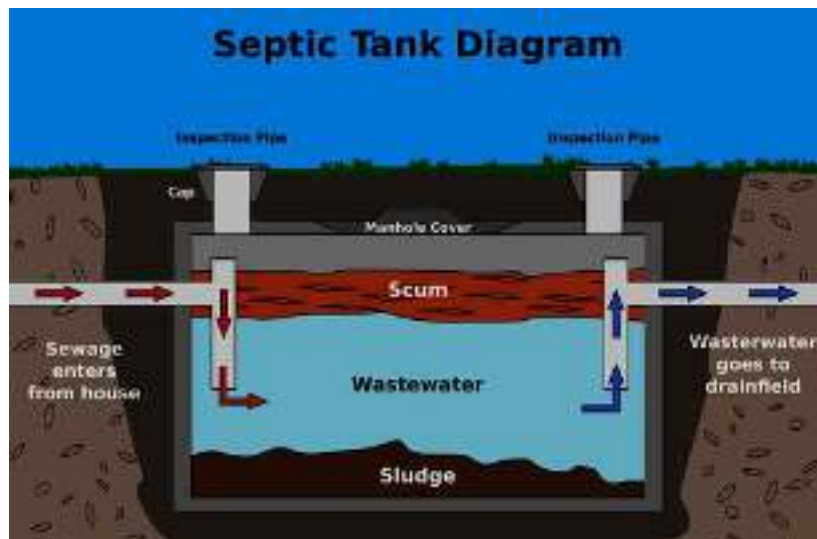


# Plumbing Installation Level IV

Based on July, 2023, Curriculum Version II



**Module Title: - Designing and sizing domestic treatment plant disposal systems**

**Module code: EIS PLI4 M04 1023**

**Nominal duration: 100 Hours**

Prepared by: Ministry of Labor and Skill

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*Addis Ababa, Ethiopia*

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## Acronym's

ATU .....	Aerobic treatment unit
MSW .....	Municipal solid waste
OHS .....	Occupational health and safety
PVC .....	Polyvinyl chloride
HDPE .....	High-density polyethylene
ABS .....	Acrylonitrile butadiene styrene
ENBC .....	Ethiopian National Building Code
BOD .....	Biochemical Oxygen Demand
TSS .....	Total Suspended Solids
FRP .....	Fiberglass Reinforced Plastic
MSW .....	Municipal solid waste

## Introduction to the Module

The Designing and sizing domestic treatment plant disposal systems helps to know the Concepts of domestic Treatment Plant Disposal Systems, System requirements, Design system layout, Restore work area in plumbing installation field. This module cover skill, knowledge and attitude required to Designing and sizing domestic treatment plant disposal systems.

This module is designed to meet the industry requirement under the plumbing installation work occupational standard, particularly for the unit of competency:

### This module covers the following units:

- Concepts of domestic Treatment Plant Disposal Systems
- System requirements
- Design system layout
- Restoring work area.

### Learning Objective of the Module

- Explain Concepts of domestic Treatment Plant Disposal Systems
- Identify system requirements
- Prepare design system layout
- Restore work area.

### Module Instruction

For effective use these modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” given at the end of each unit and
5. Read the identified reference book for Examples and exercise

## Unit one: Concepts of domestic Treatment Plant Disposal Systems

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Introduction domestic Treatment Plant Disposal Systems
- Nature and scope of planning task
- Safety (OHS) and environmental requirements
- Sequencing and organizing work.
- Tools, materials and equipment
- Work area preparation

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Explain domestic Treatment Plant Disposal Systems
- Identify nature and scope of planning task.
- Adhere Safety (OHS) and environmental requirements.
- Sequence and organize work.
- Select and check tools and equipment.
- Prepare work area.

## 1.1. Introduction of domestic Treatment Plant Disposal Systems

Domestic treatment plant disposal systems are used to treat and dispose of wastewater from homes and other residential properties. These systems are typically used in areas that are not connected to a municipal sewer system.

Domestic treatment plant disposal systems typically use a combination of physical, biological, and chemical processes to remove pollutants from wastewater. The specific treatment processes used will vary depending on the type of system and the quality of the wastewater.

### Common domestic treatment plant disposal systems include:

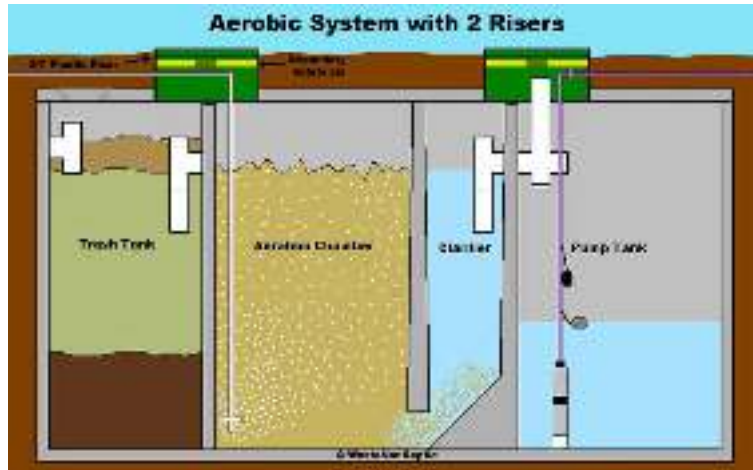
**Septic tank systems:** Septic tank systems are the simplest and most common type of domestic treatment plant disposal system. Septic tanks use a combination of gravity and natural bacteria to break down solids and remove organic matter from wastewater.



**Figure 1-1** Septic tank systems

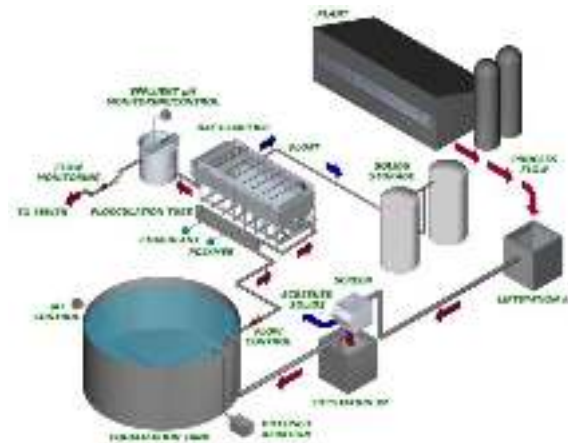
**Aerobic treatment systems:** Aerobic treatment systems use oxygen to break down solids and remove organic matter from wastewater. Aerobic treatment systems are more complex and expensive than septic tank systems, but they are also more efficient and can produce a higher quality effluent.





**Figure 1-2** Aerobic treatment systems

**Packaged treatment plants:** Packaged treatment plants are pre-engineered systems that are typically used for larger residential properties or commercial applications. Packaged treatment plants use a variety of treatment processes, including physical, biological, and chemical processes, to remove pollutants from wastewater.



**Figure 1-3** Packaged treatment plants

The effluent from a domestic treatment plant disposal system is typically discharged to a drain field or a body of water. The drain field is a system of perforated pipes that are buried in the ground. The effluent from the treatment plant flows into the drain field and seeps into the soil.

Domestic treatment plant disposal systems are an important part of protecting public health and the environment. By properly treating and disposing of wastewater, domestic treatment plant disposal systems help to prevent the spread of disease and pollution.

**Drain field:** The drain field is a system of perforated pipes that are buried in the ground. The effluent from the septic tank flows into the drain field and seeps into the soil. The soil further treats and filters the effluent as it passes through.

Septic tank systems are a relatively simple and effective way to treat and dispose of wastewater in rural areas. However, it is important to properly maintain septic tank systems to ensure that they are operating efficiently and not polluting the environment.



**Figure 1-4** drain field system

### **Different types of septic tank systems**

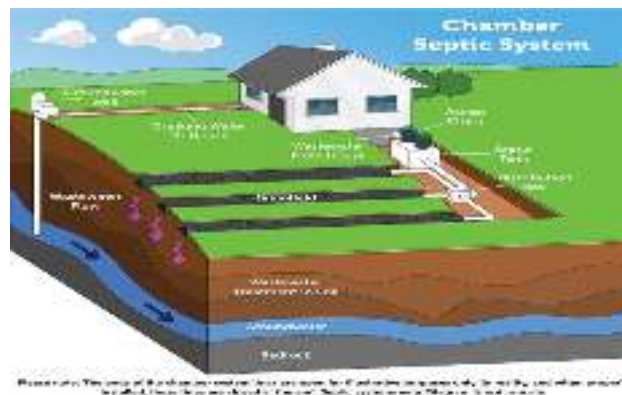
There are several different types of septic tank systems available, each with its own advantages and disadvantages. The best type of septic tank system for a particular property will depend on a number of factors, including the size of the property, the type of soil, and the groundwater level.

**Conventional septic tank systems** are the most common type of septic tank system. They are relatively simple and inexpensive to install, and they can be used on a variety of soil types. However, conventional septic tank systems require a large amount of space for the drain field.



**Figure 1-5** Conventional septic tank systems

**Chamber systems** are a newer type of septic tank system that is becoming increasingly popular. Chamber systems are more expensive to install than conventional septic tank systems, but they require less space for the drain field. Chamber systems are also a good option for properties with high groundwater levels.



**Figure 1-6** Chamber systems

**Other types of septic tank systems include:**

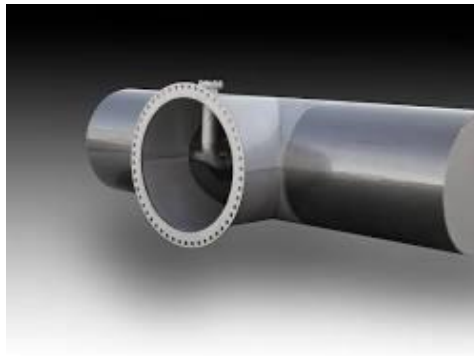
**Mound systems:** Mound systems are a good option for properties with high groundwater levels or shallow soil. Mound systems consist of a raised bed of sand and gravel that is filled with wastewater from the septic tank. The effluent from the mound system seeps into the soil below.

**Sand filter systems:** Sand filter systems use sand to filter wastewater from the septic tank. Sand filter systems produce a high quality effluent that can be discharged to a small drain field or reused for irrigation. However, sand filter systems are more expensive to install and maintain than conventional septic tank systems.

**Constructed wetland systems:** Constructed wetland systems use plants to filter wastewater from the septic tank. Constructed wetland systems are a good option for properties with large areas of land available. However, constructed wetland systems can be more expensive to install and maintain than conventional septic tank systems.

**The process of water treatment:** is a multi-step process that removes contaminants from raw water to make it safe for human consumption. The specific steps involved in the water treatment process vary depending on the quality of the raw water and the intended use of the treated water. However, the general steps are as follows:

1. **Intake and screening:** The raw water is first pumped into the water treatment plant, where it is screened to remove large debris, such as leaves, sticks, and rocks.



