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Drinking water, wastewater and stormwater systems and services — Operation and maintenance of on-site domestic wastewater services

Systèmes et services relatifs à l'eau potable, à l'assainissement et à la gestion des eaux pluviales — Fonctionnement et maintenance des services d'eaux usées domestiques sur site

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Foreword

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

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

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

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

For an explanation 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*.

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 Operation and maintenance

Operation and maintenance (O&M) activities encompass all decisions and actions needed for controlling and maintaining the facilities of an on-site domestic wastewater system (ODWS) to achieve the system's objectives and to ensure the system meets regulatory requirements.

O&M is essential to the long-term performance of ODWS. All system components require regular or routine maintenance when in operation.

O&M service visits can provide early detection of issues that could result in malfunction of ODWS if left uncorrected. Early detection makes it possible to take action before a system becomes a public health hazard, detrimental to the environment or a liability for the property owner.

Operation includes activities taken in the course of normal functioning, such as control of equipment and inspections. Maintenance includes all preventive and corrective work required to ensure that equipment continues to work efficiently and to keep civil works, buildings and the other facilities in an adequate state. Removal of wastewater and sludge (also referred to as septage) is an essential activity to ensure the proper functioning of ODWS and, depending upon the local context, can be regarded either as operation or maintenance.

This document takes into consideration that each system can have different requirements for inspection and maintenance. Therefore, an understanding of the particular design and operational parameters is essential to ensure the O&M is carried out within the applicable regulatory context.

0.2 Global perspective

WHO/UNICEF estimates in *Progress on Drinking Water, Sanitation and Hygiene*[5] indicate that at the time of the report 2,3 billion people lacked access to "improved sanitation". Of these, 892 million people worldwide still practised open defecation.

Globally, the management of wastewater facilities continues to face dramatic challenges requiring innovative solutions caused by the increasing demand for services, diminishing resources, rising service expectations of customers, climate change impacts and increasingly stringent regulatory requirements.

ODWS are prevalent in all countries and are, in general, managed by owner-operators or community-operators, i.e. by the users who are the residents singly or collectively on the property where the unit or infrastructure is installed. In some cases, ODWS can also be managed by public or private operators rather than the owners of the properties.

However, when ODWS are managed by owner-operators or community-operators, it is observed that the associated facilities are often not properly managed, causing health hazards and pollution into the surrounding environment. This is often due to lack of knowledge or resources. Therefore, it is important to train expert operators and establish an O&M management system.

In some countries, maintenance workers are required by law to hold a specified qualification, which can also stipulate the frequency and content of the maintenance operations.

In developing countries and regions, there are many examples of advanced decentralized wastewater treatment facilities installed in commercial facilities, hotels and hospitals. However, it is a common issue that maintenance guidelines and regulations, which the owners and users of these facilities need to comply with, are insufficiently developed. It needs to be kept in mind that the development of such guidelines and regulations based on this document can bring numerous benefits.

0.3 General objectives

ISO 24521 addresses O&M from a management perspective, i.e. that they should be performed and monitored, but does not provide detailed technical instructions of operational and maintenance activities suitable for and appropriate to such systems.

This document addresses in practical terms the essential O&M activities managed by owner-operators, community-operators or other operators, consolidating the basic technical dos and don’ts for O&M.

This document is primarily intended as an aid for responsible entities when developing guidelines and regulations on O&M that are to be followed by owners, users or operators of ODWS.

Drinking water, wastewater and stormwater systems and services — Operation and maintenance of on-site domestic wastewater services

1 Scope

This document provides guidance and specifications for the operation and maintenance (O&M) of on-site domestic wastewater services, using appropriate technologies at any level of development. This document supplements and is intended to be used in conjunction with ISO 24513 and ISO 24521.

This document provides assistance to relevant authorities, training organizations, certification bodies and other responsible entities for the development of regulations, plans and manuals, as well as information and training materials addressed to operators and users of on-site domestic wastewater systems (ODWS).

This document is applicable to both publicly and privately operated on-site domestic wastewater (blackwater and greywater) systems for one or more dwellings or other premises where wastewater is generated.

The scope of this document includes the following:

— O&M of ODWS from the operator’s perspective;

— O&M of ODWS from the user’s perspective;

— training and information aspects;

— environmental, health and safety issues.

The following are outside the scope of this document:

— detailed design of ODWS;

— limits of acceptability for discharge of wastewater or sludge;

— analytical methods;

— management structure of wastewater services’ activities for O&M;

— content of contracts or subcontracts.

NOTE 1 Management of ODWS, especially in rural areas and areas under development, is sometimes provided by the owners of the premises where wastewater is generated. In such cases, the owners of the premises carry out the management themselves. In this document, the term “services” includes “self-services” provided by the owners or users of the premises.

NOTE 2 Especially in undeveloped areas, sanitary wastewater is collected in an undiluted form. Sources of sanitary wastewater in this document are domestic, excluding stormwater runoff.

NOTE 3 The designation of activities as operation activities or maintenance activities can differ according to the local context. However, it is important that activities essential for the proper functioning of ODWS are carried out, no matter how these activities are designated.

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
back flushing
pumping water into a septic or holding tank to agitate and release solids from the sides and bottom of the tank

3.2
blackwater
black water
wastewater originating from sanitary sources (e.g. toilets, urinals and bidets)

Note 1 to entry: Wastewater from kitchen sinks, food waste grinders or dishwashers can be included, subject to local requirements.

[SOURCE: ISO 20670:2018, 3.10 — definition modified and note to entry added.]

3.3
effluent
wastewater that has been processed through a primary treatment (e.g. settlement unit, septic tank) or a secondary treatment (e.g. wastewater treatment plant)

Note 1 to entry: In the context of wastewater treatment plants, effluent that has been treated is sometimes called secondary effluent or treated effluent.

3.4
soil treatment dispersal area
area where wastewater is distributed through a series of pipes or channels into the soil

3.5
treatment field
soil treatment component of on-site domestic wastewater services

Note 1 to entry: Also referred to as absorption, dispersal, leaching or drainage field.

4 On-site domestic wastewater systems

4.1 General

On-site domestic wastewater systems (ODWS) are widely used throughout the world to treat, dispose of, disperse or reuse domestic wastewater in areas where centralized sewerage systems are not viable or currently not available.

The main objective of an ODWS is to protect public health and the environment.

Any wastewater or effluent entering the groundwater table risks causing severe illness in those who ingest the contaminated water.

High nitrogen and phosphorous loads can enter surface water bodies, causing excess nutrification. This oversupply of nutrients can cause algal blooms or eutrophication, reducing the available oxygen in the water body and causing aquatic life to die off. Algal blooms can also produce toxins that can make the water unsafe for use.

The process of collecting and treating domestic wastewater provides for a reduction in pathogen and bacteria loads, reduction or removal of chemical pollutants, as well as organics, suspended solids (SS) and other contaminants prior to discharge.

ODWS can protect the environment by retaining highly concentrated nutrients (e.g. phosphate, nitrogen). Retention of these resources limits eutrophication and reduces the reliance on alternative sources which are limited (e.g. phosphate) and/or costly (e.g. nitrogen). In addition, disinfection can be used before discharge for more efficient reduction in pathogens (refer also to Annex G).

Proper design, installation and O&M of ODWS are critical to reduce public health issues and/or environmental degradation due to wastewater and effluent. O&M is essential to the long-term performance of ODWS technologies. All system components require regular maintenance. O&M service visits can provide early detection of problems that could result in malfunction of ODWS if not discovered. Early detection makes it possible to take remedial action before a system becomes a public health hazard, a detriment to the environment or a liability for the owner or operator. In order to ensure optimum functionality of an ODWS, any issues should be addressed or faulty components repaired as soon as they are identified.

4.2 Description

An ODWS is a self-contained system designed to store, treat and discharge, disperse or reuse wastewater. An ODWS can serve one or more homes or other premises and is usually situated on the same site as the premise or premises it serves and is not connected to a centralized or public sewer system. Cluster wastewater treatment systems are ODWS that serve two or more premises. Cluster systems serving a small number of premises are also referred to as “shared” systems.

An ODWS can be as simple as a privy or more complex, such as a septic system, an aerobic or anaerobic treatment system or similar systems with or without a soil treatment dispersal area.

Some ODWS are designed, installed and operated to treat wastewater prior to discharge, dispersal or reuse. They are also designed to collect sludge in a safe way and to enable the safe removal of sludge for transport and appropriate further handling. The proper design, installation and O&M of an ODWS are fundamental to ensure system performance and longevity while protecting public health and the environment.

The design process involves:

— comprehensive site and soil evaluation, soil testing;

— assessment of the facility or residential occupancy and use;

— knowledge of the raw wastewater characteristics;

— consideration of effluent quality required by relevant discharge standards;

— wastewater flow rates and volume.

Siting the ODWS requires consideration of the location of other utilities, including wells and any other water sources or water bodies adjacent to or on the property being served. ODWS require adequate vertical and horizontal separation from water tables, water sources and water courses in order to protect the environment as required by the relevant authority. They should also ensure that wastewater and effluent are controlled and dispersed in such a way as to limit contact with humans and domestic animals in order to prevent potential health hazards.

4.3 Components

ODWS can consist of the following components:

— user interface;

— collection;

— removal and transportation;

— treatment;

— disposal, dispersal or reuse.

Further information regarding ODWS components is available in ISO 24521.

4.4 Types

4.4.1 General

On-site domestic wastewater systems (ODWS) vary from basic to advanced technologies and can achieve various levels of treatment, ranging from basic storage to tertiary wastewater treatment.

On-site treatment can be performed either by aerobic or anaerobic processes. These systems can consist of a single treatment unit or a treatment system using a combination of several units, both with an effluent discharge process.

4.4.2 Basic ODWS

The storage of a basic ODWS can consist of a collection unit or holding tank that stores excreta or wastewater, which can be collected at fixed intervals at the place of generation and transported to a dedicated facility, where it is further treated and disposed of. Some of the most basic technologies commonly used for ODWS include improved traditional latrines, ventilated improved pit (VIP) latrines, double-vault compost latrines, bored-hole latrines, pour-flush latrines and holding tanks.

Basic treatment systems can consist of a septic tank (solid-liquid separation process) at the place of generation with the effluent discharging to the environment, either to the soil or to surface water (where allowed). The types of basic ODWS shown in Figure 1 do not describe all options for every user, community or site. The examples provide a range of basic ODWS for different conditions, which can offer solutions to the largest number of users and comply with public health, socioeconomic and environmental requirements.

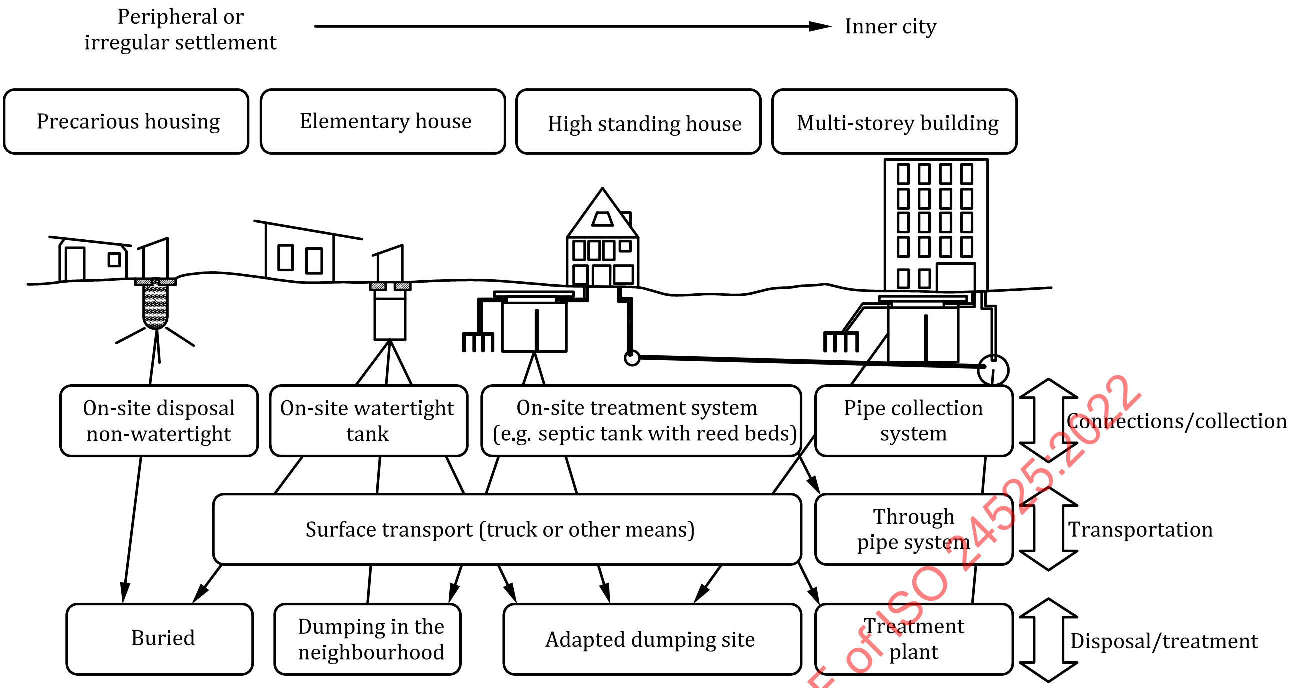

Figure 1 — Overview of components of wastewater systems

4.4.3 Alternative ODWS

Alternative ODWS is a general term for wastewater treatment systems using an aerobic or anaerobic treatment process that is different from basic ODWS. The term alternative ODWS encompasses a broad range of technologies that vary widely in treatment performance and space requirements, referring to a complete treatment system or just one component within a system.

