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

Activités relatives aux services de l'eau potable et de l'assainissement — Lignes directrices pour la gestion des services publics d'assainissement 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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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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 224, *Drinking water, wastewater and stormwater systems and services*.

This second edition cancels and replaces the first edition (ISO 24511:2007), 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.

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

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 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.[25]

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 World Health Organization, 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.[25]

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.[25]

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.[25]

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 compliance;

— processes to assure 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;

— 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[5].

— 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[14].

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[18] 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[18], while introducing a holistic perspective of the water sector in the smart city.

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 services 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 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 be a promoter for 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[5] (service-oriented), this document and ISO 24512[6] (all being management-oriented).

ISO 24510[5] 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.

This document, ISO 24512[6] and ISO 24536[13] 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[5], ISO 24512[6] and ISO 24536[13] 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.

The guidelines given in this document, ISO 24510[5] and ISO 24512[6] 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[5] and ISO 24512[6] 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 (PIs) 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[5] and ISO 24512[6]. 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[5] and ISO 24512[6] 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[5] and ISO 24512[6] 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[5] and ISO 24512[6] is voluntary, in accordance with ISO rules.

This document, ISO 24510[5] and ISO 24512[6] 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[5] and ISO 24512[6] does not depend upon adoption of ISO 9001[1] and/or ISO 14001[2]. Nevertheless, this document, ISO 24510[5] and ISO 24512[6] are consistent with those management system standards. Implementation of an overall ISO 9001[1] and or ISO 14001[2] management system can facilitate the implementation of the guidelines contained within this document, ISO 24510[5] and ISO 24512[6]; conversely, these guidelines can help to achieve the technical provisions of ISO 9001[1] and ISO 14001[2] for organizations choosing to implement them.

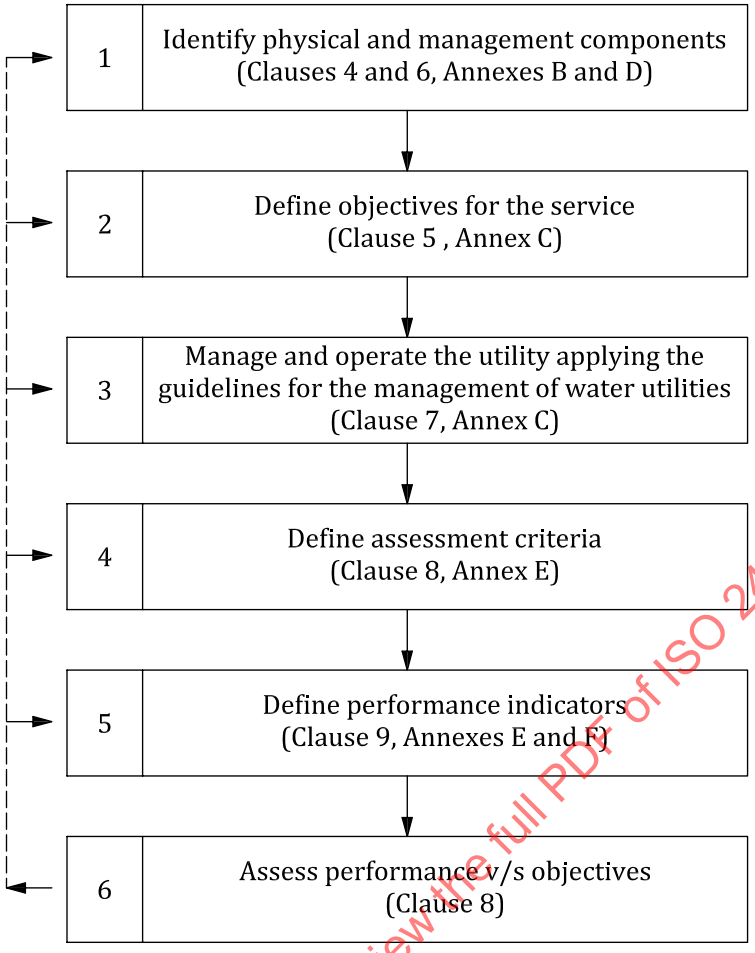


Figure 1 — Implementation actions and sequence

0.5 Wastewater services

Wastewater systems are built and operated mainly to protect public health and the environment. The type of wastewater system should be chosen and adapted in context with the density of the population, climatic conditions, environmental requirements for treatment and the technical or socio-economical ability of the responsible body to implement it, operate it and maintain it. It should be cost-effective and sustainable, as well as permitting phased development to overcome the financial constraints while not compromising the stated objectives.

Operationally, the broad objectives of a utility are to provide wastewater collection services on a continuous or at least-intermittent basis (depending on the service mechanism chosen), meeting the related capacity requirements. Methods of wastewater treatment and or disposal should correspond to the chosen collection system.

Appropriately treated wastewater is eventually returned to the environment and can have significant impact on both quantity and quality of natural water resources.

Effective and safe management of residues resulting from wastewater treatment, including their final disposal or reuse, is becoming increasingly important due to concerns about both environmental protection and resource conservation.

Since it often has a lifetime stretching over several human generations, wastewater infrastructure should demonstrate intergenerational equity. Consequently, a wastewater utility, regardless of ownership, is public in nature and will be subject to public scrutiny and policy. Other criteria, such as cost or affordability and service sustainability, are addressed in appropriate clauses of this document.

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

1 Scope

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

This document is applicable to publicly and privately owned and operated wastewater utilities but does not favour any particular ownership or operational model.

NOTE 1 Wastewater is always generated when water is used or consumed. Accordingly, sources of wastewater can be residential, industrial, commercial or institutional. Collected storm water or (melted) snow can also be considered as wastewater, as it often carries contaminants and pathogens picked up from air or ground surfaces on its way to a collection system. In certain circumstances, especially in undeveloped areas, sanitary waste is collected in an undiluted form.

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

The following are within the scope of this document:

— the definition of a language common to different stakeholders;

— objectives for the wastewater utility;

— guidelines for the management of wastewater utilities;

— service assessment criteria and related examples of performance indicators, all without setting any target values or thresholds.

The following are outside the scope of this document:

— methods of design and construction of wastewater systems;

— regulation of the management structure and the methodology of wastewater service activities of operation and management;

— regulation of the content of contracts or subcontracts;

— topics related to the systems inside buildings, between the point-of-discharge and the point-of-collection.

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.

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, 3.712]

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* (3.9) is provided

[SOURCE: ISO 24513:2019, 3.1.8.5]

3.4
confidence grade
assessment (3.2) 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* (3.13) allow *services* (3.9) to *users* (3.10), within its defined area of responsibility

[SOURCE: ISO 24513:2019, 3.3.38]

3.6
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.]

3.7
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".[24]

Note 2 to entry: Indicators can refer to context, conditions, means, activities or *performances* (3.8).

[SOURCE: ISO 24513:2019, 3.9.10]

3.8
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* (3.9)], systems or organizations.

[SOURCE: ISO 24513:2019, 3.9.1]

3.9
service
output of an organization with at least one activity performed between the organization and, in the first place, its *user* (3.10) 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* (3.11)];

— 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 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]

3.10
user
DEPRECATED: consumer
person, group or organization that benefits from drinking water delivery and related *services* (3.9), *wastewater* (3.11) 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]

3.11
wastewater
water arising from any combination of domestic, industrial or commercial activities, surface runoff and any accidental sewer inflow or infiltration water and which can include collected stormwater, discharged to the environment or sewer

Note 1 to entry: The definition of wastewater in this document also includes sanitary waste in the non-liquid form (i.e. solid or undissolved or not soluble).

Note 2 to entry: Wastewater can flow in separate or combined sewer systems.

Note 3 to entry: Collected storm water can carry contaminants and pathogens picked up from the air or ground surfaces.

[SOURCE: ISO 24513:2019, 3.2.2.2, modified — Notes 1, 2 and 3 to entry have been added.]

3.12
wastewater system
asset system providing the functions of collection, transport, treatment and discharge of *wastewater* (3.11) and wastewater residues

[SOURCE: ISO 24513:2019, 3.5.12.3]

3.13
water utility
whole set of organization, processes, activities, means and resources necessary for abstracting, treating, distributing or supplying drinking water, for collecting, conveying, treating, disposing of or reusing *wastewater* (3.11) or for the control, collection, storage, transport and use or disposal of stormwater, and for providing the associated *services* (3.9)

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 wastewater systems

4.1 General

A wastewater system generally comprises:

— wastewater source;

— collection and transport of wastewater and residues removed from wastewater;

— treatment of wastewater and disposal of residues;

— storage, transport and disposal or reuse.

See Annex A, A.1, A.2 and A.3.

NOTE Treated wastewater for drinking is a separate item covered under ISO 24512[6] but is the principal focus of ISO/TC 282, *Water reuse*.

4.2 Types of wastewater systems

The systems can be centralized, decentralized for a small system (subsystem) or on-site.

NOTE On-site systems are further discussed in ISO 24521[11] and ISO 24525[12].

Schematic presentations showing the wastewater systems and the relations between the various components are shown in, A.2 and A.3.

Depending on the extent of the development of the wastewater services in a particular country or area, the nature of the system components can vary. For on-site systems, only one or a few of the previously mentioned components of the system may be used (e.g. only collection, disposal). See A.3.

4.3 Centralized systems

4.3.1 Wastewater source

Wastewater sources and the volume of wastewater affect the composition of the wastewater and the nature of the treatment facility required to produce effluent able to meet environmental discharge or recycled water quality requirements. Wastewater sources include industrial, commercial, residential and stormwater. Industrial wastewater is typically the most difficult to treat, having a wide range of organic or inorganic constituents.

The polluter pay principle requires placing a cost on contaminants introduced into wastewater by industrial wastewater contributors and is a useful mechanism to minimize difficult-to-treat inputs and allow cost recovery for treatment of these components. Commercial and residential wastewater is more consistent and typically lower in organic and inorganic contaminants.

Stormwater, where it is collected in the same pipes as wastewater or delivered concurrently to a wastewater treatment plant, has the effect of diluting the organic components of the wastewater and potentially introducing additional inorganic contaminants.

