum of genotoxic compounds	0.01 µg/L
Total sum of (synthetic) steroid compounds	0.01 µg/L
Total sum of all other organic chemicals	1.0 µg/L

"The target values are not intended for use as stringent standards but serve as a reference point on which policies for the future can be based. The described approach intends to identify priorities and to facilitate the achievement of drinking water with a very high quality (Q21). For example, when a drinking water utility evaluates its current water treatment performance and wants to make plans for improvement, the target values can serve as the reference point: do the current levels in the final drinking water comply with the target values and if no, which technology should we apply to achieve compliance? Alternatively, the figures of non-compliance can be used to further reduce the emission of a contaminant. Depending on the current compliance, the urgency regarding health risks, and other socio-economic and political considerations may then determine the route to finally achieve compliance to these target values. As a side effect, applying the target values to the known emerging contaminants will result in a further pressure to reduce other potentially hazardous contaminants passing the applied treatment barriers." (Mons et al., 2013).

Such approaches could be as well considered to fix target values for substances in the resource used for production of drinking water. Those substances are not yet regulated and may be contained in the treated wastewater of Les Sables d'Olonne WWTP to be discharged into Le Jaunay reservoir, in the foreseen IPR project.

These approaches will be considered and discussed within Task 6.4 "Design of the reuse scheme and assessment of its potential impact" and Task 6.6 "Health and Environmental risk management" of the DEMOWARE project.

3 Legal procedure to follow to implement reuse in the case of the Sables d'Olonne / le Jaunay project scheme

In the case of an IPR project from the WWTP of Les Sables d'Olonne to the reservoir of Le Jaunay, several regulatory procedures will apply to implement the reuse scheme.

Next to existing procedures, a recent document by the French ANSES, the French national health safety agency, has specified new guidance elements for the specific Vendée Eau Reuse Project as presented below (ANSES, 2016).

3.1 Procedures to follow

Following procedures shall thus be followed:

1) As described in Chapter 2.1.4, the project will have to comply with the **French Water Law of January, 1992** and the French Environmental Code. The project will need an authorization demand based on an environmental impact assessment study on aquatic environments of which content is fixed by a by-law of the Department of Ecology for each rubric of the nomenclature. Currently, the rubrics that will be concerned are not yet well known but the followings will probably have to be addressed:
    a) By changing the point of discharge of the treated wastewater of the WWTP of Les Sables d'Olonne, as if it were a new WWTP:
        i) Rubric 2.1.1.0: WWTP with a gross load of organic pollution of more than 600 kg BOD5 per day, with an authorization procedure
        ii) Rubric 2.2.4.0: Facilities or activities at the origin of an effluent corresponding to a contribution to the aquatic environment of more than 1 t / day of dissolved salts, as is currently the case for the WWTP of Les Sables d'Olonne with a declaration procedure
    b) For each river and stream crossed by the transfer pipe of treated wastewater 20 km long:
        i) Rubric 3.1.2.0: Installations, structures, works or activities leading to modify the longitudinal profile or cross section of the minor bed of a watercourse or leading to the diversion of a water course, type of procedure to define
        ii) Rubric 3.1.5.0: Installations, structures, works or activities in the minor bed of a watercourse, being likely to destroy spawning grounds, growth areas and feeding areas for fish fauna, crustaceans and amphibians, or in the floodplains of rivers, being likely to destroy spawning grounds of pike, type of procedure to define
        iii) Rubric 3.3.1.0: Drying, impoundment, waterproofing, embankment of wetlands or marshes, type of procedure to define
2) In application of the French environmental code, articles R 122-1 to R122-15, the project is subject to an **impact study** that will address, in addition to the aspects mentioned above:
    a) A complete description of the project comprising information on its design and size
    b) An analysis of the initial state of the area and environments likely to be affected by the project on population, fauna and flora, natural habitats, sites and landscapes, property, ecological continuity, biological balance, climatic factors, cultural and archaeological heritage, soil, water, air, noise, natural, agricultural, forestry, marine and leisure, as well as the interrelationships between these elements;
    c) An analysis of positive and negative effects, both direct and indirect, temporary (including during the construction phase) and permanent short, medium and long term, of the project on the environment, particularly on the items listed above on energy consumption, the con-

venience of neighbourhood (noise, vibrations, smells, light emissions), hygiene, health, safety, public health, and the addition and the interaction of these effects together.

3) As the project is likely to modify the water quality of the Jaunay reservoir, the local Authority of Health and Environment will ask to **assess the impact of the discharge of the treated water of the Sable d'Olonne WWTP upstream the dam.** The evaluation will cover the new environmental and health risks related to the modification of the resource. Therefore, an environmental risk assessment study has thus been planned within the Task 6.6 "Health and environmental risk study" of WP6 of DEMOWARE.
4) A **public inquiry** will be conducted at the end of the studies and during the instruction by the health and environmental authorities (ANSES and ARS). The public inquiry will be conducted on all the municipalities affected by the change in the drinking water supply source and by the construction of the transfer pipe of treated wastewater. This issue will be partially addressed in Task 6.5 "Public acceptance" of WP6 of DEMOWARE.

The review process (of each four points listed above) will be conducted during the same procedure.

The **application document to provide to the Prefect's administration** ("Direction Départementale du Territoire et de la Mer" (DDTM) and departmental services of the water police) must include:

- The name and address of the petitioner,
- The project location ,
- The project description (location, purpose, characteristics...) and the nomenclature rubrics concerned by the project,
- An environmental risk assessment study with:
  - the direct and indirect, temporary and permanent, impacts of the project on water resources;
  - the impact assessment in view of the site's conservation objectives, the compatibility of the project with the master plan or land use planning and water management;
  - if necessary, corrective or compensatory measures envisaged;
  - the monitoring means planned and, if the operation presents a danger, the means of intervention in case of an incident or accident;
  - graphics, drawings or maps useful to the understanding of the project;
  - planned measures to offset the negative effects of the project (compensatory measures).

3.2 NEW!! Recently issued guidance elements from ANSES related to the Vendée project (January 18th, 2016)

A note of technical and scientific support ("Note d'appui scientifique et technique de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relative à un projet d'utilisation d'eaux usées traitées pour alimenter une retenue d'eau destinée à la consommation humaine (département de la Vendée) ") was very recently issued by the ANSES at the request of the Vendée Prefect (ANSES, 2016). This note addresses a draft of recommendations which specify the various items that shall be processed in the application file of the Vendée project, as described below:

- The **application for authorization** of the treated wastewater reuse project **has to provide the following evidence**:
  - The administrative status of facilities and activities on the reservoir is in order. The prefectural ordinance bearing the declaration of public utility of the protection areas shall permit the discharge of treated wastewater in the reservoir;

- The operation of the wastewater system (network and WWTP) will be fully controlled;
- Discharge of treated wastewater will have no negative impact on water quality of the reservoir and its various uses;
- The treatment steps of the drinking water production chain are adapted as to ensure compliance of the distributed water (with the drinking water limits).

- An **environmental and sanitary risks study shall be conducted** and will have to assess the impact of the discharge of treated wastewater
  - on the lake sediments,
  - on recreative uses (bathing, boating, fishing) in terms of sanitary risks,
  - on the ecological status of the receiving environment, particularly the reservoir of Le Jaunay. The ANSES estimates that the project should contribute to improving the water quality of the reservoir in terms of nutrients, chemical compounds and organic carbon contents.
- The development of such a project has to be based on a **prior and robust assessment of the initial state** of the wastewater collection and treatment system, of the drinking water treatment plant, of the other uses and of the quality of water in the dam during a representative period of at least five years.
- **Measuring campaigns over several years** including a sufficient number of samples annually **to understand seasonal variations** shall be as well planned and undertaken. These should be performed at least: at the entry and the outlet of the WWTP; at different points of the reservoir representative of its uses, especially at the discharge point of the treated wastewater and at the raw water intake of the DWTP.
  - List of parameters to follow: It is recommended to build on the research action and reduction of hazardous substances in water ("SRED") (INERIS, 2009), the research program "Analysis of priority and emerging micro-pollutants in discharges and surface water "(Coquery et al., 2011; Martin Ruel et al., 2011), WFD, health monitoring, to include parameters of “emerging” pollutants and if necessary parameters representative of local conditions.
  - Microbiological parameters will be monitored according to uses potentially affected by the project (bathing for example).
- **To assess correctly the risks related to the indirect reuse of treated wastewater** with respect to the different uses, a **hydraulic modelling of the lake** shall be done to evaluate, in all weather conditions, the dispersion and distribution of the treated wastewater that will be discharged there. It is also necessary to ensure that the transfer time between the point of discharge into the water and the raw water intake for the production of drinking water will be long enough to detect in due time a possible failure of the sanitation system.
- The operation of the WWTP shall benefit from the same attention as the facilities of the DWTP. In order to prevent any deviations (from proper operation), ANSES proposes that **the authorization** to use treated wastewater **to be conditional on the implementation of a quality management system covering the entire facility**, by the people responsible for sanitation and those responsible for the production or distribution of drinking water. This quality management system should include:
  - a regularly updated analysis and control of hazards;
  - the implementation of efficient controls and monitoring at the control points;
  - training and information of persons involved in this process.

- Possible changes in the quality of treated wastewater into the transfer pipe water to the discharge point should be taken into account.

The application will be dealt by the Conseil Départemental de l'Environnement et des Risques Sanitaires et Technologiques (CODERST), a local council for environment, health and technological risks.

The specific aspects of the project in relation to public health will be dealt by the ARS and by the ANSES (as this is a case that is not provided by regulation). Without taking in account the 5-year assessment period that can be possibly based on past results of monitoring of waste water treatment plants and drinking water, the completion time of impact studies is about 1 year and the period of regulatory investigation including the public inquiry is also about 1 year.

4 Examples of managing (indirect) potable reuse schemes and French reuse projects: Lessons learned and relevant for the Vendée case study

4.1 Worldwide waste water reuse practices: case studies

The case studies, presented in Table 11, and detailed in Annex 7, represent a diverse range of wastewater reuse practices around the world and in France. They have been chosen to illustrate the state of art of facilities and more closely related with the Vendée green field site of DEMOWARE: feasibility of a planned indirect potable reuse project from the treated urban wastewater of Les Sables-d'Olonne WWTP to the reservoir of Le Jaunay.

Worldwide, direct potable reuse (DPR) projects are few and are generally implemented in arid and semi-arid regions with a very important pressure on conventional water sources (surface or groundwater raw water supplies). Even for those cases, public acceptance is hard to obtain and becomes often a threat for the project (USEPA, 2012). The Windhoek project is one of them.

Indirect Potable Reuse projects are more common, often because they follow a previous unplanned potable reuse scheme. Success, according to the authors, often depends on an important outreach program towards the public, environmental interest groups, statutory agencies, elected officials and the media. This outreach program should be run prior to and during the implementation of the facilities (USEPA, 2012).

The last examples present some French reuse projects. The French regulation only permitting only reuse for irrigation of crops and leisure areas, the presented French examples are then only for this kind of use.

Though they do not fully correspond to the Vendée Eau reuse project, these examples are however presented because they permit to identify blocking points for uses for which health impact is potentially much less important than for the production of drinking water.

Table 11 Examples of reuse of treated waste waters intended for DW production worldwide and of reuse in France

Project	Scope of the scheme	Relevant issue with regard to the Vendée Eau reuse project
Orange county water district, Groundwater replenishment system, California, USA	Indirect potable reuse scheme based on a groundwater replenishment system	To **insure the public acceptance** of this IPR scheme, the OCWD established a **specific outreach program**.
North Texas Municipal Water District, East Fork Raw Water Supply Project, Texas, USA	Indirect potable reuse scheme based on an advanced treatment plant and an artificial constructed wetland	This IPR scheme is similar to one of the options that are considered for the reuse scheme in Vendée Eau. The **constructed wetland** is a **positive point** which could be developed in the Vendee Eau reuse scheme **to enhance the public acceptance of the project**
Upper Occoquan Service Authority (UOSA), Potable Water Reuse in the Occoquan Watershed, Northern Virginia, USA	Indirect potable reuse scheme based on advanced treatment plants discharges upstream a reservoir	This project is very similar to the foreseen Vendée Eau IPR project and the feedback/return of experience could be very profitable in matter of **communication strategy** and should be taken into consideration in the recommendations of the public acceptance study which will be undertaken

Project	Scope of the scheme	Relevant issue with regard to the Vendée Eau reuse project
		within DEMOWARE project (Task 6.5 “Public acceptance of the reuse scheme”).
Western Corridor Recycled Water Scheme, South East region of Queensland, Australia	Industrial water supply, agricultural watering and indirect potable reuse scheme based on advanced treatment plants	This project is a good example of the **importance of the public acceptance in IPR project**. The public opposition and the negative reporting by the media have led to strongly limited the IPR part of the project
Torreele aquifer recharge scheme, Belgian coast	Indirect potable reuse scheme based on the artificial recharge of the unconfined dune aquifer	European IPR project in which a large effort was put into **building trust and reaching consensus with the authorities**. Moreover, achieving **public trust through information provision** is perceived as an **important enabling factor for the reuse scheme**. Therefore, from the start of the planning period, the approach has been to inform the public and be transparent so that trust could be gained.
Montebello Forebay, California, USA	Indirect potable reuse scheme based on a groundwater replenishment system	The **authorities involved in the project have successfully collaborated to reassure regulators and the public that recycled water is safe for aquifer recharge**. The effectiveness of Soil Aquifer Treatment (SAT) has been demonstrated for decades, and a number of **health effects studies related to the use of groundwater for human consumption** have been undertaken over that time. In addition, numerous studies have been performed on the presence and fate of pharmaceuticals and personal care products in the water, virus fate and transport, recycled water residence time in the aquifers using tracer tests, and total organic carbon reduction. None of these studies have found any adverse health effects associated with using the recycled water for groundwater recharge in the Montebello Forebay
Potable Reuse Project Windhoek, Namibia	Direct potable reuse: reclaimed water is blended with conventionally-treated surface water for potable reuse	In Windhoek, Namibia, potable reuse was implemented in 1968 and was initially sporadically used when drought conditions made it necessary. An **ecological study** conducted in Windhoek examining diarrhoea and type of water supplied concludes that differences in diarrhoeal disease prevalence was associated with socio-economic factors, but not with the nature of the water supply.
Pornic golf course, South-eastern Brittany, near Loire estuary, France in a water scarce and environmental sen-	Irrigation of a golf course with reclaimed treated water	The new standards fixed by the 2010 decree about the reuse of treated water have provided an opportunity to test an approach based on a Sanitation Safety Plan.

Project	Scope of the scheme	Relevant issue with regard to the Vendée Eau reuse project
sitive area		To ensure that hazards are dealt with from the raw wastewater to the point of use, an **internal risk evaluation and management tool** has been developed and applied to this site. In Pornic, the management plan shows that adequate surveillance of critical points strengthens the effectiveness of control measures thereby ensuring better safety, especially in respect to microbial contamination.
Limagne noire, Centre of France in a water scarce area for agriculture and environmental sensitive area	Irrigation of crop culture with reclaimed treated water	This project has streamlined the management of water in this region. It has achieved significant savings on water withdrawals from rivers during the critical summer period and thus prevented potential conflicts of use. Qualitatively, irrigation with treated wastewater is used to limit discharges of phosphorus and nitrogen in the Allier river in dry periods and valuing them as fertilizers on irrigated plots.