The introduction of alternative ODWS can improve the occupational safety of workers, public health and the protection of the environment.

Alternative anaerobic systems can include reuse systems, such as anaerobic digesters, anaerobic filters and anaerobic baffled reactors, which can encourage investment in sanitation and be a response to issues in some countries. Most of them allow the use of biogas as cooking gas, for lighting or for the generation of electricity and, where culturally and legally accepted, digested sludge can be used as fertilizer following additional treatment.

Sludge from ODWS can be used as a fertilizer on land while treated greywater or wastewater can be used to flush toilets and for irrigation.

Alternative treatment processes can include aerobic treatment systems, such as media filters, membrane bioreactors, aerobic treatment units (ATUs), constructed wetlands and similar systems. The treatment capabilities vary among these processes. Consideration should be given to the desired outcomes.

The use of alternative treatment processes can be necessary when the site conditions of the native soil do not facilitate complete wastewater treatment. Secondary treatment removes the contaminants of concern and facilitates usage of the site for removal of the remaining contaminants from the effluent. Alternative on-site wastewater treatment systems typically utilize a separate treatment device after the pre-treatment tank followed by a soil treatment dispersal area (field or seepage bed).

Where discharge into surface water bodies is permitted, the use of alternative systems is advisable to ensure good water quality. Treatment processes utilizing an effective disinfection process do not necessarily require a treatment field and the treated effluent can potentially be reused.

NOTE This supports target 6.3 of the UN Sustainable Development Goals: "By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally", especially regarding indicator 6.3.2, "Proportion of bodies of water with good ambient water quality." (https://sdgs.un.org/goals/goal6).

5 Aspects of preparation and implementation relating to operation and maintenance

5.1 General

In order to ensure efficient and cost-effective O&M of ODWS it is necessary to consider the prerequisites and requirements of O&M when preparing and implementing ODWS.

Aspects of preparation and implementation relating to O&M include:

— design aspects;

— manufacturing aspects;

— construction and installation aspects;

— aspects relating to existing systems.

In addition, the management organization for O&M of ODWS should be taken into consideration. Examples of management models are presented in Annex A.

5.2 Design aspects

The correct design of an ODWS is necessary to ensure effective performance, longevity and protection of public health and the environment. ODWS need to be designed so that their effluent conforms with the water quality required by effluent discharge standards.

The design needs to pay attention to O&M aspects, including:

— ease and safety of O&M and their costs;

— accessibility for wastewater or sludge pumping and maintenance activities;

— septic tank, holding tank or another container located to ensure that vacuum trucks have ready access for servicing, for example near a roadway or driveway.

Prior to construction, drawings of the site and system should be prepared. It is recommended that these documents include a materials list and information on the site (including location of drinking water sources and drinking water pipelines) and soil analysis that was performed. As-built drawings and documentation should be provided to enable proper O&M.

Additional information on design aspects is given in Annex B.1.

5.3 Manufacturing aspects

Prefabricated ODWS shall perform for the design purpose and be produced uniformly. It is recommended that certified products are introduced and a testing or certification system established for the products where none exists. Regulations can exist regarding the use of uncertified products.

Additional information on manufacturing aspects is given in Annex B.2.

5.4 Construction and installation aspects

An ODWS shall be constructed and installed according to the design drawings or the instructions of the manufacturer. As-built drawings and documentation should be provided.

It is important that an ODWS (either comprising individual components or a packaged plant) be installed for proper and easy operation and regular maintenance.

After completion of construction and installation, the ODWS and its components shall be checked for proper functioning.

Additional information on construction and installation aspects is given in Annex B.3.

5.5 Aspects relating to existing systems

The location and identification of existing systems is important for persons not familiar with ODWS who newly arrive in areas not served by a centralized or public sewer system.

In those regions with consistent recordkeeping practices, copies of the ODWS design and its components are usually available from the local regulatory authorities. In some cases, inspectors and service providers do not have information on existing systems. If no information is available, it will be necessary to locate and identify an ODWS locally. Modern systems have covers for servicing that are visible and accessible at-grade; however, older systems can have all their covers and components buried. The following actions are strongly recommended:

— modify the structure of existing facilities to enable easy access;

— prohibit the new installation of ODWS that cannot be accessed or are difficult to access for maintenance.

In some countries, components of the system are buried under houses, decks or other structures. In such cases, locating the components is a difficult task, particularly as records of the ODWS are often missing. This can require the use of professional services.

Equipment is available to locate the ODWS using cameras or ground-probing equipment. The system can usually be located most simply by following the plumbing piping as it exits the building. The immediate area along the route of the pipe can be carefully checked by probing the surface with appropriate tools until a component of the system (such as the septic tank) is located. This area can then be excavated by digging to expose the top of the unit and therefore the lid of the access opening. Care should be taken not to damage pipes and other underground infrastructure.

Soil treatment or dispersal areas can be more difficult to locate as they can be many metres away from the other system components. Failing areas can be located by visible ponding or saturation at the surface or by the appearance of brighter green vegetation over the soil treatment dispersal area, as effluent rising to the surface brings nitrogen to the root zone.

6 Operation

6.1 General

Operation refers to the activities involved in the actual delivery of services. Operational plans should define the sequences of all essential operations required for the systems to collect, transport and treat the domestic wastewater and sludge properly. Clear operational procedures together with written, figurative and visual instructions are important to ensure the proper implementation of individual activities.

6.2 Operational procedures

6.2.1 User interface

Flush toilets are the user interface for septic systems, aerobic treatment systems and similar systems. Other user interfaces include a dry toilet or a urine-diverting toilet.

Basic ODWS can use different technologies which can require different daily operations during their use. For instance, the door of the superstructure in VIP latrines should always be closed so the superstructure remains dark inside, and the drop hole should never be covered as this would impede the airflow. When using double-vault latrines, consisting of two watertight chambers to collect faeces, wood ash and organic material should be added after each defecation or whenever required.

System inputs can apply differently to other technologies. For instance, anus cleaning materials can be advisable for the functioning of double-VIP latrines and Fossa Alterna, because they can help the degradation process, especially if they are carbon-rich (e.g. toilet paper, newsprint, corncobs). In the case of pour-flush toilets, dry cleansing materials and products used for menstrual hygiene should be collected separately and not flushed down the toilet, in order to reduce water requirements for flushing and to prevent clogging.

NOTE Double VIP latrines collect, store and partially treat excreta. The Fossa Alterna is designed to make compost by using an alternating, waterless double pit technology and requires a constant input of soil.

6.2.2 Collection

Operational procedures for collection are highly dependent on the technology in use.

Regarding more basic systems, an example is the difference between single or ventilated pits and the Fossa Alterna system. Unlike single or ventilated pits, which will be covered or emptied, the material in the Fossa Alterna is meant to be used as a soil conditioner, in which case it is extremely important that no garbage (other than carbon-rich anus cleansing material) is added to the pit. Operations are generally simple with regards to vaults. In Fossa Alterna, the mounded material beneath the toilet hole should be occasionally pushed to the sides of the pit in order to optimize the use of space. Composting chambers require more attention during their operation. The moisture should be controlled. The carbon:nitrogen ratio (CN) should be well balanced and the volume of the unit should be such that the temperature of the compost pile remains high to achieve pathogen reduction. After each defecation, a small amount of bulking material should be added to absorb excess liquid, improve the aeration of the pile and balance the carbon availability. Turning the material from time to time will boost the oxygen supply.

For more complex systems, such as septic systems, aerobic or anaerobic treatment systems and similar systems, the collection components usually consist of pipes from the interfaces and a collection unit (usually a tank). The piping from user interfaces to the collection component shall be kept free from blockages. The levels of liquid and sludge in collection units shall be checked regularly. Any equipment in the collection unit shall be checked for proper functioning.

6.2.3 Removal and transportation

6.2.3.1 Removal

It is essential to promote the regular desludging of ODWS to ensure that these systems operate at their best level of performance. When a system is not regularly desludged, it can become a source of groundwater contamination. Removal procedures are highly dependent on the technology in use. Depending on local context, desludging can be regarded either as operation or maintenance.

For some vault or chamber technologies, operation of the collection component requires removal of excreta, irrespective of the type of technique employed, but different frequencies and techniques can apply. Emptying the Fossa Alterna is easier than emptying other pits, because the pits are shallower and the addition of soil, ash and/or leaves means that the contents are less compact. The material that is removed is not offensive and presents a reduced threat of contamination. In the case of double vaults, the out-of-service pit should be well sealed to reduce water infiltration and a proper alternating schedule should be maintained. In the case of twin pits for pour-flush, the pits should be regularly emptied (after the recommended two-year resting time) and care should be taken to ensure that they do not flood during rainy seasons. Emptying is done manually using long-handled shovels and proper personal protection. Depending on the design, the composting chamber should be emptied every 2-to-10 years, but only the mature compost should be removed.

For septic systems, aerobic treatment systems and similar systems, it is recommended that the accumulated sludge and scum be removed at regular intervals. In the absence of local regulations, the intervals can be based on instructions or technical manual of the manufacturer. Emptying can be more frequent for anaerobic treatment, as fresher sludge can ensure a better methanogenesis potential and produce more biogas.

Although strongly discouraged, ODWS in some countries are located directly under the kitchen or bathroom, or their location is unknown and, in some cases, access is missing. It is recommended that such ODWS be reconstructed from the standpoint of public health. If, for various reasons, reconstruction is difficult, it is important to use caution when entering homes with hoses and other equipment, and to protect floor, walls and furniture from damage, as well as to ensure cleanliness during and after emptying. When access to an ODWS built under a house is missing, caps or covers should be installed after floor breakage to allow easy access for future desludging operations. In addition, easily accessible covers should be incorporated in ODWS design and construction when installing new systems.

In the case of above-ground tanks, if the storage tank is emptied using a vacuum truck, the inflow of air should be maintained at a sufficient rate to ensure that the tank does not implode due to the vacuum. When the storage tank is emptied, the sludge will usually be emptied along with the urine. An above-ground tank is never fully emptied when a tap is used for emptying. The tank can then require additional desludging. The desludging period should depend on the physical composition of the urine or sludge mixture and the storage conditions. When transfer stations are used, sand, grit and consolidated sludge should also be periodically removed.

In the case of systems with collection components (septic tanks, holding tanks or other containers), a qualified and experienced pumper (e.g. vacuum truck operator) should inspect, service and pump the collection component as necessary. Other factors to be considered include:

— New systems: Often wastewater from a new home contains residues from painting, varnishing, staining and cleaning, which reduce bacterial activity and increase the risk of solids damaging the soil treatment system. To avoid these problems, an early emptying of the tank is desirable, depending on the inflow conditions.