4.3.2 Transport from source to treatment

The wastewater collection and transport system consists of networks with connections to the various wastewater sources. Such networks are furnished with the necessary equipment (e.g. gates, weirs, pumps) to achieve the collection and transport function. In some cases, centralized systems will receive wastewater (treated or untreated) or separated residues from neighbouring centralized systems for further processing. In combined wastewater systems, the wastewater will be augmented with stormwater.

The systems may be pressurized (with positive or negative pressure) or the wastewater may flow by gravity. Sewerage flowing through wastewater pipework is likely to generate both odours and noxious gases which should be controlled through effective ventilation, gas scrubbers or filters, or through dosing of chemicals into the wastewater.

Centralized wastewater treatment systems frequently receive and accept septage from on-site systems. This septage is transported normally by road vehicles operated by independent transport enterprises.

Components of the centralized system for collection and transport of wastewater can include:

— drains;

— sanitary, storm or combined sewers and auxiliaries, including:

  — gravity sewers;

  — pressure or vacuum sewers;

  — interceptors or trunk sewers;

  — storage and retention basins;

— pumping and storage facilities;

— overflow structures;

— bulk liquid carriers;

— in-network wastewater condition monitoring and sampling systems;

— odour control units;

— chemical dosing systems;

— drop structures and mixing structures (designed to avoid gas generation).

4.3.3 Treatment

Treatment of sanitary or municipal wastewater and the separated wastewater residues can include several stages, depending on the nature (quality and quantity) of the wastewater source and the disposal environment (i.e. the nature and size of the receiving body of water for liquids that are not reused) and disposal method for residues that are not reused. Treatment stages can include mechanical treatment for removal of larger debris such as rags and grit, as well as settling and removal of suspended solids, biological treatment for removal of the dissolved organic contaminants, removal of nutrients such as nitrogen and phosphorus and disinfection of final effluents to remove or inactivate pathogens such as bacteria and viruses. In general, treated wastewater effluent is disposed of by direct discharge to a receiving body of water, infiltrated to land or reused.

Wastewater treatment can include for centralized or decentralized systems:

— lagoon or pond treatments (for small populations);

— treatment inlet holding tanks;

— septage receiving facilities;

— treatment facility inlet structures;

— monitoring, sampling, measuring or remote control with analysis, process and feedback facilities;

— preliminary, primary, secondary or advanced treatment and reuse or disposal facilities;

— discharge facilities or outfall structures;

— odour control facilities;

— energy recovery facilities;

— combined sewer overflow (CSO) treatment facilities;

— storm water treatment facilities.

4.3.4 Storage, transport and distribution

In general, treated wastewater effluent is disposed of by direct discharge to a receiving body of water, infiltrated to land or reused. In doing this, the wastewater may be temporarily stored in open lagoons or tanks to buffer flows, particularly where the wastewater is being reused.

4.3.5 Disposal of residues

Residues may be produced at a number of stages in the wastewater treatment process. Disposal of large volumes of untreated sludge or salts from reverse osmosis processes can pose a threat to the environment.

Since the cost of disposal of residues is volume related and residues normally contain a large amount of water, they are generally dewatered to reduce the volume.

The options for disposal, depending on quality and local requirements, are:

— transfer to a treatment facility;

— return to source water body;

— deposit at landfill sites;

— reuse, if possible.

NOTE ISO/TC 275 is developing a series of standards regarding the treatment and use of (wastewater) sludges.

4.4 On-site-systems

4.4.1 Wastewater source

On-site wastewater treatment systems are typically designed to treat, dispose of, disperse or reuse domestic wastewater in areas where centralized sewerage systems are not viable or currently not available.

NOTE ISO 24521[11] and ISO 24525[12] can assist in designing and operating on-site wastewater treatment.

4.4.2 Collection and transport

On-site systems can include a wastewater collection network within the site. On-site systems may also be connected to central systems by direct physical means or by transport vehicles.

On-site equipment for the collection of sanitary waste or wastewater can include:

a) pit latrine;

b) tank;

c) holding basin;

d) organic separators;

e) skimmers.

In some cases, the on-site collection system is only a temporary holding tank for transportation to a centralized treatment system and is usually done by tanker. In this case, transportation of sanitary waste, wastewater or wastewater residues from on-site systems to a centralized treatment plant includes:

— manually emptied storage tank;

— vacuum emptied storage tank;

— small bore (diameter) system.

4.4.3 Treatment

On-site treatment systems components can include:

— grease traps;

— septic tanks;

— anaerobic reactors;

— wetlands, lagoons or pond systems;

— soakaways;

— reed beds;

— evaporation beds;

— composting toilet;

— chemical injection systems;

— electrochemical treatment;

— bioreactors;

— Ultrafiltration (UF) or Reverse osmosis (RO) membrane systems;

— disinfection.

4.4.4 Storage, transport and distribution

Treated wastewater from the on-site treatment system may be infiltrated directly in the soil (from pit latrines) but more frequently passes through a series of on-site pipes to a storage lagoon or tank prior to discharge into the surrounding soil, reuse or land application.

For the efficient operation of bio-reactors, on-site systems require regular maintenance of the system to remove accumulated residuals and the liquid portion. Septage pumping is carried out by specialized vehicles (some with de-watering capability) to transport the residues to a central treatment plant for disposal.

4.5 Disposal or reuse of residues

Residues, after their processing using methods such as dewatering to reduce their volume, may be incinerated or sent by surface transport vehicles to a landfill site for permanent storage or burial.

Residues are increasingly finding reuse markets. Wastewater residues may be reused for soil enhancement or fertilizer purposes (whether or not mixed with other organic residuals) or may be used as an energy source through incineration with heat recovery.

Residue processing and disposal system can include:

— residues handling or conditioning facilities, such as:

  — stabilization tanks (e.g. aerobic or anaerobic digesters with possible biogas recovery);

  — conditioning facilities (for physical and or chemical conditioning of residues);

  — dewatering or drying facilities;

  — composting facilities;

— residue reuse or disposal facilities, including:

  — thermal destruction (e.g. incineration, gasification, with possible heat recovery);

— disposal buried *in situ*;

— dumping or landfill sites;

— beneficial application sites (e.g. agricultural, silvicultural land application sites).

5 Objectives for the wastewater utility

5.1 General

5.1.1 The responsible body, in conjunction with its operator(s), if relevant, should establish for the wastewater utility:

— the objectives;

— all related requirements (mandatory or self-established);

— a service assessment policy, taking into account relevant service assessment criteria and measurements, such as performance indicators.

5.1.2 All these elements should take into account:

— legal requirements;

— land and urban planning and human settlement policies established by the relevant authorities;

— expectations of the users and other stakeholders;

— possibilities of integration into the water utility of technical developments occurring regarding wastewater services;

— the physical and management components of the wastewater utility;

— the financial resources available;

— the affordability of service for the user.

Figure 2 gives an example of possible relationships among stakeholders for establishing objectives and also shows the relationships between objectives, service assessment criteria and performance indicators.

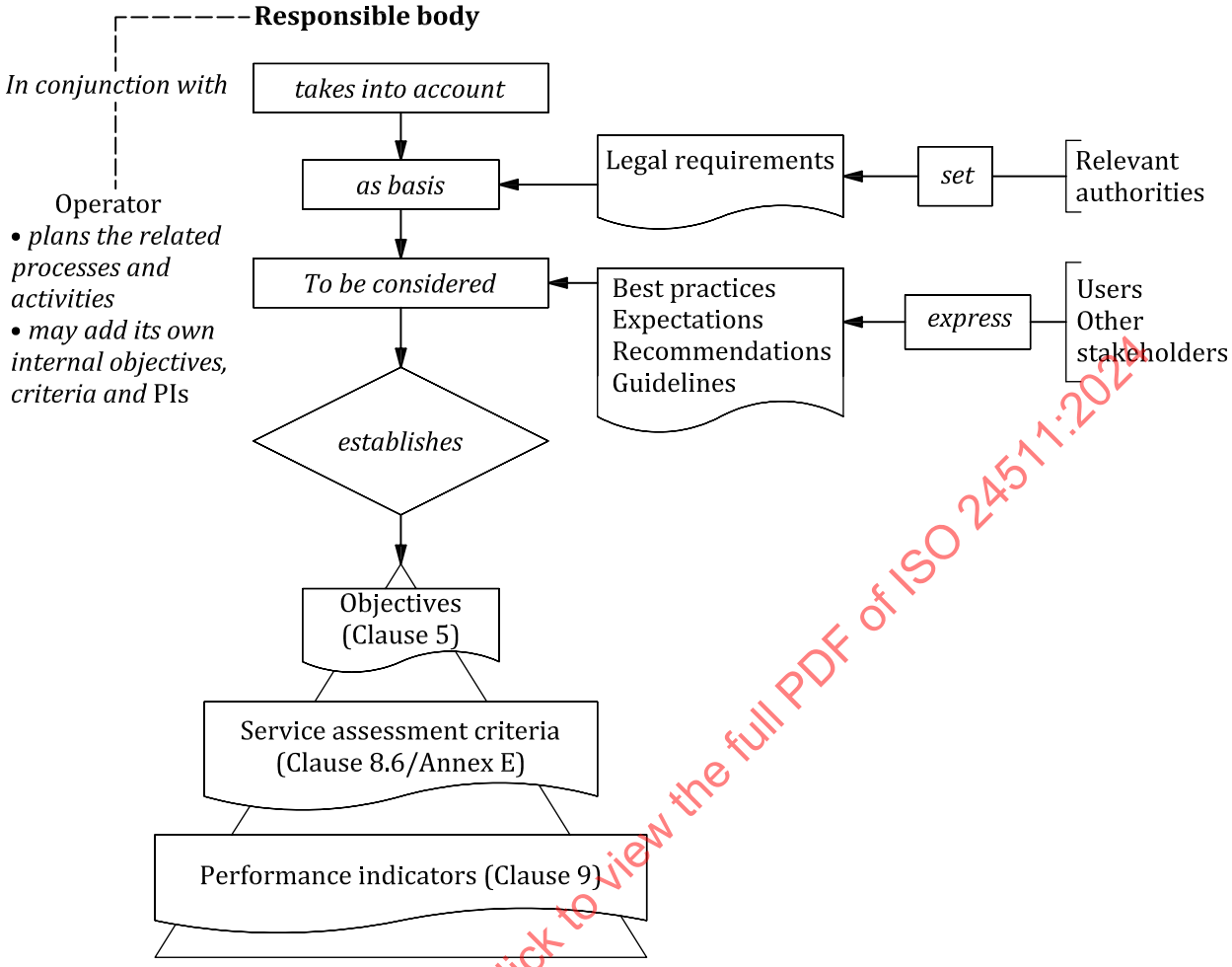


Figure 2 — Example of relevant relationships among stakeholders for establishing objectives, service assessment criteria and performance indicators

5.1.4 The management of a wastewater utility should include:

— formulation of objectives and service assessment criteria;

— evaluation of the performance by assessment.