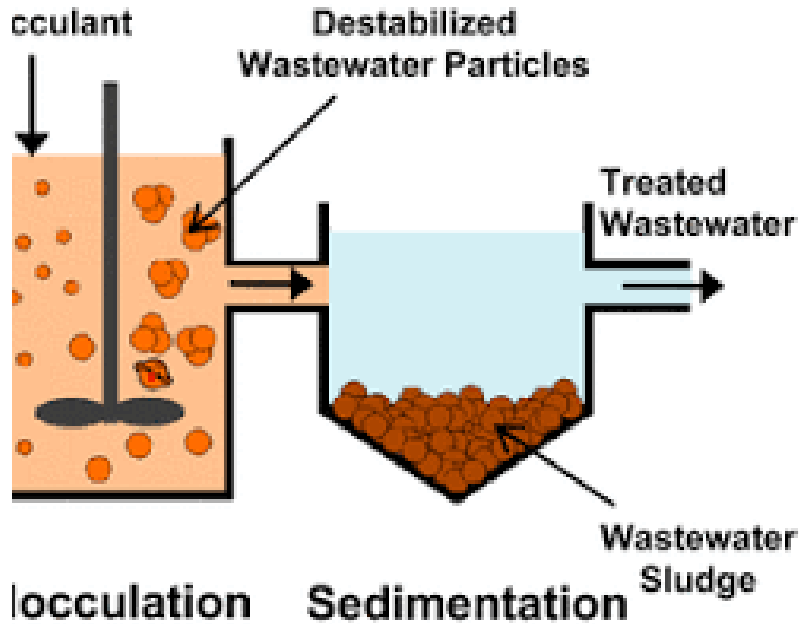
**Figure 1-7** Water treatment intake and screening

2. **Aeration:** The water is then aerated, which helps to remove dissolved gases, such as methane and hydrogen sulfide, and to oxidize iron and manganese.



**Figure 1-8** Water treatment aeration

3. **Coagulation and flocculation:** Chemicals are added to the water to cause small particles to clump together into larger flocs. This process is called coagulation. The flocs are then allowed to settle out of the water in a process called flocculation.



**Figure 1-9** Water treatment coagulation and flocculation

4. **Sedimentation:** The flocs are then allowed to settle out of the water in large sedimentation tanks. This process removes most of the suspended solids from the water.



**Figure 1-0-10** Water treatment sedimentation

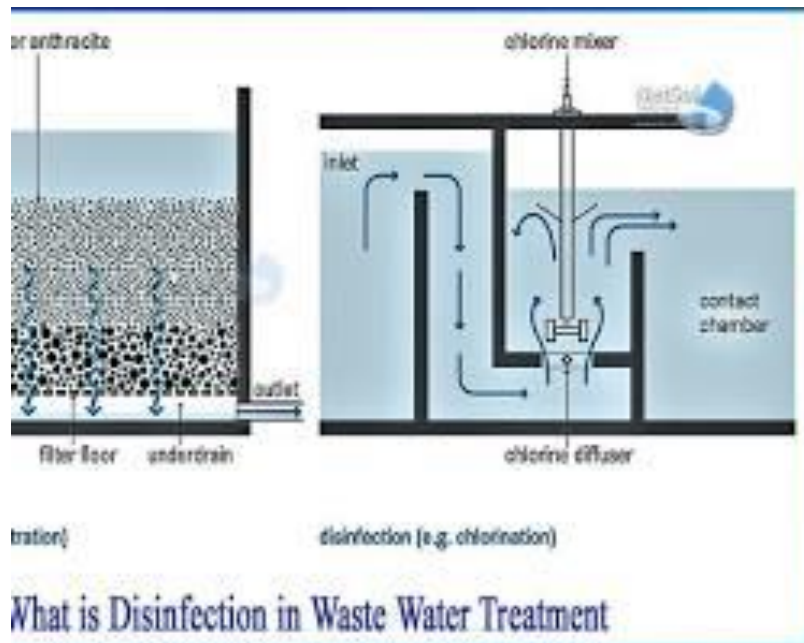


5. **Filtration:** The water is then passed through filters to remove any remaining suspended solids and bacteria.



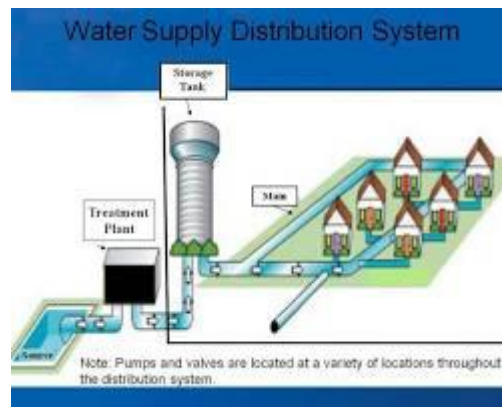
**Figure 1-11** Water treatment filtration

6. **Disinfection:** Disinfectants, such as chlorine or ozone, are added to the water to kill any remaining harmful bacteria.



**Figure 1-10-2** Water treatment disinfection

7. **Storage and distribution:** The treated water is then stored in reservoirs and distributed to homes and businesses through a network of pipes.



**Figure 1-13** Water treatment storage and distribution

The water treatment process is essential for ensuring that the water we drink is safe and clean. By following these steps, water treatment plants can remove a wide range of contaminants from raw water, including:

- Suspended solids, such as dirt, sand, and algae
- Bacteria and viruses
- Chemicals, such as pesticides and herbicides
- Heavy metals, such as lead and mercury

Once the water has been treated, it is safe to drink, cook with, and use for bathing and other household purposes.

## 1.2. Nature and scope of planning task

The nature and scope of the planning task for the course Concepts of Domestic Treatment Plant Disposal Systems will vary depending on the specific course objectives and the instructor's approach.

The nature and scope of the planning task refer to the characteristics and extent of the activities involved in the process of planning. Planning is a systematic approach to setting goals, determining actions, and allocating resources to achieve those goals. It involves analyzing the

current situation, identifying future objectives, and developing strategies to reach those objectives.

### 1.2.1. Nature of Planning Task

The nature of the planning task for a domestic wastewater treatment plant disposal system is to develop a system that is safe, efficient, and environmentally compliant.

The planning process should consider the following factors:

1. **The volume and quality of the wastewater:** The size and type of treatment plant and disposal system will depend on the volume and quality of the wastewater.
2. **The characteristics of the site:** The type of soil, the slope of the land, and the proximity to water bodies will all affect the design of the system.
3. **Local environmental regulations:** The system must comply with all relevant environmental regulations, such as those governing the discharge of treated wastewater.

The planning task typically involves the following steps:

1. **Assessment of the site:** The first step is to assess the site where the treatment plant and disposal system will be located. This includes identifying the type of soil, the slope of the land, and the proximity to water bodies.
2. **Selection of the appropriate treatment and disposal systems:** The next step is to select the appropriate treatment and disposal systems for the site. This will depend on the volume and quality of the wastewater, as well as the local environmental regulations.
3. **Design of the system:** Once the treatment and disposal systems have been selected, the system needs to be designed. This includes developing detailed drawings and specifications.
4. **Obtaining permits:** If required by law, permits will need to be obtained from the local authorities before construction can begin.
5. **Construction of the system:** The treatment plant and disposal system can then be constructed.



6. **Commissioning and operation of the system:** Once the system is constructed, it needs to be commissioned and tested to ensure that it is operating properly. The system will then need to be operated and maintained on a regular basis.

The planning task for a domestic wastewater treatment plant disposal system is complex and requires a thorough understanding of the various factors involved. It is important to consult with qualified professionals to ensure that the system is designed and installed properly.

### 1.2.2. Scope of Planning Task

The scope of the planning task for a domestic wastewater treatment plant disposal system will vary depending on the specific site and the requirements of the local authorities.

The following tasks are typically included:

1. **Site assessment:** This includes identifying the type of soil, the slope of the land, the proximity to water bodies, and any other relevant environmental factors.
2. **Selection of the appropriate treatment and disposal systems:** This will depend on the volume and quality of the wastewater, as well as the local environmental regulations.
3. **Design of the system:** This includes developing detailed drawings and specifications for the treatment plant and disposal system.
4. **Obtaining permits:** If required by law, permits will need to be obtained from the local authorities before construction can begin.
5. **Preparation of a construction schedule and budget:** This will help to ensure that the project is completed on time and within budget.
6. **Coordination with contractors and suppliers:** This is necessary to ensure that all of the necessary materials and equipment are available on time and that the project is completed safely and to a high standard.
7. **Commissioning and operation of the system:** Once the system is constructed, it needs to be commissioned and tested to ensure that it is operating properly. The system will then need to be operated and maintained on a regular basis.

### 1.3. Safety (OHS) and environmental requirements

Designing and sizing domestic treatment plant disposal systems is a critical aspect of ensuring the safe and efficient management of wastewater.

The following are some of the key safety and environmental requirements that must be considered when designing and sizing these systems:

1. **Hazard Identification and Risk Assessment:** The first step in designing and sizing a domestic treatment plant disposal system is to identify potential hazards and conduct a risk assessment. This includes identifying the types of wastewater that will be treated, the potential for hazardous substances to be present in the wastewater, and the potential for the system to fail or malfunction.
2. **Compliance with Regulations:** Domestic treatment plant disposal systems must comply with all relevant regulations and standards, including those related to wastewater discharge, water quality, and environmental protection. This may involve obtaining permits and approvals from regulatory authorities, and ensuring that the system is designed and constructed in accordance with relevant codes and standards.
3. **Proper System Design:** The design of the domestic treatment plant disposal system must take into account the type of wastewater being treated, the flow rate of the wastewater, and the desired level of treatment. The system must also be designed to minimize the risk of failure or malfunction, and to ensure that any hazardous substances present in the wastewater are properly treated and disposed of.
4. **Safety Features:** The domestic treatment plant disposal system should be designed with safety features to protect operators, maintenance personnel, and the general public. This may include safety fences, warning signs, and emergency shut-off valves.
5. **Regular Maintenance and Inspection:** Regular maintenance and inspection of the domestic treatment plant disposal system is critical to ensure that it is functioning properly and safely. This may include routine cleaning and inspection of the system, as well as regular testing of the wastewater being treated to ensure that it meets all relevant regulations and standards.

6. **Emergency Response Plan:** An emergency response plan should be developed and implemented in the event of a system failure or malfunction. This plan should include procedures for containing and cleaning up any spills or leaks, as well as procedures for notifying regulatory authorities and the public.
7. **Training and Education:** Operators and maintenance personnel should receive proper training and education on the safe operation and maintenance of the domestic treatment plant disposal system. This may include training on the proper use of safety equipment, the handling of hazardous substances, and the proper disposal of wastewater.
8. **Environmental Considerations:** The domestic treatment plant disposal system should be designed and constructed to minimize its impact on the environment. This may include the use of environmentally-friendly materials and the implementation of measures to reduce energy consumption and greenhouse gas emissions.

