
**Guidelines for treated wastewater use
for irrigation projects —**

**Part 4:
Monitoring**

*Lignes directrices pour l'utilisation des eaux usées traitées pour
l'irrigation —*

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Partie 4: Surveillance
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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 1, *Treated wastewater reuse for irrigation*.

A list of all parts in the ISO 16075 series can be found on the ISO website.

Introduction

The increasing water scarcity and water pollution control efforts in many countries have made treated municipal and industrial wastewater a suitable economic means of augmenting the existing water supply, especially when compared to expensive alternatives such as desalination or the development of new water sources involving dams and reservoirs. Water reuse makes it possible to close the water cycle at a point closer to cities by producing “new water” from municipal wastewater and reducing wastewater discharge to the environment. The reuse of treated wastewater could be also a beneficial solution to improve water body’s quality, such as for example avoiding wastewater treatment plants discharge upstream sensitive areas (shellfish aquaculture area, swimming area).

An important new concept in water reuse is the “fit-to-purpose” approach, which entails the production of reclaimed water quality that meets the needs of the intended end-users. In the situation of reclaimed water for irrigation, the reclaimed water quality may induce an adaptation of the type of plant grown. Thus, the intended water reuse applications should govern the degree of wastewater treatment required, and inversely, the reliability of wastewater reclamation processes and operation.

Treated wastewater (TWW, also referred to as reclaimed water or recycled water) can be used for various non-potable purposes. The dominant applications for the use of TWW include agricultural irrigation, landscape irrigation, industrial reuse and groundwater recharge. More recent and rapidly growing applications are for various urban uses, recreational and environmental uses and indirect and direct potable reuse.

Agricultural irrigation was, is and will likely remain the largest TWW consumer with recognized benefits and contribution to food security. Urban water recycling, in particular landscape irrigation, is characterized by fast development and will play a crucial role for the sustainability of cities in the future, including energy footprint reduction, human well-being and environmental restoration.

It is worth noting again, that the suitability of TWW for a given type of reuse depends on the compatibility between the wastewater availability (volume) and water irrigation demand throughout the year, as well as on the water quality and the specific use requirements. Water reuse for irrigation can convey some risks for health and environment, depending on the water quality, the irrigation water application method, the soil characteristics, the climate conditions and the agronomic practices. Consequently, public health and potential agronomic and environmental adverse impacts need to be considered as priority elements in the successful development of water reuse projects for irrigation. To prevent such potential adverse impacts, the development and application of international guidelines for the reuse of TWW is essential.

The main water quality factors that determine the suitability of TWW for irrigation are pathogen content, salinity, sodicity, specific ion toxicity, other chemical elements and nutrients. Local health authorities are responsible for establishing water quality threshold values depending on authorized uses and they are also responsible for defining practices to ensure health and environmental protection taking in account local specificities.

From an agronomic point of view, the main limitation in using TWW for irrigation arises from its quality. Treated wastewater, unlike water supplied for domestic and industrial purposes contains higher concentrations of inorganic suspended and dissolved materials (total soluble salts, sodium, chloride, boron, heavy metals), which can damage the soil and irrigated crops. As dissolved salts are not removed by conventional wastewater treatment technologies and appropriate good management, agronomic and irrigation practices should be used to avoid or minimize potential negative impacts.

The presence of nutrients (nitrogen, phosphorus and potassium) may become an advantage due to possible saving in fertilizers. However, the amount of nutrients provided by TWW along the irrigation period is not necessarily synchronized with crop requirements, and the availability of nutrients depends on the chemical forms.

This document provides guidance for healthy, hydrological, environmental and good operation, monitoring and maintenance of water reuse projects for unrestricted and restricted irrigation of agricultural crops, gardens and landscape areas using treated wastewater. The quality of supplied

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TWW should reflect the possible uses according to crop sensitivity (health-wise and agronomy-wise), water sources (the hydrologic sensitivity of the project area), the soil and climate conditions.

This document refers to factors involved in water reuse projects for irrigation regardless of size, location and complexity. It is applicable to intended uses of TWW in a given project, even if such uses will change during the project's lifetime; as a result of changes in the project itself or in the applicable legislation.

