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Всемирная организация здравоохранения
Европейское региональное бюро

Microbiological Parameters: current shortcomings and possible approaches

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Microbial safety in EU-DWD

General obligation about water fit for human consumption without potential danger to human health….

….translated into water quality targets

(Health) basis for pathogens

Absence of faecal indicator bacteria (FIB)

- No *E. coli* in 100 mL
- No intestinal enterococci in 100 mL
- Monitoring of finished water/consumer's tap

Article 4

General obligations

1. Without prejudice to their obligations under other Community provisions, Member States shall take the measures necessary to ensure that water intended for human consumption is wholesome and clean. For the purposes of the minimum requirements of this Directive, water intended for human consumption shall be wholesome and clean if it:

(a) is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health, and

(b) meets the minimum requirements set out in Annex I, Parts A and B;

Shortcomings

1. End-product testing for FIB is reactive check, not proactive control of microbial safety based on understanding and control of hazards (pathogens) in water sources, treatment and distribution.
2. End-product testing for FIB is too late: warns about health risk when water is already consumed
3. Viruses/*Cryptosporidium/Giardia* cause drinking-waterborne outbreaks in absence of FIB, also in EU
4. Non-enteric pathogens (*Legionella*) not covered by FIB (waterborne (warm water systems) approx. 6000 confirmed cases of legionellosis in EU, mortality 10%, estimated cases 10-15X higher)

Implication of shortcomings

End-product testing of drinking-water for faecal indicator bacteria and HPC testing **provide insufficient safeguards to public health.**

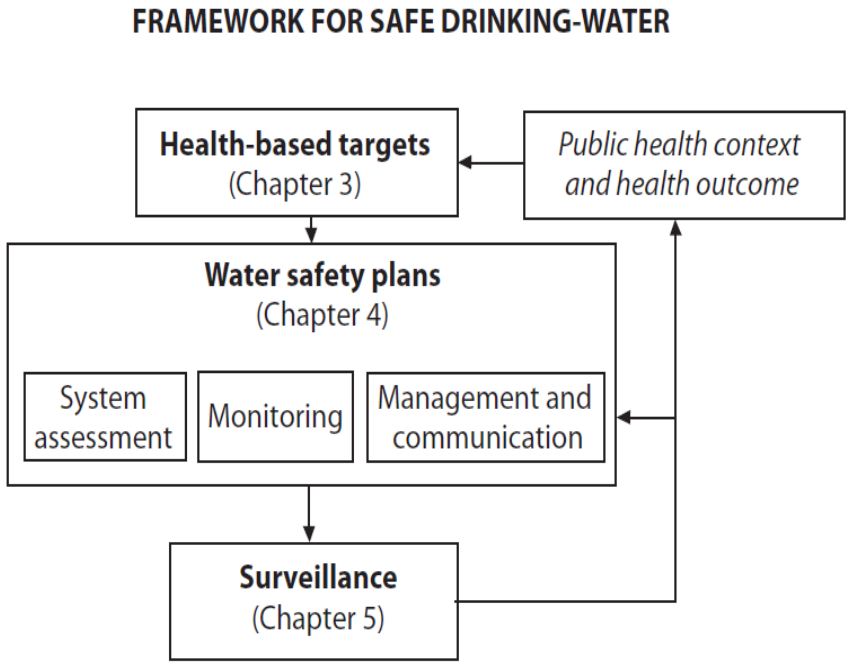
With the current state of knowledge about microbiological safety of drinking-water, the view that the general obligation of Article 4 of the EU-DWD is fulfilled with only the current point-of-compliance testing requirements for E. coli, enterococci and HPC cannot be maintained any longer.

Recognized by EU-MS and others

Country	Regulation	Additional requirements
USA	Surface Water Treatment Rule, 1989	Bacteria, Giardia, viruses, Legionella Treatment performance
USA	(Long term 2) Enhanced Surface Water Treatment Rule, 2006	Cryptosporidium Treatment performance
Canada	Guidelines for Canadian Drinking Water Quality, 2012	Enteric viruses, enteric protozoa (Cryptosporidium, Giardia), treatment performance
Australia	Australian Drinking Water Guidelines, 2011	Preventive risk management approach
England & Wales	The water supply regulation, 2001	Cryptosporidium risk assessment (no longer in force)
Scotland	Cryptosporidium directions, 2003	Cryptosporidium risk assessment
England & Wales	Water supply (water quality) regulations, 2016	Risk assessment, Drinking Water Safety Plans
Germany	DVGW recommendations W 1000, 1001, 1002	Water Safety Plans
Germany	Recommendations by the Environment Ministry, 2014	Risk assessment of enteric viruses and protozoa
Netherlands	Drinking Water Decree, 2011	Risk assessment of enteric bacteria, viruses, protozoa, Legionella
France	Guidelines for public warm water systems, 2010	Legionella
Germany	Trinkwasserverordnung, 2001	Legionella, risk assessment

WHO Guidelines

"The most effective means of consistently ensuring the safety of a drinking water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer."