The responsible body should take into account the criterion of affordability for customers when setting the objectives for the management of a wastewater utility, in accordance with the guidance given in ISO 24510. [5]

Objectives are generally defined for a certain geographic area and they should be expressed in the form of service assessment criteria.

5.1.5 The objectives specified in 5.2 to 5.10 are considered the principal objectives for wastewater utilities. Service assessment criteria related to these objectives are discussed in 8.6 and in Annex D. Possible actions that a wastewater utility can undertake to achieve these objectives are shown in Table B.1.

5.2 Protection of public health

A main objective of a wastewater utility should be to ensure the safe collection or transportation, treatment and disposal or reuse of wastewater and residues for the protection of human health and safety, while

controlling the related emissions. Wastewater utilities may have a broader public health responsibility and that is to receive and treat wastewater from on-site systems within their community.

Special precautions should be taken if the wastewater effluents or residues are reused. Such precautions may include additional treatment and minimizing risk to public health regarding effluent quality for different reuses.

5.3 Meeting users' needs and expectations

An objective of a wastewater utility should be to ensure service activities meet users' needs and expectations.

For guidelines for the assessment and improvement of the service to users and the objectives and guidelines to meet users' needs and expectations, see ISO 24510.[5]

5.4 Provision of services under normal and emergency situations

An objective of a wastewater utility should be to ensure that, under normal conditions, the wastewater services (collection, transport, treatment and disposal or reuse) are available on a continuous basis.

Wastewater services may be interrupted by planned or emergency events. Where an emergency condition applies, emergency plans and response actions should be initiated (see ISO 24518[8] and ISO/TS 24520[10]).

5.5 Sustainability of the wastewater utility

A wastewater utility should ensure that the assets are maintained and provide capacity to meet current and future needs.

When a wastewater utility makes decisions which have cost impacts, it should ensure that appropriate revenues (e.g. through corresponding service rates, tariffs or fees) will cover the related expenditures over time.

Wastewater utilities represent major social investments. It is usually expected that they provide a service over many decades. Ensuring the sustainability of a wastewater utility over time is therefore a key objective of its management.

Treated wastewater recycle, reuse as well as resources recovery should be considered, since reuse is a very good solution to environmental issues and augments the resources available to the population.

Environmental, economic and social changes will occur over the assets' lifetime, affecting water source availability as well as the needs for wastewater collection, treatment and disposal or reuse. Appropriate resources (e.g. financial) should be dedicated to meeting these needs, taking into account current social constraints without shifting the burden to future generations.

The wastewater utility should react to and plan for coping with changes in natural, economic and social environments, and strive for continuous improvement in protecting the environment and public health, taking into consideration the most current research and appropriate technology.

5.6 Promotion of sustainable development of the community

Wastewater utilities should address sustainable development, i.e. the ability for the community to grow and prosper within the environmental, infrastructural and economic resources available to it, without limiting the use of those resources by future generations. This includes contributing to and implementing sustainable development by:

— promoting efficient use of resources through recycling and reuse;

— instituting pollution prevention techniques by eliminating or separating pollutants at their sources.

In considering strategic priorities for the management of wastewater, attention should also be given to the overall management of water resources.

Distinction can be made between quantitative and qualitative aspects of wastewater management.

Quantitative aspects of water management for the promotion of sustainable development comprise the following (in the order of priority given):

— efficient use of water;

— retention and reuse;

— discharge.

Qualitative aspects of water management for the promotion of sustainable development comprise the following (in the order of priority given):

— pollution prevention from untreated wastewater;

— separation of polluted flows from non-polluted flows;

— removal and treatment of pollutants;

— removal and disposal or reuse of residues.

5.7 Protection of the environment

5.7.1 Protection of the natural environment

Another objective of a wastewater utility should be to ensure the reliable collection or transportation, treatment and disposal or reuse of wastewater and residues for the protection of the natural environment, including:

— preservation or conservation of natural resources;

— control of overflows;

— preservation of flora and fauna.

5.7.2 Protection of the built or public environment

A further objective of a wastewater utility should be the safe collection or transportation, treatment and disposal or reuse of wastewater for the protection of the built or public environment, in order to ensure:

— value to users and user safety;

— asset value and maintainability;

— functionality and value for the future;

— prevention of pollution;

— control or minimization of flooding;

— protection of amenity value (e.g. value for recreational uses).

5.8 Climate change

Wastewater utilities should prepare for the impact of climate change on the utility, including:

— being aware of how climate change phenomena can damage the physical installations of the utility;

— assessing whether climate change phenomena can affect the effectiveness of the treatment processes and the quality of the effluent;

— defining changes in wastewater flow and flow distribution due to climate change;

— if the effluent is being reused, assessing how the demand for effluent will change in terms of quantity and quality demands.

Documents are in development which will give guidance on adapting to climate change. See the ISO 24566[15] series[1)].

5.9 Higher user and service demands

Wastewater utilities should be able to stand to a higher level of demands, including:

— more stringent demands by users regarding, for example, the continuity of the services and the shortening of service interruptions;

— more stringent standards for the quality of the effluent and the quality of the service;

while considering the impact of these demands on consumer pricing.

5.10 Available technologies

An objective of the water utility should be to take advantage of available technologies relating to:

— wastewater collection and process technologies;

— implementation of digital data mining and analysis, acquiring a geographic information system (GIS) for mapping and management purposes, etc.;

— enhancing the communications processes, digitation of the system, establishing central command and control systems, etc.;

— enhancing the protection systems and procedures against risks stemming from the use of cyber communications;

— protecting against risks stemming from pathogens and chemicals.

Attention should be given to the potential adoption of future resilient technologies, see also ISO 24591-1[16][2)] and ISO 24591-2[17][3)].

6 Management components of a wastewater utility

6.1 General

It is recommended that the wastewater utility establish an integrated management approach that encompasses all the management components for providing the wastewater services, consisting of:

— activities and processes;

— resources;

— assets;

— customer relations;

— information;

— environment;

1) Under preparation. Stage at the time of publication: ISO 24566-1:2023, ISO/DIS 24566-2:2023, ISO/CD 24566-3:2023, ISO/CD 24566-4:2023.

2) Under preparation. Stage at the time of publication: ISO/FDIS 24591-1:2023.

3) Under preparation. Stage at the time of publication: ISO/FDIS 24591-2:2023.

— risks;

— user and regulatory demands;

— available technologies;

— maintenance.

The management components should also take into account a whole business approach, including interactions with potential partners and stakeholders, and possibilities of trade-offs.

Possible actions related to the management components addressed in 6.2 to 6.8 are given in Annex C.

6.2 Activities and process management

There are many individual activities and processes (operations) within a wastewater utility. These are undertaken at all levels within the hierarchy of the organization. Activities and process management include:

— policy-making;

— procedure development;

— strategy formulation;

— regulatory compliance;

— internal and external coordination;

— operations, control, re-engineering of processes;

— risk management, including all aspects and climate change.

6.3 Resources management

Wastewater utilities usually have the following resources that should be managed:

— personnel (human resources);

— material and equipment (non-fixed assets, e.g. spare parts, vehicles, chemicals) (see also 6.4);

— financial resources (revenue and expenditures);

— natural resources (e.g. land and river rights);

— obligations to stakeholders and customers.

6.4 Asset management

Wastewater utilities have tangible and intangible assets. Tangible assets should be managed on a sustainable life-cycle basis.

Management of the assets includes:

— maintaining an up-to-date system inventory;

— monitoring and documenting data;

— assessing system condition;

— planning, maintaining or rehabilitating the system;

— optimizing depreciation and reinvestment;

— identifying and managing risks;

— assuring security of the assets of terrorism and cyber threats.

All of these actions aim to ensure the serviceability of the assets. Guidance can be found in ISO 55000[19], ISO 55001[20], ISO 24516-3[7] and ISO 24516-4[8].

6.5 Customer relations management

A wastewater utility exists to provide service to its users. Customer relations management is critical to the success of the utility. Examples include:

— identifying user needs and expectations;

— striving to meet user needs and expectations;

— registering and handling of complaints;

— accounting and billing;

— communicating, educating and disseminating information.

For further guidance, see ISO 24510[5].

6.6 Information management

In all wastewater services, information management is becoming increasingly important and a feature of regulatory control programmes. Information management consists of:

— data management;

— acquisition;

— evaluation;

— registration;

— updating of data;

— data dissemination;

— information security and backup.

Increasingly, information should be communicated transparently within the utility as well as to relevant authorities, users and other stakeholders.

6.7 Environmental management

The planned development of the wastewater system should be based on a long-term strategy for environmental protection, including the needs of future generations and the impacts of climate change. It should involve improving the wastewater system step by step, taking into account the population and urbanization development, safeguarding public health and mitigation of flooding hazards.

6.8 Risk management

Risk management comprises proactive approaches taken to assure the continuity of the service and the protection of public health and is of great importance. Risk management covers:

a) emergency situations caused, for example, by technological failures, natural disasters (e.g. earthquakes, extreme weather events), criminal acts of vandalism or terrorism or other accidents;

b) qualitative and quantitative aspects linked to chronic or permanent situations, such as insufficient supply systems, regular pollution or conflicts between users (e.g. agriculture, industry).

Examples of risk management steps include:

— conducting hazard analyses;

— establishing and monitoring critical points of control;

— developing standard operating procedures including health and safety planning and management of the wastewater/sewage treatment plant operators;

— providing and implementing scheduled preventive maintenance programmes;

— maintaining on-hand inventories of materials and critical equipment;

— developing and exercising contingency and emergency plans.