#### 1.4. Sequencing and organizing work

When installing a domestic wastewater treatment plant disposal system, sequencing and organizing the work is crucial for ensuring an efficient and safe installation process. This involves carefully planning and coordinating various tasks to ensure that they are carried out in the correct order and with proper consideration for safety measures.

The following steps outline a general sequence of work for installing a domestic wastewater treatment plant disposal system:

1. **Site assessment:** Before beginning any installation work, it is important to conduct a thorough site assessment. This involves evaluating the soil conditions, topography, and available space to determine the most suitable location for the wastewater treatment plant. Additionally, any potential obstacles or environmental considerations should be identified during this stage.
2. **Design and engineering:** Once the site assessment is complete, the next step is to design and engineer the wastewater treatment system. This includes determining the appropriate size and capacity of the system based on factors such as household size, water usage, and local regulations. The design should also consider factors such as effluent quality requirements and any specific treatment processes needed.

3. **Permitting and approvals:** Before proceeding with the installation, it is essential to obtain all necessary permits and approvals from local regulatory authorities. This may involve submitting detailed plans and specifications for review and obtaining permits for construction, excavation, or environmental impact.
4. **Excavation and site preparation:** Once all necessary permits are obtained, excavation and site preparation can begin. This involves clearing the area of vegetation or structures, as well as excavating the ground to create space for the wastewater treatment system components. Proper safety measures should be followed during excavation to prevent accidents or damage to existing infrastructure.
5. **Installation of tanks and components:** The next step is to install the various components of the wastewater treatment system, including tanks, pipes, pumps, filters, and control panels. Each component should be installed according to manufacturer guidelines and industry best practices. It is important to ensure proper alignment, connection, and sealing of all components to prevent leaks or system failures.
6. **Plumbing and electrical connections:** Once the tanks and components are in place, the plumbing and electrical connections can be made. This involves connecting the pipes, valves, and fittings to ensure proper flow of wastewater through the treatment system. Electrical connections should be made by a licensed electrician following all safety codes and regulations.
7. **Testing and commissioning:** After the installation is complete, the wastewater treatment system should undergo thorough testing and commissioning. This includes checking for any leaks, verifying proper functioning of pumps and controls, and conducting performance tests to ensure that the system meets the required standards. Any necessary adjustments or repairs should be made during this stage.
8. **Backfilling and site restoration:** Once the testing and commissioning are successfully completed, the excavated area can be backfilled with suitable material. Proper compaction techniques should be used to ensure stability and prevent settling. Additionally, any disturbed areas should be restored to their original condition, including reseeded or replanting vegetation if necessary.

- 9. Operation and maintenance:** Finally, it is important to establish a regular operation and maintenance plan for the wastewater treatment system. This includes routine inspections, cleaning, and servicing of components to ensure optimal performance and longevity of the system. Regular monitoring of effluent quality should also be conducted to ensure compliance with regulatory standards.

## 1.5. Tools, materials and equipment

To designing and sizing domestic treatment plant disposal systems, it is crucial to select and check the appropriate tools, materials, and equipment. This ensures that the system functions efficiently and effectively. The selection process involves considering various factors such as the type of treatment plant, local regulations, site conditions, and budget constraints. There is a comprehensive guide on selecting and checking tools, materials, and equipment for designing and sizing domestic treatment plant disposal systems.

**Tools:** are devices that are used to perform a task, such as a hammer, a saw, or a wrench. Tools can be handheld or powered. Hand tools are powered by the user's own strength, while powered tools are powered by an external source, such as electricity or gasoline.

Common types of tools are listed below:

1. **Measuring Tools:** Accurate measurements are essential for designing and sizing treatment plant disposal systems. Common measuring tools include tape measures, rulers, levels, and laser distance meters. These tools help determine distances, elevations, and dimensions accurately.
2. **Design Software:** Utilizing design software can greatly assist in the planning and layout of treatment plant disposal systems. These software programs provide tools for creating detailed designs, calculating flow rates, determining pipe sizes, and simulating system performance.
3. **Soil Testing Equipment:** Conducting soil tests is crucial to assess the suitability of the site for installing a treatment plant disposal system. Soil testing equipment includes soil augers, penetrometers, pH meters, moisture meters, and compaction testers. These tools help determine soil composition, permeability, compaction levels, and other important parameters.

4. **Pipe Cutting and Joining Tools:** Depending on the type of pipes used in the system (such as PVC or HDPE), appropriate cutting and joining tools are necessary. These may include pipe cutters, solvent cement applicators, heat guns for welding plastic pipes, or mechanical fittings for joining different types of pipes.
5. **Excavation Tools:** Excavation is often required during the installation of treatment plant disposal systems. Excavation tools like shovels, spades, picks, trenching machines, or mini-excavators help dig trenches for laying pipes and installing tanks or chambers.

**Materials:** are the substances that are used to make something. Materials can be natural or synthetic. Natural materials are found in nature, such as wood, stone, and metal. Synthetic materials are man-made, such as plastic, rubber, and glass.

Common types of material are listed below:

1. **Pipes:** Selecting the right type and size of pipes is crucial for the proper functioning of treatment plant disposal systems. Commonly used pipes include PVC (polyvinyl chloride), HDPE (high-density polyethylene), or ABS (acrylonitrile butadiene styrene). The choice of material depends on factors such as soil conditions, local regulations, and budget.
2. **Tanks or Chambers:** Treatment plant disposal systems often require tanks or chambers for storing and treating wastewater. These can include septic tanks, aerobic treatment units, dosing chambers, or pump stations. The materials used for these structures should be durable, corrosion-resistant, and compliant with relevant standards.
3. **Filters and Media:** Depending on the treatment process employed in the system, filters and media may be necessary to remove impurities from the wastewater. This can include sand filters, activated carbon filters, or biological media like peat moss or plastic biofilm carriers. The selection of filters and media should be based on the specific treatment requirements.
4. **Electrical Components:** Treatment plant disposal systems may require electrical components such as pumps, control panels, alarms, and sensors. These components should be selected based on their compatibility with the system design, power requirements, and safety standards.

5. **Backfill Materials:** After installing pipes and tanks/chambers, backfill materials are used to fill the excavated trenches. Common backfill materials include sand, gravel, or crushed stone. The choice of backfill material should ensure proper drainage around the pipes and structural stability.

**Equipment:** is a machine or device that is used to perform a task. Equipment can be simple, such as a wheelbarrow, or complex, such as a computer-controlled milling machine. Equipment is often used in conjunction with tools and materials to perform a task.

Common types of equipment listed below:

1. **Excavators:** Excavators are essential for digging trenches and excavating soil during the installation of treatment plant disposal systems. The size of the excavator depends on the scale of the project and site conditions.
2. **Compactors:** Compaction equipment is used to ensure proper compaction of soil layers around pipes and tanks/chambers. This helps prevent settling and maintains the structural integrity of the system. Plate compactors or vibrating rollers are commonly used for this purpose.
3. **Pipe Inspection Tools:** Once the treatment plant disposal system is installed, it is important to inspect the pipes for any defects or blockages. Pipe inspection tools such as CCTV cameras or sewer inspection robots can be used to identify issues and ensure the system's long-term functionality.
4. **Testing Equipment:** Various testing equipment is required to check the performance and compliance of treatment plant disposal systems. This includes flow meters, pressure gauges, water quality analyzers, and air compressors for conducting pressure tests.
5. **Safety Equipment:** Personal protective equipment (PPE) is essential during the installation and maintenance of treatment plant disposal systems. This includes hard hats, safety glasses, gloves, high-visibility vests, and respiratory protection when working in confined spaces.



## 1.6. Work area preparation

To prepare the work area for the course on designing and sizing domestic treatment plant disposal systems, several steps need to be taken to ensure a safe and efficient learning environment. These steps include organizing the physical space, gathering necessary materials and resources, and implementing safety measures.

### Organizing the Physical Space:

1. **Clearing the Area:** Start by clearing the work area of any unnecessary clutter or obstacles. Remove any furniture or equipment that is not required for the course to create an open and spacious environment.
2. **Arranging Seating:** Set up chairs or desks in a way that allows participants to comfortably view presentations or demonstrations. Ensure that there is enough space between seats for easy movement.
3. **Providing Ample Lighting:** Proper lighting is essential for a productive learning environment. Ensure that the work area is well-lit, either through natural light sources or artificial lighting fixtures.
4. **Optimizing Acoustics:** Consider the acoustics of the room to minimize distractions and enhance communication. If necessary, use sound-absorbing materials or partitions to reduce noise levels.
5. **Creating Visual Displays:** Set up visual displays such as whiteboards, flip charts, or projectors to aid in presenting information and engaging participants.

### Gathering Necessary Materials and Resources:

1. **Course Materials:** Collect all relevant course materials, including handouts, textbooks, manuals, or any other resources required for the course. Ensure that each participant has access to these materials.
2. **Audiovisual Equipment:** Check and set up audiovisual equipment such as projectors, screens, speakers, and microphones if needed for presentations or demonstrations.



3. **Computers and Internet Access:** If computer-based activities or online resources are part of the course, ensure that each participant has access to a computer with reliable internet connectivity.
4. **Tools and Instruments:** Depending on the nature of the course, gather any specific tools or instruments required for practical exercises or demonstrations. Ensure that these tools are in good working condition.

**Implementing Safety Measures:**

1. **Emergency Exits and Evacuation Plan:** Familiarize yourself with the emergency exits and evacuation plan of the premises where the course will be conducted. Communicate this information to participants at the beginning of the course.
2. **First Aid Kit:** Have a well-stocked first aid kit readily available in case of any minor injuries or accidents that may occur during the course.
3. **Safety Guidelines:** Establish and communicate safety guidelines to participants, emphasizing the importance of following safety protocols throughout the course.

## Self-check 1

**Instruction 1:** Choose the best answer from the given alternatives

1. The primary goal of a domestic treatment plant disposal system is to:
  - A. Convert wastewater into clean water that can be safely discharged into the environment.
  - B. Remove harmful pollutants from wastewater.
  - C. Reduce the volume of wastewater.
  - D. All of the above.
  
2. The three main stages of domestic wastewater treatment are:
  - A. Primary, secondary, and tertiary treatment.
  - B. Physical, chemical, and biological treatment.
  - C. Aerobic, anaerobic, and anoxic treatment.
  - D. None of the above.
  
3. Which of the following is NOT a safety requirement for working on a domestic wastewater treatment plant disposal system?
  - A. Wearing appropriate personal protective equipment (PPE).
  - B. Being aware of the hazards associated with wastewater.
  - C. Following safe work practices.
  - D. Working alone.
  
