BS ISO 24512:2024

BSI Standards Publication

Activities relating to drinking water and wastewater services — Guidelines for the management of drinking water utilities and for the assessment of drinking water services

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National foreword

This British Standard is the UK implementation of ISO 24512:2024. It supersedes BS ISO 24512:2007, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CB/503, Drinking water and wastewater service levels.

A list of organizations represented on this committee can be obtained on request to its committee manager.

The attention of users is drawn to the existence of legislation or regulatory requirements that may override some provisions of this British Standard; in particular, to the legislation or regulatory requirements of the following:

- The Water Industry Act 1991 (as amended) and the Water Act 2014 (as amended);
- The Scottish Water (Objectives: 2021 to 2027) Directions 2020 (as amended) and the Water Industry (Scotland) Act 2002 (as amended); and
- The Water and Sewerage Services (Northern Ireland) Order 2006 (as amended).

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Activities relating to drinking water and wastewater services — Guidelines for the management of drinking water utilities and for the assessment of drinking water services

Activités relatives aux services de l'eau potable et de l'assainissement — Lignes directrices pour le management des services publics de l'eau potable et pour l'évaluation des services fournis

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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).

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This document was prepared by Technical Committee ISO/TC 224, *Drinking water, wastewater and stormwater systems and services*.

This second edition cancels and replaces the first edition (ISO 24512:2007), which has been technically revised.

The main changes are as follows:

— the objectives modified to adjust to current challenges faced by water utilities;

— changes in terms and definitions to reflect the unified terminology of ISO/TC 224 as specified in ISO 24513;

— the list of key performance indicators in Annex E modified.

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Introduction

0.1 Water issues: global context and policies framework

Water constitutes a worldwide challenge for the 21st century, both in terms of the management of available water resources and the provision of access to drinking water and sanitation for the world's population. In 2000, the United Nations (UN) recognized that access to water is an essential human right and, in conjunction with national governments, set ambitious goals (the "Millennium Development Goals") to increase access to drinking water and wastewater services, including safe disposal or reuse of residues (hereinafter jointly referred to as "water services"), particularly in developing countries. International conferences on sustainable development and water (e.g. the World Summit on Sustainable Development in Johannesburg in September 2002, the third World Water Forum in Kyoto in March 2003 and the fourth World Water Forum in Mexico City in March 2006) have highlighted this issue, and UN agencies [including the World Health Organization (WHO) and UNESCO] have developed recommendations and programmes to establish a framework in which to advance.

The United Nations' Commission on Sustainable Development (CSD13) has emphasized that governments (referred to as "relevant authorities" in this document) have a primary role in promoting improved access to safe drinking water and basic sanitation through improved governance at all levels and appropriate enabling environments and regulatory frameworks, with the active involvement of all stakeholders. This process should incorporate institutional solutions to make the water sector more productive and the management of water resources more sustainable. In this respect, the ministerial declarations from the Third and Fourth World Water Forum recommended that governments endeavour to reinforce the role of parliaments and local public authorities, particularly with regard to the provision of adequate water services, and recognized that an effective collaboration with and between these actors is a key factor for meeting water-related challenges and goals.

While substantial progress has been made in increasing access to clean drinking water and sanitation, billions of people – mostly in rural areas – still lack these basic services. Worldwide, one in three people does not have access to safe drinking water, two out of five people do not have a basic hand-washing facility with soap and water, and more than 673 million people still practise open defecation[24].

The COVID-19 pandemic has demonstrated the critical importance of sanitation, hygiene and adequate access to clean water for preventing and containing diseases. According to the WHO, handwashing is one of the most effective actions you can take to reduce the spread of pathogens and prevent infections, including the COVID-19 virus. Yet billions of people still lack safe water sanitation, and funding is inadequate[24].

A projected 40 % shortfall in freshwater resources by 2030, coupled with a rising world population, has the world careening towards a global water crisis. Recognizing the growing challenge of water scarcity, the UN General Assembly launched the Water Action Decade on 22 March 2018 to mobilize action that will help transform how we manage water[24].

The UN's Sustainable Development Goal 6, "Ensure availability and sustainable management of water and sanitation for all", sets targets to be achieved by 2030, including: achieve universal and equitable access to safe and affordable drinking water for all, improve water quality, increase water-use efficiency across all sectors, implement integrated water resources management at all levels and expand international cooperation and capacity building at that[24].

