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Water reuse in urban areas ~~—~~ — Guidelines for benefit evaluation of reclaimed water use

Recyclage des eaux dans les zones urbaines — Lignes directrices concernant l'évaluation des avantages de l'utilisation d'eau réutilisée

PROOF

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Foreword

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This document was prepared by Technical Committee ISO/TC 282, *Water Reuse*, Subcommittee SC 2, *Water reuse in urban areas*.

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

Water shortages are recognized to be some of the most crucial threats to sustainable development of society. Reclaimed water is a safe, reliable and sustainable water source to help satisfy water demands, especially in many water-scarce areas. Today, reclaimed water is used in urban areas, including agricultural irrigation, ecological or environmental flow replenishment, landscape irrigation, toilet flushing, firefighting, and car washing amongst other uses. Implementation of principles of benefit evaluations can create thorough, comprehensive, systematic, and sustainable reclaimed water use. However, the intrinsic values or the benefits of reclaimed water use are not clear. There are limited guidelines or regulations currently available, specifically regarding the benefit evaluation of reclaimed water use in urban areas at a global level.

It is important to establish a systematic, scientific and holistic benefit evaluation system for reclaimed water use. Based on the different applications of reclaimed water and the varied water quality requirements linked to the intended use, it is important to evaluate the benefits of various indicators for reclaimed water use. The benefit evaluation should take into account various indicators such as the resource, ecological and environmental, social, economic and other benefits, including the reduction of global warming.

Water ~~Reuse~~reuse in ~~Urban Areas —~~urban areas — Guidelines for ~~Benefit Evaluation~~benefit evaluation of ~~Reclaimed Water Use~~reclaimed water use

1 Scope

This document provides guidelines to evaluate the benefits of reclaimed water for applications requiring different levels of water quality and for beneficial use in urban areas.

This document is applicable, among others, by practitioners and authorities to assist water reuse planning, design, operation and management.

This document provides ~~:~~

~~—~~ evaluation indicators, procedures and examples of reclaimed water use benefits.

Design parameters and regulatory values of different reclaimed water uses as well as risk or safety evaluation of reclaimed water use are out of scope of this document.

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*

3 Terms and definitions

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

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

~~— — IEC Electropedia: available at~~

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

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

3.1
benefit evaluation
analysis contributing to decision-making on whether to adopt a project or a plan by quantifying and comparing its benefits

3.2
ecological or environmental flowsflow
E-flowsflow
water flowsflow and levelslevel that allowallows to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being

3.3
avoided cost
benefits occurred as a result of avoiding unnecessary costs while meeting demand requirements and thereby avoiding the additional resources and service waste

Note 1 to entry: This concept is from least cost or integrated resource planning.

4 Abbreviated terms

CAPEX capital expenditures

COD chemical oxygen demand

CO_2-eq CO_2 equivalent

GHG greenhouse gas

IRR internal rate of return

LCC life cycle cost

LCY local currency

NCF net cash flow

NPV net present value

OPEX operation expenditures

P phosphorous

5 General

Ensuring safety of reclaimed water is crucial to protect the environment and human health from the adverse effects of toxicants and pathogenic microorganisms. Generally, the reclaimed water safety assessment (e.g. ecological and human health risk assessment) can be conducted before implementing benefit evaluation of reclaimed water use. For detailed information on risk assessment and management, ISO 20426:2018 and ISO 20761: 2018 can be used as references. Moreover, the supplied reclaimed water quality should also meet the requirements of local specifications and end user demands.

In principle, benefit is evaluated based on the comparison between the water reuse option and the business-as-usual or other method using alternative water resources, which are referred to as baseline. The relevant option and baseline are evaluated under the same conditions with the same indicators. The baseline can include a do-nothing scenario where no solution other than water reuse can realistically be envisioned and the baseline is to do nothing. The benefit of water reuse is expressed as the difference between the indicators for the relevant water reuse option and the baseline.

The benefit evaluation of reclaimed water use should comprehensively consider resource, ecological and environmental, social and economic benefit aspects.

The benefit evaluation of reclaimed water use includes quantitative and qualitative analyses, with corresponding indicators. The indicators should be set specifically, objectively and easily for calculation and/or comparison.