All these examples show two key points for the successful implementation of IPR schemes and reuse schemes in general:

- Active communication:
  The different examples of reuse applied to planned IPR schemes show that an active communication with the community and the different stakeholders is a key factor to achieve the projects. Other examples, as in Australia, have shown that a lack of communication and education may lead to the failure of a reuse project.
- health risk assessment and monitoring of the water quality.

These two items are discussed more in details in the following sections.

4.2 Importance of communication with the public and the community

Over the world, the first and principal barrier to water reuse, as indicated by the stakeholders, is the **public perception** (Rodriguez *et al*, 2009). Some uses of reclaimed water are well accepted by the communities as the irrigation of parks, leisure facilities, non-edible crops… In **indirect potable reuse (IPR) projects**, the use of reclaimed water to produce potable water raises **reservations** amongst the community **about the safety and quality of the recycled water; the short temporal and geographical distance between wastewater and the recycled water being the principal cause of those reservations**.

The experience feedback allowed identifying factors of success or failure in the implementation of IPR projects:

1) managing information for all stakeholders;
2) maintaining individual motivation and demonstrating organizational commitment;
3) promoting communication and public dialogue;
4) ensuring a fair and sound decision-making process and outcome;

5) and building and maintaining trust" (Hartley, 2006).

Promoting communication and public dialogue, and building and maintaining trust have also been identified as key aspects in other studies (Marks, 2003; Holliman, 2004; Po *et al*, 2005).

"Effective communication between the community, key stakeholders and the project proponent is crucial to achieve community support. All recycled water projects need to be accompanied by community education to demonstrate that the current technology is adequate to protect human health. A timely and active communication program to discuss the treatment processes, the risks, the measures in place to control risks and the safety of the water, may help to increase trust in the project. The experience in the US has indicated that **community understanding and acceptance may take several years**, but that a broad community communication approach is fundamental for the successful implementation of IPR projects." (Rodriguez *et al*, 2009).

Some examples as in San Diego (California) or in Queensland (Australia) have shown that a poorly informed community or a lack of coordination between authorities can lead to the reject of an IPR project (US EPA, 2012).

Some examples, as in Australia, have shown that **a lack of communication and education may lead to the failure of a reuse project**.

As the French regulation only authorizes the reuse for irrigation and watering, this explains why there are no examples of public outreach (because the uses authorized are well accepted).

Such outreach and program of communication toward the public and the authorities will be crucial for the acceptance of the Vendée IPR project. This issue will be partially addressed within the Task 6.5 "Public acceptance of the reuse scheme" of WP6 of DEMOWARE.

4.3 Importance of health risk assessment and monitoring programs

In these different case studies of planned IPR, another key factor for success of implementation of IPR is the **health risk assessment of the water quality which leads to implementing complete monitoring programs**. The health effects of Indirect Potable Reuse (IPR) have indeed been studied for decades (Rodriguez, 2009):

"In **Windhoek, Namibia,** potable reuse was implemented in 1968 and it was initially used sporadically when drought conditions made it necessary. An ecological study conducted in Windhoek examining diarrhoea and type of water supplied concludes that differences in diarrhoeal disease prevalence was associated with socio-economic factors, but not the nature of the water supply (National Research Council, 1998). So far, no studies have been conducted in the Windhoek project examining long-term potential health impacts of micropollutants in drinking water.

In the **Montebello Forebay project**, three epidemiological studies were published, two of them using an ecological design. The latest ecological study[4] was published in 1996. In this study, a significantly higher incidence rate of liver cancer in the area with the highest percentage of recycled water was observed. However, no significant trend was observed when comparing liver cancer incidence over different exposure categories, and the authors concluded that the positive association occurred by chance. **The study does not provide evidence that recycled water has an adverse effect on cancer incidence, mortality or infectious disease outcomes**. However, the ecological studies performed thus far have been limited by

[4] An ecological study is an epidemiological study in which analyzed criteria relate to a population rather than individuals

their design and the corresponding difficulties that arise in the accurate assessment of the exposure (Sloss, 1996). A cohort study examining the association between the use of recycled water and adverse birth outcomes, including 19 categories of birth defects, was conducted from 1982 to 1993. **This study did not find any significant association between the use of recycled water and adverse birth outcomes**, and rates were also similar in groups receiving high and low proportions of recycled water (Sloss, 1999).

No prospective studies have been conducted examining the potential adverse health effects of long-term exposure to low concentration of chemical contaminants from potable reuse. However, assessment of exposure is especially challenging in studies with long latency periods, such as cancer. In the late 1990s the OCWD and an independent scientific advisory panel suggested conducting a case-control study on the use of Santa Ana River water. However, the study was found to be nonfeasible due to limitations in assessing historical exposures. **The panel did not recommend any additional epidemiological studies because any incremental risk due to recycled water is likely to be extremely small and difficult to differentiate from normal background risk** (NWRI, 2004). **The panel instead recommended a focus on monitoring to verify the effectiveness of the treatment processes**.

Given that epidemiological studies of long latency (such as cancer outcomes) are associated with many competitive risk factors and are complicated by limitations in the assessment of the exposure, epidemiological studies with health endpoints of short latency (such as gastrointestinal diseases or adverse pregnancy outcomes) may be more appropriate as a means of elucidating possible disease pathways. A critical aspect for projects considering the implementation of epidemiological studies is the **need to carefully assess the exposure to recycled water in the study population during the period of interest**. Hydrogeological modeling, geographic information systems and exposure data at the individual level may be required to link health outcomes with levels of exposure to recycled water."

A review (Rodriguez, 2009) has as well pointed out the **key points of the monitoring programs implemented in IPR projects**:

- **Monitoring is a key point to demonstrate the effectiveness of advanced treatment in meeting primary and secondary drinking water standards.** The formerly presented IPR projects, including analytical monitoring programs, have reported that the treatment can reliably produce water of equal or better quality than the existing drinking water supplies (Rodriguez, 2009 and US EPA, 2012).
- **The removal of viruses, pathogens and chemicals is dependent upon the particular material** (in particular membranes being employed in MF and RO treatment plants). Projects of IPR should then "identify membrane manufacturer studies to remove pathogens with special relevance to virus, validate the treatment process using accredited methods and protocols; perform suitable challenge tests for viruses to ensure the treatment efficiently removes these contaminants and verify the integrity of the membrane systems through routine testing. Direct methods of membrane testing, such as the pressure hold test and the diffusive air flow test, are very sensitive to identify impaired membrane integrity but they cannot be applied while the plant is in operation. Indirect methods such as particle counting, turbidity and conductivity are less sensitive but are continuous and online, and can be used as surrogates to monitor membrane integrity. Therefore a combination of both direct and indirect methods is recommended for a comprehensive monitoring program." (Rodriguez, 2009).
- Some authors "recommend the **use of chemical indicators and surrogates to monitor treatment performance**. They selected a list of wastewater-derived contaminants to determine the treatment removal efficiency of individual unit processes commonly used in IPR (i.e., soil aquifer

treatment, ozone, advanced oxidation, chlorination, carbon adsorption, and RO). The authors validated the removal efficiency of the selected chemicals for each unit process through laboratory, pilot, and full-scale experiments. Different groups of chemicals, sharing similar physicochemical characteristics, were detected at low concentrations (ng/L) for each one of the unit processes. The report concludes that, by selecting multiple chemical indicators with different physicochemical properties, it is possible to account for compounds currently not identified and new compounds synthesized and entering the environment in the future, provided they fall within the range of properties covered. The underlying concept is that absence or removal of an indicator compound during a treatment process would also assure the absence or removal of other compounds with similar properties. For example, the authors recommended the use of sulfamethoxazole, N-nitrosodimethylamine (NDMA), tris(2-chloroethyl)-phosphate (TCEP) and chloroform as chemical indicators during the initial phase of the IPR project and the use of conductivity, total organic carbon (TOC), and boron as surrogate parameters for the MF/RO system." (Rodriguez, 2009, Drewes *et al*, 2008).

→ These findings stresses the importance of implementing for the foreseen Vendée Eau reuse project a complete monitoring program to demonstrate the efficiency of the process to produce reclaimed water that complies with standards and to monitor the treatment performance continuously. This issue is addressed in Task 6.6 "Health and environmental risk management" which aims at proposing at the end a method to control and guarantee the Sanitary and Environmental Risk in the operation phase of the project ("reuse Safety Plan"). The recently issued recommendations of the ANSES are completely in line with this return of experience (ANSES, 2016).

5 Conclusion

The envisaged Indirect Potable Reuse (IPR) scheme in Vendée aims to augment the Jaunay reservoir, located 20 km away, with reclaimed treated water from the WWTP of Les Sables d'Olonne. The project is in line with both local and regional water management plans by reducing the pressure of withdrawal on water resources and by transferring water in the same watershed that supplies the city of Les Sables d'Olonne during the critical period of summer.

However this foreseen IPR project is beyond the current French regulation about reuse of urban wastewater which only authorizes uses as irrigation and watering. The Vendée Eau project is then innovative toward the current regulation as it is addressing indirect planned reuse intended for human health consumption and that Article R1321-6 of the French Public Health Code mentions that "unnatural water cannot be used to produce potable water".

On basis of the examination of the current French legislation, a legal procedure to be followed for the green field site has been proposed. It highlights that the environmental impact should be not excluded of the issues to address. Then the Vendée Eau foreseen reuse project should not degrade the actual ecological status of the Jaunay reservoir and its tributaries, according to legislations' limits. Therefore, reference state of this system will be assessed within Task 6.3 "Comprehensive study of the current situation at Les Sables d'Olonne and Jaunay reservoir".

To overcome the regulatory gap, Vendée Eau and the relevant authorities have to agree a novel approach complementing the legal procedure with a risk management component that could be derived from the WHO and Australian guidelines. It is thus proposed:

- to build on the WHO and Australian guidelines which are the more comprehensive and related to the Vendée Eau project.
  The Australian guidelines focuses on a risk management approach considered as the best way to achieve the protection of both the public health and the environment. This type of approach is built on the hazard analysis and critical control point (HACCP) system.
  - The method aims first to look at hazards in the recycled water that could potentially affect human or environmental health.
  - The next step is to estimate the risk from each hazard by assessing the likelihood that the event will happen and the consequences if it did.
  - After characterizing the risks, preventive measures to control hazards are then identified
  - The approach also includes monitoring to ensure that the preventive measures operate effectively, and verification to ensure that the management system consistently provides recycled water of a quality that is fit for its intended use.

Alternatively, other EU countries approaches could also be taken into account such as the precautionary health based parametric values in the German approach and the "threshold of toxicological concern" values (TTC) in the Q21 Dutch approach. Both set some target concentrations values to assess health risk based for emerging contaminants which are not yet regulated and organic contaminants which are regulated in both legislations on drinking water quality. These proposed values could be used to fix some target values for micropollutants in the treated wastewater to be discharged into the surface waters, which are not yet currently regulated in France.

Such approaches will be considered in Task 6.4 "Design of the reuse scheme" and Task 6.6 "Health and Environmental risk management" of WP6 of DEMOWARE.

Experiences on waste water reuse practices worldwide have shown that some aspects are of key importance for the success of schemes and shall be considered when implementing the reuse scheme in Vendée:

- guarantee a high level of safety of the reuse scheme for health and environment, in order to demonstrate that the current state of the system is preserved and the safety for human health is guaranted. Feedbacks highlight indeed the importance of implementing a monitoring program to ensure the continuous quality and reliability of the process to implement.

This issue will be addressed in Task 6.6 "Health and environmental risk management" which will eventually propose a method to control the Sanitary and Environmental Risk in the operation phase of the project ("Reuse Safety Plan").

- assuring public acceptance and trust. Feedback has to be taken into consideration, particularly as shown for the USA where projects have demonstrated the importance of the communication approach (public education, stakeholder engagement…). The Vendée Eau foreseen IPR project should rely on successful examples as in the East Fork Raw Water Supply Project where the artificial constructed wetland is a positive point which contributes to overcome the public opposition.

Such experiences and lesssons learnt will have to be taken into consideration in the public acceptance study to be done in Task 6.5.

The technical and scientific support note recently issued by the ANSES ("*Note d'appui scientifique et technique de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relative à un projet d'utilisation d'eaux usées traitées pour alimenter une retenue d'eau destinée à la consommation humaine (département de la Vendée)* ") at the request of the Vendée Prefect drafted a set of recommendations which specify the various items that shall be processed in the application file of the Vendée project. It includes indeed the above considerations.

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Annex 1 Appendix I of the Decree of 7 June, 2007: Limit values and reference values for potable water

Table 12 Quality limits for microbial parameters

Parameter	Limit	Unit
Escherichia coli (E. coli)	0	/100 mL
Enterococcus	0	/100 mL

Table 13 Quality limits for chemical parameters

Parameter	Limit value	Unit
Acrylamide	0.10	µg/l
Antimony	5.0	µg/l
Arsenic	10	µg/l
Barium	0.7	mg/l
Benzene	1.0	µg/l
Benzo[a]pyrene	0.010	µg/l
Bore	1.0	mg/l
Bromates	10	µg/l
Cadmium	5.0	µg/l
Chrome	50	µg/l
Vinyl chloride	0.5	µg/l
Copper	2.0	mg/l
Total cyanides	50	µg/l
1,2-dichloroethane	3.0	µg/l
Epichlorhydrine	0.10	µg/l
Fluor	1.5	mg/l
Polycyclic Aromatic Hydrocarbons	0.1	µg/l
Total mercury	1.0	µg/l
Microcystine-LR	1	µg/l
Nickel	20	µg/l
Nitrates (2)	50	mg/l
Nitrites (2)	0.50	mg/l
Pesticides (1)	0.1	µg/l
Total pesticides	0.50	µg/l
Lead	10	µg/l
Selenium	10	µg/l
Tetrachloroethylene and Trichloroethylene	10	µg/l
Total trihalomethanes (THM)	100	µg/l
Turbidity (3)(4)	1	NFU

(1) With the exception of 4 substances for which the limit is of 0.03 µg/l.
(2) The sum of the nitrate concentration divided by 50 and of nitrite concentration divided by 3 must remain smaller than 1.

(3) The limit of quality is applicable at the distribution point distribution, for surface waters and groundwaters coming from cracked media with a turbidity periodically important and higher than 2NFU.

(4) The reference quality is applicable at the distribution point, for waters referred to Article R. 1321-37 and for groundwaters coming from cracked media with a turbidity periodically important and higher than 2NFU. In the event of implementation a neutralization or remineralization treatment, the reference of quality will apply except possible increase of turbidity due to the treatment.