The key factors in assuring the health, environmental and safety of water reuse projects in irrigation are:

- meticulous monitoring of TWW quality to ensure the system functions as planned and designed;
- design and maintenance instructions of the irrigation systems to ensure their proper long-term operation;
- compatibility between the TWW quality, the distribution method and the intended soil and crops to ensure a viable use of the soil and undamaged crop growth;
- compatibility between the TWW quality and its use to prevent or minimize possible contamination of groundwater or surface water sources.

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Guidelines for treated wastewater use for irrigation projects —

Part 4: Monitoring

1 Scope

This document provides recommendations regarding:

- monitoring the quality of treated wastewater (TWW) for irrigation;
- monitoring irrigated plants;
- monitoring the soil with regard to salinity;
- monitoring natural water sources in neighbouring environments;
- monitoring the quality of water in storage reservoirs.

It puts emphasis on sampling methods and their frequency. Regarding the methods of analysis, this document refers to standard methods or, where not available, to other bibliographical references.

NOTE In cases where a monitoring plan already exists, these recommendations can be integrated into this plan. This is notably the case when a broader approach of risk management is implemented, such as the water safety plans (serving as a model for sanitation safety plans) developed by WHO.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 General

3.1.1 aquifer

underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand or silt) from which groundwater can be extracted

3.1.2 background water

freshwater (3.1.10) supplied for domestic, institutional, commercial and industrial use, from which *wastewater* (3.1.22) is created

3.1.3

barrier

any means including physical or process steps, that reduces or prevents the risk of human infection, by preventing contact between the TWW and the ingested produce or other means that, for example, reduces the concentration of microorganisms in the TWW or prevents their survival on the ingested produce

3.1.4

environment

surroundings in which an *organization* (3.1.13) operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation

3.1.5

environmental aspect

element of an *organization's* (3.1.13) activities, projects or *products* (3.1.15) that can interact with the *environment* (3.1.4)

3.1.6

environmental impact

any change to environmental quality, whether adverse or beneficial, wholly or partly resulting from an *organization's* (3.1.13) activities, projects or *products* (3.1.15)

3.1.7

environmental parameter

quantifiable attribute of an *environmental aspect* (3.1.5)

3.1.8

fodder crops

crops not for human consumption such as pastures and forage, fibre, ornamental, seed, forest and turf crops

3.1.9

food crops

crops which are intended for human consumption, often further classified as to whether the food crop is to be cooked, processed or consumed raw

3.1.10

freshwater

naturally occurring water on the Earth's surface (in ice, lakes, rivers and streams) and underground as groundwater in *aquifers* (3.1.1)

Note 1 to entry: Freshwater includes desalinated seawater and desalinated brackish water, but excludes seawater and brackish water.

3.1.11

irrigation project

design, development, construction, selection of equipment, operation and monitoring of works to provide suitable TWW irrigation

3.1.12

non-potable water

NPW

water that is not of drinking water quality

Note 1 to entry: It generally refers to *wastewater* (3.1.22) or TWW, but can also include other waters of non-drinking quality.

3.1.13

organization

group of people and facilities with an arrangement of responsibilities, authorities and relationships

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3.1.14
process

set of interrelated or interacting activities which transform inputs into outputs

Note 1 to entry: Inputs to a process are generally outputs of other processes.

Note 2 to entry: Processes in an *organization* (3.1.13) are generally planned and carried out under controlled conditions to add value.

3.1.15
product

any goods or services

Note 1 to entry: This includes interconnected and/or interrelated goods or services.

3.1.16
public health aspect

element of an *organization's* (3.1.13) activities, projects or *products* (3.1.15) that can interact with the public health

3.1.17
public health impact

any change to public health, whether adverse or beneficial, wholly or partly resulting from an *organization's* (3.1.13) activities, projects or *products* (3.1.15)

3.1.18
public health parameter

quantifiable attribute of a *public health aspect* (3.1.16)

3.1.19
soil

layer of unconsolidated material consisting of weathered material particles, dead and living organic matter, air space and the *soil solution* (3.1.20)

3.1.20
soil solution

liquid phase of the *soil* (3.1.19) and its solutes

3.1.21
stakeholder

individual, group or *organization* (3.1.13) that has an interest in an organization or activity

Note 1 to entry: Usually a stakeholder can affect or is affected by the organization or the activity.