7 Guidelines for the management of wastewater utilities

7.1 General

The task of the wastewater utility is to collect, transport, treat, dispose of and or reuse or facilitate the reuse of wastewater and its residues, addressing all the components of the management of the wastewater utility as stated in Clause 6 in order to fulfil the objectives as stated in Clause 5.

The organization's management structure should be designed to ensure the correct, effective and efficient planning, implementation, monitoring and checking of all tasks, processes and activities. It should encompass the full range of provided services or functions.

Process management of and within wastewater utilities should be carried out using the methodology of plan-do-check-act as follows:

— plan: establish the objectives and processes necessary to deliver results in accordance with customer demands and organizational policies;

— do: implement the processes;

— check: monitor and measure processes and product against policies, objectives and requirements for the product and report the results;

— act: take actions to continually improve process performance.

Centralized and on-site wastewater services should be improved and monitored to aid the protection of water resources and the receiving environment from pollution and to ensure maximum recovery and reuse of wastewater and residues.

Consideration should be given to the multi-barrier approach and to the safety plans:

a) wastewater treatment should result in an appropriate quality of the effluent;

b) the wastewater network should be planned, constructed, operated and maintained in order to minimize changes in the wastewater quality and to avoid, in particular, the entry of pollutants and microorganisms that can affect negatively the function and performance of the wastewater treatment plant;

c) the residues should have minimum impact on the environment.

Since a wastewater utility exists to serve its users, special consideration should be given to achieving user satisfaction. For further guidance, see ISO 24510[5].

For possible actions to achieve the objectives of a wastewater utility, see Annex B.

For possible actions to improve the management of a wastewater utility, see Annex C.

7.2 Organization

7.2.1 General

The wastewater utility should establish and document a management system comprising its hierarchy and organizational structure, responsibilities and workflow.

Periodic reviews of the management system should be carried out to ensure proper application and continual improvement.

Managers and supervisors should periodically check all legal and other requirements for compliance. If they detect non-compliance, they should initiate immediate remedial action. Should they detect non-conformity or deviation in the organizational responsibility, the workflow and or the documented regulations, appropriate corrective action should be undertaken. Attention should be paid to the security of the data management system, including any automated operational system against cyber security issues.

Management capability appropriate to the organization is required.

Adequate financial capability and funding should be provided to meet both the day-to-day operational and long-term sustainable capital requirements.

Consideration should be given to developing and making the best use of staff expertise.

At all levels, there should be sufficient staff with the necessary specialized education and training. An environment of continuous education and training should also be established.

7.2.2 Organizational structure and responsibilities

The wastewater utility should define all tasks, competencies and responsibilities relating to the activities. The management structure and organization should be clearly defined to establish responsibilities to ensure that all activities are completed correctly.

In addition to the person or persons in charge of checking and supervision, the water utility should have at its disposal a sufficient number of qualified staff. The number of staff required for the individual tasks and activities should correspond to the type and size of the water utility, the condition and size of the distribution system and any outsourced activities. The potential unavailability of staff due to holiday leave, sick leave and in-service training, as well as staff required for the proper control of fault and emergency situations, should be taken into account.

7.2.3 Organization of work flow

The wastewater utility should define the sequence of all essential operations required for the proper performance of its tasks, processes and activities on the basis of its hierarchical organization (see Clause 6), ensuring that both internal cooperation and the interfaces resulting from the integration of third-party organizations are organized in a coordinated manner. More detailed working instructions (such as standard operating procedures and operation and maintenance manuals) should be prepared whenever required, in order to ensure the proper and expert handling of individual activities, adhering to applicable national or generally accepted requirements or practices.

There should be a clear definition of the type, scope and level of detail of the organization of workflow, including the qualification level and in-service proficiency of the employees in charge of handling all tasks and activities. Attention should be given also to employee work-life balance, ensuring adequate time for family matters.

7.2.4 Operational documents and records

All tasks and activities as set out in Clause 6 should be properly documented and maintained as evidence of conformity.

Managers and supervisors should check these records at regular intervals.

All supervision and checking activities should be documented.

If not stated otherwise in national legal provisions, license permits and official directions or the nationally generally accepted requirements or practices, every document should be kept on record for a defined period. Secure retention or backup of such documents should be ensured in case of emergency or loss.

Examples of documents and records include:

— plans and documentation of the system (including control systems);

— operating instructions, diaries, records and work rules;

— financial records;

— employee records, including training, occupational health-and-safety-related records;

— test records, proof of maintenance;

— records of wastewater analysis, effluents and residue quality and quantity;

— contractual and legal affairs.

7.3 Planning and construction

The planning, development and construction of the wastewater system should be based on a long-term strategy for safeguarding the residents' health and safety, as well as protection of the natural and built environment and due consideration to the needs of future generations. It should be done by improving the wastewater system step by step, taking into account:

— local climatic conditions;

— the possibility of climate change;

— the population and urbanization development;

— the evolution of stakeholders' needs and expectations;

— changes in mandatory and legal requirements.

The construction of wastewater system components should be carried out in an economic, reliable and environmentally compatible manner. In all cases in which the effluent does not have the necessary quality level at all time, it should be treated to meet the required effluent standards.

Within the framework of this supply concept, all necessary approval and notice procedures should be carried out, interest in land and rights of way should be secured, technical design should be determined and the financing of all measures should be safeguarded.

In the case of contracting, the wastewater utility should determine and verify the contractor’s professional suitability and willingness to perform the work.

In construction projects, the wastewater utility should ensure that construction management and supervision, as well as the acceptance of contracted work, are carried out properly. Within the framework of acceptance of contracted work, it should be verified by suitable testing that the construction was done properly.

7.4 Operations and maintenance

7.4.1 General

Operations and maintenance of the wastewater system can include:

a) service connection (control of quality of installation of the connection, control of the impact of industrial connections);

b) collection and transport (e.g. inspection and assessment of conditions of sewers and drains, rehabilitation of sewers and drains, inspection of the on-site system at each emptying operation, inspection and maintenance of haulage tankers);

c) treatment, reuse (if possible) or discharge or disposal of the treated wastewater and the sludge.

The wastewater operator should develop a plan for an operation and maintenance strategy, covering both proactive and reactive activities. Proactive maintenance includes maintenance performed at planned, condition-orientated or scheduled intervals to prevent, minimize or delay failures or shutdowns that result in unplanned maintenance activities, or to ensure continued, efficient asset operation and to prolong asset life. Corrective or reactive maintenance includes maintenance performed following a failure or shutdown and involves activities necessary to repair or restore assets or systems of assets to a satisfactory condition or level of performance.

The activities and responsibilities of the wastewater operator should cover the following aspects:

— operations;

— operational efficiency controls;

— maintenance (servicing, inspection, rehabilitation, repair);

— monitoring of wastewater and residue quality and quantity;

— commissioning (stopping, restarting, decommissioning), possibly in conjunction with the responsible body;

— troubleshooting (during and outside normal hours of work);

— documentation;

— emergency response.

The management of all processes with the wastewater utilities should be undertaken in a manner that optimizes the use of equipment and resources involved.

7.4.2 Technical activities

7.4.2.1 Wastewater transport system

Wastewater can be transported by different means (e.g. pipelines, road tankers). The system should be operated in accordance with its specifications. The proper operation of the wastewater transport system may require in particular:

— controlling the transported wastewater quality, quantity, flow velocity;

— adjusting gates and or overflow weirs to the volume of wastewater transported;

— driving, filling and emptying road transport tank vehicles.

7.4.2.2 Wastewater treatment facilities

The management of treatment and other processes by the wastewater utilities should be undertaken in a manner that optimizes the use of equipment and resources involved.

Each unit of the wastewater treatment facilities should be operated in accordance with its specifications. The proper operation of the treatment facilities may require in particular:

— adjusting the treatment processes and the type and volume of chemicals used to the characteristics of the wastewater or residues treated;

— ensuring the regular supply of treatment products (e.g. chemicals), their correct storage and maintenance of receiving and dosing equipment;

— controlling the disposal or reuse of waste and of residues;

— controlling the efficiency of the processes and establishing and monitoring critical control points.

7.4.2.3 Emergency provisions

The continuity of provision of the wastewater service to users for protection of public health and environment should be a priority for the wastewater utility. The wastewater utility should therefore be prepared to take the necessary steps to deal with emergency situations.

Emergency situations can include technological failures (e.g. pipe failures), natural disasters (e.g. earthquakes and severe weather events) and criminal acts (e.g. vandalism and terrorism). Emergency plans covering all these situations should be developed. When service is interrupted, it should be restored as soon as possible. Special attention should be given to the needs of critical users or critical service areas.

For emergency situations, in order to minimize the negative impacts on the wastewater service, the wastewater utility should formulate an emergency response plan based on an assessment of risks.

It is recommended that the emergency plans be tested and that simulation exercises be conducted in order to train the operating personnel in managing emergency situations. Experience of previous emergencies and simulation exercises should be documented.

On the basis of the risks previously analysed and classified, preventive actions should be assessed and economically evaluated and appropriate response initiated.

7.4.3 Support activities

7.4.3.1 Purchasing equipment, materials and products

Written procedures should be established for both the procurement and stockpiling of all materials, equipment and products.

Clear and precise specifications should be produced and conformity assessed.

Appropriate equipment should be available to employees to carry out the tasks and activities.

The type of material used for wastewater system components (e.g. pipes, tanks, valves and gates) should be chosen based on the quality of wastewater allowed to be discharged to the system, especially as it applies to commercial and industrial discharges and takes into account the physical demands placed on the system components during installation and operation.

These should be included in both the procurement specifications and the installation and operating instructions for all such materials and components.

7.4.3.2 Contractual and legal affairs

All rights permits and contracts (e.g. supply contracts, customer contracts) should be managed properly. Specific attention should be paid to material requirements, discharge consents or discharge permits, rights to lay sewers, easements for treatment and disposal facilities.

7.4.3.3 Accounting or billing

The accounting system should take into account all costs and may include environmental and resource costs. If users are charged for the provision of wastewater, fees may reflect the full or partial costs of the wastewater utility, in accordance with applicable social policies. The calculation of the fee should be transparent.

7.4.3.4 Human resources

The wastewater utility should ensure that all employees are educated, trained and qualified for the tasks to be carried out.