Table 14 References for quality of water intended for human consumption

Parameter	Reference	Unit
Aluminium total	200	µg/l
Ammonium	0.1	mg/l
Coliform bacteria	0	/100 ml
Total free chlorine	No unpleasant smell or flavour and no abnormal change.	
Copper	1	mg/l
Chlorites	0.2	mg/l
Chlorides	250	mg/l
Sulphite reducing bacteria	0	/100 ml
Colour	Acceptable no abnormal change, particularly a colour smaller or equal to 15	mg/l of platinum referring to Pt/Co scale
Conductivity	≥ 180 and ≤ 1000	µS. cm-1 à 20° C
pH	≥ 6.5 and ≤ 9	Unités pH
Total organic carbon (TOC)	Aucun changement anormal	mg/l
Calcium-carbonate balance	Waters shall not be agressive. The calcium-carbonate balance of waters shall be at the equilibrium or waters shall slightly incrustant.	
Iron total	200	µg/l
Manganese	50	µg/l
Total count of revivable aerobic germs at 22 °C and at 37 °C	Variation in a ratio of 10 compared to the normal value	
Oxydability with potassium permanganate measured after 10 min in acidic media	5.0	mg/l O_2
Odor	Acceptable no detected smell for a dilution ratio of 3 at 25°C	
Taste	Acceptable no detected smell for a dilution ratio of 3 at 25°C	
Sodium	200	mg/l
Sulfates	250	mg/l
Temperature	25	°C
Turbidity	0.5 (3)(4) 2	NFU NFU
Total indicative dose (TID)	0.1	mSv/an
Tritium	100	Bq/l

Annex 2 Appendix III of the Decree of 11 January, 2007

ANNEXE III

LIMITES DE QUALITÉ DES EAUX DOUCES SUPERFICIELLES UTILISÉES POUR LA PRODUCTION D'EAU DESTINÉE À LA CONSOMMATION HUMAINE, À L'EXCLUSION DES EAUX DE SOURCE CONDITIONNÉES, FIXÉES POUR L'APPLICATION DES DISPOSITIONS PRÉVUES AUX ARTICLES R. 1321-38 À R. 1321-41

Les eaux doivent respecter des valeurs inférieures ou égales aux limites ou être comprises dans les intervalles figurant dans le tableau suivant sauf pour le taux de saturation en oxygène dissous (G : valeur guide ; I : valeur limite impérative).

GROUPES de paramètres	PARAMÈTRES	GROUPE						UNITÉS
		A1		A2		A3		
		G	I	G	I	G	I	
Paramètres organoleptiques.	Couleur (Pt).	10	20	50	100	50	200	mg/L
	Odeur (facteur de dilution à 25 °C).	3		10		20		
Paramètres physico-chimiques liés à la structure naturelle des eaux.	Chlorures (Cl^-).	200		200		200		mg/L
	Conductivité.	1 000 ou 1 100		1 000 ou 1 100		1 000 ou 1 100		µS/cm à 20 °C µS/cm à 25 °C
	Demande biochimique en oxygène (DBO_5) à 20 °C sans nitrification (O_2).	< 3		< 5		< 7		mg/L
	Demande chimique en oxygène (DCO) (O_2).					30		mg/L
	Matières en suspension.	25						mg/L
	pH.	6,5-8,5		5,5-9		5,5-9		unités pH
	Sulfates (SO_4^{2-}).	150	250	150	250	150	250	mg/L

GROUPES de paramètres	PARAMÈTRES	GROUPE						UNITÉS
		A1		A2		A3		
		G	I	G	I	G	I	
	Taux de saturation en oxygène dissous (O_2).	> 70		> 50		> 30		%
	Température.	22	25	22	25	22	25	°C
Paramètres concernant les substances indésirables.	Agents de surface réagissant au bleu de méthylène (lauryl-sulfate de sodium).	0,20		0,20		0,50		mg/L
	Ammonium (NH_4^+).	0,05		1	1,5	2	4	mg/L
	Azote Kjeldhal (N).	1		2		3		mg/L
	Baryum (Ba).		0,1		1		1	mg/L
	Bore (B).	1		1		1		mg/L
	Cuivre (Cu).	0,02	0,05	0,05		1		mg/L
	Fer dissous sur échantillon filtré à 0,45 µm.	0,1	0,3	1	2	1		mg/L
	Fluorures (F^-).	0,7/1	1,5	0,7/1,7		0,7/1,7		mg/L
	Hydrocarbures dissous ou émulsionnés.		0,05		0,2	0,5	1	mg/L
	Manganèse (Mn).	0,05		0,1		1		mg/L
	Nitrates (NO_3^-).	25	50		50		50	mg/L
	Phénols (indice phénol) (C_6H_5OH).		0,001	0,001	0,005	0,01	0,1	mg/L
	Phosphore total (P_2O_5).	0,4		0,7		0,7		mg/L
	Substances extractibles au chloroforme.	0,1		0,2		0,5		mg/L
	Zinc (Zn).	0,5	3	1	5	1	5	mg/L
Paramètres concernant les substances toxiques.	Arsenic (As).		10		50	50	100	µg/L
	Cadmium (Cd).	1	5	1	5	1	5	µg/L
	Chrome total (Cr).		50		50		50	µg/L
	Cyanures (CN^-).		50		50		50	µg/L
	Hydrocarbures aromatiques polycycliques (HAP) : Somme des composés suivants : fluoranthène, benzo[b]fluoranthène, benzo[k]fluoranthène, benzo[a]pyrène, benzo[g,h,i]pérylène et indéno[1,2,3-cd]pyrène.		0,2		0,2		1,0	µg/L
	Mercure (Hg).	0,5	1	0,5	1	0,5	1	µg/L
	Plomb (Pb).		10		50		50	µg/L

GROUPES de paramètres	PARAMÈTRES	GROUPE						UNITÉS
		A1		A2		A3		
		G	I	G	I	G	I	
	Sélénium (Se).		10		10		10	µg/L
Pesticides.	Par substances individuelles, y compris les métabolites.		0,1 (1, 2)		0,1 (1, 2)		2	µg/L
	Total.		0,5 (2)		0,5 (2)		5	µg/L
Paramètres microbiologiques.	Bactéries coliformes.	50		5 000		50 000		/100 mL
	Entérocoques.	20		1 000		10 000		/100 mL
	Escherichia coli.	20		2 000		20 000		/100 mL
	Salmonelles.	Absent dans 5 000 mL		Absent dans 1 000 mL				

(1) Pour l'aldrine, la dieldrine, l'heptachlore et l'heptachlorepoxyde, la limite de qualité est de 0,03 µg/L.
(2) Ces valeurs ne concernent que les eaux superficielles utilisées directement, sans dilution préalable.
En cas de dilution, il peut être fait appel à des eaux de qualités différentes, le taux de dilution devant être calculé au cas par cas.

Annex 3 List of priority substances in the field of water policy with their environmental standards, WFD 2013/39/EU

Nr	CAS number [1]	Name of prioirty substance	AA-EQS [2] Inland surface waters [3]	AA-EQS [2] Other surface waters	MAC-EQS [4] Inland surface waters [3]	MAC-EQS [4] Other surface waters	Biota EQS [12]
(1)	15972-60-8	Alachlore	0.3	0.3	0.7	0.7	
(2)	120-12-7	Anthracène	0.1	0.1	0.1	0.1	
(3)	1912-24-9	Atrazine	0.6	0.6	2.0	2.0	
(4)	71-43-2	Benzene	10	8	50	50	
(5)	7440-43-9	Brominated diphenyleth-ers [5]	≤ 0.08 (Class 1) 0.08 (Class 2) 0.09 (Class 3) 0.15 (Class 4) 0.25 (Class 5)	0.2	≤ 0.45 (Class 1) 0.45 (Class 2) 0.6 (Class 3) 0.9 (Class 4) 1.5 (Class 5)	≤ 0.45 (Class 1) 0.45 (Class 2) 0.6 (Class 3) 0.9 (Class 4) 1.5 (Class 5)	
(6 bis)	56-23-5	Carbon tetrachloride [7]	12	12	not applicable	not applicable	
(7)	85535-84-8	C10-13 Chloroalkanes [8]	0.4	0.4	1.4	1.4	
(8)	470-90-6	Chlorfenvinphos	0.1	0.1	0.3	0.3	
(9)	2921-88-2	Chlorpyrifos (ethylchlorpyri- fos)	0.03	0.03	0.1	0.1	
(9 bis)	309-00-2 60-57-1 72-20-8 465-73-6	Cyclodiene pesticides: Aldrine [7] Dieldrine [7] Endrine [7] Isodrine [7]	Σ = 0.01	Σ = 0.005	not applicable	not applicable	
(9 ter)	not applicable	DDT total [7], [9]	0.025	0.025	not applicable	not applicable	
	50-29-3	para-para-DDT [7]	0.01	0.01	not applicable	not applicable	
(10)	107-06-2	1.2-dichloroethane	10	10	not applicable	not applicable	
(11)	75-09-2	Dichloromethane	20	20	not applicable	not applicable	
(12)	117-81-7	Di(2-ethyl-hexyle)-phthalate (DEHP)	1.3	1.3	not applicable	not applicable	
(13)	330-54-1	Diuron	0.2	0.2	1.8	1.8	
(14)	115-29-7	Endosulfan	0.005	0.0005	0.01	0.004	
(15)	206-44-0	Fluoranthene	0.0063	0.0063	0.12	0.12	30
(16)	118-74-1	Hexachlorobenzene			0.05	0.05	10
(17)	87-68-3	Hexachlorobutadiene			0.6	0.6	55
(18)	608-73-1	Hexachlorocyclohexane	0.02	0.002	0.04	0.02	
(19)	34123-59-6	Isoproturon	0.3	0.3	1.0	1.0	
(20)	7439-92-1	Lead and its compounds	1.2 (13)	1.3	14	14	
(21)	7439-97-6	Mercury and its com-pounds			0.07	0.07	20
(22)	91-20-3	Naphtalene	2	2	130	130	

Nr	CAS number [1]	Name of prioirty substance	AA-EQS [2] Inland surface waters [3]	AA-EQS [2] Other surface waters	MAC-EQS [4] Inland surface waters [3]	MAC-EQS [4] Other surface waters	Biota EQS [12]
(23)	7440-02-0	Nickel and its compound	4 (13)	8.6	34	34	
(24)	84852-15-3	Nonylphenols (4-nonylphenol)	0.3	0.3	2.0	2.0	
(25)	140-66-9	Octylphenols (4-(1.1′.3.3′-tetramethyl-butyl)-phenol)	0.1	0.01	not applicable	not applicable	
(26)	608-93-5	Pentachlorobenzene	0.007	0.0007	v	not applica-ble	
(27)	87-86-5	Pentachlorophenol	0.4	0.4	1	1	
(28)	not applica-ble	Polyaromatic hydrocar-bons (HAP) (11)	not applicable	not applicable	not applicable	not applicable	
	50-32-8	Benzo(a)pyrene	1.7 × 10-4	1.7 × 10-4	0.27	0.027	5
	205-99-2	Benzo(b)fluoranthene	see footnote 11	see footnote 11	0.017	0.017	see footnote 11
	207-08-9	Benzo(k)fluoranthene	see footnote 11	see footnote 11	0.017	0.017	see footnote 11
	191-24-2	Benzo(g.h.i)pe-rylene	see footnote 11	see footnote 11	8.2×10^{-3}	8.2×10^{-4}	see footnote 11
	193-39-5	Indeno(1.2.3- cd)-pyrene	see footnote 11	see footnote 11	not applicable	not applicable	see footnote 11
(29)	122-34-9	Simazine	1	1	4	4	
(29 bis)	127-18-4	Tetrachloroethylene (7)	10	10	not applicable	not applicable	
(29 ter)	79-01-6	Trichloroethylene (7)	10	10	not applicable	not applicable	
(30)	36643-28-4	Tributyltin compounds (tributyltin- cation)	0.0002	0.0002	0.0015	0.0015	
(31)	12002-48-1	Trichlorobenzenes	0.4	0.4	not applicable	not applicable	
(32)	67-66-3	Trichloromethane	2.5	2.5	not applicable	not applicable	
(33)	1582-09-8	Trifluralin	0.03	0.03	not applicable	not applicable	
(34)	115-32-2	Dicofol	1.3×10^{-3}	3.2×10^{-5}	not applica-ble (10)	not applica-ble (10)	33
(35)	45298-90-6	Perfluorooctane sulfonic acid and its derivatives (PFOS)	6.5×10^{-4}	1.3×10^{-4}	36	7.2	9.1
(36)	124495-18-7	Quinoxyfene	0.15	0.015	2.7	0.54	
(37)		Dioxins and dioxine-like compounds (15)			not applica-ble	not applica-ble	Sum of PCDD + PCDF + PCB-TD 0.0065 $\mu g.kg^{-1}$ TEQ (14)
(38)	74070-46-5	Aclonifen	0.12	0.012	0.12	0.012	
(39)	42576-02-3	Bifenox	0.012	0.0012	0.04	0.004	

Nr	CAS number (1)	Name of prioirty substance	AA-EQS (2) Inland surface waters (3)	AA-EQS (2) Other surface waters	MAC-EQS (4) Inland surface waters (3)	MAC-EQS (4) Other surface waters	Biota EQS (12)
(40)	28159-98-0	Cybutryne	0.0025	0.0025	0.016	0.016	
(41)	52315-07-8	Cypermethrine	8×10^{-5}	8×10^{-6}	6×10^{-4}	6×10^{-5}	
(42)	62-73-7	Dichlorvos	6×10^{-4}	6×10^{-5}	7×10^{-4}	7×10^{-5}	
(43)		Hexabromocyclododecane (HBCDD) (16)	0.0016	0.0008	0.5	0.05	167
(44)	76-44-8/ 1024-57-3	Heptachlor and hepta-chlor epoxide	2×10^{-7}	1×10^{-8}	3×10^{-4}	3×10^{-5}	6.7×10^{-3}
(45)	886-50-0	Terbutryn	0.065	0.0065	0.34	0.034	

(1) CAS : Chemical Abstracts Service.

(2) This parameter is the Environmental Quality Standard expressed as a maximum allowable concentration (EQS-MAC). Unless otherwise specified, it applies to the total concentration of all isomers.

(3) Inland surface waters encompass rivers and lakes and related artificial or heavily modified water bodies.

(4) This parameter is the EQS expressed as a maximum allowable concentration (MAC-EQS). Where the MAC-EQS are marked as 'not applicable', the AA-EQS values are considered protective against short-term pollution peaks in continuous discharges since they are significantly lower than the values derived on the basis of acute toxicit.

(5) For the group of priority substances covered by brominated diphenylethers (No 5) listed in Decision No 2455/2001/EC, an EQS is established only for congener numbers 28, 47, 99, 100, 153 and 154.

(6) For cadmium and its compounds (No 6) the EQS values vary depending on the hardness of the water as specified in five class categories (Class 1: < 40 mg $CaCO_3$/l, Class 2: 40 to < 50 mg $CaCO_3$/l, Class 3: 50 to < 100 mg $CaCO_3$/l, Class 4: 100 to < 200 mg $CaCO_3$/l and Class 5: ≥ 200 mg $CaCO_3$/l).

(7) This substance is not a priority substance but one of the other pollutants for which the EQS are identical to those laid down in the legislation that applied prior to 13 January 2009.

(8) No indicative parameter is provided for this group of substances. The indicative parameter(s) must be defined through the analytical method.

(9) DDT total comprises the sum of the isomers 1,1,1-trichloro-2,2 bis (p-chlorophenyl) ethane (CAS number 50-29-3; EU number 200-024-3); 1,1,1-trichloro-2(o-chlorophenyl)-2-(p-chlorophenyl) ethane (CAS number 789-02-6; EU number 212-332-5); 1,1-dichloro-2,2 bis (p-chlorophenyl) ethylene (CAS number 72-55-9; EU number 200-784-6); and 1,1-dichloro-2,2 bis (p-chlorophenyl) ethane (CAS number 72-54-8; EU number 200-783-0).

(10) The information available is not sufficient to establish an AA-EQS for these substances..

(11) For the group of priority substances of polyaromatic hydrocarbons (PAH) (No 28), the biota EQS and corresponding AA-EQS in water refer to the concentration of benzo(a)pyrene, on the toxicity of which they are based. Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored for comparison with the biota EQS or the corresponding AAEQS in water.