3.1.22
wastewater

wastewater collected principally by municipalities, that may include spent or used water from domestic, institutional, commercial or industrial sources, and can include storm water

3.1.23
water reuse

use of treated *wastewater* (3.1.22) for beneficial use; synonymous also to water reclamation and water recycling

3.2 Use of treated wastewater (TWW)

3.2.1
agriculture

science or practice of farming, including cultivation of the *soil* (3.1.19) for the growing of crops and the rearing of animals to provide food or other *products* (3.1.15)

3.2.2

landscape

all the visible features of an area of land, often considered in terms of their aesthetic appeal such as public and private gardens, parks, road vegetation including lawns and turfed recreational areas

3.2.3

restricted irrigation

use of TWW for non-potable applications in settings where public access is controlled or restricted by physical or institutional barriers

3.2.4

restricted urban irrigation

irrigation of areas in which public access during irrigation can be controlled, such as some golf courses, cemeteries, and highway medians

3.2.5

unrestricted irrigation

use of TWW for non-potable applications in settings where public access is not restricted

3.2.6

unrestricted urban irrigation

irrigation of areas in which public access during irrigation is not restricted, such as some gardens and playgrounds

3.3 Wastewater quality

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3.3.1

category A: very high quality TWW (standards.iteh.ai)

raw wastewater (3.3.6) which has undergone physical and biological treatment, *filtration* (3.5.3) and *disinfection* (3.5.2), and its quality is according to the description in ISO 16075-2:2015, Table 1

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3.3.2

category B: high quality TWW

raw wastewater (3.3.6) which has undergone physical and biological treatment, *filtration* (3.5.3) and *disinfection* (3.5.2), and its quality is according to the description in ISO 16075-2:2015, Table 1

3.3.3

category C: good quality TWW

raw wastewater (3.3.6) which has undergone physical and biological treatment, and its quality is according to the description in ISO 16075-2:2015, Table 1

3.3.4

category D: medium quality TWW

raw wastewater (3.3.6) which has undergone physical and biological treatment, and its quality is according to the description in ISO 16075-2:2015, Table 1

3.3.5

category E: extensively TWW

raw wastewater (3.3.6) which has undergone natural biological treatment *process* (3.1.14) with long (minimum 10 to 15 days) retention time and its quality is according to the description in ISO 16075-2:2015, Table 1

3.3.6

raw wastewater

wastewater (3.1.22) which has not undergone any treatment

3.3.7**thermo-tolerant coliforms**

group of bacteria whose presence in the *environment* (3.1.4) usually indicates faecal contamination (previously called *Faecal coliforms*)

Note 1 to entry: In order to determine the quality of TWW, one can test for *Escherichia coli* (*E. coli*) or for *Faecal coliforms*, since the difference in values is not significant.

3.4 Irrigation systems**3.4.1****boom sprinkler**

mobile sprinkling machine (3.4.11) composed of two symmetrical pipes (booms), with *sprinkler* (3.4.24) nozzles distributed in one of the pipes, with the sprinkler action complemented by a gun sprinkler placed at each end of both pipes; the nozzles work through a reaction effect (similar to a hydraulic tourniquet) which drives the boom rotation at a desired speed

3.4.2**centre-pivot and moving lateral irrigation machines**

automated irrigation machine consisting of a number of self-propelled towers supporting a pipeline rotating around a pivot point and through which water supplied at the pivot point flows radially outward for distribution by sprayers or *sprinklers* (3.4.24) located along the pipeline

3.4.3**emitter****emitting pipe****dripper**

device fitted to an irrigation lateral and intended to discharge water in the form of drops or continuous flow at flow rates not exceeding 15 l/h except during flushing

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3.4.4**gravity flow irrigation systems**

irrigation systems (3.4.8), where water is applied directly to the *soil* (3.1.19) surface and is not under pressure

3.4.5**in-line emitter**

emitter (3.4.3) intended for installation between two lengths of pipe in an irrigation lateral

3.4.6**irrigation gun**

large discharge device being either a part circle or full circle *sprinkler* (3.4.24)

3.4.7**irrigation sprayer**

device which discharges water in the form of fine jets or in a fan shape without rotational movement of its parts

3.4.8**irrigation system**

assembly of pipes, components, and devices installed in the field for the purpose of irrigating a specific area

3.4.9**micro-irrigation system**

system capable of delivering water drops, tiny-streams or mini-spray to the plants

Note 1 to entry: Surface and sub-surface drip irrigation and *micro-spray irrigation* (3.4.10) are the main types of this system.