— Established systems: Emptying can be needed every 6-to-36 months under normal use. When the tank is pumped, the levels of sludge and scum should be observed and documented to be able to adjust the cleaning schedule. Sludge should not rise higher than one-third of the depth of the tank. If the tank requires pumping more often than every 12 months, the system capacity should be increased or the wastewater amount entering the system decreased.

— Seasonally used systems: If the system receives little or no use during cold periods, the tank should not be pumped dry. About 30 cm of liquid should remain in the tank to maintain the bacterial action to produce heat that reduces the risk of damage from freezing. If the system receives little or no use during hot periods, the tank should be pumped dry (e.g. to prevent breeding of insects or foul smells).

Removal procedures include:

— Informing the occupant of the pending service and noting any concerns or issues.

— Ensuring that all relevant health and safety procedures are observed, including those regarding possible harmful gases (e.g. hydrogen sulfide, methane) and an explosive atmosphere.

— Inspecting the site for possible hazards, such as clearing the area of people, or identifying high groundwater that could cause a tank to ‘float’ if emptied.

— Inspecting the area for drinking water wells and surface waters and ensuring that they are not contaminated during removal operations.

— Securing the vehicle, e.g. using wheel chocks.

— Opening the tank or pit by removing the access ports covers over the storage system.

— Breaking up sludge that has agglomerated into a solid mass, either by making use of a long-handled shovel or adding water when necessary, to reduce the viscosity of the sludge.

— Removing the scum and sludge accumulated in components other than the storage tank, such as final sedimentation tank and disinfection tank, and transferring the scum and sludge into the storage tank.

— Adjusting the biofilm amount in the aeration tank with media using the back-washing device and transferring the sludge into the storage tank.

— Cleaning the targeted components of the facility.

— Periodically removing between 90 % and 95 % of the contents. It is recommended this be verified through periodic spot checks.

— Refilling the underground tanks with water to a predetermined water level to ensure structural integrity.

— Identifying any abnormal conditions, such as high concentration of non-biodegradable materials, oils and grease. The colour and odour of the sludge can provide clues as to how the occupants are using the system, and if excessive chemicals are being discharged down the drain.

— Securing the tank lid after removal.

— Inspecting the system once empty. Checks by the operator can include:

  — listening for water running back from the discharge pipe, which can indicate plugging in the treatment (drainage) field (if present);

  — checking to make sure that inlet and outlet units are properly in place (frequently, these structures break off and can sometimes be found at the bottom of the tank);

  — inspecting the tank for cracks or damage, if possible;

  — verifying that the tank is properly vented;

  — ensuring that the tank lids are properly attached when the emptying is complete and that they are properly secured;

  — preparing a written report indicating how much waste was removed, the condition of the tank or pit, any recommendations for repairs or maintenance, any recommendations for proper use of the system and other relevant observations;

— Cleaning up any spillage using proper sorbent materials and disposing of the materials in an environmentally safe manner.

— Informing the client that the work is complete and giving them the final report. During this final interview, the operator informs the client of the findings and any recommendations.

6.2.3.2 Transportation

Wastewater and sludge are often transported from the point of collection and partial treatment to facilities where they are further treated, dispersed or reused. They can be in their original state (i.e. a mixture of solids, scum and liquid effluent – as would be typically found in a septic tank) or partially dewatered – as would be found in a pit latrine. In either case, they should be transported in tanks mounted on some type of vehicle.

Transportation can be by way of carts, tricycles or any other human-powered multi-wheeled vehicles, trucks, vacuum trucks and mobile dewatering or thickening trucks.

In some liquid-state transport applications, it can be transported via a pipe – where possible by gravity, but otherwise under pressure by pumping. Since any transportation poses a risk of accidental spillage, it is preferable that the transportation distance is shorter rather than longer.

6.2.4 Treatment

Certain operational procedures are common to all treatment units, such as assessing sludge levels, procedures for receiving and offloading wastewater and sludge and, when applicable, procedures for the on-site storage of sludge and end products, off-site transportation, as well as control of the removal of screenings, load (quantity, quality and frequency), processing (e.g. mixing compost piles, chemical addition for mechanical drying) and residence time. All treatment facilities should be regularly monitored to ensure proper functioning, otherwise offensive odours can result from the degradation of the accumulated material. Also, post-treatment technologies require continuous monitoring (e.g. influent and effluent quality, head loss of filters, dosage of disinfectants) to ensure a high performance.

In the case of septic tank systems, sludge and scum should be regularly pumped from the septic tank to protect the treatment field system. Uncleaned tanks have a reduced working capacity that results in overloads that send solids to the soil treatment dispersal area, clogging the soil and ruining its ability to treat wastewater and leading to costly repair.

The operational procedures should take the climate and the other context-dependent variables into account. For instance, the drying time or retention time can vary greatly during intensive rain periods or droughts. Wastewater and sludge characteristics (e.g. viscosity, amount of wastewater, fresh or partly stabilized sludge) and the required level of treatment also influence operational procedures.

Many other operations are technology-specific, ranging from small systems that receive few loads and therefore have relatively simple procedures to large and complex systems, which require more staff with different skill levels.

Routine operation of septic systems, aerobic or anaerobic treatment systems and similar systems involve monitoring scum and sludge levels to ensure that the tank is functioning well and checking the tank from time to time to ensure that it is watertight.

However, there can be problems with the bacterial action in the tank. In general, domestic wastewater contains a small amount of naturally occurring microorganisms that enables aerobic treatment facilities to function without additives. Seeding is effective when the activity of microorganisms is poor due to low water temperatures or other adverse conditions.

If the bacterial action in the tank is slow, the cause should be identified and corrected.

If in the aeration tank of an aerobic treatment system using a biofilm process the water becomes cloudy white (a stage also called “whitish turbidity”), this can show that the decomposition of organic matter by microorganisms is insufficient. The cause should be identified and corrected.

Any cleaner that breaks up sludge and scum creates the risk of solids reaching the final soil treatment dispersal area, ruining its ability to treat and disperse the wastewater. Avoid degreasers which are carcinogenic, not treatable in the system and put groundwater at risk.

For technologies that are basically “filters”, such as trickling filters, recirculating media filters and subsurface flow treatment wetlands (with horizontal or vertical flow), a functioning primary treatment unit to remove particulate matter is essential. A non-functioning primary treatment can lead to clogging and thus complete failure of the filter. Regular removal of primary sludge is thus the most essential operational measure for this type of treatment system.

6.3 Responsibility of system owners or users

6.3.1 General

In addition to the O&M procedures, further responsibilities of system owners or users should be clearly defined. For example, these responsibilities can refer to:

— system O&M issues;

— structures, plants and landscaping;

— vehicle traffic;

— problematic inputs.

6.3.2 System operation and maintenance issues

The relevant authority or maintenance personnel should be alerted immediately when an abnormality in the system is observed, such as a leakage, odours, erosion from rainfall events or animal intrusion.

The system owner or user should regularly check that all necessary tools and materials for operation are present. If disinfection is a part of the system design, the system owner or user should check to ensure that the appropriate form of chorine (e.g. tablets) are present or UV bulbs are operational.

Information on the disinfection of treated effluent is given in Annex G.

If the system uses electrical-powered equipment, the system owner or user should not turn off the power supply (except during maintenance or repairs).

6.3.3 Structures, plants and landscaping

No structure should be located on top of or near a system as this can damage system components and hinder O&M.

Only grass should be planted over and near the system. Grass cover and landscaping that channels rainwater away from the soil treatment dispersal area improve its performance. Trees or shrubs should not be planted as roots can clog and damage the soil treatment dispersal area and cause damage to underground tanks and pipes.

Water flowing from drains, downspouts, driveways and sump pumps should be directed away from the soil treatment area, as it should remain unsaturated for the bacterial action to take place. Changing the slopes and elevations near the system can affect its performance and longevity. Professionals should be consulted before any landscaping is undertaken that includes such changes.

6.3.4 Vehicle traffic

Vehicles shall not drive or park near or on top of the system if it is not designed for traffic loads. Even if there are vehicle load design specifications, the load capacity should be clearly indicated and a warning displayed that vehicles exceeding the load capacity are not allowed to drive or park on any part of the system.

Specifically, heavy vehicles shall not park, drive or operate on the soil treatment area, as these activities compact the soil and damage the system's performance. Only exceptionally light vehicles, such as a wheeled collection cart or a riding mower, should be allowed on the area. Avoid pathways on top of the soil treatment area.

6.3.5 Problematic inputs

Any water other than domestic wastewater shall not be discharged into the system as it would impede the system performance and overload it.

ODWS tend to be misused to dispose of food waste and other items. This adds to the organic load (solids) in the tank and changes the sludge consistency, making it more difficult to pump. Non-organic waste should be diverted from these systems. The value of food waste can be optimized via composting or anaerobic digestion rather than discarded in ODWS if they are not specifically designed for accepting and treating food waste, or when required by local regulation. Whenever possible, it is recommended that food waste is collected apart from wastewater and treated properly in facilities supervised by trained operators. In some countries, food waste can be discarded and treated by ODWS based on regulations and the ODWS technical specification.

The following domestic wastes should not be disposed of in the system:

— grease, fats, oils;

— meat, vegetable or food products.

NOTE In some regions, natural products are also used for anal cleaning and can be disposed of in basic systems that have been designed for this.

To reduce frequency of cleaning, risk of failure, damage to pumps and clogging of the distribution system, the following inputs should not be discharged into the system:

— bath oil;

— facial tissues;

— female hygiene products;

— personal hygiene products;

— condoms;

— paper towels;

— so-called “flushable” and other wet wipes;

— cigarette butts;

— cat or another animal litter;

— coloured toilet products using dyes that hinder the function of bacteria.

The following items are extremely hazardous, not treatable and inhibit digestion of solids and clarification of liquids by destroying bacteria. They shall not in any case be disposed of in an ODWS.

— every-flush deodorizers;

— solvents;

— strong acid or alkaline agents;

— medication;

— pesticides and fertilizers;

— antifreeze;

— paint, including latex solvents;

— wash water from latex paint brushes or rollers;

— gasoline, diesel fuel, oil;

— chemicals (normal amounts of drain cleaners, cleansers and bleaches should not harm the bacterial action);

— water from backflushing of water-softening equipment;

— water from cleaning of wells and cisterns.

Stones, glass, plastic, rags and other non-biodegradable materials should not be thrown in ODWS as they reduce the effective volume of the facility and hinder mechanical emptying.

6.4 Operational plan

The operational plan should provide details on the activities, materials, equipment, tools, sampling, monitoring and safety procedures which are necessary to keep the system components running properly. All these aspects have cost implications that should be carefully considered. Procedures should also be planned for specific cases, such as extreme climatic events, power shortages, overload, degradation of equipment and other accidents. The following information should be found in an operational plan:

— user manual;

— engineering drawings and related technical documents;

— as-built drawings and documentation;

— process and site schematics depicting actual location of equipment;

— responsible person or organization for each task;

— frequency of each activity;

— operation procedures;

— tools required to perform the task;

— if required, chemicals or other consumables, name of supplier and information on how they are used;

— contact and description of other potential external companies;

— safety measures required;

— information that is to be monitored and recorded.

Operations for septic systems, aerobic or anaerobic treatment systems and similar systems can require additional activities. A checklist in Annex C provides additional information.

For some system components and service modalities, organisations responsible for operation can need to interact with clients (e.g. households at the user interface). In such cases, the following activities should be considered:

— contacting client – gather contact information, such as name, phone number, address;

— creating a system for reporting and reference to track operation reports;

— identifying the property and gathering directions to the site;

— gathering system information (e.g. system type, size, components) from the client or homeowner or any paperwork such as permit information, plans, designs;

— determining the O&M frequency requirements within the jurisdiction where the system is located or according to the manufacturer's specifications;

— determining the cost of the service;

— finalizing service contract with the client, including the outline of the services provided and terms for compensation;

— conducting service visits to investigate the operation of the system.