(12) Unless otherwise indicated, the biota EQS relate to fish. An alternative biota taxon, or another matrix, may be monitored instead, as long as the EQS applied provides an equivalent level of protection. For substances numbered 15 (Fluoranthene) and 28 (PAHs), the biota EQS refers to crustaceans and molluscs. For the purpose of assessing chemical status, monitoring of Fluoranthene and PAHs in fish is not appropriate. For substance number 37 (Dioxins and dioxin-like compounds), the biota EQS relates to fish, crustaceans and molluscs, in line with section 5.3 of the Annex to Commission Regulation (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non-dioxin-like PCBs in foodstuffs (OJ L 320, 3.12.2011, p. 18).

(13) These EQS refer to bioavailable concentrations of the substances.

(14) PCDD: polychlorinated dibenzo-p-dioxins; PCDF: polychlorinated dibenzofurans; PCB-DL: dioxin-like polychlorinated biphenyls; TEQ: toxic equivalents according to the World Health Organisation 2005 Toxic Equivalence Factors.'

(15) Refers to following compounds:
7 polychlorinated dibenzo-p-dioxines (PCDD) : 2,3,7,8-T4CDD (CAS nr. 1746-01-6), 1,2,3,7,8-P5CDD (CAS nr. 40321-76-4), 1,2,3,4,7,8-H6CDD (CAS nr. 39227-28-6), 1,2,3,6,7,8-H6CDD (CAS nr. 57653-85-7), 1,2,3,7,8,9-H6CDD (CAS nr. 19408-74-3), 1,2,3,4,6,7,8-H7CDD (CAS nr. 35822-46-9), 1,2,3,4,6,7,8,9-O8CDD (CAS nr. 3268-87-9)

10 polychlorinated dibenzofuranes (PCDF) : 2,3,7,8-T4CDF (CAS nr. 51207-31-9), 1,2,3,7,8-P5CDF (CAS nr. 57117-41-6), 2,3,4,7,8-P5CDF (CAS nr. 57117-31-4), 1,2,3,4,7,8-H6CDF (CAS nr. 70648-26-9), 1,2,3,6,7,8-H6CDF (CAS nr. 57117-44-9), 1,2,3,7,8,9-H6CDF (CAS nr. 72918- 21-9), 2,3,4,6,7,8-H6CDF (CAS nr. 60851-34-5), 1,2,3,4,6,7,8-H7CDF (CAS nr. 67562-39-4), 1,2,3,4,7,8,9-H7CDF (CAS nr. 55673-89-7), 1,2,3,4,6,7,8,9-O8CDF (CAS nr. 39001-02-0)

12 polychlorinated biphenyles dioxine-like (PCB-TD) : 3,3',4,4'-T4CB (PCB 77, CAS nr. 32598-13-3), 3,3',4',5-T4CB (PCB 81, CAS nr. 70362-50-4), 2,3,3',4,4'-P5CB (PCB 105, CAS nr. 32598-14-4), 2,3,4,4',5-P5CB (PCB 114, CAS nr. 74472-37-0), 2,3',4,4',5-P5CB (PCB 118, CAS nr. 31508-00-6), 2,3',4,4',5'-P5CB (PCB 123, CAS nr. 65510-44-3), 3,3',4,4',5-P5CB (PCB 126, CAS nr. 57465-28-8), 2,3,3',4,4',5-H6CB (PCB 156, CAS nr. 38380-08-4), 2,3,3',4,4',5'-H6CB (PCB 157, CAS nr. 69782-90-7), 2,3',4,4',5,5'-H6CB (PCB 167, CAS nr. 52663-72-6), 3,3',4,4',5,5'-H6CB (PCB 169, CAS nr. 32774-16-6), 2,3,3',4,4',5,5'-H7CB (PCB 189, CAS nr. 39635-31-9).

(16) Refers to α-hexabromocyclododecane (CAS nr. 134237-50-6), β-Hexabromocyclododecane (CAS nr. 134237-51-7) and γ- hexabromocyclododecane (CAS nr. 134237-52-8).

Annex 4 Water reuse standards of California

California	
Reference document	Regulation related to Recycled Water, Title 22 of the Code of regulations, Title 22, Division 4, Chapter 3, section 60301 et seq (2009, updated in 2011) Available at: 2009 version: http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/RWregulations-01-2009.pdf (2009 version) and http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/RWstatutes2011-01-01.pdf (2011 amendments)
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Municipal wastewater ('Recycled water from sources that contain domestic waste, in whole or in part').
Potential uses and restrictions	47 potential uses grouped into 4 use categories: • Irrigation • Impoundments • Cooling • Other purposes: flushing toilets and urinals, priming drain traps, industrial process water that may come into contact with workers, fire-fighting, decorative fountains, commercial laundries, consolidation of backfill around potable water pipelines, artificial snow for commercial outdoor use, commercial car washes, etc.
Approach	Title 22 establishes uniform state-wide recycling criteria for the various uses of recycled water to assure protection of public health where recycled water use is involved. These regulatory criteria include specified approved uses of recycled water, numerical limitations and requirements, treatment method requirements and performance standards. For each potential use, a specific wastewater treatment technique is required. California has a system for approving and certifying treatment technologies under Title 22. In addition, for certain use categories, water quality criteria (numerical limit values for the total coliform content parameter) are defined and are legally-binding.
Parameters	• Only 1 parameter is specified in Chapter 3 of Title 22: total coliform content. • California however regulates various parameters for water and wastewater treatment in general, many of which may also apply to reuse. Quality parameters can also be built into definitions of treatment levels for water and wastewater, which may be contained in other regulations. Besides, many parameters may be contained in the permissions granted to individual schemes.
Monitoring	Minimum required frequency for sampling and analysis. The producer/supplier of the recycled water shall conduct the sampling. All monitoring results, operational problems, plant and equipment breakdowns, diversions to emergency storage or disposal, and all corrective or preventive actions shall be recorded (monthly summary shall be filed with the regulatory agency).

California	
Application controls	• Setback distances between area of use or impoundment of recycled water and domestic water supply wells (setback distances vary depending on the treatment that has been applied to the wastewater) • Runoff shall not enter dwellings, designated outdoor eating areas or food handling facilities and be confined to the recycled water use area • Drinking water fountains shall be protected against contact with recycled water contamination • Setback distance between spray irrigation of any recycled water and a residence or a place with public exposure similar to that of a park, playground or school yard • Signalling of areas that are accessible to the public and where recycled water is used • Physical connections between any recycled water system and any separate system conveying potable water are forbidden • In publicly accessible areas: no hose bibs, only quick couplers. • Preventive maintenance program to ensure that all equipment is kept in good operating condition • Alarm devices required to provide warning in the case of loss of power from the normal power supply or in the case of treatment process failure
Permitting system	The process is defined by California Code of Water: All persons who recycle or propose to recycle water, and who use or propose to use recycled water, must file a report with the appropriate regional water board This report shall be prepared by a qualified engineer registered in California and experienced in the field of wastewater treatment. The report shall indicate the means for compliance with the Californian regulations and any other features specified by the regional water board. If a regional water board determines that it is necessary to protect public health, safety, or welfare, it may prescribe water recycling requirements where recycled water is used or proposed to be used. The regional water boards must consult with and consider recommendations of the Department of Health Services (DHS) when issuing waste discharge/water recycling requirements; 'Title 22' criteria are used as a basis by the DHS to provide these recommendations.
Comments	California can be seen as a pioneer in the regulation of water reuse, as the first water reuse guidelines were published in 1918.

(Deloitte et al., 2014)

Annex 5 WHO guidelines (World Health Organization)

WHO	
Reference document	WHO Guidelines for the safe use of wastewater, excreta and greywater, 2006 Available at: http://www.who.int/water_sanitation_health/wastewater/gsuww/en/
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Wastewater consisting of domestic sewage that does not contain industrial effluents at levels that could pose threats to the functioning of the sewerage system, treatment plant, public health or the environment
Potential uses and restrictions	• Agriculture (Volume II of the guidelines) • Aquaculture (Volume III of the guidelines)
Approach	Risk management approach, including the following steps: • Identifying hazards • Generating evidence for health risks and the effectiveness of possible health protection measures to manage them • Establishing health-based targets to manage health risks: measurement of the gap between current health status and an ideal health situation using DALY per year and per person units (Disability-Adjusted Life Year: one DALY can be thought as one lost year of 'healthy' life). The guidelines provide health based targets for treated water use in agriculture for 6 exposure scenarios: unrestricted irrigation (lettuce or onion); restricted irrigation (highly mechanized or labour intensive); localized (drip) irrigation (high growing crops or low-growing crops). • Implementing health protection measures to achieve the health-based targets • System assessment and monitoring. Volumes II and III provide lists of selected wastewater treatment processes and the corresponding log unit pathogen removals. Volume II also lists some advantages and disadvantages of each selected treatment process.
Parameters	Volumes II and III provide a list of validation, operational monitoring and verification monitoring parameters: • 19 'validation' parameters • 24 'operational monitoring' parameters including e.g.: flow rates, BOD, algal concentration, dissolved oxygen, turbidity, pH, organic carbon, particle counts, membrane integrity (pressure testing), chlorine residual, types of crops, application timing and time to harvest, Etc. • 13 'verification monitoring' parameters including e.g.: E. coli, helminth eggs, locally relevant toxic chemicals, etc. Volume II also provides a list of 8 environmental parameters and provides details of their potential effects on soils, crops and livestock for a given concentration of these parameters in the irrigation water, as well as their relative impact on groundwater and surface water bodies: pathogens, salts, metals, toxic organic compounds, nutrients, organic matter, total suspended solids, pH

WHO	
Monitoring	3 types of monitoring: • Validation is the initial testing to prove that a system as a whole and its components are capable of meeting the performance targets • Operational monitoring is the routine monitoring of parameters that can be measured rapidly to inform management decision and prevent hazardous conditions from arising • Verification monitoring is regularly carried out to demonstrate that the system is working as intended.
Application controls	• Recommendations on how to choose the treated wastewater application method, in order to reduce health risks for farm workers, consumers and nearby communities. • Recommended measures to reduce pathogens: vigorous washing of rough-surfaced salad crops and vegetables eaten uncooked in tap water; peeling fruits; cooking vegetables • Use of protective clothing • Suggestions on measures to control some environmental impacts are presented by polluting agent or by type of environmental issue • Health protection measures against trematodes for wastewater reuse in aquaculture • Health protection measures depending on the waste-fed aquacultural system chosen
Permitting system	Not covered by these guidelines.
Comments	Microbial quality targets (numerical limit values) are provided for waste-fed aquaculture. Verification monitoring of chemical concentrations in waste-fed aquacultural products should be conducted at six months intervals by local food authorities. Contaminants that are at elevated concentrations can be singled out for more routine monitoring as necessary. Indicative limit values for chemical concentrations in fish and vegetables are also provided (arsenic, cadmium, lead, methylmercury, dioxins, DDT, TDE, PCBs)

(Deloitte et al., 2014)

Annex 6 Australian guidelines

Australia	
Approach	An important feature of these guidelines is that they recommend a risk management framework, rather than simply relying on post-treatment testing as the basis for managing recycled water schemes. The framework involves identifying and managing risks in a proactive way, rather than simply reacting when problems arise. The guidelines provide a "fit for purpose" methodology for cost-effective treatment to be applied to a water source sufficient to meet the quality appropriate for the intended use. By matching a reuse application to a wastewater source and type of treatment, water supply costs can be controlled and the costs for improved wastewater treatment technologies delayed until they are balanced by the benefits. The guidelines require to identify and assess the main health and environmental risks, and to implement preventive measures and monitoring procedures needed to reduce those risks to an acceptably low level. The guidelines specify the log removals of enteric pathogens for different treatment processes as well as the required log reductions for water reuse categories. In the guidelines on Managed aquifer recharge (2008), a health-based target derived from DALYs was introduced (Disability-Adjusted Life Year: one DALY can be thought as one lost year of 'healthy' life). This target is intended for potable schemes: controls implemented to limit negative health impacts can be measured as a reduction in DALYs. The guidelines are intended to serve as a common basis for the establishment of state-level guidelines or regulations. According to Fisher (2012)[149], following the Australian guidelines to set up a water reuse project can prove itself to be challenging: the vendor has to fully understand risk assessment, treatment technology, and has to have operational experience in order to efficiently conduct the risk assessment necessary for application of a permit.
Parameters	• 10 indicative parameters are mentioned: suspended solids, turbidity, biochemical oxygen demand, microbial quality, including faecal pathogens and indicators, chemical quality, including salinity — for example, total dissolved salts (TDS) or electrical conductivity (EC), sodium adsorption ratio (SAR), nutrients (macro and micro), heavy metals, and metalloids, pesticides and other organics, algal counts, organic matter, colour These parameters are not associated with numerical limit values. Key characteristics that should be considered for monitoring include: • Microbial indicator organisms • Salinity, sodicity, sodium, chloride, boron, chlorine disinfection residues, nitrogen and phosphorus • Any health or environment-related characteristic that can be reasonably expected to exceed relevant guideline values, even if occasionally • Any characteristic of relevance to end use or discharge of the recycled water which can be reasonably expected to exceed the guideline value, even if occasionally

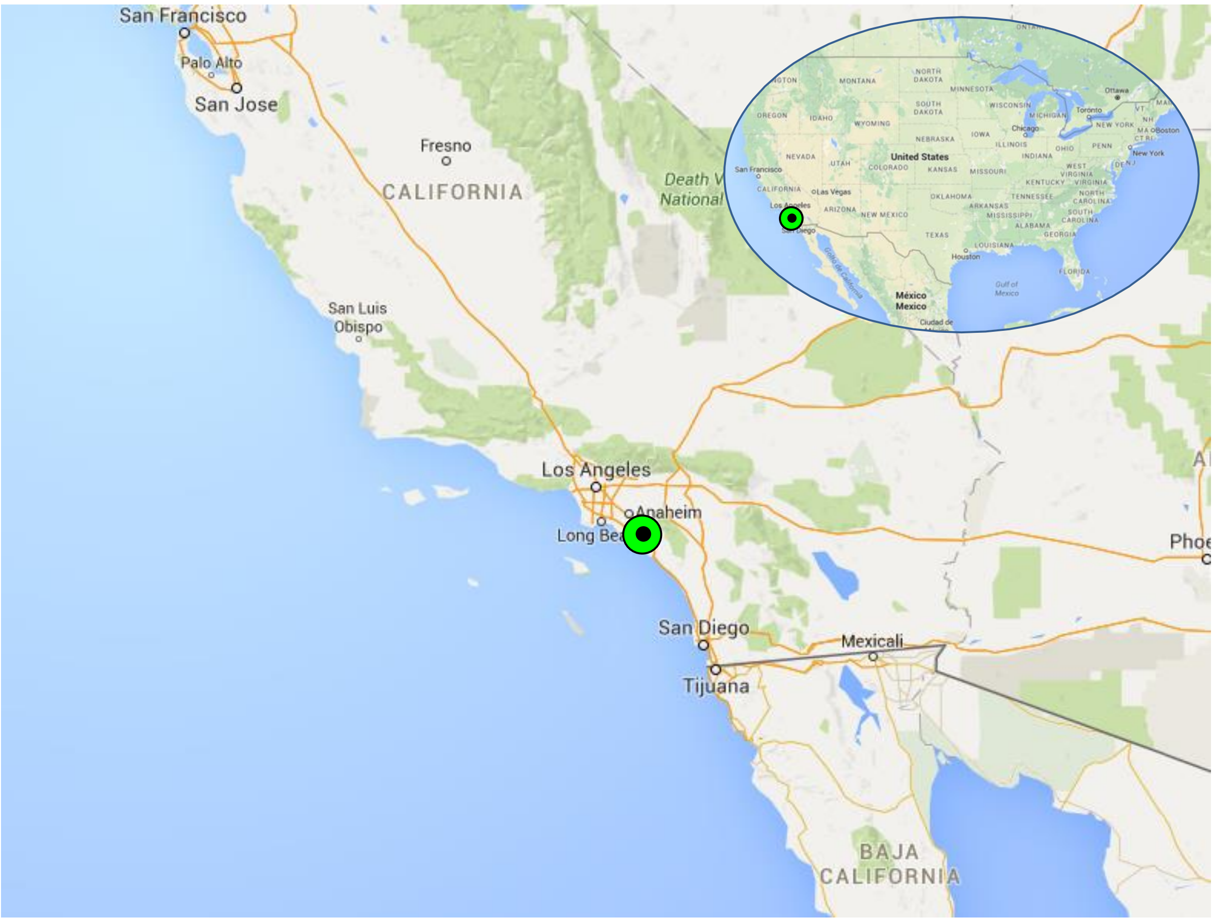
Australia	
Monitoring	All sites that could be affected by the use or discharge of recycled water may need to be monitored. The monitoring process is to be defined on the basis of the risk assessment. Different steps are recommended: • Determine the characteristics to be monitored • Determine the points at which monitoring will be undertaken • Determine the frequency of monitoring • Check documentation and reliability of data • Check satisfaction of users of recycled water • Conduct short term evaluation of results • Implement corrective responses Monitoring data should be reviewed over time and after specific events, such as heavy rainfall, which can lead to poor water quality in stormwater systems.
Application controls	The following types of measures are listed as a guidance: • Operator, contractor and end user awareness and training: they need to be aware of the potential consequences of system failure and of how decisions can affect public and environmental health • Community involvement and awareness • Restricting uses of recycled water • Controlling methods of application • Setting withholding periods between application of recycled water and use of irrigated areas or harvesting of produce • Controlling public access during application or use of recycled water • Using signage, labelling and communication to minimise accidental exposure The guidelines stress the importance of supporting these preventive measures by education of users and monitoring using surveillance and auditing. The document provides estimates of microbial hazards reductions provided by measures implemented at the site of water reuse application. It is however pointed out that there is limited information on the effectiveness of these preventive measures and that further research is required on this aspect.
Permitting system	Not covered by these guidelines. Defined at the state level.