Employees should be capable of accomplishing the tasks assigned to them. Furthermore, specially instructed, experienced or expert staff may be required to carry out special activities, in accordance with applicable provisions and generally accepted technical rules for the prevention of accidents. Before assigning a task, it should be shown that the relevant qualification requirements are met.

The utility management should be responsible for providing sufficient and suitable in-service training and instructions to maintain the qualification.

7.4.3.5 Protection of labour

The wastewater utility should provide a safe environment, appropriate equipment (e.g. personal safety equipment) and work procedures. The personnel concerned should receive instruction and training on working safely, with routine follow-up training as appropriate. Attention should be paid to the occupational health for all personnel with respect to specific risks in operating wastewater systems.

The protection of labour is especially important with the effects of climate change.

7.4.3.6 Outsourcing

When outsourcing work to a contractor, or the possibility of a public-private partnership, the responsibility for the overall service should remain with the wastewater utility. Consequently, the utility should specify that the contractor for the outsourced work:

— has all the necessary personnel and material resources to do the work;

— is capable of ensuring the proper monitoring and checking of its own activities;

— has staff of suitable skills, reliability and efficiency, as well as having the technical and expert knowledge required to perform the tasks in question;

— reports reliably and regularly on its activities and the conditions of its contract.

In the interests of stakeholder concerns about transparency, care should be taken in the provisions of the contract to maximize public access to the terms of the contract and to the outputs achieved.

7.4.3.7 Protection of the environment

Planning the development of the wastewater system should be based on a long-term strategy for environmental protection, by improving the wastewater system step-by-step, taking into account:

— the population and urbanization development;

— the possibilities for wastewater management and the reuse of treated effluents and residues;

— the safeguarding of public health and the protection of water sources;

— the interests of future generations.

The environmental impacts addressed cover more than just water-related issues and may be permanent or temporary.

Environmental management is an essential part of operating a wastewater utility and for planning its future development.

Examples of environmental management, in addition to the items mentioned under planning, include minimizing impacts of construction and repair activities (e.g. noise, community disruption).

In undertaking environmental protection plans, the utility should take into account climate change issues.

7.4.3.8 Public awareness and communications

The wastewater utility should develop and implement:

— activities to raise public awareness regarding the importance and costs of operations of the wastewater collection and treatment services, as well as disposal or reuse of treated wastewater and residues;

— programmes to communicate with the public regarding levels of service, customer needs, protection of water resources and economic, social or environmental sustainability of wastewater services.

8 Assessment of wastewater services

8.1 General

Assessment as a process should be managed to achieve a clear and precise purpose and refer to the objectives outlined in Clause 5. The following should be established as part of a comprehensive policy (see 8.2):

— the goal and scope of the assessment (see 8.3);

— the parties involved in the assessment (see 8.4);

— the methodology of assessment (see 8.5);

— the necessary service assessment criteria (see 8.6);

— the resources necessary to conduct the assessment (see 8.7);

— the production of output and recommendations for the use of the output (8.8);

— the reliability and credibility of the data to be used in the assessment;

— the consistency of the data collected for the assessment and the methods to collect it for the consistency of the output.

How and by whom the assessment information is to be used should also be identified.

If not precisely specified, the assessment can cause confusion or conflicts among the parties involved.

There is a great variety of types of assessment, depending on the characteristics listed.

EXAMPLE Environmental performance assessment, conformity assessment relating to best practice, risk assessment, audits.

The output of this process (i.e. assessment as a result) should facilitate the further decision-making process for the stakeholder requesting the assessment.

8.2 Assessment policy

The responsible body should establish a comprehensive policy for the assessment of service.

A sound assessment policy is a key component of the continuous improvement of the service. It should give a general framework for the assessment. It facilitates the determination of the actual situation and how strategic planning and decision-making influence performance.

The assessment policy should address the overall efficiency and effectiveness of the strategic planning and decision-making activities. It should be designed to encompass all of the various management systems and procedures and include self-assessment in the management component.

It should assist in the measurement of achievements of the various functions and activities performed for providing the services, closing the cycle and linking the following:

— the set of objectives stipulated in Clause 5;

— the guidelines for satisfying users' needs and expectations in Clause 6;

— the selected assessment criteria in Clause 8.

Assessment should be designed and implemented as a tool for promoting the development of collective learning and feedback to decision-making.

8.3 Goal and scope of the assessment

The general goal of assessment is to check if the water service objectives concerning the users have been met. Objectives for the service to users are defined in Clause 5.

The goal and scope for a specific assessment should be clearly defined.

This document does not deal with the assessment of the management of the utility.

Service assessments should be focused on service performance, on the satisfaction of users and on meeting regulation requirements and the objectives for the service, but not on the means used or the detailed organization implemented for meeting the objectives.

Part of the assessment of water services deals with the assessment of service to users. For service to users, assessment should focus on the interface between the utility and the user (e.g. measuring user satisfaction). Assessment of service to users should involve effectively the users in the process. More guidance is given in ISO 24510[5] for identifying users' expectations and their criteria for assessing the quality of the service.

With regard to assessment of water services (in addition to the assessment of service to users), the general recommendation is to focus on the service performance. Nevertheless, some activities do not fit well with direct measurement of their performance. In such cases, indirect assessment of the performance can be accomplished through the evaluation of some management systems (e.g. risk management, security management, asset management).

8.4 Parties involved in the assessment

The responsible parties and all other parties (e.g. the assessment team) involved in the assessment should be clearly defined. Their responsibilities, their role in the process and the framework of operation for each party should be specified.

When the responsible body and the operator(s) are not the same legal body, assessment procedures, if not fixed by legal requirements from the relevant authorities, should be agreed to in advance to provide coherent assessment results from all involved parties, in accordance with respective rights and responsibilities. The responsible body and its operator(s) should take a consistent position relevant to the assessment procedures concerning service to users.

8.5 Methodology of assessment

Due to the diversity of legal, institutional and managerial systems governing water services, this document does not present detailed service assessment procedures. However, this document should be used to configure assessment procedures appropriate to local conditions.

The selection of the assessment tools should fit the assessment goals and scope. Performance indicator systems are one of these tools (see Clause 9).

NOTE In some cases, specifications for assessments can be required by relevant authorities or by financial investors.

Assessment methodology and procedures should be:

— developed with a capacity for repeated measurement to determine trends;

— periodically reviewed to check their efficiency and effectiveness, paying attention notably to avoidance of duplication;

— flexible to adjust to changes in goals, framework, assessment criteria and indicators as new insights are gained;

— weighing the reliability, consistency and effectiveness of the data to be used in the assessment, including plans to upgrade data that is not available, accurate or accessible enough.

Some types of assessment procedures will possibly already be standardized. In such cases, it is recommended that the relevant standards be used.

EXAMPLE Review ISO 9001[1]; environmental performance evaluation (ISO 14031:2021[3]).

If, at a geographically relevant level (country, region and city), specifications are established for the water services, then these specifications should also include provisions concerning assessment processes (e.g. user satisfaction).

8.6 Service assessment criteria

The necessary service assessment criteria should be selected in accordance with the objectives and requirements of interest as determined by stakeholders, taking into account local conditions.

Each service assessment criteria should be discussed in order to establish the optimal output – the most representative, realistic, specific, efficient in the measuring technology and procedure, in representing the specific criteria, and financially acceptable.

Service assessment criteria are the link between objectives and performance indicators. The following example shows, for one of the objectives proposed in Clause 5, possible service assessment criteria. More examples are given in Annex D.

It should be noted that a service assessment criterion can be related to more than one objective.

EXAMPLE

Objective: protection of public health.

Possible service assessment criteria include:

— safe and complete collection of wastewaters discharged;

— adequate hydraulic capacity for safe transport;

— sufficient collection system robustness and integrity;

— adequate and safe wastewater treatment;

— safe disposal or reuse of treated wastewater and the separated wastewater residues.

8.7 Resources to conduct the assessment

The responsible party for the assessment should ensure that the necessary resources, including human, financial, organizational and required information technology, are available, including the search for possible procedures and technological measuring systems for the establishment of the optimal output. The team with the responsibility for carrying out the assessment should be clearly defined. This team should be empowered to specify and steer the assessment process within the given framework (e.g. goals, scope, resources, parties involved, methodology, outputs).

8.8 The production of output and recommendations for the use of the output

The output of assessment should be a report about the assessment process and its results. It should include additional guidelines for the use of these outputs. The output should make transparent the distinction between the defined targets and the actual service and make achieved levels of performance publicly available.

9 Performance indicators

9.1 General

Performance indicators are used to measure the efficiency and effectiveness of a utility in achieving its objectives, particularly those identified in Clause 5, for example resilience of the city to climate change effects and water security issues. The use of key performance indicators can provide wastewater utilities with tools to define, measure, grade and rank their performance, while aiming towards a higher standard.

NOTE No performance indicators are included in this document for on-site systems, as these do not form part of a wastewater utility. If a wastewater utility (legal entity) is formed through the collective or community ownership or management of on-site systems, then that entity will possibly wish to consider establishing a performance indicator framework for its use with the objectives of managing and improving performance and reporting to its stakeholders.

It is recommended that the owner of an on-site wastewater system should have the performance of that system monitored either directly or indirectly by a service organization (e.g. a septage haulier or a local government organization) for the quality of the effluent discharged from the system.

Performance indicator systems should be considered as a key assessment tool among the various existing assessment tools (see Clause 9).

Performance indicators should be used within the context of a comprehensive service assessment system. This system should include, among other tools, a coherent set of indicators and the related components that allow for a clear definition of these performance indicators and assist in their interpretation.

Appropriate performance indicators should reflect the agreed upon objectives for the water utility and the service standards, which can vary from water utility to water utility and the responsible body.

9.2 Performance indicator systems

9.2.1 Key components of a performance indicator system

A performance indicator system comprises a set of the following key components:

— performance indicators;

— context information;

— variables;

— programme of actions and periodic follow-up.

In addition, specific targets for each indicator should be established and routinely monitored, tracked and adjusted as needed.

9.2.2 Performance indicators

Individual performance indicators should be unique and collectively appropriate for representing the relevant aspects of the service in a true and unbiased way.