During and after service visits, the following tasks are important:

— recording date and time of visit;

— recording observations of the site and area surrounding the site;

— verifying whether all system components are present and functioning;

— completing the operational checklist;

— identifying repair needs and issues related to proper operation that have the potential to increase the lifespan of the system;

— providing a report to the client noting any maintenance or repairs that are required and outlining owner responsibilities with regards to O&M; also noting the date and time of operational inspection and whether the system is in an acceptable condition or unacceptable condition;

— keeping a copy of the report for filing.

6.5 Inspection

6.5.1 General

There are two main types of inspections for ODWS: compliance and maintenance inspections.

6.5.2 Compliance inspection

Compliance inspections are performed by health or safety administrations to ensure that an ODWS meets the regulatory framework for the jurisdiction in which it is constructed or installed. In some countries, the treated effluent quality is regularly monitored to check whether it complies with the relevant regulatory requirements.

In a compliance inspection, consideration is given to the design of the system, its location, its proximity to surface water, groundwater and wells.

Following a compliance inspection, the householder, end-user or practitioner should receive a report, either accepting the system as compliant or identifying deficiencies that should be corrected prior to reinspection.

A sample checklist is given in Annex C.

6.5.3 Maintenance inspection

A fundamental requirement of ODWS O&M is that maintenance inspections should be carried out regularly to ensure that this system is functioning as intended, to identify any areas of concern and to repair the system to ensure its return to normal functioning conditions.

At its basic level, it is recommended that a maintenance inspection includes:

— Comparing incoming flow rates and wastewater quality to the planned values to ensure the ODWS functions as intended.

— Checking piping to ensure that solids and other debris are not impacting wastewater flow.

— Assessing each component of the ODWS to ensure the system is functioning normally and as intended. This includes assessing the inflow of wastewater to the septic systems, aerobic or anaerobic treatment systems or similar systems, the effluent quality and the condition of the discharge or dispersal area. Any areas of deficiency should be noted and recommendations made in order to improve the operation or maintenance plans.

— Assessing the level of sludge and scum in the septic systems, aerobic or anaerobic treatment systems or similar systems to determine whether pumping (desludging) activities need to be carried out.

— Assessing the inner structure, such as walls or partitions, followed by a rapid repair or replacement of the components identified as broken or damaged.

— Assessing all components for functionality, including, but not limited to, pumps, effluent screens, high-water alarms, control panels, siphons and valves. Any malfunctioning components should be replaced or serviced according to the maintenance plan.

— Checking the tightness to prevent any leakage or infiltration of liquids.

For anaerobic systems using biogas, tightness towards gas shall also be checked.

Following a maintenance inspection, a report should be provided to the user or owner identifying those components that are functioning properly and those that require remediation. A proposed plan to repair or replace non-functioning components should be included in the report.

A sample checklist is given in Annex C.

7 Maintenance

7.1 General

When ODWS are properly designed, constructed, operated and maintained, they effectively reduce or eliminate most human health or environmental threats posed by pollutants in domestic wastewater. However, they require regular maintenance or they can fail. Systems need to be monitored to ensure that they work properly throughout their service lives.

ODWS are often privately owned and therefore, depending on the owner, maintenance operations are possibly not being conducted on a regular basis. To ensure ODWS are maintained properly, some jurisdictions have established mandatory requirements for O&M, which stipulate maintenance activities and frequency, thus ensuring that ODWS systems function as designed.

Regular O&M, whether regulated or voluntary, can prevent system failure, resulting in cost savings for the owner. Failing systems are expensive to repair or replace and lack of maintenance is often the culprit. An unusable system or one in disrepair will lower property values and potentially pose a legal liability. Having the system inspected and maintained regularly can be financially beneficial in comparison to the cost of replacing the entire system.

Maintenance can be either preventive or reactive.

Preventive maintenance is the action of performing routine, planned activities and includes the activities required to sustain existing assets in a serviceable condition. Many of the maintenance activities performed will be based on instructions from the system manufacturer, on observations from the operation assessment or on regulations where a mandatory system for maintenance exists. Preventive maintenance is performed at planned intervals and can take many forms. Preventive maintenance can be undertaken at condition-oriented or scheduled intervals.

Reactive maintenance involves activities necessary to repair or restore the system to a satisfactory condition or level of performance after a malfunction has occurred and been identified.

Maintenance plans should include preventive (planned) activities and reactive activities (following a failure of the equipment or infrastructure).

Maintenance for septic systems, aerobic or anaerobic treatment systems or similar systems can require additional activities. The checklist in Annex C provides additional information.

7.2 User interface

7.2.1 Preventive maintenance

Dry toilets with no mechanical parts should not need repairs except in the event that they crack. However, it is always important to periodically check their functioning, for example regarding odour seals. For example, every month the floor slab of ventilated improved latrines should be checked for cracks and the vent pipe and fly screen should be inspected to ensure they are not damaged. Maintenance of cistern flush toilets is required for the replacement or repair of some mechanical parts or fittings. Any damage found should be repaired. Repair of the superstructure can also be necessary.

In general, all surfaces of the user interface technologies should be cleaned regularly to prevent odours, to keep the facilities free of flies and to minimize the formation of stains. This can include cleaning the drop hole, the squatting pan or seat and the superstructure with brush and bucket. Even in the case of cistern flush toilets, although flush water continuously rinses the bowl, the toilet should be scrubbed clean regularly to maintain hygiene and prevent the build-up of stains. In the case of ventilated toilets, dead flies, spiderwebs, dust and other debris should be removed from the ventilation screen to ensure a good flow of air.

7.2.2 Reactive maintenance

Table 1 presents typical faults that require reactive maintenance for the user interface of basic systems which generally do not use flush toilets, including the risks, causes and typical maintenance measures to correct the fault and prevent recurrence.

Table 1 — Examples of reactive maintenance for the user interface of basic ODWS

Fault	Risk	Cause	Measures
Breakdown of floor slab	People falling; health risk	Inappropriate materials or improper curing of concrete	Improve the quality of the floor slab
Flooding of toilets	Content of toilets or latrines spread into the surroundings; health risk	Improper location, rising of water table	Raise latrines or consider relocating them
Wastewater or sludge back-flow	Wastewater or sludge odour detected inside the facility, general discomfort and health risk	Wastewater backup, foul gases coming from wastewater surfacing in the yard	Check for wastewater backup and deal accordingly
Malfunctioning of the structure of ventilated improved latrines and similar systems	Flies come inside the facility – general discomfort and health risk	Superstructure is allowing too much light to come into the latrines	Control the light inside the facility so that flies are not attracted by the light coming through the squat hole and therefore do not fly out into the superstructure
	Fly screen damaged – poor aesthetic and health risk	Inferior quality fly screens get damaged easily by the effects of solar radiation and foul gases	Change fly screens to ones of higher quality

7.3 Collection

7.3.1 Preventive maintenance

Preventive maintenance regarding collection can include:

— checking functionality and cleaning all equipment used for collection, including pumps;

— cleaning of the pad and loading area of transfer stations (underground holding tanks) to minimize odours, flies and other vectors from becoming nuisances;

— frequently cleaning screens to ensure a constant flow and prevent backups;

— regular checking of the function and watertightness of access point covers;

— checking of collection point accesses and clearing any obstacles;

— checking of monitoring ports to ensure the system is working properly.

The lack of preventive maintenance is often the cause of major repairs.

7.3.2 Reactive maintenance

Table 2 presents typical faults that require reactive maintenance for collection, including the risks, causes and typical maintenance measures to correct the fault and prevent recurrence.

Table 2 — Examples of reactive maintenance for collection in basic ODWS

Fault	Risk	Cause	Measures
Leakage occurring in double-pit vaults	Environmental contamination Public health risks	The dividing wall is not impermeable Soil is too permeable	Reinforce the dividing wall
Malodorous dry latrines, difficult to empty	Difficulties in emptying at the required frequency	Contents of dry latrines are too wet	Avoid pouring water into dry vaults
Difficulties in emptying single pits	Clogging of the pump Increased exposure to human health risks during the emptying process	Solid waste and dry-cleaning materials being disposed of in single pits	Discard solid waste and dry-cleaning materials separately because they shorten the life of the pit

Due to a more complex technology, the collection components of septic systems, aerobic or anaerobic treatment systems and similar systems can have additional faults requiring reactive maintenance.

7.4 Removal and transportation

7.4.1 Preventive maintenance

Wastewater and sludge collection vehicles need to be regularly checked and maintained by professionals as the lack of preventive maintenance is often the cause of major repairs. The addition of chemical additives for desludging is not recommended because they tend to corrode the tank of the truck. It might be necessary to purchase expensive replacement parts, tyres and equipment, which can be particularly difficult in some regions where spare parts and a mechanic to repair broken pumps or trucks are scarce.

In the case of above-ground tanks, it is important to frequently wash this equipment to minimize bacterial growth, sludge accumulation and unpleasant odours. Mineral and salt build-up in the tank or in connecting pipes can be manually removed (sometimes with difficulty) or dissolved with a strong acid (e.g. 24 % acetic).

7.4.2 Reactive maintenance

Table 3 presents typical faults that require reactive maintenance for transportation, including the risks, causes and typical maintenance measures to correct the fault and prevent recurrence.

Table 3 — Examples of reactive maintenance for removal and transportation

Fault	Risk	Cause	Measures
Leaking of wastewater or sludge from emptying pipe	Discomfort due to foul smell Public health risks	Breakage in the pipe used to pump out wastewater or sludge from system component	Repair or replace the pipe Line the pipe
Leaking of wastewater or sludge from containers	Discomfort due to foul smell Public health risks	Containers not properly secured or tightly closed	Check for unsecured containers, then tightly close and clean affected area
Leaking of pumping action by vacuum tankers	Discomfort due to foul smell Public health risks	Container not properly secured or tightly closed	Check for unsecured connection, tightly close and clean affected area of vacuum tanker and surrounding area
Overflow of wastewater in systems using cartage techniques	Discomfort due to foul smell Contamination of nearby area Public health risks	Overdue emptying Overload of system	Check for overflow and contain it as per vessel capacity

7.5 Treatment

7.5.1 Preventive maintenance

Common preventive maintenance of treatment systems includes cleaning the effluent filter, resetting control units, cleaning orifices and screens, replenishing oil and cleaning the filters of the blower among other activities.

A qualified and experienced professional should inspect and service the treatment unit of the ODWS once a year for the first three years and then at least every three years. Aerobic or anaerobic treatment systems and similar systems can require more frequent inspections and servicing as more electrical and mechanical equipment is used.

Preventative maintenance routines should be undertaken, including:

— measuring level of effluent, including the sludge and scum layers, to see if the tank requires pumping;

— extracting sludge and coarse solids from the basins and canals, if present;

— checking baffles in the tank to ensure they are not degraded and are functioning as intended;

— checking effluent filters (if present) and cleaning if necessary;

— testing high-water alarm (if present) to ensure it is functioning properly;

— if the system has a pump, testing to ensure it is functioning properly;

— if the system has a soil treatment dispersal area, checking for sponginess or ponding;

— inspecting tank lids to ensure they are not cracked or broken and that they are closed or sealed properly;

— if the system has monitoring openings, checking the caps to ensure they are present and are not cracked or broken;

— carrying out maintenance in accordance with the manufacturer's requirements for inspection, in the absence of regulatory requirements;

— carrying out basic housekeeping activities, including picking up refuse and vegetation control.

Some preventive maintenance activities depend on the technology. For instance, in waste stabilization ponds, aquatic plants (macrophytes) should be removed as they can provide a breeding habitat for mosquitoes and prevent light from penetrating the water. In planted drying beds, the plants should be periodically thinned, harvested and removed. Gas equipment in biogas reactors requires special attention as it needs careful and regular cleaning to prevent corrosion and leaks.

In the case of septic systems, aerobic or anaerobic treatment systems and similar systems, preventive maintenance activities can include:

— verification of the inflow rate and hydraulic functioning of the units;

— prevention of clogging by checking for unusual rising water levels;

— verification of sludge return rate and adjustment if necessary;

— regularly removing sludge and scum from the unit;

— checking function and performance of each tank, including the water quality and accumulated sludge level;

— repacking and exercising valves (e.g. locating and maintaining fully operational valves);

— regularly maintaining mechanical equipment, including oiling and greasing pumps, centrifuges or emptying trucks, regularly cleaning air filters of electromagnetic blowers and replacing the diaphragm when necessary;

— regularly checking power supply for equipment powered by electricity, such as pumps and blowers, including the electrical resistance of the equipment to ensure that there is no current leakage;

— corrosion control – scraping rust, painting metal surfaces and repairing corroded concrete;

— regularly checking tightness toward liquid to prevent leakage;

— regularly checking tightness toward gas in anaerobic treatment systems using biogas;

— regularly adding disinfectant, when used.