(Deloitte et al., 2014)

Annex 7 Examples of IPR existing projects and French reuse existing projects

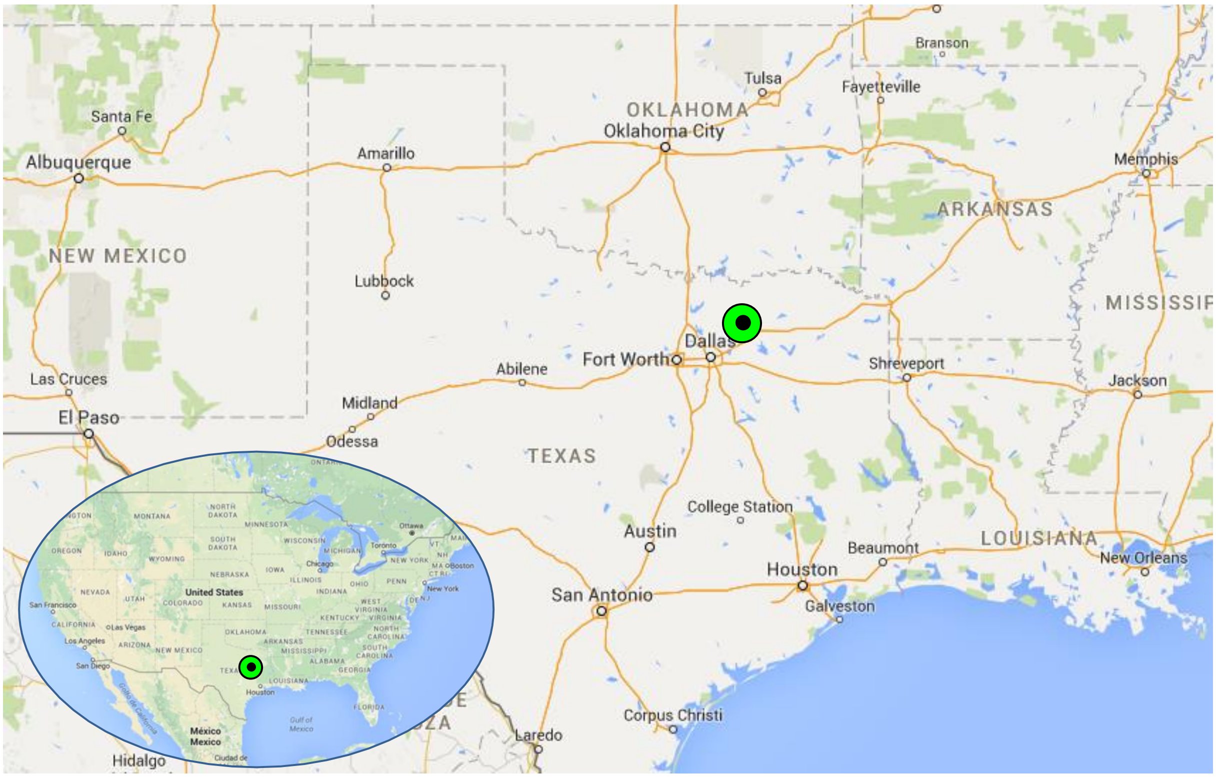
Project	Scope of the scheme
Orange county water district, Groundwater replenish-ment system, California, USA	Indirect potable reuse scheme based on a groundwater replenishment system
North Texas Municipal Water District, East Fork Raw Water Supply Project, Texas, USA	Indirect potable reuse scheme based on an advanced treatment plant and an artificial constructed wetland
Upper Occoquan Service Authority (UOSA), Potable Water Reuse in the Occoquan Watershed, Northern Virginia, USA	Indirect potable reuse scheme based on advanced treat-ment plants discharges upstream a reservoir
Western Corridor Recycled Water Scheme, South East region of Queensland, Australia	Industrial water supply, agricultural watering and indirect potable reuse scheme based on advanced treatment plants
Belgium aquifer recharge, West of Belgium	Indirect potable reuse scheme based on the artificial re-charge of the unconfined dune aquifer
Montebello Forebay, California, USA	Indirect potable reuse scheme based on a groundwater replenishment system
Potable Reuse Project Windhoek, Namibia	Direct potable reuse: reclaimed water is blended with conventionally-treated surface water for potable reuse
Pornic golf course, South-eastern Brittany, near Loire estuary, France in a water scarce and envi-ronmental sensitive area	Irrigation of a golf course with reclaimed treated water
Limagne noire, Centre of France in a water scarce area for agriculture and environmental sensi-tive area	Irrigation of crop culture with reclaimed treated water

Project	Orange county water district Groundwater replenishment system (GWRS)
Period of implementation	2008
Stakeholders	Orange County Water District (OCWD), Orange County Sanitation District (OCSD), Regional Water Quality Control Board, California Department of Public Health
Location	Southern California, USA



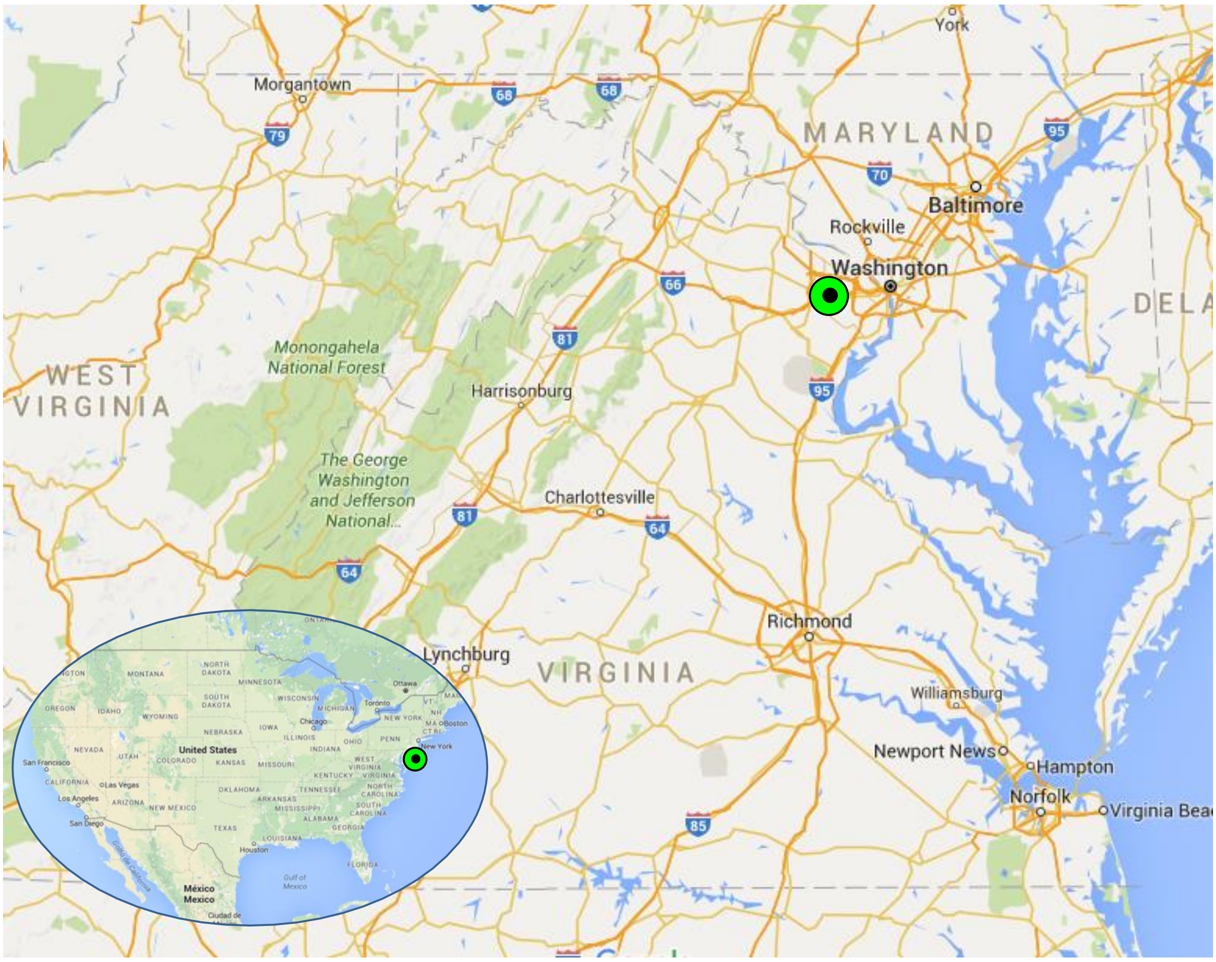
Water treatment system	Blended treated wastewater from OCSD for 4,200 l/s (secondary treated wastewater)
Reuse facility	Advanced Treatment Water Facility capable of producing 3,070 l/s for indirect potable reuse. The ATWF system removes pharmaceuticals, pesticides and other contaminants before the reclaimed water is pumped into basins to replenish groundwater. The AWTF includes microfiltration, reverse osmosis and advanced oxidation processes (UV and hydrogen peroxide).
Volume, quantity	3,070 l/s (97 Mm^3/y) for indirect potable reuse by withdrawal from the groundwater is replenished (an expansion project to 4,380 l/s is ongoing)
Economic approach	Capital cost: $481 million Annual operating budget: $28.5 million Assessment: $0.20/$m^3$ (compared to the cost of imported water supplies, $0.61/$m^3$)
Project background, difficulties, lessons learned	Prior to the GWRS, OCWD operated Water Factory 21 (WF-21), a first-of-its-kind water treatment facility that produced 960 L/s for a seawater intrusion barrier,

	from 1976 through 2004. In the mid-1990s, OCSD faced the possibility of building a second ocean outfall at a cost of $200 million. At the same time, OCWD was dealing with problems of sea-water intrusion and the need to expand WF-21 from 920 to 1530 L/s. Joining ef-forts in 1997, OCSD agreed to supply OCWD with 4200 L/s of secondary treated wastewater at no cost. OCSD and OCWD also agreed to share the $481 million cost to construct the GWRS. After signing a cooperative agreement to plan and construct the GWRS, OCWD and OCSD established the GWRS Steering Committee to oversee planning, design and construction in cooperation with each agency’s governing board. Whereas the original scheme was realised before the era of extensive public in-volvement, the Orange County Water District foresaw the poten-tial opposition the expansion might face. Four million dollars were spent over a ten year time period to build acceptance. This public involvement and education campaign consisted of speeches by representatives of the OCWD, many tours, as well as opinion surveys to identify common con-cerns. As a result, the project could count on wide support and commit-ment, and ended up facing virtually zero public opposition. **One of the most important measures OCWD uses to evaluate success is public ac-ceptance of IPR**. An aggressive outreach program was established to educate and secure support from local, state and federal policymakers, business and civic lead-ers, health experts, environmental advocates and academia. Because of the nega-tive and misinformed public perception of purifying wastewater to drinking water, the agencies decided that the “clean water” agency should be out front to manage day-to-day management of the outreach campaign. To brand the safety, purity and high quality of water, OCWD staff led outreach and interfaced with consumer media, while OCSD staff served as advisors on outreach decisions and helped manage trade media relations. The team made more than 1,200 presentations from 1999 to 2007, secured thousands of media impressions, and garnered more than 600 letters of support including those from all 21 city councils, the district’s senators and congressional representatives, local state as-sembly members, state senators, the governor, and the Orange County Board of Supervisors. Agencies that govern or influence water policy were also supportive including the Department of Water Resources, CDPH and the Santa Ana RWQCB. *Source: US EPA, 2012*

Project	North Texas Municipal Water District (NTMWD) East Fork Raw Water Supply Project (EFRWSP)
Period of implementation	2004
Stakeholders	North Texas Municipal Water District, local authorities, environmental interest groups
Location	Northern Texas, USA
	
Water treatment system	Blended treated wastewater from 4 regional wastewater treatment plants and 12 small wastewater treatment plants owned by NTMWD
Reuse facility	**A constructed wetland**, downstream of the Lavon lake, covers 1,840 acres (~7.5 km²) and has a residence time of 7 to 10 days. The discharge of the wetland is pumped and discharged into the Lavon lake. A 2 steps initial nursery was created to provide a plant stock of selected wetland emergent species for the full scale wetland. A diversion pump station of 625,000 m^3/d is used to divert flow to the upstream of the wetland A conveyance pump station of 25,000 m^3/d is used to convey the wetland treated water to Lavon Lake by a 43 miles of 84-inch diameter conveyance pipeline
Volume, quantity	24,000 m^3/d at full capacity of the pump station, the treated water being pumped and discharged upstream the Lavon lake reservoir in a wetland.
Economic approach	Construction cost : $280 million