Examples of key issues for effective drinking water and sanitation services policy frameworks are:

— clear definition of the roles of the different stakeholders;

— definition of sanitary rules and organization for assessment of conformity;

— processes to ensure consistency between the policies regarding urban development and water utility infrastructure;

— regulation for water withdrawal and wastewater discharge;

— information to the users and the communities;

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— the use of advanced and upcoming equipment and data handling technologies for enhancing the efficiency of the services as stated in the proposed revision of ISO 24510[7];

— planning for the water utility services to be able to cope with climate change effects on the availability and quality of the water utility resources to maintain service level required, as stated in ISO 24540[16].

0.2 Water utilities: general objectives

In addition to public health protection, sound management of the water utilities is an essential element of integrated water resources management. When applied to these utilities, sound management practices will contribute, both quantitatively and qualitatively, to sustainable development. Sound utility management also contributes to social cohesion and economic development of the communities served, because the quality and efficiency of water services have implications for virtually all activities of society.

As water is considered a "social good" and activities related to water services support the three aspects (economic, social and environmental) of sustainable development, it is logical that the management of water utilities be transparent to and inclusive of all stakeholders identified in accordance with the local context.

There is a broad array of types of stakeholders that can play a role in activities related to water services.

Examples of such stakeholders include:

— governments or public agencies (international, national, regional or local) acting with legal or legislative authority;

— associations of the utilities themselves (e.g. international, regional or multinational and national drinking water or wastewater associations);

— autonomous bodies seeking to play an overview role (e.g. organizations concerned, such as non-governmental organizations);

— users and associations of water users.

The relationships between stakeholders and water utilities vary around the world. In many countries, there are bodies that have responsibility (in whole or in part) for overseeing the activities related to water services, whether the utilities are publicly or privately owned or operated and whether they are regulated by relevant authorities or acting in a system of technical self-regulation. Standardization and technical self-regulation are possible ways of ensuring involvement of all stakeholders and meeting the subsidiarity principle.

The aim of water utilities is logically to offer services to everybody in the area of responsibility of the utility and to provide users with a continuous supply of drinking water and the collection and treatment of wastewater (including stormwater), under economic and social conditions that are acceptable to the users and to the utility. Water utilities are expected to meet the requirements of relevant authorities and the expectations specified by the responsible bodies in conjunction with the other stakeholders, while ensuring the long-term sustainability of the service. In a context of scarcity of resources, including financial resources, it is advisable that the investments made in installations be appropriate and that necessary attention be paid to proper maintenance and effective use of the installations. It is advisable that water tariffs generally aim at meeting cost-recovery principles and at promoting efficiency in the use of the resources, while striving to maintain affordable basic access to water services.

It is advisable that the stakeholders be involved in both setting service objectives and service standards and assessing the adequacy and efficiency of service.

0.3 City services and quality of life

In many cases, water utilities are service providers of cities. The concept of smart cities has been explored in literature of recent years, while ISO/TC 268, *Sustainable cities and communities*, standardizes the field of sustainable cities and communities to help interested parties measure their performance. ISO 37120[17] introduces indicators to measure the performance of cities, some of which relate to water and wastewater. This document intends to complement the indicators and methodologies depicted in ISO 37120[17], while introducing a holistic perspective of the water sector in the smart city.

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0.4 Objectives, content and implementation of this document

The objective of this document is to provide the relevant stakeholders with guidelines for assessing and improving the service to users and with guidance for managing water utilities, consistent with the overarching goals set by the relevant authorities and by the international intergovernmental organizations noted previously. This document also intends to provide relevant stakeholders with guidelines to help deal with recent developments in the field of water service management, such as climate change, higher user and regulatory demands and the development of advanced technologies, mainly data mining and analysis, communications and digitization. Newly available technologies can be used and developed to protect against risks that stem from the use of cyber communications. This document is intended to facilitate dialogue between the stakeholders, enabling them to develop a mutual understanding of the functions and tasks that fall within the scope of water utilities.

Using key performance indicators (KPIs) will promote ongoing improvements and eventually initiate the use of new and more efficient technologies, procedures and preventive approaches.

The group of standards addressing water services consists of ISO 24510[7] (service-oriented), ISO 24511[8] and this document (both management-oriented).

ISO 24510[7] addresses the following topics:

— a brief description of the components of the service relating to the users;

— core objectives for the service, with respect to users' needs and expectations;

— guidelines for satisfying users' needs and expectations;

— assessment criteria for service to users in accordance with the provided guidelines;

— examples of performance indicators linked to the assessment criteria that can be used for assessing the performance of the service.