Each performance indicator should:

— be clearly defined, with a concise and unequivocal interpretation;

— be assessed from variables that are easily and reliably measured, at a definite frequency of collection report and audit and at a reasonable cost;

— contribute to the expression of the level of actual performance achieved in a certain area;

— be related to a specified geographical area (in the case of comparison analysis, this should be for the same geographical area);

— be related to a specific time period (e.g. annual, quarterly);

— allow for a clear comparison with targeted objectives and simplify an otherwise complex analysis;

— be verifiable;

— be simple and easy to understand;

— be objective and avoid any personal or subjective appraisal.

Performance indicators are typically expressed as ratios between variables. These ratios may be commensurate (e.g. %) or non-commensurate (e.g. $\$/m^3$). In the case of non-commensurate ratios, the denominator should represent one dimension of the system (e.g. number of service connections; total water main length; annual costs). This allows for comparisons through time or between systems.

Variables that can vary substantially in time (e.g. annual extraction or discharge volumes), particularly if not under the control of the utility, should be avoided as denominators in the indicator ratios. An exception can be made when the numerator varies in the same proportion as the denominator.

A clear processing rule should be defined for calculating each indicator. The rule should specify all the variables required and their algebraic combination. The variables may be data generated and managed within the utility (utility data) or externally (external data). In either case, the quality of the data should be assessed (see 8.3) and verified. The interpretation of the performance indicators should not be carried out without taking into account the context, particularly if it is based on comparisons with other cases. Therefore, complementary to the performance indicators, the context information should consider also the characteristics of the system and the region in which the services are provided.

Additional information on performance indicators and grading systems for performance indicators is provided in Annexes D, E and F.

9.2.3 Variables

Each variable should:

a) fit the definition of the performance indicator or context information it is used for;

b) refer to the same geographical area and the same period of time or reference date as the performance indicator or context information it will be used for;

c) be as reliable and accurate as the decisions made based on it require.

Some of the variables are external data and mainly informative, and their availability, accuracy, reference dates and limits of the corresponding geographical area is generally out of the control of the utility. In this case, variables should also:

— whenever possible be collected from official sources, which include information on the accuracy and reliability of the variable(s);

— be essential for the performance indicator assessment or interpretation.

9.2.4 Context information

Context information defines inherent characteristics of a system that are relevant for the interpretation of the performance indicators. There are two possible types of context information:

— information describing pure context and external factors that are not under the control of the utility (e.g. demographics, topography, climate);

— characteristics that can only be influenced by management decisions in the long term (e.g. age of the infrastructures).

9.3 Quality of the information

The quality of the data should reflect the importance of the assessment being conducted.

A scheme providing information on data quality is needed so that users of the performance indicators and context information are aware of the reliability of the information available. The value of the performance indicators can be questionable without this scheme.

The scheme should consider, for example, the data format, report, scaling of instruments involved in the process, the control and audit of the updating of the data, accuracy and reliability.

The confidence grade of a performance indicator can be assessed in terms of its accuracy and reliability. The accuracy accounts for measurement errors in the acquisition of input data. The reliability accounts for uncertainties in evaluating the reliability of the source of the data.

An example of a confidence-grading scheme is presented in Annex F.

9.4 Example of a performance indicator

Performance indicators are relevant to service assessment criteria to which they link. The following example shows, for one of the objectives proposed in Clause 5, possible performance indicators relevant to one of the service assessment criteria shown in 8.6. More examples are given in Annex E.

Objective: protection of public health.

The main objective of a wastewater utility should be to ensure safe collection, treatment and disposal or reuse of wastewater for the protection of human health and safety.

Possible service assessment criteria: safe discharge of wastewater.

Possible performance indicator: discharge from wastewater treatment plants (WWTPs) into the receiving bodies complying with discharge consents.

Performance indicator: WWTPs compliance with discharge consents (%).

Definition: percentage of the population equivalent (if applicable) that is served by wastewater treatment plants that comply with the applicable discharge consents.

Processing rule: [population equivalent that is served by wastewater treatment plants conforming to applicable standards (number)] during a defined period of time × 100 / [population equivalent served by wastewater treatment plants managed by the utility during the defined period of time (number)].

Comment: Each responsible body should establish requirements for safe discharge consents from WWTP into the environment and use acceptable methods of measurement. Discharge consents refer to the effluent quality standards that apply. The compliance is assessed regarding the loads or concentrations and their potential environmental impacts. This indicator should normally be assessed for one-year period. It may also be assessed for periods shorter than one year, but special care is required in result interpretation when used for internal or external comparisons.

International Water Association (IWA) code: wEn 1)

NOTE The example presented here uses a short version of how to deal with and calculate a performance indicator.

See Annex E for a more extensive example of how to deal with and calculate a performance indicator.

Annex A
(informative)

Schematics of wastewater systems

A.1 Components of wastewater systems

A wastewater system generally comprises four components:

— a wastewater source;

— a means for collecting or transporting the wastewater from the source or sources (whether by physical connection or not);

— a treatment facility or facilities;

— a discharge, disposal or reuse component for treated effluents and the separated residues.

In some simple systems (e.g. pit latrines), the treatment component is not present or, if present, can include only a screening component, depending on the quantity and quality of the wastewater and the disposal method.

In more complex wastewater systems, there can be multiple sources of widely varying wastewater quality, multiple pumping stations and storage or equalization tanks in the collection and transport system, or a combination of pumped and trucked wastewaters, multiple stages to the treatment facility and processes, pumping and re-treatment facilities in the disposal or reuse component, including treated wastewater reservoirs, processed residues or compost storage areas, post treatment transportation elements to deliver treated wastewater or wastewater residues to the point-of-use.

A.2 Schematic of wastewater systems

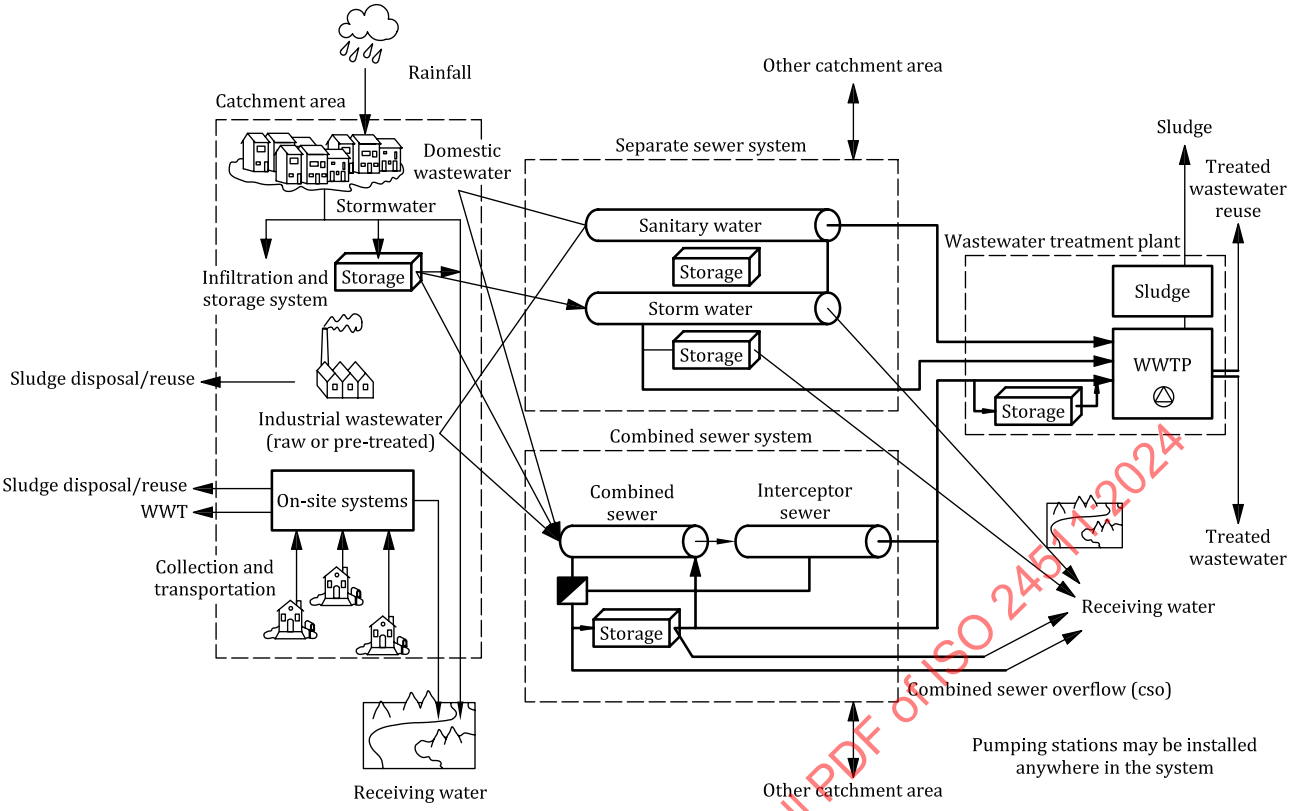
Figure A.1 provides a schematic of wastewater systems.

NOTE Depending on the extent of the development of the wastewater services in a particular country or area, the nature of the system components can vary. For on-site systems, only one or a few of the previously mentioned components of the system can be used (e.g. only collection, disposal). See A.3.

A.3 Types of wastewater systems

Figure A.2 shows different types of wastewater systems.