4. When sequencing and organizing work on a domestic wastewater treatment plant disposal system, it is important to:
  - A. Consider the dependencies between different tasks.
  - B. Estimate the time and resources required for each task.
  - C. Identify critical tasks and prioritize them accordingly.
  - D. All of the above.

5. Which of the following tools and equipment is typically used to select and check tools, materials, and equipment for a domestic wastewater treatment plant disposal system?
- A. Checklists  
B. Specifications  
C. Drawings  
D. All of the above.

**Instruction2:** Write **True** if the statement is correct and write **False** if the statement is incorrect.

- Domestic wastewater treatment plant disposal systems are designed to remove all pollutants from wastewater.
- The primary stage of domestic wastewater treatment typically involves physical processes such as screening and grit removal.
- Secondary treatment is the most important stage of domestic wastewater treatment, as it removes most of the organic matter from the wastewater.
- Tertiary treatment is used to remove additional pollutants from wastewater, such as nutrients and heavy metals.
- It is important to follow safe work practices when working on a domestic wastewater treatment plant disposal system to avoid exposure to harmful pollutants.

**Instruction3:** Write short answer for the following questions

- What are the main components of a domestic wastewater treatment plant disposal system?
- What are the different types of domestic wastewater treatment systems?
- What are some of the safety requirements for working on a domestic wastewater treatment plant disposal system?
- What are some of the factors to consider when sequencing and organizing work on a domestic wastewater treatment plant disposal system?
- What are some of the tools and equipment that are typically used to select and check tools, materials, and equipment for a domestic wastewater treatment plant disposal system?

## Unit two. Identify system requirements.

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Obtaining and confirming information
- Applying and consulting Ethiopian standards
- Domestic treatment system type, capacity, and performance requirements
- Land capability for on-site land application of effluent
- Suitable area for domestic water treatment plant
- Sizing treatment system in Ethiopian standards

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Obtain and confirming information
- Apply and consulting Ethiopian standards
- Identify Domestic treatment system type, capacity, and performance requirements
- Identify Land capability for on-site land application of effluent
- Identify suitable area for domestic water treatment plant
- Identify sizing treatment system in Ethiopian standards

## 2.1. Obtaining and confirming information

Designing and sizing domestic treatment plant disposal systems involves obtaining and confirming information from various reliable sources. This process is crucial to ensure the proper functioning and compliance of these systems with relevant regulations and standards.

In this comprehensive response, we will discuss the steps involved in obtaining and confirming information for designing and sizing domestic treatment plant disposal systems.

**Step 1: Identify the Regulatory Framework:** The first step in obtaining information for designing and sizing domestic treatment plant disposal systems is to identify the regulatory framework that governs these systems. This includes understanding the local, regional, and national regulations, guidelines, and standards that apply to wastewater treatment and disposal. These regulations often specify the design criteria, sizing requirements, and performance standards for domestic treatment plant disposal systems.

**Step 2: Review Design Guidelines:** Once the regulatory framework is identified, it is essential to review design guidelines provided by authoritative sources. These guidelines offer valuable insights into the best practices for designing and sizing domestic treatment plant disposal systems. They often cover topics such as system components, hydraulic loading rates, effluent quality requirements, soil characteristics, and site suitability assessments.

To review design guidelines for designing and sizing domestic treatment plant disposal systems, it is important to follow a systematic approach that ensures compliance with relevant regulations and best practices.

The following steps outline the process of reviewing design guidelines for this specific course:

- A. **Identify the Relevant Design Guidelines:** Start by identifying the specific design guidelines that are applicable to domestic treatment plant disposal systems. These guidelines may vary depending on the country or region you are in. Look for guidelines provided by regulatory bodies, professional organizations, or academic institutions specializing in wastewater treatment.

- B. Review Regulatory Requirements:** Familiarize yourself with the regulatory requirements governing domestic treatment plant disposal systems in your area. These regulations may include standards for effluent quality, system capacity, setback distances, and construction specifications. Pay close attention to any updates or amendments to these regulations.
- C. Understand System Components:** Gain a thorough understanding of the various components involved in domestic treatment plant disposal systems. This includes septic tanks, distribution boxes, drain fields (also known as leach fields), and other related infrastructure. Review the design considerations and sizing criteria for each component.
- D. Study Soil Characteristics:** Soil plays a crucial role in the proper functioning of a domestic treatment plant disposal system. Review the guidelines related to soil testing and characterization, as well as the impact of soil properties on system design and performance. Understand factors such as soil permeability, texture, depth to groundwater, and slope stability.
- E. Evaluate Hydraulic Loading Rates:** Hydraulic loading rates determine the amount of wastewater that can be applied to the drain field per unit area per day. Review guidelines that provide recommendations for calculating hydraulic loading rates based on factors such as soil type, site conditions, and expected wastewater flow rates.
- F. Consider Site Conditions:** Assessing site conditions is essential for designing an effective domestic treatment plant disposal system. Review guidelines that address factors like topography, proximity to water bodies, flood zones, and setback requirements from buildings, wells, and property boundaries. These guidelines will help ensure the system is appropriately located and protected.
- G. Assess Treatment Technologies:** Domestic treatment plant disposal systems may incorporate various treatment technologies, such as aerobic or anaerobic processes, to improve effluent quality. Review guidelines that outline the selection and sizing criteria for these treatment technologies based on factors like wastewater strength, expected effluent quality, and site-specific conditions.

- H. **Review Maintenance and Operation Guidelines:** Proper maintenance and operation are crucial for the long-term performance of domestic treatment plant disposal systems. Familiarize yourself with guidelines that provide recommendations for routine inspections, pump-out schedules, and troubleshooting common issues. These guidelines will help ensure the system remains functional and compliant over time.
- I. **Consider Environmental Impact:** Domestic treatment plant disposal systems should be designed to minimize environmental impact. Review guidelines that address topics such as nutrient management, protection of groundwater resources, and prevention of surface water contamination. Understand the requirements for monitoring and mitigating potential environmental risks associated with these systems.
- J. **Stay Updated:** Design guidelines for domestic treatment plant disposal systems may evolve over time as new research findings emerge or regulations change. Stay updated with the latest developments in the field by regularly referring to authoritative sources, attending relevant conferences or workshops, and engaging with professional networks.

**Step 3: Consult Expert Resources:** To obtain accurate information, it is advisable to consult expert resources in the field of wastewater treatment and disposal. These resources can include professionals such as civil engineers, environmental consultants, or wastewater treatment specialists who have experience in designing and sizing domestic treatment plant disposal systems. Their expertise can provide valuable insights into specific design considerations, system performance expectations, and troubleshooting potential issues.

**Step 4: Conduct Site Assessments:** Site assessments are crucial for obtaining accurate information about the specific conditions at the location where the domestic treatment plant disposal system will be installed. This involves evaluating factors such as soil type, groundwater levels, slope stability, proximity to water bodies or wells, and available space for system installation. Site assessments help determine the suitability of different types of treatment technologies and inform the design process.

**Step 5: Perform Hydraulic Calculations:** Hydraulic calculations are essential for sizing domestic treatment plant disposal systems. These calculations involve determining the hydraulic

loading rates, which depend on factors such as the number of users, average water consumption per user, and peak flow rates. The sizing of components such as septic tanks, distribution boxes, and drain fields is based on these hydraulic calculations to ensure proper system performance.

**Step 6: Consider Treatment Technologies:** There are various treatment technologies available for domestic wastewater treatment, including septic systems, aerobic treatment units, and advanced treatment systems. Each technology has its own design considerations and sizing requirements. It is important to consider the specific needs of the project, site conditions, effluent quality requirements, and regulatory constraints when selecting the appropriate treatment technology.

**Step 7: Verify Design with Local Authorities:** Once the design is complete, it is crucial to verify it with local authorities responsible for approving domestic treatment plant disposal systems. This step ensures that the design meets all regulatory requirements and local guidelines. Local authorities may require submission of design plans, specifications, and supporting documentation for review and approval before installation can proceed.

**Step 8: Monitor System Performance:** After the domestic treatment plant disposal system is installed and operational, it is important to monitor its performance regularly. This includes assessing effluent quality, system capacity, and any potential issues or malfunctions. Monitoring helps identify any necessary adjustments or maintenance requirements to ensure continued compliance with regulations and optimal system performance.

## 2.2. Applying and consulting Ethiopian standards

When designing and sizing domestic treatment plant disposal systems in Ethiopia, it is essential to consult and apply the relevant Ethiopian standards to ensure the safety and effectiveness of the system. The following is a detailed guide on the standards and factors to consider when designing and sizing domestic treatment plant disposal systems in Ethiopia.

### 1. Ethiopian National Building Code (ENBC)

The Ethiopian National Building Code (ENBC) is the primary standard for the design and construction of buildings in Ethiopia. The code provides guidelines for the design and installation of plumbing and sewage systems, including domestic treatment plant disposal



systems. The ENBC requires that all buildings with a sewage system must connect to a public sewer or install a private sewage system that meets the standards set by the Ethiopian Ministry of Works and Urban Development.

## 2. Ethiopian Standard (ES) 1144-2:2007

Ethiopian Standard (ES) 1144-2:2007 is the national standard for the design, installation, and maintenance of domestic wastewater treatment systems. The standard provides guidelines for the design and installation of treatment plants, including the selection of appropriate treatment technologies and the design of disposal systems.

## 3. Ethiopian Standard (ES) 1144-3:2010

Ethiopian Standard (ES) 1144-3:2010 is the national standard for the design, installation, and maintenance of on-site sanitation systems. The standard provides guidelines for the design and installation of on-site sanitation systems, including the selection of appropriate treatment technologies and the design of disposal systems.

### Factors to Consider When Designing and Sizing Domestic Treatment Plant Disposal Systems

1. **Site-specific conditions:** Site-specific conditions, such as soil type, groundwater table, and topography, must be considered when designing and sizing domestic treatment plant disposal systems. These conditions can affect the performance of the treatment system and the safety of the disposal system.
2. **Treatment technology:** The type of treatment technology used in the treatment plant must be considered when designing and sizing the disposal system. Different treatment technologies have different requirements for disposal systems, and the selection of the appropriate technology will depend on the specific needs of the project.
3. **Flow rate and loading:** The flow rate and loading of the treatment plant must be considered when designing and sizing the disposal system. The flow rate and loading will determine the size of the disposal system and the type of disposal method used.