ISO 24511[8] and ISO 24536[15] address the following topics:

— a brief description of the physical or infrastructural and managerial or institutional components of water utilities;

— core objectives for water utilities, considered to be globally relevant at the broadest level;

— guidelines for the management of the water utilities;

— guidelines for the assessment of the water services with service assessment criteria related to the objectives and performance indicators linked to these criteria.

The performance indicators presented in this document, ISO 24510[7], ISO 24511[8] and ISO 24536[15] are simply for purposes of illustration, because assessing the service to users cannot be reduced to a single or universal set of performance indicators.

The scope formally excludes the installations inside a user's premises. However, attention is drawn to the fact that the quality of the supplied water (or discharged wastewater) can be adversely impacted between the point of delivery (or, in the case of wastewater, the point of collection) and the point of use (or, in the case of wastewater, the point of discharge) by the installations inside the premises. Some stakeholders, such as relevant authorities, owners, contractors and users, can have a role to play regarding this issue.

Because the organization of water utilities falls within a legal and institutional framework specific to each country, this document does not prescribe the respective roles of various stakeholders, nor does it define required internal organizations for local, regional or national bodies that can be involved in the provision of water services. In particular, this document does not interfere with the free choice of the responsible bodies regarding the general organization and the management of their utilities. This document is applicable to publicly and privately owned and operated utilities alike and does not favour any particular ownership or operational model.

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The guidelines given in this document, ISO 24510[7] and ISO 24511[8] focus on users' needs and expectations and on the water services themselves, without imposing a means of meeting those needs and expectations, the aim being to permit the broadest possible use of this document, ISO 24510[7] and ISO 24511[8] while respecting the cultural, socio-economic, climatic, health and legislative characteristics of the different countries and regions of the world. It should therefore be understood that, in the short-term, it is not always possible to meet the expectations of local users. This can be due to factors such as climate conditions, resource availability and difficulties relating to the economic sustainability of the water services, particularly regarding financing and the users' ability to pay for improvements. These conditions can limit the achievement of some objectives or restrict the implementation of some recommendations in developing countries. However, this document is drafted with such constraints in mind and, for example, allows for differing levels of fixed networks and the need for on-site alternatives. Notwithstanding the need for flexibility in terms of engineering and hardware, many recommendations in this document, such as consultation mechanisms, are intended to apply universally.

In order to assess and improve the service to users and to ensure proper monitoring of the improvements, an appropriate number of performance indicators or other methods for checking conformity to requirements can be established. The use of performance indicators is only one of the possible support tools for continuous improvement. Stakeholders can select performance indicators from the examples given or develop other relevant performance indicators, taking into account the principles described in this document, ISO 24510[7] and ISO 24511[8]. The performance indicators logically relate to the objectives for which they are defined through the assessment criteria, and are used to measure performance. They can also be used to set required or targeted values. This document does not impose any specific indicator or any minimum value or performance range. It respects the principle of adaptability to local contexts, facilitating local implementation.

While it is in no way intended that this document, ISO 24510[7] and ISO 24511[8], and more specifically the performance indicators given as examples, be considered as a prerequisite or condition for the implementation of a water policy or for the financing of projects or programmes, they can serve to assess progress towards policy goals and the objectives of financing programmes.

The objective of this document, ISO 24510[7] and ISO 24511[8] is not to lay down systems of specifications supporting direct certification of conformity but to provide guidelines for the continuous improvement and assessment of the service. Use of this document, ISO 24510[7] and ISO 24511[8] is voluntary, in accordance with ISO rules.

This document, ISO 24510[7] and ISO 24511[8] are consistent with the principle of the "plan-do-check-act" (PDCA) approach: they propose a step-by-step process, from identifying the components and defining the objectives of the utility to establishing performance indicators, with a loop back to the objectives and to the management, after having assessed the performances. Figure 1 summarizes the content and application of this document. Implementation of this document, ISO 24510[7] and ISO 24511[8] does not depend upon adoption of the ISO 9001[2] and/or the ISO 14001[3] standards. Nevertheless, this document, ISO 24510[7] and ISO 24511[8] are consistent with those management system standards. Implementation of an overall ISO 9001[2] and/or ISO 14001[3] management system can facilitate the implementation of the guidelines contained within this document, ISO 24510[7] and ISO 24511[8]; conversely, these guidelines can help to achieve the technical provisions of ISO 9001[2] and ISO 14001[3] for organizations choosing to implement them.