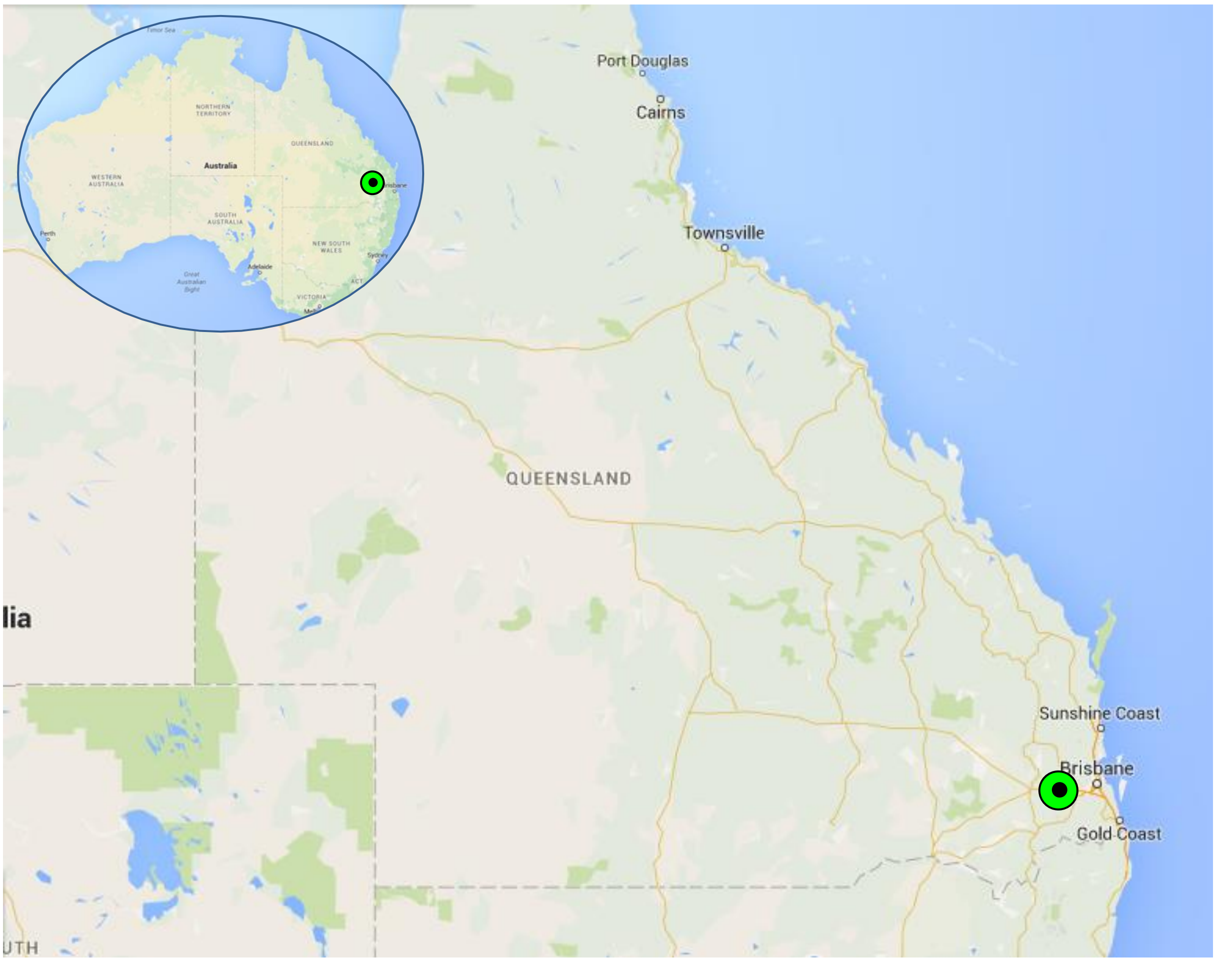
Project background, difficulties, lessons learned	North Texas Municipal Water District (NTMWD) currently provides potable water to a population of over 1.6 million in a region north and east of the City of Dallas. Water is diverted for treatment from the NTMWD's primary raw water supply reservoir, Lavon Lake. This supply is supplemented with transfers to Lavon Lake from two other water supply reservoirs, one located in the Red River basin and one in the Sulphur River basin. In addition to its potable water supply facilities, NTMWD owns and operates 4 regional wastewater treatment plants and operates 12 smaller wastewater treatment plants within its service area. NTMWD is located in one of the fastest growing regions in the United States. By 2020, the service area population is anticipated to grow by nearly 700,000 and more than double in the next 50 years. As a result of this unprecedented growth, NTMWD developed the East Fork Raw Water Supply Project (EFRWSP) in order to further augment water supply in Lavon Lake. Because of the potential decrease of the freshwater inflows to Galveston Bay, the project involved many stakeholders from Dallas to Houston and the coastal region. The project required a lengthy negotiation with all these parties. The wetland and nature centre was developed through a partnership with the Carolyn Hunt Trust Estate, which owns and operates a ranch and a smaller wetland on the property. The project has experienced **very little public opposition**, and overall is **seen as an asset to the area by environmental interest groups, the water supply community and the general public**. This **positive image** is **largely attributed to the constructed wetland, which provides multiple benefits associated with water supply, aquatic life habitat enhancement, and extensive educational and research opportunities**. *Source: US EPA, 2012*

Project	Upper Occoquan Service Authority (UOSA) Potable Water Reuse in the Occoquan Watershed (PWROW)
Period of implementation	1971-ongoing
Stakeholders	Upper Occoquan Service Authority (UOSA), Virginia State Water Control Board (VDEQ), Virginia Department of Health (VDH), Fairfax County, Prince William County, Cities of Manassas and Manassas Park
Location	Northern Virginia, USA



Water treatment system	UOSA reclamation plant includes preliminary and primary treatment followed by complete mixed activated sludge with biological nitrogen removal. Advanced water treatment processes include lime precipitation and two stage recarbonation with intermediate settling; these processes remove phosphorus and are barriers to pathogens and heavy metals. Final polishing is accomplished with multimedia filtration, granular activated carbon adsorption, chlorination and dechlorination.
Reuse facility	-
Volume, quantity	120,000 m^3/d on an annual average, and full capacity of 205,000 m3/d to supplement the raw water supply in the Occoquan Reservoir
Economic approach	Unknown

Project background, difficulties, lessons learned	The Occoquan Reservoir is a critical component of the water supply for approximately 1.5 million residents of Northern Virginia, a highly urbanized region located west of Washington, D.C. By the mid-1960s, this urbanization was adversely affecting water quality of the Occoquan Reservoir, resulting in an unplanned and unintended indirect potable reuse scenario, where 11 small wastewater treatment plants were discharging effluent upstream of the reservoir. Poorly treated wastewater, with urban and agricultural runoff, threatened continued use of the Occoquan Reservoir for public water supply. In 1971, the Virginia State Water Control Board (VDEQ) and the Virginia Department of Health (VDH) adopted a plan to protect the Occoquan Reservoir as a drinking water supply. The Occoquan Policy mandated a newly conceived framework for water reuse and set in motion **the first planned and intentional use of reclaimed water for supplementing a potable surface water supply in the United States**. While **water quality improvement was the primary driver** for implementing planned and intentional potable water reuse in the Occoquan system, **supplementing the raw water supply was always an underlying objective**. Although the mid-Atlantic region of the U.S. is not considered dry or arid, the population density results in stressed water supply, and limited per capita water availability. This situation becomes more pronounced during periodic extended drought conditions. When water reclamation was first proposed, a number of hearings were conducted to explain what was to be implemented and to provide the public a venue to express their views. UOSA has always engaged in an active program to provide tours to local students, from grade school through college, during which potable reuse is thoroughly explained. These tours have been conducted for more than 30 years, providing public outreach to the local population on the importance of UOSA's mission. In addition, UOSA maintains a public website where it' role in potable water reuse is clearly expressed. UOSA's success has not required dedicated public relations staff or a formal public outreach and communication program. According to stakeholders, the greatest key to success of this project is that it was implemented specifically to improve water quality problems in the existing surface water reservoir being used as the drinking water supply. Although water quality was the major driver, it was clearly recognized that treated wastewater flows returned to the reservoir would be a significant and valuable resource in the future. *Source: US EPA, 2012*

Project	Western Corridor Recycled Water Scheme Water Reuse (industrial, agricultural and potable water uses) in the West-ern Corridor
Period of implementation	2006
Stakeholders	Seqwater (south east Queensland), state Government of Queensland
Location	South East region of Queensland, Australia
	
Water treatment system	Three advanced water treatment plants were constructed at Bundamba, Luggage Point and Gibson Island, and these draw water from six existing wastewater treatment plants
Reuse facility	The water is distributed via a network of pipelines of more than 200 kilometres length
Volume, quantity	230,000 m^3/d at full capacity
Economic approach	A$408 million (€270 million)

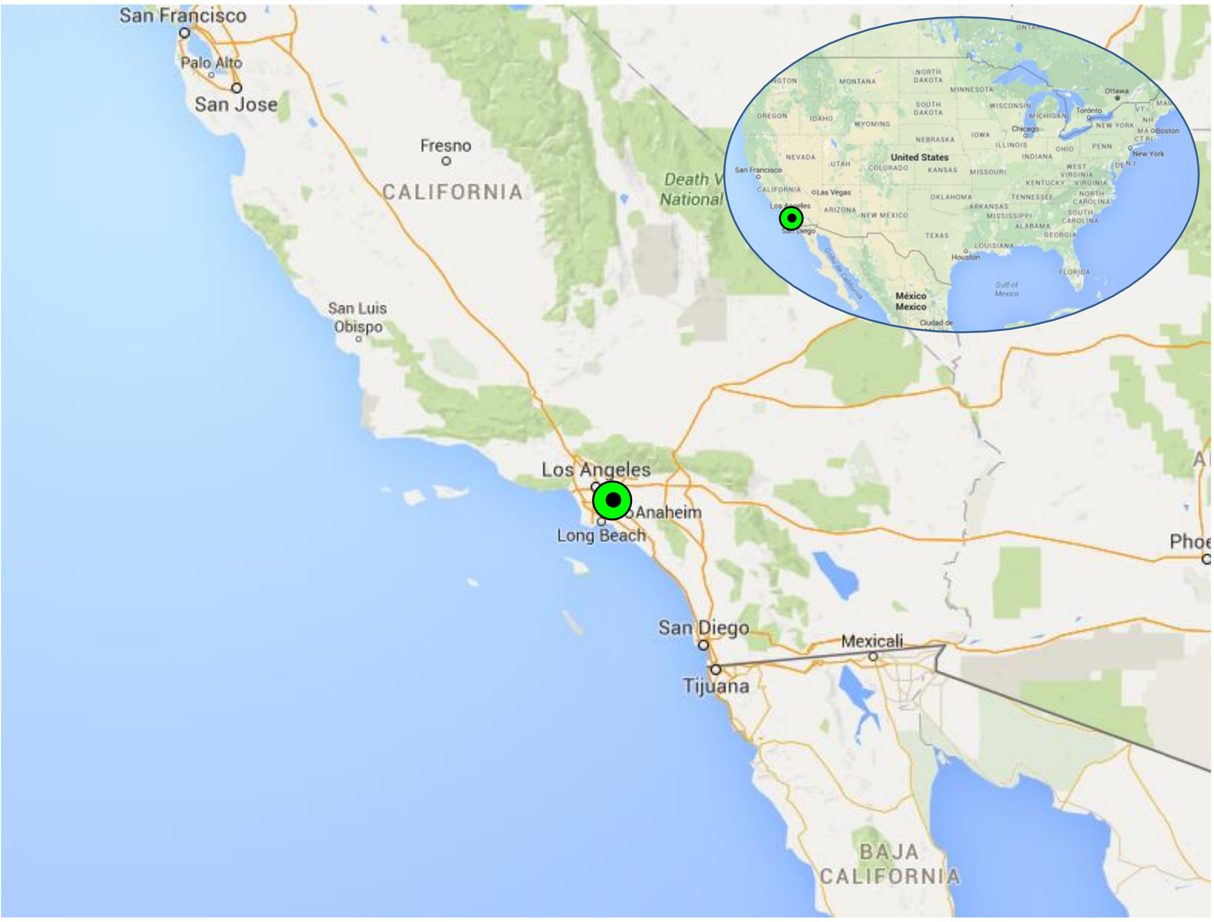
Project background, difficulties, lessons learned	The Western Corridor Recycled Water Scheme, a recycled water project, is located in the South East region of Queensland in Australia. The scheme that is managed by WaterSecure is a key part of the SEQ Water Grid constructed by the Queensland Government in response to population growth, climate change and severe drought. In Stage 1 of the project the scheme has provided an alternative water source for Swanbank Power Station and both Tarong Power Station and Tarong North Power Station. Supplies to Swanbank started in 2007 and supplies to Tarong and Tarong North started in June 2008. The system has the capacity to provide water to other industrial users, agricultural users and to supplement drinking water supplies in Wivenhoe Dam. Testing of the pipeline to Wivenhoe Dam has been conducted, however in November 2008, Premier Anna Bligh declared that recycled water would not enter the dam unless levels drop to below 40%. As of May 2009, the three power stations are the main customers of the recycled water, consuming 112,000 m^3/d. Since coming online in August 2007, through to July 2010, the Western Corridor Recycled Water Scheme has supplied more than 37 million m^3 of water into the SEQ Water Grid. In January 2013 it was reported that the Newman government was considering shutting down part or the whole scheme. In September 2013, former Premier Peter Beattie admitted that the scheme was a "tragic error of judgment" in the way that the Bligh government handled the creation of the water grid. **Public opposition, negative reporting by the media**, and a season of increased rainfall (making the reuse, which was clearly portrayed as an emergency measure, perceived no longer necessary) made **the state government decide to only augment drinking water reservoirs if dam levels fall below 40%**, which effectively “mothballed” the indirect potable reuse part of the project, even if meanwhile the infrastructure already had been built. As a consequence, only about half of the design capacity is currently being used, mostly as cooling water for local power plants. *Source: US EPA, 2012; Johnstone, 2009*

Project	Belgium aquifer recharge Water reclamation for aquifer recharge in the Flemish dunes
Period of implementation	2002
Stakeholders	Intermunicipal Water Company of the Furnes Region (IWVA)
Location	West of Belgium

Water treatment system	Primary sedimentation, pre-denitrification, and aerobic treatment, followed by secondary clarification and (Wulpen wastewater treatment plant) Screen, Ultrafiltration, reverse osmosisO (Toreele reclamation plant)
Reuse facility	Two infiltration ponds, withdrawal wells connected to a conveyance network to the potable water production of Saint-André
Volume, quantity	2 million m^3/y (annual average on the first 9 years of operation)
Economic approach	€7 million
Project background, difficulties, lessons learned	In the western part of Belgium's Flemish coast, water demand increased from 526,000 m³ in 1950 to 5,500,000 m³ in 1990. The dune water catchments, where fresh groundwater is pumped from the unconfined aquifer by the Inter-municipal Water Company of the Furnes Region (IWVA), could not produce more water as continued pumping would cause saline intrusion. Ecological interest in the dunes was also growing, so alternative exploitation methods were studied to remediate decreasing water levels and to guarantee current and future water abstraction possibilities. This resulted in the development of a project for artificial recharge of the unconfined dune aquifer of St-André. Because no other water sources were available for year-round aquifer recharge, the IWVA decided to reclaim water from the Wulpen WWTP for the production of infiltration water. The largest portion of the wastewater is from households. Because the rainwater

	is collected in the same sewer system, the effluent water quality can vary greatly. In Torreele, a large effort was put into building trust and reaching consensus with the authorities. Moreover, achieving public trust through information provision is perceived as an important enabling factor for the Torreele scheme. Therefore, from the start of the planning period, the approach of IWVA has been to inform the public and be transparent so that trust could be gained. Since the start of the project, 35 to 40 percent of IWVA's annual drinking water production is fulfilled by the combination of reuse/recharge. The recharge water is subject to stringent water quality standards due to the sensitive environment al nature of the dune area to be recharged. Because treated wastewater is high in both salt and nutrient content, RO was chosen as the final treatment step at the Torreele facility. RO requires a high-quality influent, so UF membranes precede the RO process. Water reuse intended for drinking water production, both direct and indirect, is not possible without intensive water quality monitoring. Both UF and RO processes performed as expected – UF produced water free of bacteria and suspended solids. UF proved to be a good pre-treatment for RO, and the infiltration water meets the quality standards that were set and turbidity is monitored as the first quality control step. Submerged UF was also capable of handling the expected variations in effluent water quality. Biofouling and scaling prevention is a constant concern with water reuse when using membranes. Reduction in consumption of chemicals and energy has been achieved since start-up by reducing aeration in the UF system, optimizing RO recovery rates to minimize scaling, and intermittent chlorination for control of biofouling. The membrane waste concentrate streams are now combined with the portion of the treated wastewater that is not reclaimed and discharged in the nearby brackish canal. However, IWVA I currently investigating natural systems for concentrate treatment within DEMOWARE Project (Demonstration site in WP1) In the last ten years, the drinking water demand in the area decreased from 5.5 million m³ in 2002 to 4.9 million m³ in 2010. Public education on the proper use of drinking water, increased prices due to higher taxes for discharge of the used water, and decreased leakage of the distribution network all contributed to this decrease. The decreased use of drinking water meant that less infiltration has been required in recent years. *Source: US EPA, 2012*