In addition, it is highly recommended that the maintenance of septic systems, aerobic or anaerobic treatment systems and similar systems be conducted by certified or appropriately trained technicians. In the absence of regulatory requirements, maintenance should be conducted at a specified frequency in accordance with the manufacturer's requirements.

7.5.2 Reactive maintenance

Table 4 presents typical faults that require reactive maintenance for treatment, including the risks, causes and typical maintenance measures to correct the fault and prevent recurrence.

Table 4 — Examples of reactive maintenance for treatment

Fault	Risk	Cause	Measures
Backflow of wastewater in building	Discomfort due to foul smell Public health risk Contamination of floors, walls, furnishings in affected area Potential flammable or explosive gases	Clogged line to the collection unit (e.g. septic tank) Clogged collection unit Clogged unit inlet or outlet Saturated soils treatment component	Call service professional Call pumper: have collection unit (e.g. tank) pumped out Clear house drain with plunger and clearing device, i.e. snake Open windows for air flow Remove all contaminated materials Disinfect contaminated area with a bleach solution
Overflow of tanks	Discomfort due to foul smell Public health risk	Clogged inlet or outlet or connection between compartments	Call service professional
Wastewater odour – indoors	Discomfort due to foul smell Public health risk Potential flammable or explosive gases	Failure of one or more treatment unit components Wastewater backup in house Roof or other vent blocked Wastewater surfacing in yard Improper plumbing	See O&M manual, call service professional Ensure wastewater is not backing up into house (see above) Clear roof or other vents Ensure wastewater is not ponding on surface in yard Call qualified person to inspect piping system
Wastewater surfacing in yard (ponding)	Public health risk Attracts pests Contamination of water and soil	Excess water entering system System blockages Broken pipes Improper system design Non-installation or lack of drain trap Pumps and controls issue	Call pumper; have collection unit (e.g. tank) and surfacing effluent pumped off Call qualified person to inspect piping system Review system design Have pump and controls checked to ensure they are working or set properly Restrict access to affected area until problem resolved Restrict water usage Provide disinfection to areas and allow sunlight to access and dry area

Table 4 *(continued)*

Fault	Risk	Cause	Measures
Wastewater odour – outdoors	Nuisance Indication of other issues	Wastewater surfacing in yard (see above) Monitoring port caps damaged or removed Manhole cover broken or removed Improper pipe construction Soil treatment component failing	Check to see if wastewater is surfacing in yard (see above) Replace any broken or missing monitoring port caps Replace any broken or missing manhole covers Have soils treatment component inspected to ensure it is functioning properly
Saturation and ponding evident in trenches Pump operational; effluent not surfacing	Potential for backup into home Potential for effluent to come to surface	Overload of soils treatment component Improperly designed system	Reduce water usage Let system rest to see if it rejuvenates Replace soils component
Alarm is sounding	Untreated wastewater being discharged System to back up into home	Failure of one or more components	See O&M manual Call service professional
System high-water alarm activated	Untreated wastewater being discharged System to back up into home	Electrical breaker activated Pump unplugged Pump failure	Check breaker for alarm Check pump power source Replace pump Call pumper, have tank pumped

7.6 Maintenance plan

Well-developed maintenance plans can often minimize reactive interventions to emergency situations, which are frequently more costly and complex. They should include the task details, frequency of actions, tools and supplies needed to accomplish the tasks, amount of time required and inspections to be conducted at scheduled intervals.

In the absence of regulatory requirements, the maintenance plan should be aligned with manufacturer requirements, local context, climate and asset-specific monitoring information and should include a monitoring schedule for the purpose of continuous monitoring and maintenance of the ODWS.

When implementing a maintenance plan, task details should be entered into the equipment maintenance logbook or database, along with any difficulties encountered.

8 Plans and instructions for collection of wastewater and sludge

8.1 Collection practices

8.1.1 General

There are a variety of collection mechanisms utilized in the management of ODWS:

— Portable containers, such as jerry cans, drums or other above-ground containers, can be used to collect human excreta.

— Earthen pits are also used to collect and contain human excreta and waste.

— Holding tanks (e.g. drums, vaults) are underground containment systems used to collect wastewater or sludge.

— Septic systems, aerobic or anaerobic treatment systems and similar systems are used to collect wastewater or sludge.

The collected wastewater or sludge is removed mechanically or manually and transported to a receiving facility for treatment, buried or spread on farmland as soil enrichment material, if in accordance with relevant regulations.

Wastewater and sludge can be collected mechanically, using a vacuum truck or other pumping mechanism or manually with a scoop or a bucket. Whether collecting mechanically or manually, entering the septic or holding tank should be avoided. Entry into septic or holding tanks should only be attempted by those trained in confined space entry and with careful regard to possible hazardous gases and explosive atmospheres. Special protective clothing and equipment shall be used.

A checklist, including desludging procedures for aerobic or anaerobic treatment systems and similar systems, is given in Annex C.3.

8.1.2 Mechanical removal

Mechanical removal is more expensive than manual removal; however, it is generally more hygienic than manual removal and therefore preferred. There can also be limitations on accessibility for the equipment required for mechanical removal.

Mechanical removal can involve the use of a truck-mounted tank and a vacuum pump, or a portable tank and vacuum pump. Vacuum trucks can carry a significant amount of wastewater or sludge and are able to service multiple sites prior to hauling to a receiving facility. It is necessary to check in advance whether wastewater and sludge can be accepted at the targeted receiving facility.

With a mounted tank, vacuum trucks are not dependent upon portable collection containers for the transfer of wastewater or sludge.

Mechanical removal can further be optimized with the use of mobile dewatering or thickening trucks.

Some considerations regarding the decision to use mechanical removal or collection with a vacuum truck include:

— ease of access, as narrow streets and inadequate roadways can inhibit access;

— expense, as it is possible that some communities and homeowners cannot afford this type of collection service;

— lack of access to receiving facilities for the treatment of the collected wastewater and sludge;

— access to a water source, which can be required to create a slurry when encountering compacted sludge;

— sanitary requirements, as this is the most sanitary collection and transfer method.

In areas where access is difficult, mechanical removal can involve the use of pumps mounted on carts or other multi-wheeled vehicles. With no truck engine to power the pumping mechanism, access to electricity or other power sources is necessary.

Considerations regarding the decision to use mechanical removal by other means include:

— use of portable containers for the transfer of wastewater or sludge;

— use of carts, bicycles or other multi-wheeled vehicles for transporting containers;

— access to a power source;

— access to receiving facilities in proximity to the collection area;

— if necessary, access to a water source to create a slurry, which is more easily removed;

— chance of spillage during the transfer process greater than when using a vacuum truck;

— less sanitary collection and transfer method than using a vacuum truck.

Mechanical removal practices should take the following into consideration:

— Septic systems, aerobic treatment systems and similar systems should only be pumped through the manhole (access port) of each tank or tank compartment. In the specific case of anaerobic treatment systems, the tank shall remain closed during pumping to avoid leakage of biogas or entrance of oxygen. The tank shall be equipped with an extraction pipe and an isolating valve.

— Pumping should not take place through the observation port.

— Wastewater should not be discharged through the outlet pipe.

— Wastewater or sludge should not be leaked or spilt onto the ground during the collection process.

— When removing wastewater or sludge by a vacuum or centrifugal pump, the pump should be fitted with a hose, which delivers the wastewater or sludge to a sealed, watertight tank.

— During the pumping process, sludge should be agitated to allow for easier removal. However, the liquid level should be reduced by at least 30 cm below the outlet pipe before agitating wastewater solids.

— If using back flushing or air injection techniques, refill the tank with water to a predetermined level.

— Proper personal protection equipment, such as coveralls, a face mask and gloves, shall be worn while performing this service so that skin, eyes, nose or mouth are not exposed to wastewater or sludge.

8.1.3 Manual removal

Manual removal involves the use of scoops or buckets to transfer the wastewater or sludge to portable containers ready for transport.

Manual removal requires more rudimentary equipment; however, it presents a greater risk of spillage and human contact with the wastewater or sludge. There is also a social unacceptability aspect with regards to manual waste collection.

Various tools can be utilized to aid in the removal of wastewater or sludge from underground tanks, pits or latrines:

— rods and poles or other long cylindrical tools to probe the location of tanks and access ports;

— manually powered augers or suction pumps;

— long-handled baskets, scoops or shovels to scoop or lift the sludge into transport containers;

— hand tools to remove access lids, tank lids and access ports;

— rakes and hooks to lift and remove non-biodegradable matter;

— hoses or water source to add to hardened sludge to create a slurry for easy removal.

Recommended manual removal practices include:

— a bucket or basket on a rope lowered into the tank to collect the wastewater solids and liquids;

- long poles utilized to scrape solids from the bottom and walls of the tank for easier scooping into buckets or baskets;
- not entering the septic tank or holding tank;
- not allowing wastewater or sludge to leak or spill onto the ground during the collection process;
- transferring the wastewater or sludge to watertight, transportable containers.

8.2 Collection containers

ODWS typically collect wastewater (effluent and wastewater) or sludge in either septic tanks for discharge to a treatment component or holding tanks for storage and removal.

Collection containers used for removing the wastewater or sludge from a septic tank or a holding tank include pumps or vacuum tanks, drums, vaults, chambers or jerry cans.

Collection containers should be:

- watertight, to avoid leakage or spillage;
- transportable by truck, cart, tricycle or other multi-wheeled vehicles.

These collection containers can be taken to a receiving facility for treatment and dispersal or discharge, or they can be taken and emptied at a transfer station, where the wastewater or sludge can be held for later removal to a receiving facility.

Transfer stations can be utilized when the distance to a receiving facility capable of treating the wastewater or sludge is prohibitive.

8.3 Collection frequency

8.3.1 General

Factors influencing how frequently wastewater and sludge should be collected include:

- size of the collection component (septic tank, holding tank or another container);
- volume of solids in the wastewater being collected.

Collection can be done more frequently in the case of anaerobic treatment systems, as fresher sludge has a higher methanogenesis potential and produces more biogas.

Holding tanks, latrines and earthen pits that are infrequently pumped are at risk of overflowing, thereby creating a significant health and safety issue. It is recommended that regulatory authorities provide guidelines or requirements for collection frequency.

8.3.2 Tank size

The size of the tanks in septic systems, aerobic or anaerobic treatment systems and similar systems impacts the frequency of waste collection.

As the tank fills with wastewater, solids separate out and sink to the bottom of the tank, while fats, oils and grease rise to the top above the remaining middle, clarified liquid level. In a two-compartment tank, the clarified effluent in the middle transits the baffle into the second chamber of the tank and is then discharged to the soil treatment component (when used).

Regardless of whether the tank is a single-compartment or multiple-compartment tank, as more and more wastewater enters the tank, more solids and fats build up, reducing the capacity of the tank to settle out the wastewater. If a soil treatment component is used and if the tank loses enough settling capacity, solids, fats, oils and grease can be discharged to the soil treatment component and clog the soil pores, stressing the soils and potentially causing a system failure.

8.3.3 Volume of solids being collected

Wastewater higher in solids takes up capacity in the tank, thereby reducing the settling capacity and requiring a greater frequency of waste collection. The volume of solids being collected can be predicated by the number of people using the system and the type of material being introduced to the system.

Septic tanks, holding tanks and collection tanks (e.g. in aerobic or anaerobic treatment systems and similar systems) should be pumped when the:

— distance between the bottom of the scum and the bottom of the outlet pipe is lower than a prescribed level;

— distance between the top layer of scum and the bottom of the tank cover is within a prescribed value;

— sludge is within a prescribed distance from the bottom of the outlet pipe.

Refer to relevant regulations or permits for prescribed values. In the absence of values in regulations or permits, refer to the specifications of the designer or manufacturer of the system.