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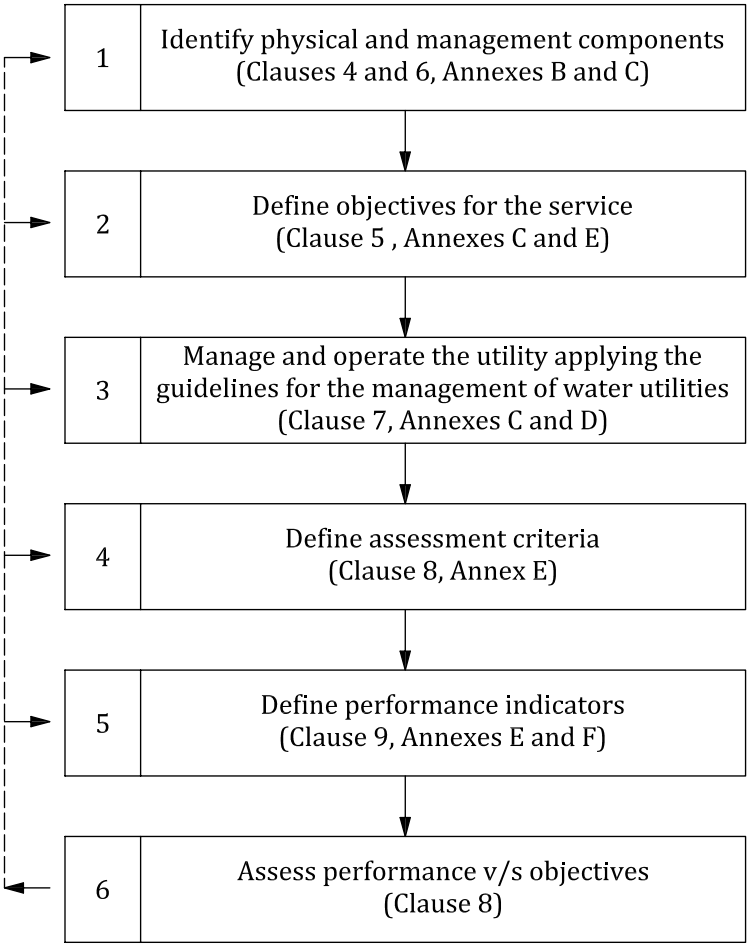

Figure 1 — Implementation actions and sequence

0.5 Drinking water supply services

When reading this document, it is important to bear in mind that utilities have constructed infrastructure and facilities that are operated primarily to supply drinking water to users of the service. Many utilities can supply the users either by direct pipe connection or by other means (e.g. trucks, bottles). In broad terms, the social objectives of the service are to promote public health and social and economic development while protecting the environment.

This document only applies to services to and at the point of delivery to the user (which can be different from the point of consumption or use).

The function of utilities is to provide drinking water for civil life, urban activities and industrial or other uses. The supply of drinking water is considered to be a core activity on which society depends and it therefore has a social as well as a public welfare role. Supplying drinking water involves the abstraction of water from the environment and the construction of infrastructure having a lifetime typically stretching over several human generations. This suggests that intergenerational equity and regard must also be a feature of the assessment of the service. Consequently, a water utility, regardless of ownership, is public in nature and will be subject to public scrutiny and policy.

NOTE Intergenerational equity means that current societies or populations do not take actions or ignore current responsibilities that result in unfairly shifting economic or social burdens to future generations.

Operationally, under normal conditions, the broad objectives of a utility are to supply drinking water on a continuous basis. Some utilities cannot provide drinking water on a continuous, 24 h-a-day, 7-days-a-week basis, nor is there an expectation that this will be achieved. Often these utilities are those that cannot deliver safe drinking water. In such cases, an intermittent but scheduled supply can be satisfactory if quantities supplied are sufficient to meet users' reasonable demands.

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The drinking water should be suitable for direct human consumption regardless of the other uses made of the water delivered. Efforts should be made to achieve that quality at all times. Where that is the general expectation, when potability standards are not maintained or achieved, a specific warning to users should be provided.

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Activities relating to drinking water and wastewater services — Guidelines for the management of drinking water utilities and for the assessment of drinking water services

1 Scope

This document provides guidelines for the management of drinking water utilities and the assessment of drinking water services.

This document is applicable to publicly and privately owned and operated water utilities. It does not favour any particular ownership or operating model.

This document addresses drinking water systems in their entirety and is applicable to systems at any level of development (e.g. on-site systems, distribution networks, treatment facilities).