Key principles

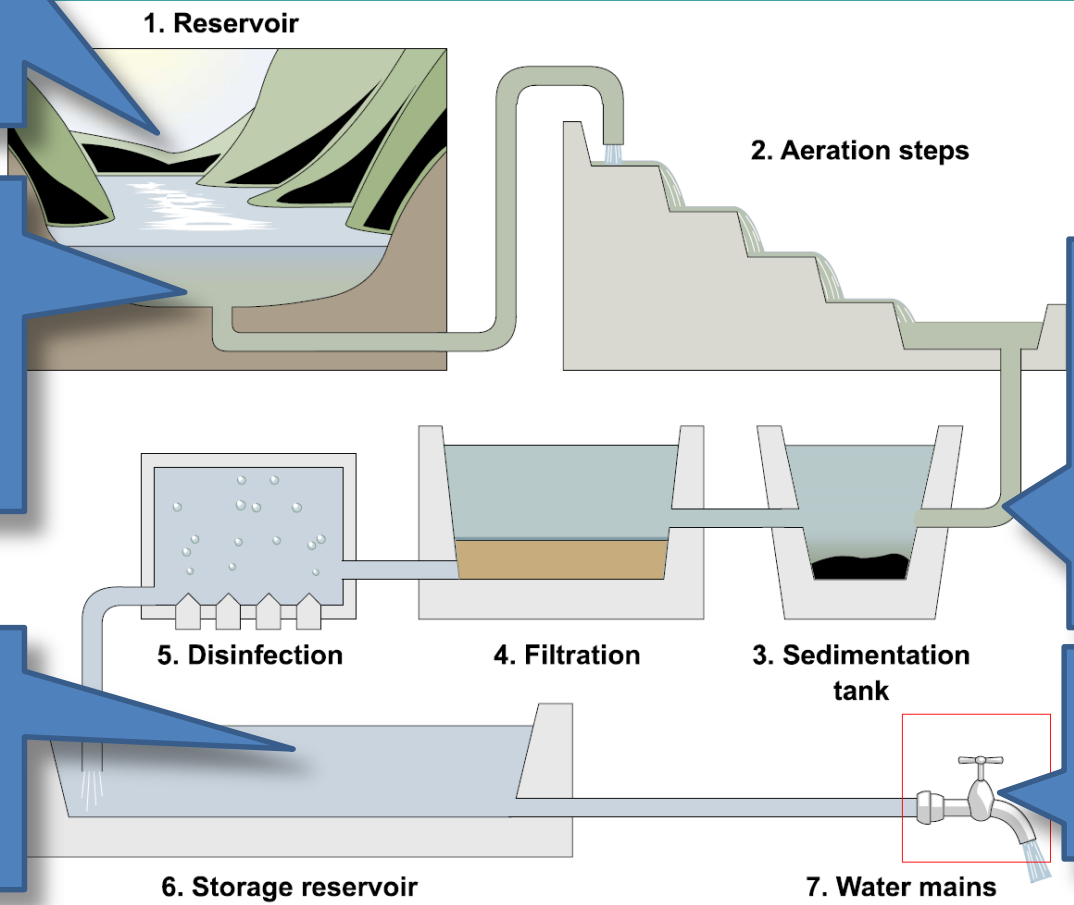
- A system / **risk assessment** to determine whether the drinking-water supply (from source to treatment to point of consumption) as a whole can provide safe water
- **Operational monitoring** of the Critical Control Points: control measures in the drinking-water supply that are of particular importance in securing drinking-water safety.
- **Management plans** documenting the system assessment and monitoring plans and describing actions to be taken in normal conditions and incident conditions, including upgrade and improvement, documentation and communication.