Wastewater treatment plants can be included in the boundary if necessary, as is often the case in comprehensive evaluations. The baseline scenario and the evaluation boundary including conventional wastewater treatment processes should also be determined for the benefit evaluation which is based on comparisons with the water reuse scenario.

Different water reuse projects and different utilization scenarios can be evaluated separately. Afterwards, the overall evaluation or comprehensive evaluation results can be obtained.

6 Indicators of benefit evaluation of reclaimed water use

6.1 Holistic indicator system

The indicators for benefit evaluation of reclaimed water use can be classified in four categories: resource, ecological and environmental, social and economic.

The main indicators for different benefit evaluation categories are listed in Table 1~~Table 1~~. If necessary, other indicators can be considered and incorporated for evaluation. Annex A~~Annex A~~ provides examples of indicators for the evaluation of natural environment improvement by reclaimed water use in the social benefit category.

Evaluation indicators can be selected according to the evaluation needs and reclaimed water use characteristics. A comprehensive evaluation system should contain a reasonable number of indicators in terms of different aspects and avoid repetition.

Table 1 — Example of main indicators for benefit evaluation of reclaimed water use

Category	Indicators
Resource benefit	Conventional water resource savings, energy, carbon, and phosphorous resource recovery, etc.
Ecological and environmental benefit	Reduction of contaminants, electricity use, greenhouse gas (GHG) emissions, and achievement of E-flows, ecosystem protection/restoration, etc.
Social benefit	Improvement of local natural environment, improvement of regional natural environment, etc.
Economic benefit	Avoided cost, net present value (NPV), internal rate of return (IRR), etc.

6.2 Resource benefits

6.2.1 Conventional water resource savings

Reclaimed water can be an alternative water resource for many activities that do not require potable water quality. The amount of conventional water resource (i.e. surface water, rivers and lakes and groundwater that are naturally available) savings due to the substitution by reclaimed water and other water-saving activities can be calculated using Formula (1)~~Formula (1):~~:

$$Q_t = A_1 - Q_s \quad (1)$$

where

A_1 is the amount of conventional water resource savings~~ (~~, expressed in m³~~)~~;

Q_t is the amount of reclaimed water use~~ (~~, expressed in m³~~)~~;

Q_s is the amount of water savings from water-saving activities and measures~~ (~~, expressed in m³~~)~~.

6.2.2 Energy resource recovery

Reclaimed water contains energy resources which can be further extracted and utilized. The amount of energy (heat or cold) resource recovery during water reclamation and reuse processes can be calculated using Formula (2)~~Formula (2)~~:

~~(2)~~

$$A_2 = Q_w \times \rho \times \Delta t \times C$$
$$A_c = \frac{A_2 \times F}{F+1}$$
$$A_h = \frac{A_2 \times H}{H-1} \qquad (2)$$

where

A_2 is the amount of heat or cold energy recovered during water reclamation and reuse processes~~ (~~, expressed in kJ~~)~~;

Q_w is the amount of reclaimed water used during the process~~ (~~, expressed in m³~~)~~;

ρ is the density of reclaimed water~~ (~~, expressed in kg/m³~~)~~;

Δt is the temperature ~~differences~~difference of extracted reclaimed water~~ (°~~, expressed in °C~~)~~;

C is the specific heat capacity of reclaimed water, 4,19 kJ/(kg·°C);

A_c is the amount of cold energy output of the reclaimed water heat pump system~~ (~~, expressed in kJ~~)~~;

A_h is the amount of heat energy output of the reclaimed water heat pump system~~ (~~, expressed in kJ~~)~~;

F is the performance coefficient of reclaimed water heat pump unit for cooling;

H is the performance coefficient of reclaimed water heat pump unit for heating.

6.2.3 Carbon resource recovery

Reclaimed water contains carbon resources which can be further extracted and utilized. The amount of carbon resource recovery during water reclamation and reuse processes can be calculated using Formula (3)~~Formula (3)~~:

$$A_3 = \sum_{i=1}^{n} A_{3,i} \qquad (3)$$

where