The following are within the scope of this document:

— the definition of a language common to different stakeholders;

— the definition of the components of drinking water supply systems;

— guidelines for the management of drinking water utilities;

— guidelines for objectives, service assessment criteria and related performance indicators, appropriate for the assessment of drinking water services.

The following are outside the scope of this document:

— target values and thresholds for proposed objectives, service assessments criteria and related performance indicators;

— matters relating to the design and construction of drinking water systems;

— matters relating to the management structure of drinking water utilities;

— matters relating to the regulation of drinking water services, including management and operational activities;

— matters relating to regulating the content of contracts or subcontracts;

— installations between point of delivery and point of use.

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 24513, *Service activities relating to drinking water supply, wastewater and stormwater systems — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24513 and the following apply.

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

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

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

3.1
accuracy
closeness of agreement between a measure and the accepted reference value

Note 1 to entry: The term "accuracy", when applied to a set of measures, involves a combination of random components and a common systematic error or bias component.

[SOURCE: ISO 24513:2019, 3.7.10]

3.2
assessment
process, or result of this process, comparing a specified subject matter to relevant references

[SOURCE: ISO 24513:2019, 3.7.12]

3.3
community
one or more natural or legal persons and, in accordance with national legislation or practice, their associations, organizations or groups, having interests in the area where the *service* (3.11) is provided

[SOURCE: ISO 24513:2019, 3.1.8.5]

3.4
confidence grade
assessment of the quality in terms of *accuracy* (3.1) and reliability

[SOURCE: ISO 24513:2019, 3.7.13]

3.5
coverage
extent to which the assets of a water utility allow *services* (3.11) to *users* (3.12), within its defined area of responsibility

[SOURCE: ISO 24513:2019, 3.3.38]

3.6
drinking water
DEPRECATED: potable water
water intended for human consumption

Note 1 to entry: Requirements for drinking water quality specifications are generally laid down by the national relevant authorities. Guidelines[25] have been established by the World Health Organization (WHO).

[SOURCE: ISO 24513:2019, 3.2.2.1]

3.7
drinking water system
asset system providing the functions of abstracting, treating, storing, distributing or supplying *drinking water* (3.6)

[SOURCE: ISO 24513:2019, 3.5.12.2]

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3.8
Geographical Information Systems
GIS
in the strictest sense, a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations

[SOURCE: ISO 23611-6:2012, 3.3.1, modified — Note 1 to entry has been deleted.]

3.9
indicator
parameter, or a value derived from parameters, which provides information about a subject matter with a significance extending beyond that directly associated with a parameter value

Note 1 to entry: Adapted from OECD works on "Core sets of indicators for environmental performance reviews"[23].

Note 2 to entry: Indicators can refer to context, conditions, means, activities or *performances* (3.10).

[SOURCE: ISO 24513:2019, 3.9.10]

3.10
performance
measurable result

Note 1 to entry: Performance can relate either to quantitative or qualitative findings.

Note 2 to entry: Performance can relate to the management of activities, processes, products [including *services* (3.11)], systems or organizations.

[SOURCE: ISO 24513:2019, 3.9.1, modified — Note 3 to entry has been deleted.]

3.11
service
output of an organization with at least one activity performed between the organization and, in the first place, its *user* (3.12) and, in the second place, a stakeholder

Note 1 to entry: The dominant elements of a service are generally intangible.

Note 2 to entry: Service involves activities and processes within an organization (utility), at the interface with the user, to establish user requirements as well as upon delivery of the service and can involve a continuing relationship.

Note 3 to entry: Provision of a service can involve, for example, the following:

— an activity performed on a user-supplied tangible product (e.g. wastewater);

— an activity performed on a user-supplied intangible product (e.g. processing new connection requests);

— delivery of an intangible product (e.g. the delivery of information in the context of knowledge transmission);

— the creation of ambience for the user (e.g. in reception offices).

Note 4 to entry: A service is generally experienced by the user and can be monitored by one or more stakeholders.

Note 5 to entry: The word "service" in common English can also refer to the entity providing the actions related to the subject in question, as is implicit in such phrases as "bus service", "police service", "fire service" and "water or wastewater service". In this context and usage, "service" implies the entity that is delivering the service, for example "the public transport of passengers", "the provision of public security", "fire protection and response" and "delivering *drinking water* (3.6) or collecting wastewater". If "service" can be understood in this way, "water service" becomes synonymous with "*water utility* (3.13)"

[SOURCE: ISO 24513:2019, 3.3.7]

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3.12
user
DEPRECATED: consumer
person, group or organization that benefits from *drinking water* (3.6) delivery and related *services* (3.11), wastewater service activities, stormwater service activities or reclaimed water delivery and related services

Note 1 to entry: Users are a category of stakeholder.