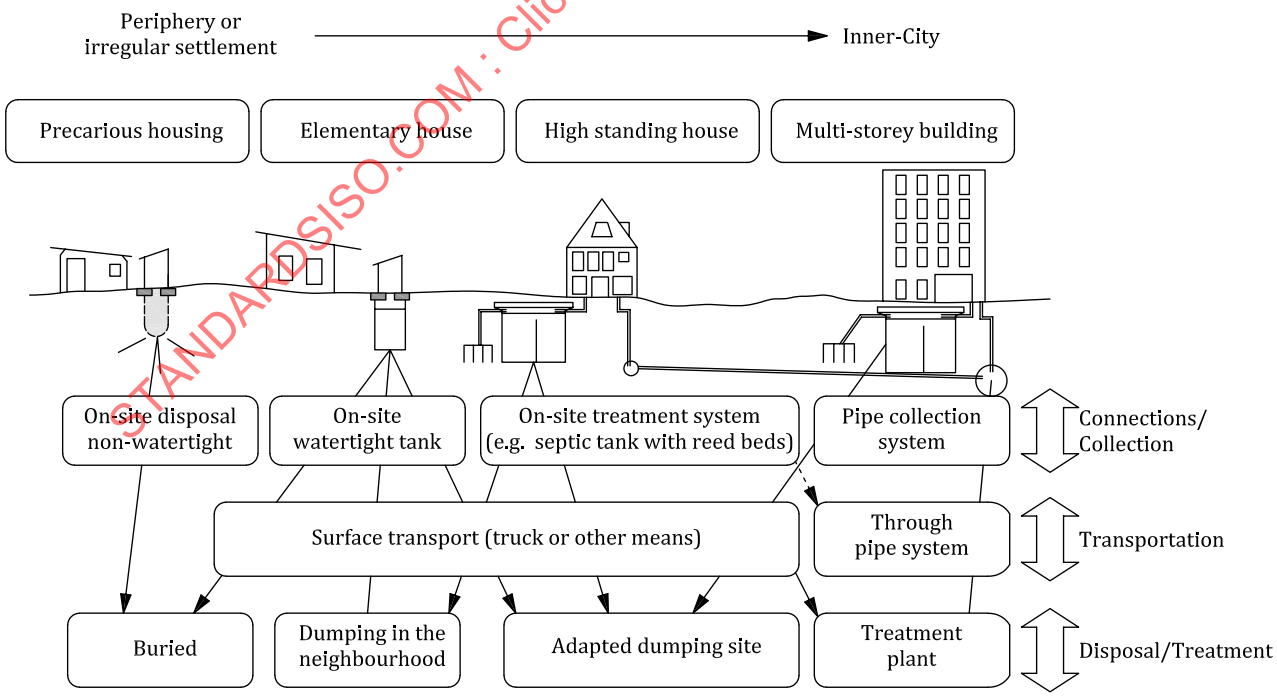
NOTE The following terms are commonly used when referring to on-site wastewater systems: improved traditional latrine, ventilated improved pit latrine, double-vault compost latrine, bored hole latrine, pour-flush latrine, septic tank, vacuum tanker.



NOTE In this document, the term "sludge" is replaced by the term "residue".

SOURCE Reprinted with permission from *Performance Indicators for Wastewater Services, Manual of Best Practice Series*. London: IWA Publishing, 2003. ISBN: 1900222906.[38]

Figure A.1 — Schematic of wastewater systems



SOURCE Based on a scheme from Hydroconseil, France, 2002.

Figure A.2 — Types of wastewater systems

Annex B
(informative)

Possible actions to achieve the objectives of the wastewater utility

In order to achieve the objectives described in Clause 5, a series of related possible actions can be developed, which can serve to achieve more than one objective, as illustrated in Table B.1.

Table B.1 — Wastewater utility objectives and examples of possible actions

Wastewater utility objective	Examples of possible actions
Protection of public health (see 5.2)	— maintain and secure health and safety of personnel — provide training for personnel to improve their abilities — identify and meet user needs — respond to user complaints swiftly and appropriately — provide users with communication opportunities to express their opinions — give consideration to people in neighbouring communities to gain their support — provide understandable and transparent information to users, — act as a responsible stakeholder in watershed or river basin institutions — promote integrated water resource management in water projects — control and limit pollution in the flows of water returned to the environment or reused — protect water quality in public water bodies — educate users on environmental management concerns and also on not to discharge certain substances — do not adversely affect wastewater systems or the environment (e.g. establish sewer by-laws) — consider local rules, regulations and user requirements
NOTE Certain actions can be applicable to more than one objective.	

Table B.1 *(continued)*

Wastewater utility objective	Examples of possible actions
	— minimize the impacts of combined sewer overflows (CSO) — address diffuse pollutants in stormwater systems — utilize good practices for disposal or reuse of the wastewater collection and treatment residues — maintain stable quality of final effluent against, fluctuation of water quality and quantity in influent — improve service quality by developing and introducing new technologies — maintain backup systems to avoid overflow of untreated wastewater into the environment and to maintain quality of final effluent in cases of power supply interruptions or break-downs of wastewater system elements (e.g. pumps, treatment process equipment)
Meeting users' needs and expectations (see 5.3)	— see ISO 24510[5]

Provision of services under normal and emergency situations (see 5.4)	— monitor sewer clogging
	— identify and address problem spots of the network (where blockages reoccur)
	— keep an appropriate stock of spare parts (e.g. sewer pipes, pumps)
	— limit impact of disasters and accidents:
	  — provide information to related organizations
	  — establish systems to cope with leakage and inflow of toxic, hazardous or explosive substances
	  — prepare for earthquake and other natural disasters
	  — operate and maintain rainwater drainage systems for flood control
	  — develop a plan to secure public health in cases of possible system damage from natural disasters, e.g. earthquakes

Sustainability of the wastewater utility (see 5.5)	— develop applicable revenue sources to ensure cost recovery and long-term sustainability of the wastewater infrastructure and services — ensure long-term functionality of systems while considering cost-effectiveness — assign qualified personnel — develop a clear and fair service charge structure that accounts for local economic considerations and revitalization efforts, considering affordability of service to users — maintain an up-to-date asset inventory and forecast new asset needs — maintain sound finances in accordance with long-term management projections
NOTE Certain actions can be applicable to more than one objective.	

Table B.1 *(continued)*

Wastewater utility objective	Examples of possible actions
	— analyse management conditions using appropriate methods while considering regional characteristic — continue cost reduction efforts — identify and meet user needs — respond to users' complaints swiftly and appropriately — provide users with communication opportunities to express their opinions — apply measures against ageing of system components to maintain sound systems — act as a responsible stakeholder in basin institutions — maintain and secure health and safety of personnel — provide training for personnel to improve their abilities — provide users with communication opportunities to express their opinions — give consideration to people in neighbouring communities to gain their support — improve service quality by developing and introducing new technologies — participate as volunteers in local events

Promotion of sustainable development of the community
(see 5.6)
	— contribute to sustainable integrated water resources management policies
	— act as a responsible stakeholder in basin institutions
	— promote integrated water resources management in water projects
	— promote reuse of treated wastewater
	— optimize energy efficiency and minimize consumption of energy in wastewater systems
	— optimize the use of renewable energy in wastewater systems
	— ensure users comply with requirements to connect to wastewater systems, including limitations on:
	  — quantity and quality of wastewater discharged
	  — related generation of gases, noise, vibration and odours
	  — ability to dispose and reuse wastewater residues
	— maximize utilization of wastewater residues:
	  — use as energy source
	  — recycle as fertilizer for greenery and agricultural land
	  — recycle as construction materials
	— utilize good practices for disposal or reuse of wastewater residues

NOTE Certain actions can be applicable to more than one objective.	

Table B.1 *(continued)*

Wastewater utility objective	Examples of possible actions

Protection of the natural environment (see 5.7.1)	— promote integrated water resources management in water projects
	— control and limit pollution in the flows of water returned to the environment or reused
	— protect water quality in water bodies
	— promote reuse of treated wastewater
	— operate wastewater systems with considerations for the global environment
	— educate users on environmental management concerns, including impact of hazardous substances
	— establish and enforce sewer by-laws to protect wastewater systems and the environment
	— minimize the impacts of combined sewer overflows (CSO)
	— address diffuse pollutants in stormwater systems
	— maintain stable final effluent quality irrespective of fluctuations in quality and quantity of influents
	— limit impact of disasters and accidents:
	  — provide information to related organizations
	  — establish systems to cope with leakage and inflow of toxic, hazardous or explosive substances
	  — prepare for earthquakes and other natural disasters
	  — operate and maintain stormwater systems for flood control
	  — develop a plan to secure public health under emergency conditions by ensuring or restoring continuity of service
	— monitor the wastewater system processes
	— provide monitoring systems to prevent inflow of hazardous substances into the wastewater system

NOTE Certain actions can be applicable to more than one objective.	

Table B.1 *(continued)*

Wastewater utility objective	Examples of possible actions
Protection of the built or public environment (see 5.7.2)	— ensure users comply with requirements to connect to wastewater systems, including limitations on: — quantity and quality of wastewater discharged — related generation of gases, noise, vibration and odours — ability to dispose and reuse wastewater residues — utilize good practices for disposal or reuse of the wastewater residues — conduct systematic operations and preventive as well as reactive maintenance for stable service and activities: — apply measures to prolong the life of system components to maintain sound systems — prevent any subsidence due to pipe collapse — maintain stable water quality of final effluent against fluctuation of water quality and quantity in influent — limit impact of disasters and accidents: — provide information to related organizations, — establish systems to cope with leakage and inflow of toxic, hazardous or explosive substances — prepare for earthquakes and other natural disasters — operate and maintain stormwater systems for flood control — develop a plan to secure public health under emergency conditions by ensuring or restoring continuity of service — guide the management of commercial and industrial discharge into the sewer system in accordance with applicable requirements, through information and education campaigns — provide monitoring system to prevent inflow of hazardous substances into wastewater systems — maintain backup systems to avoid overflow of untreated wastewater into the environment and to maintain quality of final effluent in cases of power supply interruptions or break-downs of wastewater system elements (e.g. pumps, treatment process equipment) — minimize infiltration and exfiltration in wastewater systems
Climate change (see 5.8)	— follow the current information about climate change's impact on water sources that can affect water systems — study the potential risks to the water systems associated with climate change phenomena — monitor changes in water flow and flow distribution due to climate change
Higher user and regulatory demand (see 5.9)	— study the trends in the demands by users regarding the quality and changes in the services provided to users and prepare to respond to those trends — keep track of the plans for changing or adding to the regulatory requests by authorities, such as the health and environmental authorities and prepare to satisfy these new or changed requests
NOTE Certain actions can be applicable to more than one objective.	

Table B.1 *(continued)*

Wastewater utility objective	Examples of possible actions
Available technologies (see 5.10)	— implement data mining and analysis (geographic information system for mapping and management purposes) — implement communications and digitation (central command and control) — implement protections against risks stemming from the use of cyber communications
NOTE Certain actions can be applicable to more than one objective.	

Annex C
(informative)

Possible actions related to the management of the wastewater utility

The possible actions illustrated in Table C.1 are developed from the possible actions shown in Table B.1, related to the management components of the wastewater utility.