all approach: risk assessment

Know pathogen (b, v, p) sources and transport dynamics in catchment

Know pathogen contamination level at water intake (peak events)

Know the distribution network hazards/events



Know pathogen removal by critical water treatment processes (events)

Know hazards/events in plumbing systems

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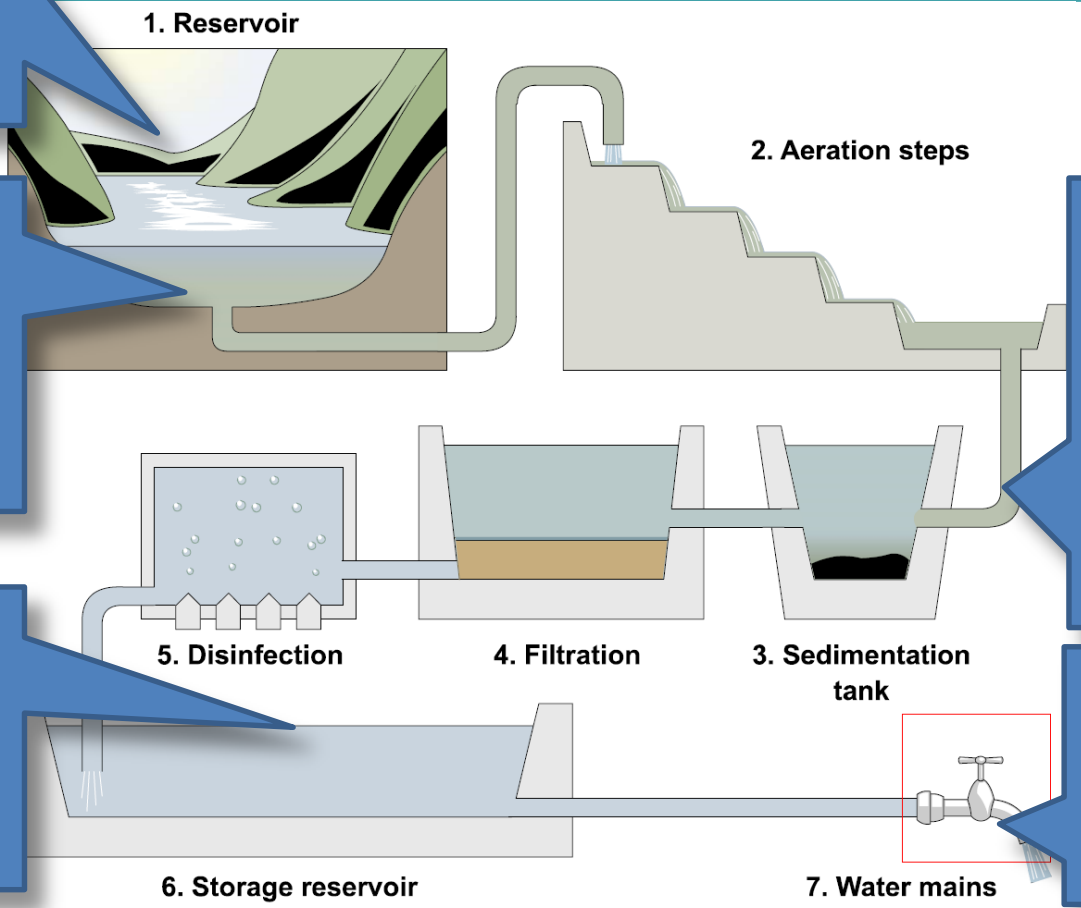
Overall approach: control

Catchment protection

Intake protection (peak events; operational monitoring)

Protect the distribution network: operational monitoring



Control critical water treatment processes: operational monitoring & action plans (events)

Control plumbing systems: operational monitoring

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WHO Guidelines to EU-DWD

Guidelines' approach towards assessing and managing microbial hazards in drinking-water fills the gaps in the EU-DWD.

It ensures that drinking-water will also be safe with regards to enteric viruses and protozoa and towards opportunistic pathogens that may grow in distribution/plumbing systems.

Key elements

Risk assessment

The objective of the Risk assessment is to

- describe the water supply system from catchment to consumer
- identify hazards and risks
- evaluate whether the control measures (from engineered barriers to hygiene protocols) are able to adequately control these risks

Monitoring

The objective of Monitoring is “to verify that the measures in place to control risks to human health throughout the water supply chain from the catchment area through abstraction, treatment and storage to distribution are working effectively and that water at the point of compliance is wholesome and clean” (EU-DWD).