Note 2 to entry: Users can belong to various economic sectors: domestic users, commerce, industry, tertiary activities, agriculture.

Note 3 to entry: The term “consumer” can also be used, but in most countries the term “user” is more frequent when referring to public services. It is not appropriate for wastewater services.

[SOURCE: ISO 24513:2019, 3.1.8.4, modified — in Note 3 to entry "It is not appropriate for wastewater services" has been added.]

3.13
water utility
whole set of organization, processes, activities, means and resources necessary for abstracting, treating, distributing or supplying *drinking water* (3.6), for collecting, conveying, treating, disposing of or reusing wastewater or for the control, collection, storage, transport and use or disposal of stormwater, and for providing the associated *services* (3.11)

Note 1 to entry: Some key features for a water utility are:

— its mission, to provide drinking water services or wastewater services or the control, collection, storage, transport and use of stormwater services, or a combination thereof;

— its physical area of responsibility and the population within this area;

— its responsible body;

— the general organization with the function of operator being carried out by the responsible body or by legally distinct operators;

— the type of physical systems used to provide the services, with various degrees of centralization.

Note 2 to entry: Drinking water utility addresses a utility dealing only with drinking water; wastewater utility addresses a utility dealing only with wastewater; stormwater utility addresses a utility dealing only with stormwater.

Note 3 to entry: When it is not necessary, or it is difficult to make a distinction between responsible body and operator, the term “water utility” covers both.

Note 4 to entry: In common English, “water service” can be used as a synonym for “water utility”, but this document does not recommend using the term in this way.

[SOURCE: ISO 24513:2019, 3.3.1]

4 Components of drinking water supply systems

4.1 General

A drinking water supply system generally comprises four components:

— water source (see 4.3);

— intake and transport (see 4.4);

— treatment, if necessary, and if appropriate, disposal of residues (see 4.5 and 4.7);

— storage, transport and distribution (see 4.6).

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The drinking water supply system extends only to the point-of-delivery to the user. Installations from the point-of-delivery to the point-of-use are excluded.

4.2 Types of drinking water supply systems

The systems can be centralized or on-site.

Schematic presentations showing the elements or components of drinking water systems and the relations between the various components are shown in Annex A.

The supply can be continuous or intermittent; the water may be delivered continuously by pipe to the users or intermittently by some other means (e.g. truck, bottle). In addition, the utility may be linked to other utilities allowing the exchange (import or export) of raw or treated water.

In some simple systems, the treatment facility component may not be present, depending on the quality of the raw water, or the facility may include only a disinfection component. In more complex drinking water systems, there may be multiple sources, multiple pumping stations and reservoirs in the transport system, multiple stages to the treatment facility and processes and pumping and re-treatment stations in the distribution system, including re-treatment activities at treated water reservoirs.

4.3 Water source

Any water, either groundwater or surface water, can be a water source. Surface water sources include streams, rivers, lakes or reservoirs. Seawater and reclaimed wastewater are increasingly important as water sources. Groundwater is water contained within the geological formations accessed by springs, wells or boreholes.

Water utilities generally should use the water that is available to them. Groundwater sources are normally less exposed than surface water to microbial and other hazards. Large utilities may have a number of independent water sources.

4.4 Intake and transport

The water intake system normally requires pumping stations to abstract water from the groundwater or a surface source and to transport the water to the treatment facility, if any. Some utilities may have the advantage of a water source that allows the use of gravity fed transport systems. The transmission mains may have in-system storage reservoirs. To protect the water from microbiological hazards, disinfection systems may be used.

Where the force of gravity is strong, utilities should install pressure reducing valves and can install hydro-electric generators to take advantage of the gravitational force.

4.5 Treatment

Drinking water treatment facilities can vary from basic systems, providing disinfection, to multiple processes, providing clarification (e.g. coagulation, flocculation and filtration steps) with pH adjustment as necessary for optimal treatment and processing. Mechanical filtration using micro-filtration or reverse osmosis technology is also increasingly being used (e.g. for desalination of brackish or saline water sources). A final stage of treatment is often used to provide disinfection and inactivation of pathogens and to ensure disinfection residuals exist in the distribution system. More advanced technologies can be employed as necessary and appropriate.

Residues may be produced at a number of stages in the water treatment process (see 4.7).

Some utilities with extremely high-quality water sources may not have any treatment facilities.

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