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Second edition

Guidelines for treated wastewater use for irrigation projects —

Part 3: Components of a reuse project for irrigation

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

Partie 3: Éléments d'un projet de réutilisation en irrigation

PROOF/ÉPREUVE

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Foreword

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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).

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For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 1, *Treated wastewater reuse for irrigation*.

This second edition cancels and replaces the first edition (ISO 16075-3:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

— editorial changes;

— addition of Annex F.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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.

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 can induce an adaptation of the type of plant grown. Thus, the intended water reuse applications are to govern the degree of wastewater treatment required and inversely, the reliability of wastewater reclamation processes and operation.

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

Agricultural irrigation was, is, and will likely remain the largest reuse water consumer with recognized benefits and contribution to food security. Urban water recycling, landscape irrigation in particular, 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.

The suitability of treated wastewater 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, the 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 treated wastewater is essential.

The main water quality factors that determine the suitability of treated wastewater 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 treated wastewater 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, and heavy metals), which can damage the soil and irrigated crops. Dissolved salts are not removed by conventional wastewater treatment technologies and appropriate good management, agronomic, and irrigation practices are intended to be used to avoid or minimize potential negative impacts.

The presence of nutrients (nitrogen, phosphorus, and potassium) can become an advantage due to possible saving in fertilizers. However, the amount of nutrients provided by treated wastewater 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 treated wastewater 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 treated wastewater 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 the following:

— adequate 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.

This document is not intended to prevent the creation of more specific standards or guides which are better adapted to specific regions, countries, areas, or organizations. If such documents are published, it is recommended to reference this document to ensure uniformity throughout the treated wastewater use community.

Guidelines for treated wastewater use for irrigation projects —

Part 3: Components of a reuse project for irrigation

1 Scope

This document covers the system's components needed for the use of treated wastewater (TWW) for irrigation. Emphasis is placed on irrigation methods, mainly drip irrigation, as this method represents an efficient method of irrigation and water saving, while reducing the pollution of the crops. Despite the fact that water quality and filtration of treated wastewater (herein TWW) using drip irrigation are critical, open irrigation systems are more popular and are frequently used for irrigation with TWW and therefore are covered in this document.

This document covers issues related to the main components of a TWW irrigation project, including the following:

— pumping stations;

— storage reservoirs;

— treatment facilities (for irrigation purposes);

— filtration and disinfection;

— distribution pipeline networks;

— water application devices: irrigation system components and treatment.

This document is not intended to be used for certification purposes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20670, *Water reuse — Vocabulary*

ISO 16075-1, *Guidelines for treated wastewater use for irrigation projects — Part 1: The basis of a reuse project for irrigation*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20670 and ISO 16075-1 apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.2 Abbreviated terms

BOD	biochemical oxygen demand
COD	chemical oxygen demand
HDPE	high-density polyethylene
NPW	non-potable water
PE	polyethylene
PVC	polyvinyl chloride
TWW	treated wastewater
WW	wastewater
WWTP	wastewater treatment plant

4 Storage reservoir

4.1 General

TWW is sent by a transmission pipeline to the distribution centre where water is distributed to agricultural or other users.

Operational and seasonal storage facilities should be placed downstream the wastewater treatment plant to equalize daily and seasonal variations in flow from the WWTP to the distribution centre, so as to:

— meet peek irrigation demands;

— store excess of TWW entering the irrigation system in relation to irrigation demands (including winter storage);

— minimize the consequences of a disruptive operation of WWTP or temporary flow of unsuitable quality of TWW to the operation of the irrigation system.

Storage reservoirs can also be used to provide additional treatment to the TWW when managers of irrigation systems need to control changes of wastewater quality that can affect the operation of the irrigation system or to increase the TWW quality.

4.2 Reservoir types

Storage facilities can be **open** reservoirs or ponds or **closed** reservoirs.

Closed reservoirs can be fixed roof reservoirs including underground reservoirs or reservoirs with removable floating cover (partial or full covered).

Closed reservoirs are more expensive, but can have several advantages:

— reduced evaporation;

— lower potential for algal growth;

— no possibility of contact of wastewater with people or animals;

— protection of stored wastewater from rainfall runoff.

The disadvantage of these reservoirs is that they require periodic cleaning due to biofilm formation and biofouling, and due to the lack of photosynthesis there is greater potential for the development of anaerobic conditions and therefore odour emission.

4.3 Storage time

According to the requirements of the irrigation project, there are two main types of storage, the **short-term** and the **long-term storage**.

Short-term storage is needed in most irrigation systems for equalizing and balancing TWW supply and application that occur during one or more days (according to the needs of the irrigation system).

Short-term storage is usually provided by concrete or plastic tanks and small ponds while long-term storage is usually provided by dams, large ponds, lakes, or aquifer storage and recovery.

Long-term storage can be divided to:

— Seasonal storage, that accumulate water during long periods of treatment plant discharge higher than irrigation demand. The stored TWW may be used when the irrigation demands are higher than the treatment plant discharge. This storage is generally used in open large reservoirs. The residence time is generally months.