9 Plans and instructions for transportation of wastewater and sludge

9.1 General

Wastewater and sludge are often transported from the point of collection and partial treatment to facilities where they are further treated, dispersed or reused.

In all means of transport, the tanks or pipelines (e.g. pumps, pipes, hoses, valves, joints, caps, plugs) should be watertight, constructed of materials that will resist any corrosive effects of the wastewater and sludge, and used under conditions that prevent spillage or leaking during loading, transporting or unloading, as such spillage can present risks to public health and the environment. Where spillage has occurred, the pumper or hauler is responsible for cleaning the area surrounding the discharge location.

The tanks on vehicles should be able to withstand any pressures they are subjected to under normal operating procedures, including pressures arising from surges caused by the vehicle's motion. Tanks loaded on vehicles but not forming part of the vehicles should be securely attached to avoid overturning. All equipment utilized to contain or transport wastewater or sludge should be maintained regularly to ensure its integrity. The transport vehicles themselves should be maintained to ensure safe operating capability.

Tanks and equipment used for the loading, transportation and unloading of wastewater and sludge should be constructed to be easily cleaned and maintained and should be in a clean condition when not in use. Such tanks and equipment should not be used to transport potable water or water used for irrigation or street washing, due to the danger of cross-contamination.

Tanks and equipment used to transport wastewater and sludge shall be clearly marked as transporting waste.

Truck and equipment washing facilities should be constructed and designed to prevent contamination of a water source or water course due to back siphonage or other reasons.

Collected wastewater and sludge should only be discharged into a public sewer system, wastewater treatment plant or dedicated sludge treatment plant designed, operated and licensed for that purpose. The use of GPS trackers on vacuum trucks can be useful in preventing negative practices such as the open dumping of the collected sludge in inappropriate locations.

Tanks and equipment utilized for transporting wastewater or sludge shall be cleaned, maintained and stored separately from equipment used for the transport of potable water.

9.2 Transport methods and equipment

9.2.1 General

The preferred method for transporting wastewater and sludge is use of dedicated wastewater or sludge hauling trucks, sometimes referred to as pumper trucks or vacuum trucks. Wastewater and sludge is pumped into the tank on the truck, which can carry several hundreds of litres.

The volume of collected sludge can be further reduced and optimized prior to transport and discharge to a treatment facility or a transfer station with the use of mobile dewatering trucks (for communal or clustered ODWS) or mobile thickening trucks (for individual ODWS). These types of vacuum trucks are equipped to concentrate suspended solids in sludge from an initial concentration of 1 % to 1,5 % to either 2 % to 3 % or 15 % to 25 %, depending on the equipment technologies. The supernatant produced by this process is returned to the ODWS.

Although transport and its associated cost can be reduced by using mobile dewatering trucks, it is important to consider their benefit-cost ratio compared to conventional vacuum trucks and ensure that there is a sufficiently large market due to the increased purchase and operating costs.

Other forms of transport can be portable containers mounted on tricycles or other human or animal-powered multi-wheeled vehicles.

The transported wastewater and sludge should go to an approved receiving or treatment facility or to a public wastewater sewer. If permitted by the relevant authorities, the wastewater or sludge can be applied on farmland, pasture or other allowable lands (e.g. tree nurseries).

Land application relies on the availability of large tracts of land and suitable soil characteristics in order to be effective at treating and dispersing wastewater and sludge.

No matter which methodology is utilized for the removal of wastewater and sludge, it is important to take precautions to avoid direct contact with the wastewater or sludge in order to protect the health of the workers and any others in the vicinity and avoid spillage to protect public health and the environment.

Most of the manually operated small-scale equipment and some of the mechanized equipment described previously are not capable of transporting sludge. Low-cost transport equipment, standardized or customized, is therefore not often used for the transport of sludge to the transfer station or treatment facility.

Equipment used in transportation can be of two forms:

— manually propelled by human or animal power;

— motorized.

The aspects that need to be considered for the transportation of wastewater or sludge include:

— type of vehicle to be used, including its roadworthiness, maintenance, licences and permits, and where it is kept when it is not in service;

— type of wastewater or sludge removal equipment, including hoses, pumps, augers and other tools of the trade;

— spill-management equipment to be used, including shovels, disinfectants, sorbents and collection bags;

— skills of the operator, including any training and certifications required to perform the work;

— procedures that need to be followed, including rules of the road and activities at the treatment plant;

— other aspects, such as the use of transfer stations, worker health and safety, and emerging technologies.

Transporters of wastewater or sludge should maintain records containing the following information:

— source of the wastewater or sludge (name and address);

— date and time of collection;

— volume collected;

— location of wastewater or sludge discharge:

  — receiving facility;

  — land spreading;

  — other;

— receipt for the delivered wastewater or sludge.

Transporters of wastewater or sludge should maintain these records on file for review by authorized third parties upon request.

Many jurisdictions require that vehicles and containers used for transporting wastewater or sludge be registered annually. Requirements for the training of transporters can vary from one jurisdiction to the next.

9.2.2 Manual (non-motorized) transport

Carts used for general transport of materials as well as customized carts designed for transporting sludge can be used, especially in low-income countries. Design of these carts can vary but a typical cart has a load bed mounted on a single axle with one or more wheels. The capacity is usually not more than 200 l and the carts are able to manoeuvre in very tight spaces over a range of about 3 km.

Due to their low load capacity and limitation of the distance covered, manual low-cost transport equipment is not preferred for long-distance transportation.

9.2.3 Mechanised transport

Usage of mechanized transport offers a potential for transporting larger loads at increased speed and reduces the travel times compared with manual transportation. However, maintenance of motorized transportation is more complex than for manual transportation.

Motorized tricycles are a low-cost option for transportation of wastewater or sludge. Their size and power vary on design and they can navigate tighter spaces and narrower streets than other motorized vehicles. Some of these models can have a capacity of up to 1 000 kg.

Other, more expensive, motorized transport equipment can be used for transportation of wastewater or sludge, such as pick-up trucks, whose capacity range up to 1 000 kg. For larger loads, full-scale trucks equipped with permanently mounted tanks are used.

10 Plans and instructions for treatment and dispersal or recycling

10.1 Receiving facilities and treatment

Collected wastewater and sludge are typically hauled to a receiving facility where they are discharged into a centralized wastewater treatment plant or a dedicated sludge treatment plant. Wastewater or sludge being discharged into a receiving facility shall meet the quality parameters set by that facility. Receiving facilities generally charge a fee to hauling companies for the use of the facility. The fee is typically charged per litre received.

Centralized treatment plants can provide primary, secondary and tertiary treatment, along with disinfection prior to discharge into a water body or recycling such as land application on farmland, pasture or other allowable lands, such as tree nurseries. Wastewater or sludge can be dewatered, composted and then utilized for soil enrichment. Centralized treatment plants can also consist of or include an anaerobic stage to use the organic content to produce biogas.

10.2 Safe dispersal or recycling

There are strict guidelines regarding the composting of dewatered wastewater or sludge as well as for the land application. Land application relies on UV disinfection from natural sunlight, uptake of water and nutrients by vegetation, and final treatment in the soil treatment dispersal area.

The following criteria are recommended when utilizing land application as a method for treating and dispersing wastewater or sludge:

— there should be suitable vertical separation between the application point (surface) and the groundwater table;

— land should not be too steeply sloped;

— land should not be close to surface water bodies or public or private wells;

— land application should not take place in winter when the ground is frozen;

— wastewater or sludge applied to the land surface should have any non-organic materials removed and then be tilled into the soil.

11 Training and information aspects

11.1 Training aspects

11.1.1 General

Training for those working with ODWS is extremely important. Safe handling of wastewater and sludge protects personal and public health and the environment.

Training those who work with ODWS in any capacity helps to ensure their personal protection, protection of the general public and protection of the environment. Training can differ slightly from one discipline to the next; however, some training should be universal for all disciplines.

In some jurisdictions, training is mandatory. Where training is mandatory, there is typically a standard set of rules and regulations that should be adhered to when designing, installing, operating or maintaining ODWS. Rules for the collection and transport of wastewater and sludge can also be in place.

Training can be available through industry associations, local colleges, government agencies and other training organizations.

In addition to training, it is recommended that a qualification system regulated by local or national authorities is established to ensure a quality of services that meets standardized target levels.

11.1.2 Core training

Core training for all disciplines should include:

— interaction with and education of users;

— record keeping;
— knowledge of local regulations and requirements;
— awareness of user responsibilities;
— worksite safety;
— understanding the pathogens and bacteria of concern;
— understanding fundamentals of wastewater and sludge treatment;
— understanding safe wastewater and sludge handling;
— awareness of explosive atmospheres that are to be avoided in sludge storage and anaerobic sludge treatment;
— safety training regarding the use of personal protective equipment (PPE);
— safety and emergency response plans;
— understanding work and personal hygiene.

11.1.3 Design training

Training regarding design should include:

— understanding of soils
  — how water moves through soils;
  — loading rates for specific soil textures, structures and other characteristics;
  — how pathogens and other constituents are treated in the soil interface;
— wastewater and sludge
  — understanding of water quality control and relevant regulations;
  — difference between residential and high-strength wastewater (e.g. industrial wastewater);
  — understanding wastewater flows;
  — calculating wastewater and sludge volumes;
  — chemicals and other constituents of concern in wastewater or sludge;
  — understanding of treatment methods and technologies;
— system sizing
  — tank sizing;
  — volume considerations;
  — calculating dispersal area size;
— system components
  — system configuration, design and installation;

  - understanding piping, pumping and pressure distribution design;
- drafting or drawing
  - ability to draw or draft system designs;
  - ability to read plans and blueprints;
  - ability to develop O&M plans.

11.1.4 Construction and installation training

Training regarding construction and installation should include:

- excavating techniques and machinery;
- machine and manual excavation skills;
- safety training regarding equipment and machinery use;
- ability to read and understand blueprints and plans;
- knowledge and skills for pipework construction;
- knowledge and skills for groundwater dewatering during installation;
- knowledge concerning electrical installations;
- relevant regulations.

11.1.5 Collection training

Training regarding collection should include:

- wastewater and sludge management safety;
- relevant regulations;
- operation and handling of tools necessary for collection;
- safe management of collection containers;
- operation of mechanical and manually operated pumping mechanisms.

11.1.6 Transportation training

Training regarding transportation should include:

- materials to be pumped and materials to be avoided;
- relevant regulations;
- truck equipment and components;
- drive and control mechanisms;
- basic and advanced pump-out skills and procedures;
- loading and unloading;
- reasons to manage these materials;
- basic mechanics of vacuum and pressurization;

— pump operations;
— basic pump truck operation;
— special licenses, if required;
— manifests and reports;
— operation of the pumping mechanisms on vacuum trucks;
— operation of the various pumping mechanisms on wheeled carts and other multi-wheeled vehicles;
— road and transport safety;
— training in the safe transport of wastewater and sludge;
— knowledge of transportations rules and regulations.

11.1.7 Operation and maintenance training

Training regarding O&M should include:

— understanding health and safety requirements and procedures;
— understanding how systems function;
— understanding piping and pressure distribution;
— knowledge of pumps and controls;
— knowledge of various types of systems and their O&M requirements;
— knowledge and ability of water-quality measurements and use of the necessary equipment;
— ability to read and understand an O&M manual or programme;
— knowledge and ability to use excavation equipment;
— knowledge and ability to use tools and material necessary for O&M;
— knowledge of equipment and tool safety.

11.2 Information aspects necessary for operation and maintenance

Information on all aspects of ODWS can be available for both practitioners and end-users through industry associations, local health offices and environmental agencies.

Information on examples of appropriate and inappropriate usage is given in Annex D.

Examples of frequently asked questions by users are given in Annex E.

A list of information sources is included in the Bibliography.

12 Health and safety

12.1 Hazards

Working around wastewater and sludge provides the potential for exposure to hazards. Operation, maintenance and repair of ODWS all provide the potential for exposure to harmful contaminants. The magnitude of risk varies depending on the type of ODWS. Mandatory health and safety regulations issued by various authorities generally exist.