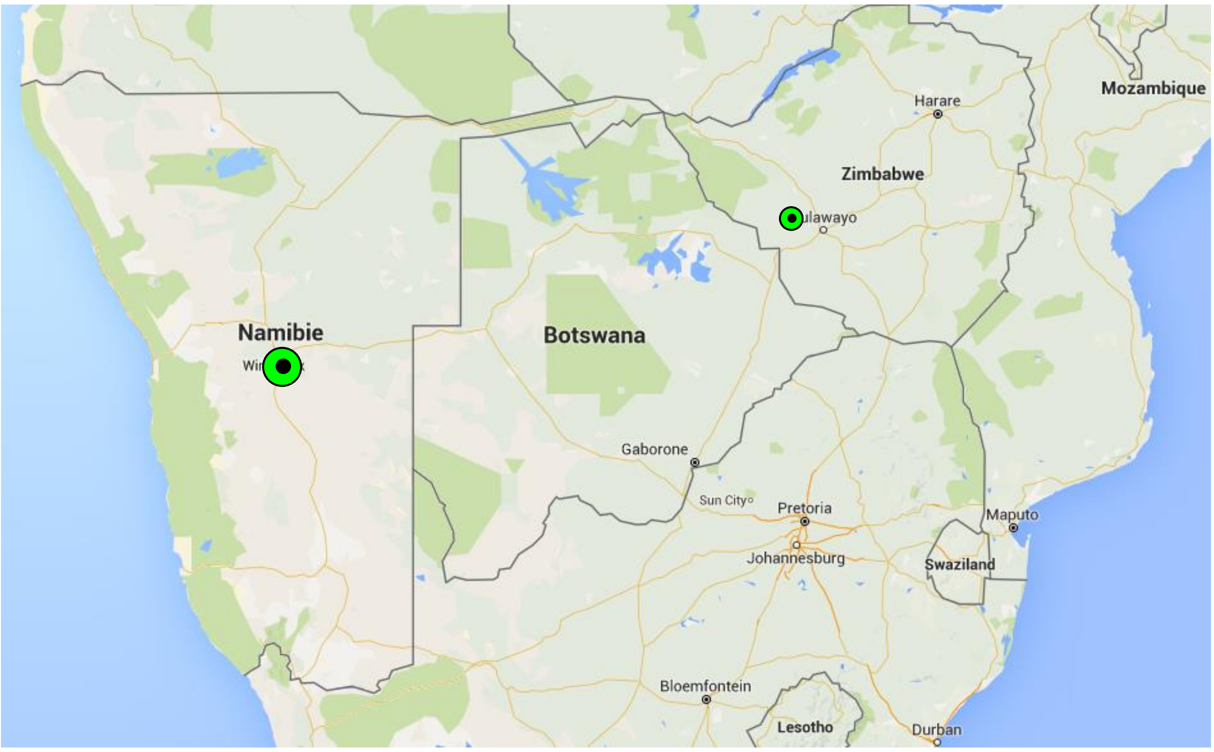
Project	Montebello Forebay Groundwater recharge Project Water reclamation for aquifer recharge in California
Period of implementation	1962
Stakeholders	Water Replenishment District of Southern California (WRD)
Location	Southern California, USA



Water treatment system	Primary sedimentation, pre-denitrification, and aerobic treatment, followed by secondary clarification and (Wulpen wastewater treatment plant) Screen, Ultrafiltration, reverse osmosisO (Toreele reclamation plant)
Reuse facility	Water is percolated into the groundwater using two sets of spreading grounds: the Rio Hondo Coastal Spreading Grounds, which consist of 235 ha with 20 individual basins, and the San Gabriel Coastal Spreading Grounds which consists of 52 ha with 3 individual basins, and within portions of the San Gabriel River (125 ha). Recycled water is conveyed to spreading grounds by gravity through existing waterways
Volume, quantity	54 million m^3/y
Economic approach	Unknown
Project background, difficulties, lessons learned	The Montebello Forebay Groundwater Recharge Project (MFGRP) has successfully been recharging the groundwater with recycled water since August 20, 1962. This is the oldest planned groundwater recharge project using recycled water in Cali-

	fornia. To date, over 1.6 million ac-ft (1,970 MCM) of recycled water has been recharged at the MFGRP to replenish the Central Groundwater Basin, which provides 40 percent of the total water supply for Los Angeles County. In the 1950's, following a rapid population growth in the region, excessive and unregulated pumping resulted in an overdraft that dropped the groundwater table and allowed seawater to intrude into the aquifer. In response, the Water Replenishment District of Southern California (WRD) was formed to manage this basin by regulating pumping and purchasing supplemental water supplies for replenishing the groundwater. Sources of groundwater replenishment in the Central Basin include recycled water, imported river water (Colorado River and State Project water), and local storm runoff. Use of recycled water for replenishment began at the Montebello Forebay area of the Central Basin in 1962, following construction of the Whittier Narrows WRP. The effectiveness of reuse from the Whittier Narrows WRP led to the decision to construct additional WRPs in the Los Angeles area in the 1970's, two of which (San Jose Creek and Pomona) also contribute to the recharge of the Central Basin. In the late 1970's, the WRPs were upgraded with tertiary treatment resulting in production of an effluent that met federal and state drinking water standards for heavy metals, pesticides, trace organics, major minerals, nitrogen, and radionuclides, and had extremely low levels of microorganisms and turbidity. In the early 2000's, the WRPs were upgraded again, to provide nitrification/denitrification, further improving the quality of the recycled water. In the late 2000's, sequential chlorination was implemented, minimizing production of trihalomethanes and N-nitrosodimethylamine. And in 2011, the Whittier Narrows WRP began using UV disinfection. The MFGRP provides a new water supply, roughly equivalent to the demands of a quarter of a million people. After fifty years of operation, the WRPs continue to operate consistently, producing an extremely high quality effluent, and monitoring continues to indicate that groundwater quality has not been adversely impacted. In addition, the use of recycled water in lieu of imported water for replenishing the groundwater has saved tens of millions of dollars a year in water purchases. Because recycled water is highly reliable, cost effective, locally controlled, and drought-resistant, there are ongoing plans to increase the amount of recycled water recharged in the Central Groundwater Basin and ultimately eliminate the basin's dependence on imported water. *(USEPA, 2012)*

Project	Windhoek Potable Reuse Project Water reclamation for Direct Potable Reuse in Namibia
Period of implementation	1968 to 2002: Goreangab Water Reclamation Plant Since 2002: new Goreangab water reclamation plant (NGWRP)
Stakeholders	Municipality of Windhoek
Location	Centre of Namibia



Water treatment system	Powdered activated carbon (PAC) dosing, pre-oxidation and pre-ozonation, flash mixing, enhanced coagulation and flocculation, dissolved air flotation, dual media rapid gravity sand filtration, ozonation, BAC filtration, GAC filtration, ultra-filtration (UF), disinfection and stabilisation.
Reuse facility	Water is blended up to 50% with treated surface water and fed into the distribution system
Volume, quantity	21,000 m^3/d
Economic approach	Unknown
Project background, difficulties, lessons learned	Regular droughts in Namibia and a continuous shortage of potable water to Windhoek have necessitated the municipality to investigate alternative sources of raw water supply. The most viable option proved to be reuse of municipal wastewater from the largest sewage treatment plant in Windhoek, the Gammams Water Care Works, with augmentation from a surface water source on the outskirts of the city, the Goreangab Dam. The orginal (now "Old") Goreangab Water Reclamation Plant was built over 30 years ago to reclaim municipal effluent for potable water purposes. This plant was upgraded and extended several times during the last 30 years but reached the end of its viable life span in the late 1990s and was also technologically no longer up to date. It was therefore decided to build a new, larger reclamation plant, the NGWRP, using the "multiple barrier"

	approach (see below). This plant was put into operation in mid-2002 and will now be further elucidated on. To increase both the level of awareness of water savings and the acceptance of direct potable reuse, the city of Windhoek has arranged adequate education programmes in schools, radio and television, as well as in the printed media. Evaluation of these programmes showed that the biggest benefit would be accomplished if water awareness forms part of the normal curriculum in schools. Reclaiming drinking water from municipal secondary effluent is not generally acceptable to the public and psychological barriers have to be broken down first. However, with persistent and good marketing as done in the above-mentioned education programmes, this perception can be changed. The people of Windhoek have even derived some pride from the fact that they are the only city worldwide where direct potable water reuse is practised. Since the beginning of potable reuse in 1968 in Windhoek, no outbreak of waterborne disease has been experienced and no negative health effects have been attributed to the use of reclaimed water. This forms a prerequisite for acceptance by the population and an indication for the trust by the latter in potable reuse is the fact that less than 5% of the population uses additional point source treatment in their homes. *(Lahnsteiner, 2007)*

Project	Pornic golf course Irrigation of a golf course with reclaimed treated water
Period of implementation	1994
Stakeholders	Local authorities, Management of the golf course, Veolia (WWTP operator)
Location	South-eastern Brittany, near Loire estuary, France in a water scarce and environmental sensitive area
	
Water treatment system	WWTP of 50,000 pop. eq with activated sludge step followed by disinfection (in summer only) and a 7,000 m^3 lagoon. Compliance with the 2010 decree led to upgrade the entire process to a new WWTP comprising screening, aeration ponds, a membrane bioreactor with immerged UF membranes and UV disinfection
Reuse facility	A 5 km long discharge pipe from WWTP to the golf course, low pressure aero-sprinklers near inhabited areas
Volume, quantity	Supply of 70 000 m^3/year of reclaimed treated water (12% of the total capacity of the WWTP) to irrigate 20 ha of the golf course (48% of its surface)

Economic approach	Unknown
Project background, difficulties, lessons learned	The upgrade of the WWTP in Pornic, needed by the new standards fixed by the 2010 decree, has provided an opportunity to test an approach based on a Sanitation Safety Plan. To ensure that hazards are dealt with from the raw wastewater to the point of use, **an internal risk evaluation and management tool has been developed and applied to this site**. This tool follows the methodology proposed by WHO and consists of: • A detailed hazard checklist, including 102 microbial and physicochemical hazards and their possible origin. This list is then simplified by parameter groups to achieve a check list of 20 hazards. • A risk evaluation matrix based on a scoring system (occurrence probability times potential impact). • An evaluation sheet to validate effectiveness of control measures and surveillance means. • A risk re-evaluation sheet that proposes corrective actions to deal with residual risks. • A series of questions following the multi-barrier concept guides the user through the evaluation of control measures from raw water to endpoint use. Gaps in the treatment process, potential failures and good practices concerning health and environmental protection may thereby be highlighted. For instance, hazardous events linked to UV operation, such as lamp degradation or increase of effluent turbidity, are controlled through maintenance and operational actions and checked by online measurements. In Pornic, **the management plan shows** that **adequate surveillance of critical points** (e.g. operational monitoring of turbidity of treated wastewater, UV dose of tertiary effluent) **strengthens the effectiveness of control measures thereby ensuring better safety, especially in respect to microbial contamination.** *Source: David, 2015*

Project	Saint-Gildas-de-Rhuys golf course Irrigation of the Rhuys Kerver golf course with reclaimed treated water
Period of implementation	2004
Stakeholders	Local authorities, Management of the golf course (Saur group), Saur (WWTP operator)
Location	South-eastern Brittany, France, in a bathing water sensitive area

Water treatment system	WWTP of 18,000 pop.eq optimized in 2011 for the reuse according to the new regulation. The process includes an activated sludge process, a clarifier and a nitrogen and phosphate removal step with $FeCL_3$. The optimization made in 2011 specifically for the reuse included an UF step with UV disinfection and a storage basin of 800 m^3
Reuse facility	A 2 km long discharge pipe from WWTP to the 700 m^3 storage basin near the golf course irrigation facility
Volume, quantity	60,000 m^3 are irrigated by spray on 19 ha of the golf course (92% of the irrigation needs of the golf course)
Economic approach	€ 740,000 (except the UF step)

Project background, difficulties, lessons learned	Golf Rhuys-Kerver is a 6 km course, nestled in a coastal area classified Natura 2000. Its greens are popular with 400 subscribers who regularly come to practice with occasional customers (10,000 occasional customers over 25 000 with a summer peak in green fees along the all year with 45% in the summer period). The maintenance of such a path requires the daily attention of greenkeeper. Depending on rainfall, 65,000 m^3 annual watering are necessary for departures, fairways and greens spread over 60 hectares of the site from March-April to September-October. In the late 90s, a reflection was committed to study the feasibility and cost of a solution of Reuse. It was environmentally desirable, economically attractive (the treatment plant is only 2 km far) even as demand focuses on periods of the year when consumption peaks are the largest (including summer). The treatment plant operated by Saur, and property of the municipal association of sanitation and drinking water (SIAEP) of the Rhuys peninsula, is located east of the étier (river) of Kerpont. It has been expanded and modernized in 2010-2011. The prior equipment, with a capacity of 9 000 pe, was undersized, the population growing from 1,600 to 12,000 in high season. It was equipped with a **membrane technology** to replace a conventional activated sludge facility. Output processing, the quality of the water conforms to standards for bathing water use which ensures the safety of its discharge into the sea, 250 meters from the shore. This technology has also **achieved a quality water graded of "A"** in accordance with the French Decree of August 2nd, 2010 on the use of treated wastewater for irrigation (see chapter 4.3 for more details). **Once treated, water intended for reuse is disinfected with UV facility** and stored in a holding tank of 800 m^3 before being pumped to the golf course which also has a 700 m^3 buffer tank. Consumption is precisely 700 m^3 per day and can go up to 900 m^3 in the summer. On the course, watering is traditionally done at night to avoid excessive evaporation and hinder the practice of golf during the day. Although it is not drinking water, the golf management complies with the local regulation and does not irrigate between 8:00 AM and 8:00 PM. This **project** has been **both profitable for the local authorities by suspending discharge of treated wastewater during the summer period, complying to the WWTP authorization permit. Similarly and for the golf course owner has reduced the cost of the watering** (annual tax of 15,000 € paid to the WWTP owner instead of 60,000 € for drinking water previously consumed for the watering). The **new Decree of June 25th, 2014** has introduced **new constraints for the reuse, especially during windy conditions**. To respect this regulation, the reuse should be limited around 30 days during the watering period (around 15% of the current situation), according to the average annual wind force average for the region. The city of Saint-Gildas Rhuys could no longer meet the discharge limit into the sea.. No information is currently available about the impact of the new Decree on the operation of this reuse facility *Source: Union nationale des industries et entreprises de l'eau et de l'environnement (National union of water and environment industries and companies), confidential document, 2015*