4. **Disposal method:** The disposal method must be considered when designing and sizing the disposal system. The most common disposal methods for domestic treatment plant disposal systems in Ethiopia are surface disposal and subsurface disposal. Surface disposal is the most common method and involves the discharge of treated wastewater into a waterbody or a drainage system. Subsurface disposal involves the discharge of treated wastewater into the ground, either through a drip irrigation system or a percolation system.
5. **Regulatory requirements:** Regulatory requirements must be considered when designing and sizing domestic treatment plant disposal systems. The Ethiopian Ministry of Works and Urban Development sets regulations for the design and installation of domestic treatment plant disposal systems, and these regulations must be followed to ensure the safety and effectiveness of the system.
6. **Maintenance and operation:** The maintenance and operation of the treatment plant and disposal system must be considered when designing and sizing the system. The system must be designed to be easy to maintain and operate, and the maintenance and operation costs must be factored into the design and installation costs.
7. **Cost and affordability:** The cost and affordability of the treatment plant and disposal system must be considered when designing and sizing the system. The system must be designed to be cost-effective and affordable for the users, while still meeting the required standards and regulations.
8. **Environmental impact:** The environmental impact of the treatment plant and disposal system must be considered when designing and sizing the system. The system must be designed to minimize the environmental impact and to protect the receiving waterbody or soil.
9. **Social and cultural factors:** Social and cultural factors, such as the availability of water and the acceptability of the treatment plant and disposal system to the local community, must be considered when designing and sizing the system. The system must be designed to be acceptable to the local community and to meet their needs and expectations.

### 2.3. Domestic treatment system type, capacity, and performance requirements

Designing and sizing domestic treatment plant disposal systems involves considering various factors such as the type of treatment system, its capacity, and performance requirements. These aspects are crucial in ensuring the effective and efficient treatment of domestic wastewater before its safe disposal.

**Type of Treatment System:** There are several types of treatment systems available for domestic wastewater treatment. The selection of the appropriate system depends on factors such as the level of treatment required, available space, budget constraints, and local regulations.

**Common types of domestic treatment systems include:**

1. **Septic Tanks:** Septic tanks are one of the most commonly used treatment systems for domestic wastewater. They consist of a large underground tank where wastewater is collected and allowed to settle. The solid waste settles at the bottom, while the liquid portion flows out into a drain field for further treatment.
2. **Aerobic Treatment Units (ATUs):** ATUs are compact treatment systems that use oxygen to break down organic matter in wastewater. These systems typically include a tank with an aeration mechanism that promotes the growth of aerobic bacteria, which help in the decomposition process.
3. **Constructed Wetlands:** Constructed wetlands mimic natural wetland ecosystems to treat wastewater. They consist of shallow basins filled with gravel or soil and planted with wetland vegetation. As wastewater flows through these basins, it undergoes physical, chemical, and biological processes that remove pollutants.
4. **Advanced Treatment Systems:** Advanced treatment systems incorporate additional processes to achieve higher levels of treatment. These may include technologies such as membrane filtration, disinfection, or nutrient removal processes like denitrification or phosphorus removal.

**Capacity Requirements:** The capacity requirement for a domestic treatment system depends on factors such as the number of people served by the system, water usage patterns, and peak flow rates. It is essential to accurately estimate the average daily flow and peak flow rates to determine the appropriate size of the treatment system.

The average daily flow is typically calculated based on the water usage per person, which can vary depending on factors such as residential or commercial use, local regulations, and water conservation practices. Peak flow rates are estimated by considering factors such as simultaneous water usage events, such as showers, laundry, and dishwashing.

**Performance Requirements:** The performance requirements for domestic treatment systems are defined by regulatory agencies and may vary depending on the location. These requirements ensure that the treated wastewater meets specific quality standards before being discharged or reused.

**Common performance parameters include:**

1. **BOD (Biochemical Oxygen Demand):** BOD measures the amount of oxygen required by microorganisms to decompose organic matter in wastewater. Lower BOD levels indicate better treatment efficiency.
2. **TSS (Total Suspended Solids):** TSS refers to solid particles suspended in wastewater. Effective treatment systems should remove a significant portion of suspended solids to prevent clogging of downstream pipes and potential environmental impacts.
3. **Nutrient Removal:** Depending on the environmental sensitivity of the receiving water bodies, nutrient removal requirements may include reducing nitrogen and phosphorus levels in the treated effluent.
4. **Pathogen Removal:** Treatment systems should effectively remove or inactivate pathogens present in domestic wastewater to prevent the spread of waterborne diseases.

To ensure compliance with performance requirements, regular monitoring and maintenance of the treatment system are necessary.

## 2.4. Land capability for on-site land application of effluent

The land capability for on-site land application of effluent refers to the suitability of a particular piece of land for the disposal of treated wastewater from domestic treatment plants.

This process involves applying the treated effluent onto the land surface, allowing it to percolate through the soil, and eventually being absorbed by plants or recharging groundwater.

1. **Land capability assessment:** is crucial in designing and sizing domestic treatment plant disposal systems to ensure that the effluent is properly treated and disposed of without causing harm to the environment or public health. Several factors need to be considered when evaluating the land's capability for on-site land application, including soil type, slope, depth to groundwater, vegetation cover, and proximity to water bodies or sensitive areas.
2. **Soil type:** plays a significant role in determining the land's capability for effluent disposal. Different soil types have varying infiltration rates and water-holding capacities, which affect how well the effluent can be absorbed into the ground. Soils with high clay content tend to have slower infiltration rates and may not be suitable for on-site land application. On the other hand, sandy soils with good drainage properties are generally more favorable for effluent disposal.
3. **Slope:** of the land is another important factor to consider. Steep slopes can lead to rapid runoff and erosion, preventing proper absorption of the effluent into the soil. Ideally, land with gentle slopes is preferred for on-site land application to allow sufficient time for infiltration and minimize surface runoff.
4. **Depth to groundwater:** is critical in determining whether on-site land application is feasible. If the groundwater table is too close to the surface, there is a higher risk of contaminating drinking water sources or causing waterlogging issues. A minimum separation distance between the bottom of the absorption area and the groundwater table should be maintained to prevent these potential problems.
5. **Vegetation cover:** on the land surface helps enhance evapotranspiration and evaporation rates, reducing the amount of effluent that reaches the groundwater. Areas with dense

vegetation cover, such as grasslands or forests, are generally more suitable for on-site land application.

6. **Proximity to water bodies:** is an essential consideration to prevent contamination of surface water or sensitive areas. The disposal site should be located at a safe distance from streams, rivers, lakes, or wetlands to minimize the risk of pollution.

## 2.5. Suitable area for domestic water treatment plant

When considering the suitable area for a domestic water treatment plant, several factors need to be taken into account. These factors include the availability of space, proximity to the water source, accessibility for maintenance and operation, and compliance with local regulations. Additionally, the design and sizing of the treatment plant disposal system should also be considered.

**Availability of Space:** The first consideration when selecting an area for a domestic water treatment plant is the availability of sufficient space. The plant should have enough room to accommodate all the necessary components, including treatment units, storage tanks, and any required infrastructure. It is important to ensure that there is enough space for future expansion if needed.

**Proximity to Water Source:** The location of the treatment plant should be close to the water source it is intended to treat. This reduces the cost and complexity of transporting water from its source to the treatment facility. Proximity to the water source also helps minimize potential contamination risks during transportation.

**Accessibility for Maintenance and Operation:** The chosen area should be easily accessible for maintenance and operation purposes. This includes having proper road access for delivery of chemicals and equipment, as well as easy access to electrical power and other utilities required for the functioning of the treatment plant. Adequate space should be available for maneuvering vehicles and equipment during maintenance activities.

**Compliance with Local Regulations:** It is crucial to ensure that the selected area complies with all local regulations and zoning requirements related to water treatment plants. These regulations may include setback distances from residential areas or protected natural areas, noise restrictions,

and environmental impact assessments. Compliance with these regulations is essential to ensure that the treatment plant operates legally and without causing harm to the environment or nearby communities.

**Design and Sizing of Disposal System:** In addition to selecting a suitable area for the treatment plant itself, consideration must also be given to the design and sizing of the disposal system. This includes determining how treated water will be safely discharged or reused. Factors such as soil conditions, topography, and local regulations will influence the design of the disposal system. It is important to ensure that the chosen area can accommodate the necessary infrastructure for safe and efficient disposal of treated water.

## 2.6. Sizing treatment system in Ethiopian standards

Designing and sizing domestic treatment plant disposal systems in accordance with Ethiopian standards requires considering several factors. These factors include the number of people served by the system, the wastewater flow rate, the type of treatment system, and the effluent quality requirements. The Ethiopian standards for domestic treatment systems are outlined in the Ethiopian Building Code Standard (EBCS) 127:2019.

**The first step in sizing a treatment system is to determine the population served by the system.** This can be done by considering the number of households or estimating the average number of people per household. The EBCS 127:2019 provides guidelines for estimating the population served based on household size.

**The next step is to calculate the wastewater flow rate.** This is typically done by multiplying the population served by a design flow factor. The design flow factor takes into account factors such as water usage patterns, peak flow rates, and infiltration/inflow. The EBCS 127:2019 provides design flow factors for different types of buildings and facilities.

Once the wastewater flow rate is determined, the appropriate type of treatment system can be selected. There are several types of treatment systems commonly used in domestic applications, including septic tanks, aerobic treatment units, and constructed wetlands. Each type of system has its own design criteria and requirements.



For septic tank systems, the size of the septic tank is determined based on the wastewater flow rate and retention time. The retention time is typically set at a minimum of 24 hours to allow for settling and digestion of solids. The EBCS 127:2019 provides guidelines for sizing septic tanks based on these parameters.

Aerobic treatment units (ATUs) are another option for domestic treatment systems. The size of an ATU is determined based on the wastewater flow rate and treatment efficiency requirements. ATUs use oxygen to promote biological degradation of organic matter, resulting in a higher treatment efficiency compared to septic tanks. The EBCS 127:2019 provides guidelines for sizing ATUs based on these parameters.

Constructed wetlands are a natural treatment option for domestic wastewater. The size of a constructed wetland is determined based on the wastewater flow rate and the required hydraulic loading rate. The hydraulic loading rate is typically set at a maximum of 0.1-0.2 meters per day to allow for proper treatment. The EBCS 127:2019 provides guidelines for sizing constructed wetlands based on these parameters.