Examples of construction, installation, operation, maintenance and collection hazards include:

— drowning;

— trench collapse;

— falls;

— confined spaces;

— exposure to deadly gases, such as chlorine or hydrogen sulfide;

— exposure to an explosive atmosphere due to methane;

— exposure to an oxygen-deficient environment;

— exposure to bacteria, fungus, parasites and viruses.

Additional information on pathogen and bacteria concerns is given in Annex F.

12.2 Hazard mitigation

Careful work habits provide protection. Those working with ODWS, particularly operation, maintenance and repair, should have access to:

— training and education about the hazards of wastewater and sludge;

— a place on-site with clean water, soap and disinfectant for washing hands;

— a place for washing, disinfecting and cleaning up after work;

— gas detection equipment;

— ventilation equipment;

— correct PPE, such as gloves, goggles, face shield, water-resistant suit, gas mask or respirator, depending on the job;

— clean areas set aside for eating and smoking;

— cleaning facilities or services for clothing and equipment to limit exposure to disease-causing agents.

12.3 Personal hygiene

Attention to personal hygiene can provide protection from pathogens borne through contact with faecal matter:

— Most important: wash hands well with clean water and soap before eating or smoking and after work. Guidelines for proper handwashing are available from the WHO website (https://microbenotes.com/hand-washing-steps/#guidelines-of-handwashing-by-the-world-health-organization-who) as well as from other health-related institutions.

— Do not touch nose, mouth, eyes or ears unless hands have been washed. Bacteria and virus transfer occur when germs are transferred from hands to these areas.

— Keep fingernails short; use a stiff soapy brush to clean under nails.

— Wear waterproof gloves when cleaning pumps or screens and when handling wastewater, sludge or grit.

— Always wear gloves, especially when hands are chapped, burned or cut.

— Change out of badly soiled clothing.

— Shower and change out of work clothes before leaving work.

— Keep soiled work clothes away from other clothing.

— Report work illnesses or injury immediately.

— If illness occurs, those working with ODWS in any capacity should inform medical staff of their work environment.

— Those working around wastewater or sludge should have up-to-date vaccinations for tetanus, diphtheria and hepatitis B.

12.4 Safety during construction and installation

Mandatory safety regulations issued by various authorities regarding construction and installation generally exist. During construction and installation, actions relating to safety include:

— using proper personal protection equipment

  — hard hat;

  — steel-toed boots;

  — safety vest or jacket;

  — safety goggles;

  — safety harness (if required);

— marking underground utilities prior to excavation;

— placing spill piles away from excavation edges or trench edges;

— shoring in unstable soils or when otherwise required by geotechnical conditions;

— using dewatering techniques (e.g. drainage, wells, sumps, pumps) when groundwater, spring water or surface water intrudes into the construction site.

12.5 Safety during operation and maintenance

Mandatory safety regulations issued by various authorities regarding O&M generally exist. During O&M, actions relating to safety include:

— Using proper personal protection equipment

  — hard hat;

  — steel-toed rubber or leather boots;

  — safety vest or jacket;

  — waterproof clothing;

  — safety goggles;

  — gloves;

  — gas protection equipment.

— Never entering a tank unless proper health and safety procedures for confined space entry are followed, including procedures regarding possible hazardous gases.

— Avoiding direct exposure to wastewater or sludge on the skin or in the eyes, nose or mouth. Having the proper vaccinations against viruses present in wastewater and sludge, such as hepatitis B.

— Securing and regularly inspecting lids to prevent deliberate or accidental entry.

— Keeping children and pets away from the tank during servicing and cleaning.

— Preventing electric shock and explosion. Explosive methane and other gases are produced by ODWS. Not smoking, using electric lights or power tools or allowing flames or sparks near the septic tank and soil treatment dispersal area.

— Maintaining electrical connections in good repair and protecting above-ground electrical components from weather and mechanical damage.

— Using appropriate wastewater or sludge-collection equipment, such as pipes and hoses.

— Avoiding infectious diseases. Contact with the liquid, sludge and scum in the tank can cause infectious diseases. After any contact with an ODWS, thoroughly washing and disinfecting hands and the other parts of the body that have been in contact with wastewater or sludge. In addition, cleaning and disinfecting the protective equipment.

— Marking the system location and keeping heavy vehicles and equipment off. Not parking, driving or operating any heavy vehicle on the tank or soil treatment dispersal area.

— Keeping fertilizers and flammables out of the system. There is a risk of explosion if fertilizers or petroleum products are placed in an ODWS.

— Not using organic and inorganic chlorine together.

12.6 Safety during removal and transportation

Mandatory safety regulations issued by various authorities regarding removal and transportation generally exist. During removal and transportation, actions relating to safety include:

— Checking in with facility guard or operator.

— Carefully following instructions regarding the sampling of wastewater or sludge. Some treatment plant or transfer stations have designated sites for residential wastewater or sludge, and others for commercial sludges. Plant operators can request samples of the wastewater or sludge prior to allowing discharge if it is suspected that it can contain materials hazardous to the plant.

— Positioning the truck in the designated location for wastewater or sludge removal, parking and taking the gear out of the truck, applying the parking brake and chocking the wheels.

— Removing the hose and making the connections.

— Engaging the power take-off or other mechanism for unloading the tank and completing the offloading process.

— Obtaining the necessary authorization and access to the transfer station prior to transporting wastewater or sludge, as some transfer stations have locked inlets.

— Ensuring sufficient water is available for washing the solids, as some transfer stations have screens to remove non-biodegradable solids.

— Storing any screened non-biodegradable solids in a safe location to drain and dry prior to containment and/or proper disposal, either through incineration or landfilling.

— Using proper lifting techniques when discharging drums into a transfer station, such as standing on a stable surface and ensuring all protective equipment is worn.

— Cleaning up any spillage in the area around the inlet after completing the discharge of wastewater or sludge into the transfer station and resealing the inlet.

— Using PPE, such as gloves and hard hats, and not smoking during the entire collection and discharge operation.

— Replacing hoses and equipment, following adequate hygiene practices (e.g. hand washing), and completing the required paperwork.

Annex A
(informative)

Management models

A.1 General

On-site domestic wastewater services (ODWS) tend to be provided by a combination of stakeholders such as public departments, public or private utilities, private entrepreneurs, non-governmental organizations (NGOs) and community organizations.

A.2 Responsibilities of stakeholders

Each stakeholder can take charge of one or more components within the service chain in many different ways. In some institutional arrangements, each component is provided by a different stakeholder, in which case enforcement, monitoring and coordination can be more difficult. In other cases, some components can be serviced by the same stakeholder with some efficient gains.

For example, if the same stakeholder is in charge of the treatment and the reuse components, advantages can be obtained from the marketing of end products, which can then be used to finance the treatment infrastructure. Also, the management of the collection and transport components, together with treatment, involves highly developed skills but reduces the risk of unauthorised discharging.

A.3 Public, private and non-profit sectors

All the stakeholders' roles can be carried out by either the public or the private sectors, both through a direct or delegated management model. The tendency towards increased political autonomy for local governments is predicated on the principle that such entities are more responsive to the local needs and allocate resources more equitably. However, these processes frequently face a lack of human resources, underfunding from central authorities, dependency on the political situation and potential low priority towards ODWS.

Private participation can range from the involvement of multinational companies to small-scale enterprises. The inherent dynamism of private entrepreneurs can be a benefit. However, some drawbacks include potentially low technical and managerial skills, which should be considered. In particular, informal providers, such as sludge emptiers, are often unrecognized, harassed, denied permits or banned from discharging sludge at treatment facilities, despite their capacity to service areas where no other service providers are operating.

Non-profit civil society organisations, such as NGOs and community-based organisations, present the advantage of their physical and social proximity to poor communities. However, they are possibly not able to respond to the required levels of technical and managerial skills of certain technologies and often face a lack of long-term funding and weak integration in the institutional framework.

A.4 Direct community participation

Direct community participation in O&M is also crucial. Where latrines are used by a single household, O&M tasks are implemented by the household itself (user or landlord) or by hired operators. If two or more households use the latrine, sharing activities such as cleaning tasks must be agreed upon. In the case of public latrines, user associations can also be considered. Challenges of cohesion, coordination and collective work of households have to be considered.

A.5 Institutional arrangements

The distribution of responsibilities among the above-mentioned stakeholders should be based on the specifics of the local situation, the strengths and weaknesses of each stakeholder, their existing skills and interests.

Activities can be carried out on demand or based on a contractual agreement outlining a scheduled service. According to the particular situation and the stakeholders who are involved, formalization documents can be required to define roles, the O&M requirements, the quality standards and the monitoring programme. These can take different forms, such as licences, contracts, partnership agreements, standards and laws.

Regardless of the institutional arrangement, and since the entire service chain is interlinked, special care needs to be taken to clearly allocate responsibilities, to avoid overlaps and to provide incentives for efficient operations and coordination. Operators should have an organized, transparent and efficient management structure, while maintaining flexibility to allow for growth and innovations (e.g. in pricing procedure or technology development). Also, regulations and enforcement should be developed by independent government entities.

Annex B
(informative)

Aspects of preparation and implementation

B.1 Design aspects

The design of efficient and cost-effective ODWS should ensure performance, longevity and protection of public health and the environment and the O&M of the ODWS.

ODWS can either be constructed on-site using a series of components (e.g. a septic tank system comprising a tank with connections to the building and connections to a treatment field) or complete pre-packaged systems (package plant) which simply require connection to the building and to the discharge point.

To design an ODWS, it is necessary to know the quantity and quality of wastewater to be treated in order to determine the treatment process and the capacity of the facility. The amount of wastewater and pollutant load can be estimated from the planned treatment population if the unit per capita loading, or wastewater amount and pollutant loads per population equivalent (PE), is available. If these data are not available, the volume of wastewater can be estimated by the volume of water consumed (e.g. with a meter) while the amount of pollutant load can be estimated by referring to the concentration values of items such as biochemical oxygen demand (BOD) and total suspended solids (TSS) in the influent from reference values. In the absence of unit per capita loading for a new building to be built, the volume of wastewater and amount of pollutant load can be estimated by referring to similar existing buildings.

The treatment process and capacity of the facility should be designed to satisfy public health requirements and meet the mandatory effluent quality (discharge standards) for the volume of wastewater and the amount of pollutant load to be treated.

When deciding the treatment process and capacity of the facility, attention needs to be paid to the following matters:

— geographical and geological conditions;

— initial investment cost, and operation and management costs;

— maintenance manageability;

— safe treatment and dispersal;

— potential for recycling of sludge;

— potential for recycling treated wastewater;

— potential for utilizing organic matter for biogas production.

Designing septic systems, aerobic or anaerobic treatment systems or similar systems requires an evaluation of the serviced property for its ability to support an ODWS and, subsequently, the development of a site plan. The process of assessing the site and soils where the system is to be installed is the most important part of the design process. Only after appropriate assessment of the soil and calculation of the flows being generated for treatment can a system be designed that will meet the local regulatory framework, if any, while protecting public health and the environment. The design documents should include a site drawing and soil assessment reports.

The site assessment should consider the location of any other utilities on the property, including any wells, either public or private, water, power or gas lines. For the use of a soil treatment dispersal or filtration system, the soil on the site should be evaluated to determine its ability to accept and treat wastewater.

Other site factors include land area requirements and the ability of the site to meet water resource protection needs, such as:

— depth to water table or other limiting layers;

— potential for water table rise;

— soil permeability;

— location with setbacks from wetlands and surface waters;

— proximity to public and private wells;

— proximity to shorelines;

— adequate space to repair a failing system;

— ease of access for routine maintenance;

— potential or existing drainage patterns.

ODWS require regular maintenance; therefore, siting should be such that the system is accessible for emptying and maintenance activities. For example:

— tanks located to be easily accessible for O&M;

— effluent filters (if required) located to give ease for periodical cleaning or replacement;

— pumps installed for easy removal during servicing maintenance or replacement;

— monitoring ports installed at either end of the distribution laterals to provide the ability to check the system for ponding;

— cleanouts installed at the end of each distribution lateral to provide the ability to check the pressure in the laterals and to allow the laterals to be flushed and scoured.

The size of the residence or facility being served should be recorded, along with any higher-than-normal water using features or practices to determine the peak wastewater flow rate generated.