Table C.1 — Management components and examples of possible actions

Management components of the wastewater system	Examples of possible actions
Activities and process management (see 6.2)	— establish corporate objectives — establish corporate strategies — develop and implement strategic, tactical and operation plans — identify regulatory requirements and assure compliance — assure coordination between processes — establish operational procedures — ensure protection of automated systems from cyber terrorism
Resources management – personnel (human resources) (see 6.3)	— secure and maintain health and safety of personnel — employ appropriate personnel for the jobs considering their technical competences and skills — ensure that personnel comply with laws/by-laws/regulations — provide training for personnel to improve their abilities — assign qualified personnel — instruct personnel to act in good faith in relation to customers — ensure that human resources are able to maintain a satisfactory work load or private time balance
Resources management – financial (costs and benefits) (see 6.3)	— develop a clear and fair service charge structure that accounts for local economic considerations and revitalization efforts considering affordability to users — develop applicable revenue sources to ensure cost recovery and long-term sustainability of wastewater infrastructure and services — ensure long-term functionality of systems while considering cost-effectiveness — maintain sound finances in accordance with the long-term management projections — analyse management conditions using appropriate methods while considering regional characteristic — implement cost-effectiveness measures — ensure accounting systems and financial plans are secure against cyber attacks

Table C.1 *(continued)*

Management components of the wastewater system	Examples of possible actions
Assets management (see 6.4)	— maintain an up-to-date asset inventory (technical and financial) — define performance targets for the main types of assets — define asset condition assessment protocols — record failure and repair events — record asset investment and maintenance costs — forecast new asset needs and corresponding costs — ensure that automated systems are protected from cyber attack
Customer relations management (see 6.5)	— identify and meet customer needs — respond to users' complaints swiftly and appropriately — provide users with communication opportunities to express their opinions — give consideration to people in neighbouring communities to gain their support — organize events promoting the wastewater facilities — participate as volunteers in local events — provide understandable and transparent information for users
Information management (see 6.6)	— identify data needs and data flows related to management and to service assessment — define data collection protocols — establish data updating protocols — ensure information integration and protection

Table C.1 *(continued)*

Management components of the wastewater system	Examples of possible actions

Environmental management (see 6.7)	— contribute to sustainable integrated water resources management policies
	— act as a responsible stakeholder in watershed or river basin institutions
	— promote integrated water resources management in wastewater projects,
	— control and limit pollution in the flows of water returning to the environment
	— protect water quality in receiving water bodies
	— consider the impacts of climate change and the need to protect future generations
	— protect and conserve water sources for drinking
	— promote reuse of treated wastewater and residues
	— operate wastewater systems with consideration for the global environment
	— educate users on environmental management concerns and also on not to discharge substances adversely affecting wastewater systems or the environment
	— promote energy efficiency and minimize consumption of energy in wastewater systems
	— optimize the use of renewable energy in wastewater systems
	— comply with local rules and regulations and consider user requirements
	— ensure customers comply with requirements for connection to wastewater systems
	— minimize the impacts of combined sewer overflows (CSO)
	— address diffuse pollutants in stormwater systems
	— maximize utilization of wastewater residues:
	  — use them as energy source
	  — recycle them as fertilizer for greenery and agricultural lands
	  — recycle them as construction materials
	— utilize good practices for disposal or reuse of the wastewater collection and treatment residues

Risk management (see 6.8)	— conduct risk analyses — develop standard operating procedures — provide and implement scheduled preventive maintenance programmes — maintain inventories of materials and critical equipment — develop contingency and emergency plans and exercise these plans in a timely manner

Annex D
(informative)

Example of an assessment methodology for deciding on the implementation and calculation of performance indicators for wastewater utilities

D.1 Example of an assessment methodology for deciding on the implementation and calculation of performance indicators

a) Identify key topics which should be complied with based on measurable performances indicators, such as:

— relevant regulation of water and wastewater quality, asset maintenance, customer service etc.;

— relevant stakeholders' demands.

b) Identify key topics that are recommended as measurable performance indicators.

c) Identify general goals for each topic.

d) Identify and grade benefits and risks from each goal.

e) Identify the stakeholders for each goal.

f) Define – preferably via teams – the different alternatives for performance indicators to each goal and relevant type of set of data, considering:

— existing data in the system, its accuracy, accessibility, and quality;

— procedures and technologies for the collection of the data;

— costs, simplicity, HR effectiveness, etc.

g) Form a suggested frame and calculation formula for each performance indicator considering:

— means of collection;

— frequency of collection;

— format of data to be reported;

— normalization of the performance indicator;

— means to keep or upgrade the accuracy and reliability of data;

— systems to control, monitor, verify and audit all of the above.

h) Form a suggested plan for the implementation of the process, showing:

— human resources;

— responsibilities;

— technologies for the collection of the data;

— data reporting formats, frequencies and formulae to calculate performance indicators, maintenance procedures for equipment, systems, and processes;

— monitor and audit procedures;

— costs;

— benefits and risks;

— timetable for the implementation of each procedure and technology;

— timetables for output achievements analysis that will include data analysis, calculating the variables and outputs of each performance indicator formula, and for the setting of each achievement desired for the next output achievement analysis.

i) Approve the decisions taken from the suggested plan with your stakeholders.

j) Implement the approved plan.

k) At the first output achievement analysis, set a suggested output achievement for the next analysis and a specific plan designed to reach each output achievement, considering:

— realistic of the desired achievement;

— costs;

— timetables, responsibilities, teams;

— priorities and risks;

— technological options;

— regulation and stake holders' demand;

— crisis preparedness;

— customer expectations.

l) Approve the plan with the relevant stakeholders.

m) Implement your approved plan.

n) Monitor and audit your plan.

o) Add, change, and improve each segment of your plan in order to constantly improve the performance of the utility with new technologies, procedures, customers, stakeholders and regulation demands, etc.

D.2 Examples of a wastewater utility's objectives that can be considered as a platform for performance indicators and examples of recommended measurable performance indicators related to each one of these objectives

a) Environment:

— minimum nonconformities from standard requirements of treated wastewater;

— minimum sewage overflows from urban manholes;

— minimum sewage underground losses, minimum upper ground sewage bursts.

b) Public health:

— minimum sewage overflows from urban manholes;

— minimum upper ground sewage bursts.

c) Service level – maximum responding time for telephone, email and frontal waiting time.

d) Systems or infrastructure:

— maximum data for GIS layers;

— age of infrastructure lower than its existence period;

— maximum automation in control systems and sensors.

e) Crisis preparedness – minimum nonconformities in crisis preparedness external audit.

f) Climate changes – existence of long-term master plan that considers climate changes and the degree of its execution.

g) Cyber protection:

— maximum cyber defence systems;

— minimum score at cyber successful hacking attempts at exercise level.

h) Sustainability – maximum reuse of treated wastewater.

i) Redundancy – maximum redundancy for collecting, pumping and treating sewage.

j) Monitoring and audit level – maximum execution of monitoring, event detection and internal and external audits plan, including water demand analysis and tracking.

k) system operation – carbon emission savings, repayable operation to avoid failures.

l) Human Resources:

— maximum professional knowledge for each utility worker on relevant topics;

— maximum redundancy in organizational knowledge, efficient use of HR.

m) Transparency – maximum approved data accessible for customer.

n) Safety:

— minimum accidents and almost-accidents;

— minimum nonconformities in safety internal and external audits.

Annex E
(informative)

Examples of service assessment criteria related to the wastewater utility objectives, performance indicators related to assessment criteria, and service assessment criteria related to componentsof a wastewater system

E.1 Examples of service assessment criteria related to the wastewater utility objectives

E.1.1 General

The wastewater objectives from Clause 5 are stated, followed by examples of possible service assessment criteria.

The examples of objectives and possible service assessment criteria are summarized in Table E.1.

E.1.2 Protection of public health

The main objective of a wastewater utility is to ensure the safe collection, treatment and disposal or reuse of wastewater for the protection of human health and safety (see 5.2).

Possible assessment criteria:

— appropriate coverage of services to users;

— health and safety of personnel;

— system integrity;

— safe discharge of wastewater.

E.1.3 Meeting users' needs and expectations

An objective of a wastewater utility should be to ensure service activities meet users' needs and expectations (see 5.3).

Possible assessment criteria: see ISO 24510[5] for guidance.

E.1.4 Provision of services under normal and emergency situations

An objective of a wastewater utility should be to ensure that, under normal conditions, the wastewater service (collection, treatment and disposal or reuse) is available without interruption. When interruptions have occurred, the objective should be to restore service as quickly as possible (see 5.4).

Possible assessment criteria:

— continuity of wastewater treatment plant operation;

— minimization of sewer blockages;

— development of an emergency plan;

— appropriate stock of spare parts (e.g. sewer pipes, pumps).

E.1.5 Sustainability of the wastewater utility

An objective for a wastewater utility should be to ensure that the quality of the services is maintained and developed, as appropriate, in order to meet current and future needs, taking into account economic and social constraints (see 5.5).

An objective for a wastewater utility should be to ensure that the assets are maintained and developed, as appropriate, in order to meet current and future needs, taking into account economic and social constraints (see 5.5).

Possible assessment criteria:

— network performance (e.g. sewer collapse or blockages);

— assets' condition (e.g. age, reliability);

— operating costs;

— staffing levels and competencies;

— financial performance:

  — billing;

  — collection;

  — debt;

  — affordability.

E.1.6 Promotion of sustainable development of the community

An objective of a wastewater utility is to promote sustainable development namely by promoting efficient use of water and energy, retention and reuse, separation of polluted from non-polluted flows (see 5.6).

Possible assessment criteria:

— reuse of treated wastewater;

— sustainable use of energy (savings and reuse);

— cost recovery and long-term sustainability of services;

— clear and fair charge structures;

— understandable and transparent information to the users or customers.

E.1.7 Protection of the environment

1) Protection of the natural environment

   An objective of a wastewater utility is to ensure the safe collection, treatment and disposal of wastewater for the protection of the natural environment (see 5.7.1).

   Possible assessment criteria:

   — prevention and control of overflows;

   — monitoring of environmental emissions;

   — sustainable use of energy;

   — preservation of ecosystems (flora and fauna).