## Self-check 2

**Instruction1:** Choose the best answer from the given alternatives

1. Which of the following is NOT a step in the process of identifying system requirements for a domestic wastewater treatment plant disposal system?
  - A. Obtaining and confirming information
  - B. Applying and consulting Ethiopian standards
  - C. Designing the treatment system
  - D. Sizing the treatment system
  
2. When obtaining and confirming information to identify system requirements for a domestic wastewater treatment plant disposal system, it is important to consider the following factors:
  - A. The type and quantity of wastewater to be treated
  - B. The site conditions where the treatment system will be located
  - C. The environmental regulations that apply
  - D. All of the above
  
3. Ethiopian standards for domestic wastewater treatment plant disposal systems specify requirements for the following:
  - A. The type and capacity of the treatment system
  - B. The performance of the treatment system
  - C. The design and construction of the treatment system
  - D. All of the above
  
4. When selecting a domestic wastewater treatment system, it is important to consider the following factors:
  - A. The type and quantity of wastewater to be treated

- B. The site conditions where the treatment system will be located
  - C. The environmental regulations that apply
  - D. All of the above
5. When sizing a domestic wastewater treatment system, it is important to consider the following factors:
- A. The peak flow rate of wastewater
  - B. The average flow rate of wastewater
  - C. The desired performance of the treatment system
  - D. All of the above

**Instruction2:** Write **True** if the statement is correct and write **False** if the statement is incorrect.

1. It is not necessary to consult Ethiopian standards when identifying system requirements for a domestic wastewater treatment plant disposal system.
2. The land capability for on-site land application of effluent should be considered when selecting a domestic wastewater treatment system.
3. The suitable area for a domestic wastewater treatment plant should be located away from residential areas and water bodies.
4. The peak flow rate of wastewater is the most important factor to consider when sizing a domestic wastewater treatment system.
5. Ethiopian standards specify the minimum treatment requirements for domestic wastewater treatment plant disposal systems.

**Instruction3:** Write short answer for the following questions

1. What are the steps involved in identifying system requirements for a domestic wastewater treatment plant disposal system?
2. What are some of the factors to consider when selecting a domestic wastewater treatment system?

3. What are some of the factors to consider when sizing a domestic wastewater treatment system?
4. What are the benefits of consulting Ethiopian standards when identifying system requirements for a domestic wastewater treatment plant disposal system?
5. What are some of the environmental regulations that apply to domestic wastewater treatment plant disposal systems in Ethiopia?

## Unit three: Design system layout.

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Developing disposal system plan
- sustainability principles and concepts
- Specifying and optimizing materials
- Recording plans
- Restoring work area

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Develop disposal system plan
- Identify sustainability principles and concepts
- Specify and optimizing materials
- Record plans
- Restore work area

### 3.1. Developing disposal system plan

Developing a disposal system plan involves careful consideration of various factors to ensure efficient and environmentally responsible waste management. This comprehensive process includes assessing the types and quantities of waste generated, evaluating available disposal methods, establishing appropriate infrastructure, implementing waste reduction strategies, and complying with relevant regulations.

There is a detailed guide on how to develop a disposal system plan:

1. **Assessing Waste Generation:** The first step in developing a disposal system plan is to assess the types and quantities of waste generated within the target area. This assessment should include both solid and hazardous waste streams. Solid waste can include municipal solid waste (MSW), construction and demolition debris, industrial waste, and agricultural waste. Hazardous waste may consist of chemicals, pharmaceuticals, heavy metals, or other substances that pose a risk to human health or the environment.

To conduct an accurate assessment, gather data on waste generation rates, composition analysis, and seasonal variations. This information can be obtained through surveys, waste audits, or collaboration with local authorities and waste management companies. Analyzing this data will help identify the specific challenges and opportunities associated with waste management in the area.

2. **Evaluating Disposal Methods:** Once the waste generation has been assessed, it is crucial to evaluate the available disposal methods. Several options exist for managing different types of waste:
  - A. **Landfill:** Landfills are commonly used for non-hazardous solid waste disposal. When evaluating landfill options, consider factors such as proximity to the waste source, capacity, environmental impact assessments, liner systems to prevent groundwater contamination, gas collection systems for methane capture, and long-term monitoring requirements.
  - B. **Incineration:** Incineration is a thermal treatment process that reduces the volume of solid waste while generating energy. When considering incineration as a disposal method,

assess factors such as air emissions control systems, energy recovery potential, ash management practices, and compliance with emission standards.

C. **Recycling:** Recycling involves the collection, sorting, and processing of waste materials to produce new products. Identify recyclable materials within the waste stream and evaluate the feasibility of establishing recycling programs. Consider factors such as market demand, collection infrastructure, sorting facilities, and partnerships with recycling companies.

D. **Composting:** Composting is a natural process that converts organic waste into nutrient-rich soil amendments. Assess the potential for implementing composting programs for organic waste generated from households, businesses, or agricultural activities. Consider factors such as space requirements, odor control measures, and end-market demand for compost products.

E. **Waste-to-Energy:** Waste-to-energy technologies involve converting waste into electricity or heat through processes like anaerobic digestion or gasification. Evaluate the suitability of Waste-to-energy options based on waste composition, energy recovery potential, environmental impacts, and regulatory requirements.

F. **Special Waste:** Hazardous waste and other special waste streams require specialized disposal methods. Identify appropriate treatment facilities or disposal sites that comply with hazardous waste regulations and ensure proper handling and containment.

3. **Establishing Infrastructure:** Developing an effective disposal system plan requires establishing the necessary infrastructure to support waste management operations. This includes:

A. **Collection Systems:** Determine the most suitable collection systems based on the waste types and quantities identified during the assessment phase. Consider options such as curbside collection, drop-off centers, or specialized collection services for hazardous or bulky waste.

B. **Transfer Stations:** Transfer stations act as intermediate points where waste is consolidated before being transported to final disposal facilities. Evaluate the need for

transfer stations based on geographical considerations, transportation logistics, and cost-effectiveness.

C. **Processing Facilities:** Depending on the chosen disposal methods, consider establishing or upgrading processing facilities such as recycling centers, composting sites, or WtE plants. Ensure these facilities meet environmental standards and have appropriate equipment for efficient operations.

D. **Transportation:** Develop a transportation plan to move waste from collection points to processing or disposal facilities. Consider factors such as distance, mode of transport, vehicle types, and routing optimization to minimize costs and environmental impacts.

4. **Implementing Waste Reduction Strategies:** A disposal system plan should prioritize waste reduction strategies to minimize the amount of waste generated. This can include:

A. **Source Separation:** Encourage residents, businesses, and institutions to separate recyclable materials from the general waste stream. Implement education and outreach programs to raise awareness about the importance of source separation and provide guidance on proper sorting practices.

B. **Waste Minimization:** Promote waste minimization practices such as reducing packaging, encouraging reusable products, and implementing composting programs for organic waste. Collaborate with businesses and industries to identify opportunities for waste reduction within their operations.

C. **Product Design:** Advocate for product design that considers end-of-life management, recyclability, and the use of environmentally friendly materials. Encourage manufacturers to adopt sustainable packaging practices and reduce the generation of non-recyclable or hazardous waste.

5. **Compliance with Regulations:** Ensure that the disposal system plan complies with local, regional, and national regulations governing waste management. Familiarize yourself with applicable laws related to waste classification, handling, transportation, and disposal. Engage with regulatory authorities to obtain necessary permits or licenses for operating waste management facilities.

6. **Monitoring and Evaluation:** Regularly monitor and evaluate the performance of the disposal system plan to identify areas for improvement. Establish key performance indicators (KPIs) such as waste diversion rates, recycling rates, or energy recovery efficiency. Use this data to refine strategies, optimize operations, and adapt to changing waste management needs.

### 3.1.1. Septic tank

Septic tank is a receptacle or vault used to collect organic wastes discharged from the house sewer. The main function of the septic tank is to liquefy and precipitate solid wastes purifying odorous materials.

Sewage that are discharged into the tank is retained, and during its retention, about 60% to 70% of the suspended solids of the sewage is removed largely by sedimentation to form a semi-liquid substance called sludge which accumulate at the bottom of the septic tank and parts of the solid is formed into floating scum. Both scum and sludge are processed by anaerobic bacteria forming liquid and gasses. This process is called digestion and the solid matter is reduced in sizes and consequently changed in character.



Figure 3-1 Septic tank

**The septic tank combines two processes:**

- Sedimentation in the upper portion of the tank and



- Anaerobic decomposition of the accumulated sludge at the bottom.

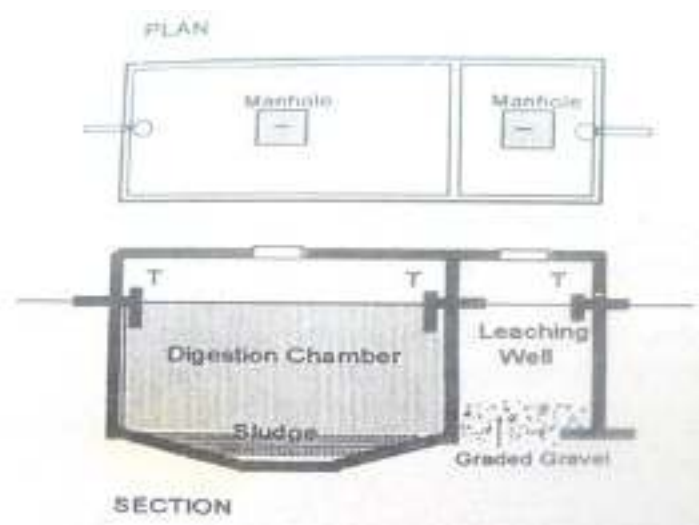
Decomposition of organic matter from human waste is a bacteriological process caused by the following:

1. Aerobic Bacteria
2. Anaerobic Bacteria
3. Facultative Bacteria

The life process of aerobic bacteria is in the presence of material oxygen, and the anaerobic bacteria functions in the absence of free oxygen. Facultative bacteria also function even with or without free oxygen available. It should be understood that these bacteria's have no relation to diseases. They thrive naturally in sewage and will function when conditions are favorable in terms of **food supply, temperature and moisture.**

The human waste or excreta are decomposed until the organic matters are transformed into materials that could not be utilized by the bacteria in their life process. The process of decomposition is regarded as **stabilization.**

Decomposition caused by anaerobic bacteria which is sometimes referred to as putrefaction, is accompanied by bad odors. On the other hand, aerobic decomposition is not accompanied by unpleasant odor. A sewage that turns dark and smell unpleasantly due to anaerobic decomposition is called Septic. Decomposition caused by aerobic bacteria is accomplished with no definite time and could be within a matter of hours.



**Figure 3-2** Septic tank

## Different Gasses Produced Inside the Septic Tank

Gasses inside the septic tank ranges from organic to non-organic gasses and these are:

1. Methane ( $\text{CH}_4$ ) gas is a combination of hydrogen and carbon. It is a principal component of natural gas.
2. Carbon Dioxide ( $\text{CO}_2$ ) is a combination of carbon and oxygen. It is the simplest oxide of carbon.
3. Carbon Monoxide ( $\text{CO}$ ) is a by-product of methane. It is a poisonous gas.
4. Hydrogen ( $\text{H}_2$ ) evolves as a moist gas from organic waste.
5. Hydrogen Sulfide ( $\text{H}_2\text{S}$ ) is a colorless gas with offensive odor.
6. Sulfur Dioxide ( $\text{HO}_2$ ) is also a colorless gas having an irritating odor.

These gasses are usually discharged into the atmosphere through the ventilation pipe.