Project	Limagne noire Irrigation of crop culture with reclaimed treated water
Period of implementation	1992 (feasibility study) 1996 (pilot) 1998 (implementation at full scale, 1st stage)
Stakeholders	Local authorities, farmers, Veolia (WWTP operator)
Location	Centre of France in a water scarce area for agriculture and environmental sensitive area

Water treatment system	WWTP of 425,000 p.e. The process includes an activated sludge process with a phosphate and nitrogen removal step with $FeCL_3$.
Reuse facility	Pumping station (PS) at the output of the WWTP 8 storage basins filled by the PS : 13 ha, 312,000 m^3 (global storage capacity) A conveyance pump station of 1,540 m^3/h is used to convey the treated water through a distributing network of 60 km long to supply 51 farmers

Volume, quantity	Irrigated area average every year: 700 ha Area equipped: 1400 ha Number of farms concerned: 51 Volume of water for irrigation season (May to September): 700,000 to 1,200,000 m^3 Water flow discharged by the treatment plant in August: 50 000 m^3/d
Economic approach	Cost : €5.33 million
Project background, difficulties, lessons learned	Faced with the scarcity of water resources and climatic hazards posing a risk to their business, farmers in the black Limagne have developed a unique irrigation system in France. Since the late 1990s, the Limagne Noire irrigation network supplies a perimeter of 700 ha of effluent from the agglomeration of Clermont-Ferrand treated by the **sewage plant and a lagoon in the basins of a sugar factory nearby**. This embodiment allows operators to address both the water needs of crops and respect for the environment. The **treated wastewater used is of quality A** (as defined by the Decree of 2 August 2010). It is monitored every 15 days at the sewage plant output, at the output of the treatment lagoons and at the points of use. A full epidemiological monitoring of three years was carried out at the beginning of the project and showed revealed no problem to fix problems. Moreover, since the beginning of the project a monitoring committee led by ARS (local health authority) meets to take stock of the last irrigation season, especially as regardspaying specific attention to the water quality analytical results. This project has streamlined the management of water in this region by **achieving significant savings on water withdrawals from rivers during the summer critical period** and prevent potential conflicts of use. **Qualitatively, irrigation with treated wastewater is used to limit discharges of phosphorus and nitrogen in the Allier river in dry periods** and valuing them as fertilizers on irrigated plots. Finally economically, the reliability of the water supply secures agricultural activities as an important economic activity in the region. **Distance constraints introduced by the Decree of June 25, 2014 make it impossible to irrigate an important area currently irrigated with treated wastewater.** A compliance of the project with the new requirements would lead at best to a drastic reduction in the number of irrigated plots and most likely to the stoppage of the project. *Source: SOMIVAL, 2012*

Annex 8 Table of the substances of concern for the Loire Bretagne water district (SDAGE)

Tableau des objectifs de réduction des émissions de substances d'intérêt pour le bassin Loire-Bretagne à échéance 2021

	Substance	Description	N° CAS	SANDRE	Classe	Objectif de réduction entre 2010 et 2021
DCE (Annexe)	Anthracène	Hydrocarbure aromatique polycylique	120-12-7	1458	SDP*	30%
	Benzène	Hydrocarbure aromatique monocylique	71-43-2	1114	SP**	30%
	Cadmium et ses composés	Métal	7440-43-9	1388	SDP	100%
	C10-13-chloroalcanes	Paraffines chlorées ayant été utilisées comme plastifiants et agent ignifuge (retardateurs de flamme)	85535-84-8	1955	SDP	100%
	1,2-dichloroéthane	Production du PVC, solvant	107-06-2	1161	SP	30%
	Dichlorométhane (chlorure de méthylène)	Solvant	75-09-2	1168	SP	30%
	Di(2-éthylhexyl)phtalate (DEHP)	Plastifiant	117-81-7	6616	SDP	10%
	Diuron	Biocide	330-54-1	1177	SP	10%
	Fluoranthène	Hydrocarbure aromatique polycylique	206-44-0	1191	SP	10%
	Isoproturon	Herbicide (domaine agricole pour cultures d'hiver)	34123-59-6	1208	SP	30%
	Plomb et ses composés	Métal	7439-92-1	1382	SP	30%
	Naphtalène	Hydrocarbure aromatique polycylique (anti-mites)	91-20-3	1517	SP	30%
	Nickel et ses composés	Métal	7440-02-0	1386	SP	30%
	Nonylphénols	Tensioactifs	25154-52-3 104-40-5 84852-15-3	1957 5474 1958	SDP	100%
	Octylphénols	Fabrication de résines (pneumatiques, encres d'impression …)	1806-26-4 140-66-9	1920 1959	SP	10%
	Composés du tributylétain	Biocide utilisé dans les antifoulings	688-73-3 36643-28-4	1820 2879	SDP	100%
	Trichlorobenzènes	Intermédiaires organiques, lubrifiants, solvants, fluides diélectriques, fluides de transfert de chaleur…	12002-48-1	1774	SP	10%
	Trichlorométhane (chloroforme)	Produit de dégradation de l'eau de javel, anesthésique, conservateur	67-66-3	1135	SP	30%
DCE (Liste I)	Tétrachloroéthylène (perchloroéthylène)	Solvant (pressings, traitement de surface...)	127-18-4	1272		100%
	Trichloroéthylène	Solvant	79-01-6	1286		100%
Directive 2013/39/UE	Quinoxyfène	Fongicide (contre l'oïdium)	124495-18-7	2028	SDP	10%
	Aclonifène	Herbicide pour cultures tournesol, pommes de terre, tabac, pois…	74070-46-5	1688	SP	10%
	Bifénox	Herbicide	42576-02-3	1119	SP	10%
	Cybutryne	Algicide utilisé dans les antifoulings	28159-98-0	1935	SP	10%
	Cypermethrine	Insecticide	52315-07-8	1140	SP	10%
Polluants spécifiques de l'état écologique	Arsenic	Métalloïde	7440-38-2	1369		30%
	Chrome	Métal	7440-47-3	1389		30%
	Cuivre	Métal	7440-50-8	1392		30%
	Zinc	Métal	7440-66-6	1383		30%
	Toluène	Solvant	108-88-3	1278		10 %
	Métaldéhyde	Molluscicide	108-62-3	1796		10 %
	Métazachlore	Herbicide	67129-08-2	1670		10 %
	Chlortoluron	Herbicide	15545-48-9	1136		30 %
	Aminotriazole	Herbicide	61-82-5	1105		10 %
	Nicosulfuron	Herbicide	111991-09-4	1882		10 %
	Oxadiazon	Herbicide	19666-30-9	1667		30 %
	AMPA	Produit de dégradation	1066-51-9	1907		10 %
	Glyphosate	Herbicide	1071-83-6	1506		10 %
	2,4 MCPA	Herbicide	94-74-6	1212		30 %
	Diflufenicanil	Herbicide	83164-33-4	1814		10 %
	2,4 D	Herbicide	94-75-7	1141		30 %
	Boscalid	Fongicide	188425-85-6	5526		10 %

* substance dangereuse prioritaire
** substance prioritaire

Annex 9 RSDE - Micro-pollutants list measured during the initial campaign depending on the size of the sewage treatment plant (Annex 3 of the Circular of September 29th, 2010)

FAMILLE	SUBSTANCES (1)	CODE SANDRE (2)	NUMÉRO DCE (3)	NUMÉRO 76/464 (4)	LQ à atteindre par substance par les laboratoires prestataires en µ g/l	STEU traitant une charge brute de pollution supérieure ou égale à 6 000 kg DBO5/j	STEU traitant une charge brute de pollution supérieure ou égale à 600 kg DBO5/j et inférieure à 6 000 kg DBO5/j
Substances de l'état chimique DCE – Arrêté du 25 janvier 2010 (dangereuses prioritaires DCE – et liste I de la directive n° 2006/11/CE)							
HAP	Anthracène	1458	2	3	0,02	x	x
HAP	Benzo (a) Pyrène	1115	28		0,01	x	x
HAP	Benzo (b) Fluoranthène	1116	28		0,005	x	x
HAP	Benzo (g, h, i) Pérylène	1118	28		0,005	x	x
HAP	Benzo (k) Fluoranthène	1117	28		0,005	x	x
Métaux	Cadmium (métal total)	1388	6	12	2	x	x
Autres	Chloroalcanes C_{10}-C_{13}	1955	7		5	x	x
Pesticides	Endosulfan	1743	14		0,01	x	x
Pesticides	HCH	5537	18		0,02	x	x
Chlorobenzènes	Hexachlorobenzène	1199	16	83	0,01	x	x
COHV	Hexachlorobutadiène	1652	17	84	0,5	x	x
HAP	Indeno (1, 2, 3-cd) Pyrène	1204	28		0,005	x	x
Métaux	Mercure (métal total)	1387	21	92	0,5	x	x
Alkylphénols	Nonylphénols	5474	24		0,3	x	x
Alkylphénols	NP1OE	6366			0,3	x	x
Alkylphénols	NP2OE	6369			0,3	x	x
Chlorobenzènes	Pentachlorobenzène	1888	26		0,01	x	x
Organétains	Tributylétain cation	2879	30	115	0,02	x	x
COHV	Tétrachlorure de carbone	1276		13	0,5	x	x
COHV	Tétrachloroéthylène	1272		111	0,5	x	x
COHV	Trichloroéthylène	1286		121	0,5	x	x
Pesticides	Endrine	1181			0,05	x	x
Pesticides	Isodrine	1207			0,05	x	x
Pesticides	Aldrine	1103			0,05	x	x
Pesticides	Dieldrine	1173			0,05	x	x
Pesticides	DDT 24'	1147			0,05	x	x
Pesticides	DDT 44'	1148			0,05	x	x
Pesticides	DDD 24'	1143			0,05	x	x

Pesticides	DDD 44'	1144			0,05	x	x
Pesticides	DDE 24'	1145			0,05	x	x
Pesticides	DDE 44'	1146			0,05	x	x
Substances de l'état chimique DCE – Arrêté du 25 janvier 2010 (substances prioritaires DCE)							
COHV	1, 2 dichloroéthane	1161	10	59	2	x	x
Chlorobenzènes	1, 2, 3 trichlorobenzène	1630	31	117	0,2	x	x
Chlorobenzènes	1, 2, 4 trichlorobenzène	1283	31	118	0,2	x	x
Chlorobenzènes	1, 3, 5 trichlorobenzène	1629		117	0,1	x	x
Pesticides	Alachlore	1101	1		0,02	x	x
Pesticides	Atrazine	1107	3		0,03	x	x
BTEX	Benzène	1114	4	7	1	x	x
Pesticides	Chlorfenvinphos	1464	8		0,05	x	x
COHV	Trichlorométhane	1135	32	23	1	x	x
Pesticides	Chlorpyrifos	1083	9		0,02	x	x
COHV	Dichlorométhane	1168	11	62	5	x	x
Pesticides	Diuron	1177	13		0,05	x	x
HAP	Fluoranthène	1191	15		0,01	x	x
Pesticides	Isoproturon	1208	19		0,1	x	x
HAP	Naphtalène	1517	22	96	0,05	x	x
Métaux	Nickel (métal total)	1386	23		10	x	x
Alkylphénols	Octylphénols	1959	25		0,1	x	x
Alkylphénols	OP1OE	6370			0,1	x	x
Alkylphénols	OP2OE	6371			0,1	x	x
Chlorophénols	Pentachlorophénol	1235	27	102	0,1	x	x
Métaux	Plomb (métal total)	1382	20		2	x	x
Pesticides	Simazine	1263	29		0,03	x	x
Pesticides	Trifluraline	1289	33		0,01	x	x
Autres	Di(2-éthylhexyl)phtalate (DEHP)	6616	12		1	x	x
Substances spécifiques de l'état écologique DCE – Arrêté du 25 janvier 2010							
Pesticides	2,4 D	1141			0,1	x	x
Pesticides	2,4 MCPA	1212			0,05	x	x
Métaux	Arsenic (métal total)	1369		4	5	x	x
Pesticides	Chlortoluron	1136			0,05	x	x

Métaux	Chrome (métal total)	1389		136	5	x	x	
Métaux	Cuivre (métal total)	1392		134	5	x	x	
Pesticides	Linuron	1209			0,05	x	x	
Pesticides	Oxadiazon	1667			0,02	x	x	
Métaux	Zinc (métal total)	1383		133	10	x	x	
Autres substances – Arrêté du 31 janvier 2008								
Anilines	Aniline	2605			50	x		
Autres	AOX	1106			10	x		
BTEX	Ethylbenzène	1497		79	1	x		
BTEX	Toluène	1278		112	1	x		
BTEX	Xylènes (Somme o, m, p)	1780		129	2	x		
COHV	Chlorure de vinyle	1753		128	5	x		
Autres	Titane (métal total)	1373			10	x		
Métaux	Chrome hexavalent et composés (exprimé en tant que Cr VI)	1371			10	x		
Métaux	Fer (métal total)	1393			25	x		
Métaux	Étain (métal total)	1380			5	x		
Métaux	Manganèse (métal total)	1394			5	x		
Métaux	Aluminium (métal total)	1370			20	x		
Métaux	Antimoine (métal total)	1376			5	x		
Métaux	Cobalt (métal total)	1379			3	x		
Organétains	Dibutylétain cation	1771		49, 50, 51	0,02	x		
Organétains	Monobutylétain cation	2542			0,02	x		
Organétains	Triphénylétain cation	6372		125, 126, 127	0,02	x		
PCB	PCB 28	1 239		101	0,005	x		
PCB	PCB 52	1241			0,005	x		
PCB	PCB 101	1242			0,005	x		
PCB	PCB 118	1243			0,005	x		
PCB	PCB 138	1244			0,005	x		
PCB	PCB 153	1245			0,005	x		
PCB	PCB 180	1246			0,005	x		
Pesticides	Chlordane	1132			0,01	x		
Pesticides	Chlordécone	1866			0,15	x		
Pesticides	Heptachlore	1197			0,02	x		

Pesticides	Mirex	5438			0,05	x	
Pesticides	Toxaphène	1284			0,05	x	
Autres	Hexabromobiphényle	1922			0,02	x	
Autres	Hydrazine	6323			100	x	
Autres	Hydrocarbures	2962			50	x	
Autres	Méthanol	2052			10	x	
Autres	Indice phénol	1440			25	x	
Autres	Sulfates	1338			10 000	x	
Autres	Fluorures totaux	1391			170	x	
Autres	Cyanures	1390			50	x	
Autres	Chlorures	1337			10 000	x	
Pesticides	Lindane	1203			0,02	x	
Autres	Sulfonate de perfluorooctane (SPFO)	6560			0,05	x	

(1) Les groupes de micropolluants sont indiqués en italique.
(2) Code Sandre du micropolluant : http://sandre.eaufrance.fr/app/References/client.php.
(3) Correspondance avec la numérotation utilisée à l'annexe X de la DCE (directive n° 2000/60/CE).
(4) Numéro UE : le nombre mentionné correspond au classement par ordre alphabétique issu de la communication de la Commission européenne au Conseil du 22 juin 1982.