— Aquifer storage, which is commonly combined with soil aquifer treatment (by means of infiltration basins). The residence time may be months or years.

4.4 Problems and strategies

During the storage period, wastewater is subject to changes that affect its physical, chemical, and biological quality. Bacterial regrowth and/or entering from the surroundings, nitrification, algae growth, and production of H_2S (responsible for odour emission and risk of corrosion to metal components in the irrigation system) are the main biological processes affecting the quality of stored TWW. Increase in suspended solids sediments and dissolved oxygen, modification of pH, decrease of nutrients concentration (particularly nitrogen), and residual disinfectant are also effects that result from storage. Natural decay of microorganisms (especially pathogenic microorganisms) during storage depends on the water retention time and operation conditions of the reservoir.

Due to the high dependency of chemical and biological reactions with the temperature and the pH of the wastewater, climate conditions and type of reservoir (open or closed) considerably affect the TWW quality during storage. Temperature, particularly in warm regions, and rainfall are important factors for stored water quality particularly in open reservoirs.

Management strategies that should be adopted to reduce physical, chemical, and biological problems associated with wastewater storage in open and closed reservoirs are indicated in Table 1 and Table 2.

Table 1 — Problems associated with wastewater storage in open reservoirs and management strategies

Problems	Management strategies
— Temperature stratification — Low content of dissolved oxygen — Release of odours	— Installation of aeration facilities – submerged or surface mixers or recirculating pumps — Maintaining elevated oxygen concentrations (positive redox) through the water column and mainly at the sediment water interface to prevent phosphorus from entering the water column and keep it in the sediment
— Sediments	— Periodic mechanical or hydraulic dredging of accumulated sediments at an interval according with the particular local conditions (five years is considered an acceptable period)[a]
— Excessive growth of algae and zooplankton — Reduction of internal recycling of phosphorous	— Proper mixing of wastewater in order to improve the photo-oxidation of organic matter induced by the sunlight — Addition of chemical algaecides. Copper sulfate can have toxicity effects associated with copper accumulation (overdosing has adverse impacts on reservoir ecosystem). According to this: caution is required when using copper sulfate and quantities should be reduced as much as possible — Maintenance of fish that eat algae and zooplankton. Addition of chemical dyes to reduce sunlight penetration as well as the growth of algae. Chemical dyes should be such as do not harm health, plant or the environment — Biomanipulation of zooplankton (in shallow reservoirs) — Ultrasonic emissions placed into the open reservoir
— High content of suspended solids	— As suspended solids removal depends on particle size and residence time, consideration should be given to these factors when designing the storage reservoirs
— Microorganisms regrowth	— Increasing disinfectant residual — Disinfecting the TWW that enter the irrigation system — Increasing residence time [b] — Improving storage quality and facilities — Isolating and disinfecting problematic sites in pipelines
— Increase of insects namely mosquitoes	— Spraying of adequate insecticides — Mechanical methods such as keeping the water moving — Biological controls such as natural larvicides and use of larvae eating fish — Keeping banks trimmed

[a] According to the surface area and depth of the reservoir and the accumulation of the sediments.

[b] Sometime there can be an increase in contaminants, due to the increase in residence time, because of secondary contamination.

Table 2 — Problems associated with wastewater storage in closed reservoirs and management strategies

Problems	Management strategies
— Wastewater stagnation	Recirculation of wastewater (pumping and configuration of inlet and outlet piping promoting water recirculation) Maintaining elevated oxygen concentrations (positive redox) through the water column and especially at the sediment water interface, to help prevent phosphorus from entering the water column and keep it locked in the sediment
— Low content of dissolved oxygen — Release of odours	Aeration (aeration devices)
— Loss of disinfectant residual — Regrowth of microorganisms	Improved management of operational regime on the reservoirs

5 Additional treatment facilities

5.1 General

Additional treatment steps can be necessary to achieve the wastewater (physical, chemical, or biological) quality required for the planned use of TWW.

The need for additional treatment of wastewater to be used in irrigation depends on:

— the TWW quality;

— irrigation system;

— crops to be irrigated;

— regulatory requirements;

— potential adverse environmental and public health impacts of irrigation.

Filtration (particularly in sprinkler and micro-irrigation systems) and disinfection (chlorination) are often needed.

5.2 Filtration

The concentration of suspended solids and sediments in TWW is generally low enough for most irrigation systems. However, in pressurized irrigation systems, to limit algae content and prevent biological growth in pipes and clogging of sprinklers head and emitters, filtration can be installed upstream of the pumping station (particularly in drip and low-volume sprinkler irrigation systems).

Common filters used in pressurized systems include granulated media filters (gravel or sand filters), disc, and strainer filters. In drip irrigation systems, two different filters (e.g. sand and screen filters) can be installed in series.

Filtration can be set up downstream in open long-term storage reservoirs using a gravel filter, a sand filter, or a disc filter.

The characteristics of filters commonly used in irrigation systems are indicated in Table 3.