## Construction of the Septic Tank

Septic Tank is constructed either of the following materials:

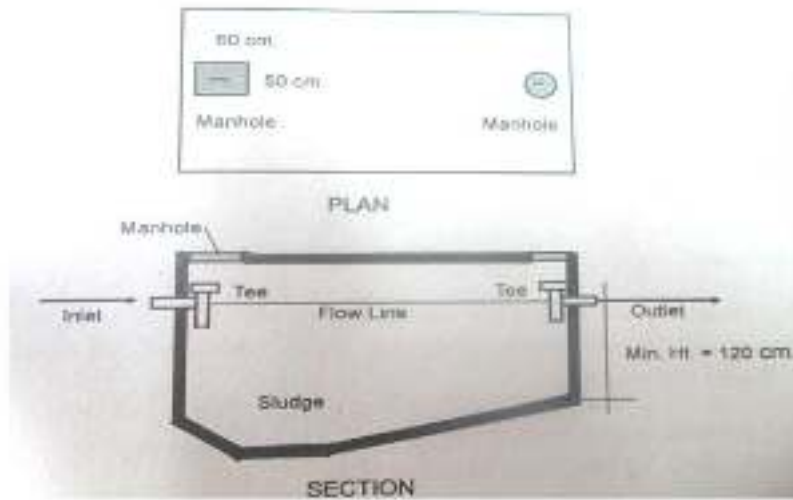
- Reinforced concrete
- Prefabricated asbestos
- Plastered concrete hollow blocks
- Thin metal or plastic

The most popular and widely accepted material for construction of septic tank is the plastered concrete hollow block or the reinforced concrete. Others have not gained acceptance due to costs and durability.

## General Conditions in the Construction of Septic Tank

1. The concrete and masonry septic tank is usually constructed in a rectangular form. The reason is to retard the even flow of the waste and to avoid disturbing the decomposition processes inside the tank.
2. The minimum inside width of a septic tank is 90 centimeters and the minimum length is 150 centimeters.

3. 120 centimeters depth of the liquid content of the tank is adequate for effective decomposition of the organic materials. It is not impractical however to construct a tank of greater depth provided that the depth should not be deeper than the natural ground water table.
4. The inlet and outlet inverts of the septic tank are usually of long turn sanitary Tee casted in the concrete wall of the tank. The inverts are installed in the wall of the tank at least 120 centimeters from the bottom equally spaced from both sides.
5. The invert extension into the liquid of the tank should not be more than 30 centimeters. The idea of extending the invert into the liquid of the tank not exceed 30 centimeters is to assure delivery of the incoming sewage or effluent below the scum line. Scum refers to the lighter organic materials that rises to the surface of the water.
6. The bottom of the digestion chamber should be sloped to one low point. The purpose is to gather the settled organic materials into one mass to favor the propagation of the anaerobic bacteria.
7. The septic tank is provided with manholes extended a few centimeters above the surface of the soil to overcome infiltration of surface water. The manhole also serves the purpose of cleaning, inspection and repair.
8. Septic tank for large plumbing installation are provided with suspended compartment attached to the ceiling slab of the tank. The baffle plate is extended to the bottom of the tank about 40 centimeters below the scum line. Each compartment of the tank which is separated by the baffle plate is provided with manhole.
9. Septic tank should be constructed near the surface because the correction of the waste depends upon the extent of oxidation and the existence of anaerobic bacteria. Another kind of bacteria that splits and digest the effluent is the aerobic bacteria which could survive in the subsoil not more 150 centimeters below the surface. Oxidation of the effluent deeper than 150 centimeters would become extremely difficult.



**Figure 3-3** Single chamber septic tank

### Location of Septic Tank

Location of the septic tank must observe the following considerations:

1. The septic tank maybe located closer to the building it serves providing a minimum distance of 2.00 meters from the outside wall.
2. As much as possible, septic tank should not be located closer to the doors or windows.
3. Septic tank should be at least 15 meters away from any source of water supply. The farther the better.

### Size of Septic Tank

There is no mathematical formula available yet for having a definite size of a septic tank. However, sanitary authorities agreed in principle that:

1. For a family of 6 persons the minimum tank capacity should be approximately 1.3 cu. Meters with a minimum size of 90 centimeters wide, 150 centimeters long and 120 centimeters depth.
2. A larger tank is not advisable because the bacterial activities would be retarded. The size of the tank is proportionally based on the number of persons expected to be served. In

other words, the volume of the tank has a rational proportion with the volume of incoming waste for bacterial activities to be in favorable condition.

3. For residential installation, the practice is to allow 5 to 6 cu. feet of tank volume per person, thus a septic tank that will serve a family of 12 persons must have liquid capacity of not more than 72 cu. feet or 538 gallons. (Note: one cubic foot is equal to 7.48 gallons and 1 cubic meter is equal to 264.172 gallons)
4. **Sizing Calculations:** Perform sizing calculations to determine the required capacity of each component in the disposal system. This includes estimating the size of septic tanks or ATUs based on wastewater flow rates and retention times, determining pipe diameters based on hydraulic loading rates and friction losses, and sizing pumps or blowers based on pressure or airflow requirements.

To size a septic tank or ATU, you will need to know the following:

1. **Wastewater flow rate:** This is the amount of wastewater that is generated by the household or business. The flow rate can be estimated based on the number of bedrooms and the average water usage per person per day.

To estimate the wastewater flow rate for a household, you can use the following formula:

**Wastewater flow rate = Number of bedrooms \* Average water usage per person per day**

For example, a household with 3 bedrooms and an average water usage of 50 gallons per person per day would have a wastewater flow rate of 150 gallons per day.

Once you know the wastewater flow rate, you can use it to size the septic tank or ATU. The septic tank or ATU should be large enough to hold at least two days of wastewater.

2. **Retention time:** This is the amount of time that the wastewater spends in the septic tank or ATU. The retention time is typically 2-3 days for septic tanks and 1-2 days for ATUs.

Once you have this information, you can use the following formula to calculate the required capacity of the septic tank or ATU:

**Septic tank or ATU capacity (gallons) = Wastewater flow rate (gallons per day) \* Retention time (days)**

For example, a household with 3 bedrooms and an average water usage of 50 gallons per person per day would require a septic tank or ATU with a capacity of at least 3,000 gallons:

**Septic tank or ATU capacity (gallons) = 3 bedrooms \* 50 gallons per person per day \* 2 days of retention = 3,000 gallons**

### Sizing Pipe Diameters

To size pipe diameters, you will need to know the following:

3. **Hydraulic loading rate (HLR):** This is the flow rate of wastewater per unit area of pipe. The HLR is typically limited to 2 feet per second for gravity sewers.
4. **Friction losses:** This is the energy that is lost due to friction between the wastewater and the pipe walls. The friction losses can be calculated using a variety of methods, such as the Hazen-Williams equation.

Once you have this information, you can use the following formula to calculate the required pipe diameter:

**Pipe diameter (inches) = (4 \* Wastewater flow rate (gallons per minute)) / (HLR (feet per second) \*  $\pi$ )**

For example, a gravity sewer with a flow rate of 50 gallons per minute would require a pipe with a diameter of at least 4 inches:

**Pipe diameter (inches) = (4 \* 50 gallons per minute) / (2 feet per second \*  $\pi$ ) = 4 inches**

### Sizing Pumps and Blowers

To size pumps and blowers, you will need to know the following:

5. **Pressure or airflow requirements:** This will depend on the specific application. For example, a pump used to transfer wastewater from a septic tank to a drain field will need to be able to generate enough pressure to overcome the head loss of the system.

6. **Efficiency of the pump or blower:** This is the percentage of energy that is converted into useful work. The efficiency of pumps and blowers varies depending on the type of equipment and the operating conditions.

Once you have this information, you can use the following formula to calculate the required power rating of the pump or blower:

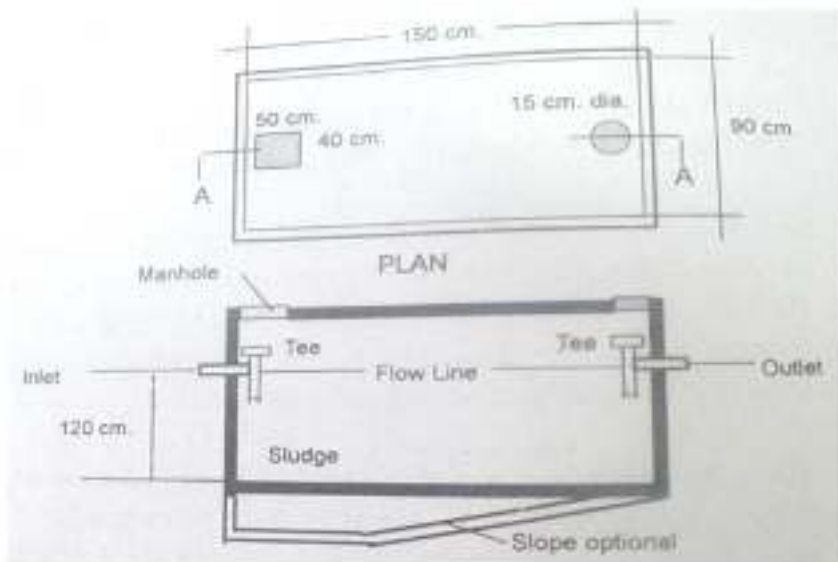
**Power rating (watts) = (Pressure or airflow requirements \* Efficiency) / (Conversion factor)**

The conversion factor depends on the units of pressure or airflow that are being used. For example, the conversion factor for converting psi to watts is 0.7457.

For example, a pump that needs to generate 10 psi of pressure and has an efficiency of 60% would require a power rating of 745.7 watts:

$$\text{Power rating (watts)} = (10 \text{ psi} * 0.6) / (0.7457) = 745.7 \text{ watts}$$

It is important to note that these are just general guidelines. The specific sizing calculations required for your disposal system will vary depending on the specific application. It is important to work with a qualified professional to ensure that your disposal system is properly sized and designed.



**Figure 3-4** Minimum size of septic tank

### Technical Data in Determining Volume of Septic Tank

Minimum Width - - - - - 90 centimeters

Minimum Length - - - - - 150 centimeters

Minimum depth of water - - - - 120 centimeters

- For residential buildings to serve

large number of people, allocate - - - - - 0.14 to 0.17 cu. m. of liquid per person

- For a small residential house to serve

up to 12 persons, the chamber should

have a liquid content of not more than - - - - - 2.0 cubic meters

- For school, commercial and industrial

establishments, the volume of the

septic tank should not be less than - - - - - 0.057 cu. meter nor

septic tank should not be more than - - - - - 0.086 cu. meter per person

### 3.2. Sustainability principles and concepts

Designing and sizing domestic treatment plant disposal systems requires careful consideration of sustainability principles and concepts. Sustainability in this context refers to the ability to meet the present needs of wastewater treatment while ensuring the availability of resources for future generations. It involves minimizing environmental impacts, conserving resources, and promoting social equity.