- Operational monitoring to verify that all critical elements of the catchment to tap chain are working effectively (generally non-microbiological)
- Verification monitoring to verify that water is wholesome and clean (generally microbiological)

How to implement this in the EU-DWD?

Legionella pneumophila

Include requirement for risk assessment for warm water systems in public buildings

Parameter	Role in risk-based approach	Priority for inclusion	Monitoring requirement	Quality requirement
MICROBIOLOGICAL PARAMETERS (ANNEX I PART A)				
Legionella pneumophila	Risk assessment: reference pathogen for pathogens that are able to grow in water distribution networks or plumbing systems in EU.	High	No	No

How to implement this in the EU-DWD?

Legionella pneumophila

Include requirement for risk assessment and monitoring for warm water systems in public buildings

Parameter	Role in risk-based approach	Priority for inclusion	Monitoring requirement	Quality requirement
MICROBIOLOGICAL PARAMETERS (ANNEX I PART A)				
Legionella pneumophila	Risk assessment: reference pathogen for pathogens that are able to grow in water distribution networks or plumbing systems in EU.	High	No	No
Legionella pneumophila	Verification of distribution/plumbing control.	High	Yes	Yes
INDICATOR PARAMETERS (ANNEX I PART C)				
Colony count 22˚C	Verification of distribution/plumbing control against growth of micro-organisms, including opportunistic pathogens	High	Yes	Yes, relative (no abnormal change)

Legionella pneumophila risk assessment

Assess risk factors

- water temperature of 25–50 °C
- presence of biofilms (and amoeba)
- aerosol production (showerheads, nebulizers, etc.)
- poor removal of nutrients for growth of microbes
- distribution system stagnation, dead zones
- construction materials that contribute to microbial growth
- inefficient or ineffective disinfection (biofilms)

Legionella pneumophila risk assessment

Evaluate control measures

- cold water <25, warm water >50-60 °C
- limit presence of biofilms (and amoeba) by adequate removal of nutrients for growth of microbes
- design to limit stagnation, dead zones
- construction materials code: no support microbial growth
- biofilm disinfectants (chloramine)

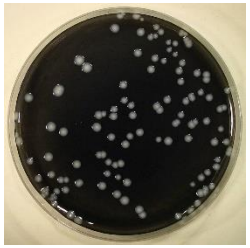
Legionella pneumophila monitoring

Operational monitoring

- water temperature, ideally continuously in warm water systems
- disinfectant residual
- turbidity
- treated water nutrient content (biodegradable organic matter)
- inspect (plumbing) system design

Verification monitoring

- *Legionella pneumophila*
- point of compliance/aerosolization
- <100 - <1000 / litre



Legionella pneumophila

Table 11. Reported culture-confirmed cases of Legionnaires' disease and *Legionella* isolates by species, EU/EEA, 2014

Species	Culture-confirmed cases	
	n	%
L. pneumophila	777	95
L. longbeachae	14	2
L. micdadei	6	1
L. bozemanii	2	<1
L. macaechernii	1	<1
L. sainthelensi	1	<1
L. other species	6	<1
L. species unknown	12	1
Total	**819**	**100**

ECDC, 2016

How to implement this in the EU-DWD?

Enteric pathogens

Include requirement for risk assessment (surface water supplies)

Parameter	Role in risk-based approach	Priority for inclusion	Monitoring requirement	Quality requirement
MICROBIOLOGICAL PARAMETERS (ANNEX I PART A)				
Reference pathogens: **B: Campylobacter** **V: enterovirus** **P: Cryptosporidium**	Risk assessment: reference pathogens for enteric pathogens in EU. Raw water (surface water) characterization, basis for treatment performance target	High	No (optional)	No. Indirect, via treatment performance target

Enteric pathogens: risk assessment

Assess risk factors

- Contamination of source water with excreta from man, livestock, wildlife
- Contamination of source water with (treated) domestic sewage, run off of manure, leaching of septic tanks and manure storage
- Events leading to peak contamination of source waters, such as heavy rains, snowmelt and flooding
- Insufficient treatment, treatment failure or periods of suboptimal or poor treatment performance, allowing breakthrough of pathogens
- Accumulation of pathogens in the treatment chain (such as via filter backwash water)
- Ingress of pathogens via open storage or openings, leaks etc. in the treatment plant
- Ingress of pathogens in storage reservoirs or the piped network (leaks, low/no pressure events, repairs, cross-connections etc.)