Other site factors include land area requirements and the ability of the site to meet water resource protection needs, such as:

— depth to water table or other limiting layers;

— potential for water table rise;

— soil permeability;

— location with setbacks from wetlands and surface waters;

— proximity to public and private wells;

— proximity to shorelines;

— adequate space to repair failing system;

— ease of access for routine maintenance;

— potential or existing drainage patterns.

A design report should be prepared, determining adequate siting and system sizing along with site plans, material list and an operation and maintenance (O&M) manual. The design report should be made available to the property owner, the person(s) or contractor installing the system and the relevant inspection agency (if any).

B.2 Manufacturing aspects

For the manufacturing of prefabricated ODWS, it is essential that these systems perform for the purpose they have been designed and are produced uniformly. It is strongly recommended that certified products are introduced and a testing or certification system established for the products where none exists.

Requirements for prefabricated ODWS include:

— Performance: create a structure that can achieve the designed treatment performance and meet the targeted effluent standards.

— Robustness: create a structure and use materials with sufficient robustness to avoid structural collapse over time or cracks due to wear, or the passage of vehicles over the area of installation. In the case of prefabricated units made of material such as plastic or fibreglass, guidance should be given on measures needed to achieve structural integrity (e.g. support pillars and slabs).

— Watertightness: create a watertight structure into which groundwater shall not enter and from which wastewater shall not leak into the ground. Lids should be watertight to avoid water entry or wastewater exit from the facility.

— Size: create a structure that can bear a sufficient volume of water. This volume can be prescribed by regulation or law.

— Operation and maintenance: create a structure that allows adequate O&M.

— Access: provide for installation of accessible and functional lids at grade. It is also recommended that the access lids be secured to prevent unauthorized access.

These requirements can be prescribed by regulation or law, or certified based on a performance test.

B.3 Construction and installation aspects

Prior to construction and installation, drawings of the site and system shall be prepared. It is recommended that these documents include a materials list, specification sheets and information on the site and soil analysis that was performed.

The materials used in the construction of an ODWS can be prescribed within the regulatory jurisdiction in which the system is built.

Requirements and recommendations for the components and construction materials of ODWS include:

— tanks of septic systems, aerobic or anaerobic treatment systems or similar systems

  — structural integrity;

  — watertightness;

  — gas-tightness in the case of anaerobic systems;

  — burial depth;

  — need for insulation;

  - — ability to transport (portable containers only);
- — personnel access extensions
  - — watertight;
  - — allow easy access for O&M;
- — tank or access lids
  - — structurally sound;
  - — secure and childproof;
  - — above grade to allow easy access for O&M;
- — piping materials
  - — pressure-rated piping;
  - — pressure-rated fittings;
- — plumbing glue
  - — waterproof;
  - — rated for extreme temperatures (heat or cold);
- — pumps
  - — rated for the proper head pressure and flow rate;
  - — located to allow easy access for O&M;
- — effluent filters
  - — rated for the correct flow rate for the system;
  - — consideration given to ease of O&M following installation;
- — drain and filter materials
  - — clean washed sands and gravels;
  - — other materials approved by the regulatory authority.

It is important that an ODWS be installed for proper and easy O&M. The following requirements apply to a wide range of ODWS types. For basic systems, such as improved traditional latrines, ventilated improved pit latrines, double-vault compost latrines, bored hole latrines and pour-flush latrines, it is possible that only some of these requirements are applicable.

Requirements and recommendations for construction and installation include:

- — protection of the facility to prevent damage during construction and installation;
- — full understanding of the situation of the site, such as the installation location at the facility and the discharge location;
- — storage of materials and equipment at the construction site in such a way that does not endanger their quality and performance capability;
- — utilizing appropriate construction safety measures to prevent harm caused by ground collapse, falling materials and other security issues;

— actions during construction and installation:

  — where work is performed close to buildings or other features, prevention of inclination, collapse, etc.

  — when performing root cutting work, consideration of the conditions of the excavation area and potential groundwater intrusion to prevent ground collapse;

  — when backfilling, ensuring that no foreign matter enters the system components and ensuring sufficient compaction around the tankage and inlet and outlet piping;

  — ensuring the ODWS is level prior to and during backfilling;

— where a high groundwater table exists, tanks and packaged plants installed utilizing anti-buoyancy measures;

— all electrical components properly installed by an electrician to ensure wiring and grounding are installed properly and there are no safety or function concerns;

— where appropriate, electrical components installed outside on a post or structure near the equipment and housed in a waterproof, lockable box to ensure that weather does not impact the electronics and the system cannot be tampered with;

— any mechanical components, such as pumps, blowers (aerators) or mixers, tested for functionality and normal operation as well as checked according to manufacturers' instructions.

Facilities should be placed to ensure that vacuum trucks have ready access to them for servicing, i.e. near a roadway or driveway.

Lids should be above grade. The soil around the tank access opening below the lid should be sloped away from the lid so that water does not pool around the lid or flow into the lid, causing entry of groundwater into the septic tank.

In the case of a septic system, an effluent filter should be installed in the dosing or siphon chamber to prevent the release of solids and fats into the soil interface. This effluent filter should be cleaned periodically, therefore it should be installed for easy access and removal.

Pumps, if any, should be lowered into the pump chamber on a chain or rope made of a material with sufficient resistance to corrosion, which can then be secured to the access opening to allow for easy removal of the pump during servicing or replacement.

The delivery line from the tank to the soil treatment component should be sufficiently sloped. The delivery line should not be placed where there will be construction, such as a building or driveway over the top of it. If the line is to be installed under a driveway in cold climates with frost, then the delivery line should be inserted in a frost box to prevent freezing of the line due to compaction of the soil above it.

The distribution laterals in the soil treatment dispersal area should be sufficiently sloped and should be installed perpendicular to the ground slope. The flow to the laterals should be adjusted to ensure the lateral at the bottom of a slope is not receiving more effluent than the laterals upslope.

Monitoring ports such as inspection chambers should be installed at either end of the distribution laterals to allow the system to be checked for ponding.

Cleanouts should be installed at the end of each distribution lateral to provide the ability to check the pressure in the laterals and to allow the laterals to be flushed and scoured.

For the medium-to-large-scale aerobic treatment systems built of reinforced concrete at the site of installation, the same precautions taken as for the construction of wastewater treatment plants for sewer systems should be observed, for example, the dimensions and shape of each tank and the piping work.

Annex C
(informative)

Examples of checklists

C.1 Compliance inspection checklist

1. Date of initial system installation and commissioning ___________________________
2. Date of last operation and maintenance (O&M) inspection ____________________________
3. Date of last system maintenance activities and a brief description of those activities

   ____
4. Proximity to surface water ____
5. Proximity to neighbouring homes/buildings ___________________________________
6. Proximity to property lines ____
7. Proximity to water wells ____
8. Depth to groundwater ____
9. Type of system and system component:
   - ☐ Pit
   - ☐ Gravity distribution
   - ☐ Pressure distribution
   - ☐ Soil discharge
   - ☐ Water discharge
   - ☐ Other ____
10. Has the original system been changed or modified?
    - ☐ Yes
    - ☐ No

If yes, explain ____

11. Odour – is there an odour present within 3 m of system?
    - ☐ None
    - ☐ Mild
    - ☐ Strong
    - ☐ Chemical
    - ☐ Sour

☐ Foul odour of rotten eggs (presence of H_2S)

Source or cause of odour if present ____

12. Is the tank's level correct?

☐ Yes

☐ No

13. Do the inlet and outlet pipes have the correct gradient/alignment?

☐ Yes

☐ No

14. Surfacing of effluent on ground?

☐ Yes

☐ No

15. Changes in landscape or drainage patterns?

☐ Yes

☐ No

16. All manway/access lids present at grade and in good condition?

☐ Yes

☐ No

17. Condition of discharge area:

☐ Signs of saturation

☐ Slumping between laterals

☐ Ponding at surface

☐ Other __________________________________

18. Overall system condition:

☐ Acceptable

☐ Unacceptable

☐ Maintenance inspection needed

☐ Mitigation required

Comments

____
____
____

19. System appears to meet regulatory requirements?

☐ Yes

☐ No

If no, explain

____
____
____

Final documentation issued to user or client – date, name of inspector/service, provider/contact information.

C.2 Maintenance inspection checklist

1. Has the original system been changed or modified?

   ☐ Yes

   ☐ No

If yes, explain:

____
____
____

2. Odour – is there an odour present within 3 m of system?

   ☐ None

   ☐ Mild

   ☐ Strong

   ☐ Chemical

   ☐ Sour

Source and cause of odour if present ____

3. Surfacing of effluent on ground?

   ☐ Yes

   ☐ No

4. Changes in landscape or drainage patterns?

   ☐ Yes

   ☐ No

5. All components present and not modified?

   ☐ Yes

   ☐ No

6. All manway/access lids present at grade and in good condition?

   ☐ Yes

   ☐ No

7. Is the system impacted by foot or other traffic?

   ☐ Yes

☐ No

8. Estimated system daily flow based on data or on number of bedrooms/bathrooms or number of occupants ___________________

9. Water meter present?

☐ If yes, then flow value/# of days = litres per day (LPD)

☐ No

☐ Not applicable

10. Strength of effluent:

☐ Residential strength

☐ High strength

Influent sewage strength per test results: _________________

Effluent sewage strength per test results: _________________

11. Piping clear of debris?

☐ Yes

☐ No

12. If a blower is present, does it function?

☐ Yes

☐ No

13. If an aeration process device is present, does it function normally?

☐ Yes

☐ No

14. Pump present and functioning?

☐ Yes

☐ No

15. Is system dosed?

☐ Timed

☐ Demand

16. Control panel?

☐ Yes – functioning properly

☐ No – needs attention

☐ Not applicable

17. Siphon?

☐ Yes – functioning properly

☐ No – needs attention

☐ Not applicable

18. Initial treatment components – assess condition and integrity of septic tank, aerobic treatment unit or another container:

☐ In good condition

☐ Needs repair or replacement

19. Does septic system, aerobic/anaerobic treatment system or similar system require pumping?

☐ Sludge and scum levels checked

☐ Requires service

☐ Does not require service at this time

20. Identify discharge area:

☐ Soil treatment field

☐ Water discharge

☐ Other ____________________

21. Condition of discharge area:

☐ Signs of saturation

☐ Slumping between laterals

☐ Ponding at surface

☐ Other ______________________________________

22. Effluent filter present?

☐ Yes

☐ No

23. Effluent filter requires cleaning?

☐ Yes

☐ No

24. High water alarm?

☐ Yes - functioning

☐ No – needs repair

☐ Not applicable

25. Other components not listed:

____
_

26. Prior to completion:

☐ All controls are set on the appropriate mode

☐ Power is on to all components

- ☐ Verify lids are secure
- ☐ Remove all tools from site
- ☐ No sewage is on the ground surface

27. Overall system condition:

- ☐ Acceptable
- ☐ Unacceptable
- ☐ Maintenance needed – provide list of needed maintenance
- ☐ Maintenance performed – provide report
- ☐ Mitigation required – provide recommendations

Final documentation of service provided to user or client – date, name of inspector/service, provider/contact information.

C.3 Operation and maintenance checklist for aerobic or anaerobic treatment systems

An example of a checklist for operation and maintenance of aerobic or anaerobic treatment systems is given in Table C.1.

Table C.1 — Example checklist for operation and maintenance of aerobic or anaerobic treatment systems

Component	Routine tasks	Evaluation	Remedy
Pre-treatment chamber (e.g. sludge storage tank)	Remove sludge from pre-treatment chamber	Requires regular pumping (every 1 to 5 years minimum). Assess for: — abnormal rise in water level — outbreak of mosquitoes or flies — entry of foreign materials — growth of scum — generation of sludge deposit	Contact manufacturer or seller for complete information on removal of equipment, access to individual chambers, coordination of services and proper disposal of tank contents Clean as needed
Disinfection tank or component	Check disinfection	Inspect by qualified person at required intervals (generally every 3 to 4 months). Assess: — condition of contact with treated water — type of disinfectant — generation of deposits — amount of residual disinfectant	Replace chlorine tablet(s) or refill liquid chlorine and clean dispenser Replace UV light (if applicable) Clean as needed