Enteric pathogens: risk assessment

Evaluate controls

- Catchment protection measures (protected groundwater zones, safe setback zones, riparian buffer zones, sewer overflow diversion etc.)
- Source protection measures (intake stops/relocation, flow diversion, etc.)
- Treatment processes: set treatment performance target
- Pressure and integrity of distribution network
- Hygiene protocols for repair and maintenance works in treatment plants and distribution networks

Enteric pathogens: risk assessment

- Treatment performance target

  1. Establish reference pathogen level in source water
  - Using sanitary survey and *E. coli* monitoring
  - Pathogen monitoring for validation (optional)

  2. Set treatment performance target
  - = pathogen level source – safe pathogen level treated (=10^{-6} DALY)

  3. Assess ability of treatment chain to remove reference pathogens
  - Using sanitary survey and operational monitoring
  - Surrogate (*E. coli*, coliphages, *Clostridium* spores) monitoring in source and treated water for validation (optional)

Enteric pathogens monitoring: operational

Operational monitoring of critical control points

- Catchment
  - River flow, turbidity
- Treatment
  - Chemical disinfection: dose and residual disinfectant, contact time (flow), temperature, (pH)
  - UV: UV irradiation, flow, UV transmittance
  - Filtration: turbidity (<0.3 NTU)
- Distribution
  - Inspection of works, monitoring of pressure, turbidity, (disinfectant residual)

Parameter	Role in risk-based approach	Priority for inclusion	Monitoring requirement	Quality requirement	Monitoring site
INDICATOR PARAMETERS (ANNEX I PART C)					
Turbidity	Operational monitoring of efficacy of physical removal by filtration processes	High	Yes	Yes	Post-filtration

Enteric pathogens monitoring: verification

Parameter	Role in risk-based approach	Priority for inclusion	Monitoring requirement	Quality requirement	Monitoring site
MICROBIOLOGICAL PARAMETERS (ANNEX I PART A)					
E. coli[1]	Risk assessment: typing of source water contamination level, peak events	High	Yes	No	Source water
E. coli[1]	Verification of treatment control for enteric bacterial pathogens	High	Yes	Yes (0/100ml)	Post-treatment
E. coli[1]	Verification of distribution control against ingress of excreta	High	Yes	Yes (0/100ml)	Consumer
INDICATOR PARAMETERS (ANNEX I PART C)					
Clostridium perfringens, ~~including~~ spores[3]	Verification of treatment control for disinfection-resistant pathogens such as Cryptosporidium	High	Yes	Yes	Post-treatment
Coliphages	Risk assessment: typing of source water contamination level, peak events (groundwater sources)	High	Yes	No	Groundwater
Coliphages	Verification of treatment control for enteric viruses.	High	Yes	Yes	Post-treatment

Enteric pathogens monitoring: no longer needed

Parameter	Role in risk-based approach	Priority for inclusion	Monitoring requirement	Quality requirement	Monitoring site
MICROBIOLOGICAL PARAMETERS (ANNEX I PART A)					
Enterococci	Risk assessment: typing of source water contamination level, peak events	Medium	Yes	No	Source
Enterococci[1]	Verification of treatment control for enteric bacterial pathogens	Medium	Yes	Yes (0/100ml)	Post-treatment
Enterococci	Verification of distribution control against ingress of excreta	Medium	Yes	Yes (0/100ml)	Consumer
INDICATOR PARAMETERS (ANNEX I PART C)					
Coliform bacteria	Verification of treatment control	Low	No	No	
Coliform bacteria	Verification of distribution control	Low	No	No	

Summary

- Current EU-DWD not adequate against viruses, protozoa and opportunistic pathogens (*Legionella pneumophila*)
- Risk assessment/risk management approach in WHO Guidelines can provide adequate protection
- Key elements:
  - Risk assessment
  - Monitoring, operational & verification

  Both elements already embedded in EU-DWD, implementation for new pathogens requires operational translation

Summary

- Implementation in EU-DWD:
  - Legionella pneumophila risk assessment, operational and verification monitoring
  - Enteric pathogens risk assessment, operational and verification monitoring
  - Redefine role of existing parameters in light of risk assessment / risk management approach
  - Add (and remove) microbiological parameters to complete the approach