**Environmental Sustainability:** Environmental sustainability is a fundamental principle when designing and sizing domestic treatment plant disposal systems. It involves minimizing the negative impacts on the environment throughout the lifecycle of the system. Key concepts include:

- Waste Minimization:** The design should aim to minimize the generation of wastewater by promoting water conservation measures such as low-flow fixtures, rainwater



harvesting, and graywater reuse. This reduces the overall load on the treatment system and conserves water resources.

- B. **Energy Efficiency:** The treatment process should be designed to minimize energy consumption. This can be achieved through the use of energy-efficient equipment, optimization of process design, and integration of renewable energy sources such as solar or wind power.
- C. **Pollution Prevention:** The system should be designed to prevent or minimize pollution of water bodies and soil. This can be achieved through proper treatment processes that remove contaminants effectively, as well as appropriate disposal methods for treated effluent or sludge.
- D. **Natural Systems Integration:** Where feasible, incorporating natural systems such as constructed wetlands or bio filtration can enhance treatment efficiency while providing additional ecological benefits such as habitat creation and biodiversity preservation.

**Resource Conservation:** Conserving resources is another important aspect of sustainability in domestic treatment plant disposal systems. This involves optimizing resource use throughout the system's lifecycle.

Key concepts include:

- A. **Water Conservation:** Designing for water efficiency not only reduces the demand on freshwater sources but also reduces the volume of wastewater generated. This can be achieved through efficient fixtures, rainwater harvesting, and graywater reuse.
- B. **Nutrient Recovery:** Domestic wastewater contains valuable nutrients such as nitrogen and phosphorus. Designing treatment systems that allow for the recovery of these nutrients can reduce the reliance on synthetic fertilizers and promote circular economy principles.
- C. **Material Selection:** Choosing materials with low environmental impact, such as recycled or locally sourced materials, reduces the embodied energy and carbon footprint of the system. It also promotes resource efficiency and waste reduction.

**Social Equity:** Sustainability in domestic treatment plant disposal systems should also consider social equity, ensuring that the benefits and burdens of the system are distributed fairly among different stakeholders.

Key concepts:

- A. **Affordability:** The design should consider the affordability of the system for all users, including low-income households. This may involve exploring cost-effective technologies and financing options to ensure access to adequate sanitation services.
- B. **Accessibility:** The system should be designed to be accessible to all users, including people with disabilities or special needs. This includes considerations such as appropriate infrastructure design, user-friendly interfaces, and maintenance accessibility.
- C. **Community Engagement:** Involving local communities in the design and decision-making process fosters a sense of ownership and ensures that their needs and concerns are taken into account. This can be achieved through public consultations, education programs, and partnerships with local organizations.

### 3.3. Specifying and optimizing materials

Designing and sizing domestic treatment plant disposal systems involves selecting and optimizing materials that are suitable for the specific requirements of the system. The materials used in these systems should be able to withstand the harsh conditions of wastewater treatment, provide efficient treatment processes, and ensure long-term durability. In this comprehensive response, we will discuss the various materials commonly used in domestic treatment plant disposal systems and their optimization.

- 1. **Tanks and Chambers:** One of the key components of a domestic treatment plant disposal system is the tank or chamber where wastewater is collected and treated. These tanks need to be constructed using materials that are resistant to corrosion, leakage, and degradation. The most commonly used materials for tanks and chambers include:

- A. **Concrete:** Concrete tanks are widely used due to their durability and strength. They can withstand high loads and provide excellent resistance against chemical attacks from wastewater. Reinforced concrete tanks are often preferred for larger systems.
  - B. **Fiberglass Reinforced Plastic (FRP):** FRP tanks offer excellent resistance to corrosion, making them suitable for wastewater treatment applications. They are lightweight, easy to install, and have a long lifespan. FRP tanks are commonly used in smaller domestic treatment plants.
  - C. **Polyethylene (PE):** PE tanks are lightweight, cost-effective, and resistant to corrosion. They are easy to transport and install, making them suitable for smaller treatment plants or decentralized systems.
  - D. **Steel:** Steel tanks are strong and durable but require proper coating or lining to protect against corrosion. They are commonly used in larger treatment plants where high strength is required.
  - E. Optimizing tank materials involves considering factors such as cost, durability, ease of installation, maintenance requirements, and specific site conditions.
- 2. Pipes and Fittings:** The selection of pipes and fittings in domestic treatment plant disposal systems is crucial for ensuring efficient flow of wastewater and preventing leaks or blockages. The following materials are commonly used for pipes and fittings:
- A. **PVC (Polyvinyl Chloride):** PVC pipes are widely used due to their affordability, corrosion resistance, and ease of installation. They are available in various sizes and can handle both gravity and pressure flow systems.
  - B. **HDPE (High-Density Polyethylene):** HDPE pipes offer excellent chemical resistance, durability, and flexibility. They are commonly used for larger diameter pipes and where there is a need for high strength and impact resistance.
  - C. **Ductile Iron:** Ductile iron pipes are strong, durable, and resistant to corrosion. They are commonly used for larger diameter pipes in gravity flow systems.

- D. **Stainless Steel:** Stainless steel pipes provide excellent corrosion resistance and are suitable for aggressive wastewater environments. They are commonly used in industrial or commercial treatment plants.

Optimizing pipe and fitting materials involves considering factors such as hydraulic performance, chemical resistance, installation requirements, maintenance needs, and cost-effectiveness.

3. **Media and Filtration Materials:** In domestic treatment plant disposal systems, media and filtration materials play a crucial role in removing contaminants from wastewater. The selection of these materials depends on the specific treatment processes employed. Some commonly used materials include:

- A. **Sand:** Sand is widely used as a filtration medium due to its ability to remove suspended solids from wastewater. It is cost-effective and readily available.
- B. **Activated Carbon:** Activated carbon is effective in removing organic compounds, odors, and certain chemicals from wastewater. It is commonly used in adsorption processes.
- C. **Gravel:** Gravel is often used as a support medium for biological treatment processes such as trickling filters or submerged aerated filters. It provides a large surface area for microbial growth.
- D. **Synthetic Filter Media:** Synthetic filter media such as textile-based materials or synthetic polymers can be used in specialized filtration systems where specific contaminants need to be removed.

Optimizing media and filtration materials involves considering factors such as treatment efficiency, contaminant removal capabilities, lifespan, availability, and cost.

### 3.4. Recording plans

Designing and sizing domestic treatment plant disposal systems involves careful planning and documentation to ensure the system is efficient, effective, and compliant with regulations. Recording plans for this process is crucial for future reference, maintenance, and potential modifications.

There is a comprehensive guide on how to record plans for designing and sizing domestic treatment plant disposal systems:

1. **Create a Design Brief:** Start by creating a design brief that outlines the objectives, requirements, and constraints of the project. This document should include information such as the expected wastewater flow rate, influent characteristics, effluent quality standards, available space, budget limitations, and any specific regulatory requirements.
2. **Site Assessment:** Conduct a thorough site assessment to gather essential data for the design process. This includes determining the soil type, groundwater level, topography, available space for installation, proximity to water bodies or sensitive areas, and any potential limitations or challenges.
3. **System Selection:** Based on the design brief and site assessment, select an appropriate domestic treatment plant disposal system that meets the project's requirements. There are various options available such as septic tanks with absorption fields, aerobic treatment units (ATUs), or advanced treatment technologies like membrane bioreactors (MBRs) or constructed wetlands.
4. **Detailed Design:** Develop a detailed design plan that includes all necessary components of the chosen disposal system. This may involve creating schematic diagrams, hydraulic profiles, and layout plans showing the location of tanks, pipes, pumps, filters, and other relevant equipment. Consider factors such as accessibility for maintenance and future expansion.
5. **Sizing Calculations:** Perform sizing calculations to determine the required capacity of each component in the disposal system. This includes estimating the size of septic tanks or ATUs based on wastewater flow rates and retention times, determining pipe diameters based on hydraulic loading rates and friction losses, and sizing pumps or blowers based on pressure or airflow requirements.
6. **Material Specifications:** Specify the materials to be used for each component of the disposal system.

When selecting materials for a domestic wastewater treatment plant disposal system, it is important to consider the following factors:

- A. **Durability:** The materials should be able to withstand the harsh conditions of the wastewater environment, including exposure to chemicals, bacteria, and temperature extremes.
- B. **Corrosion resistance:** The materials should be resistant to corrosion, which can be caused by exposure to chemicals, bacteria, and electrolytes in the wastewater.
- C. **Compatibility with wastewater characteristics:** The materials should be compatible with the specific characteristics of the wastewater, such as its pH, temperature, and chemical content.

The following are some common materials used for different components of a domestic wastewater treatment plant disposal system:

**Tanks:** are vessels that are used to store liquids or gases. They can be made from a variety of materials, such as steel, plastic, or concrete. Tanks can be found in a variety of industries, including oil and gas, chemicals, and food and beverage.

- A. **Concrete:** Concrete tanks are durable and corrosion resistant, but they can be expensive and difficult to install.
- B. **Fiberglass:** Fiberglass tanks are lightweight and easy to install, but they can be less durable than concrete tanks.
- C. **Plastic:** Plastic tanks are lightweight and easy to install, but they can be less durable than concrete or fiberglass tanks.

**Pipes:** are tubes that are used to transport liquids or gases. They can be made from a variety of materials, such as steel, plastic, or copper. Pipes can be found in a variety of industries, including construction, manufacturing, and plumbing.

- A. **PVC:** PVC pipes are durable and corrosion resistant, and they are relatively inexpensive.
- B. **HDPE:** HDPE pipes are durable and corrosion resistant, and they are also flexible, which makes them easy to install in difficult areas.

**Other equipment:** is refer to a wide range of machines and devices that are used to perform a task. Some examples of other equipment include:

- A. **Pumps:** Pumps should be made of materials that are compatible with the wastewater characteristics, such as stainless steel or cast iron.
  - B. **Valves:** Valves should be made of materials that are durable and corrosion resistant, and they should also be compatible with the wastewater characteristics.
  - C. **Filters:** Filters should be made of materials that are durable and corrosion resistant, and they should also be compatible with the wastewater characteristics.
7. **Regulatory Compliance:** Ensure that the design plans comply with local, state, and national regulations governing domestic treatment plant disposal systems. This may involve adhering to setback distances from water bodies or property lines, meeting effluent quality standards, obtaining necessary permits or approvals, and following specific design criteria outlined in relevant codes or guidelines.
  8. **Record Keeping:** Maintain detailed records of all design plans, calculations, specifications, and regulatory compliance documentation. These records should be organized and easily accessible for future reference or potential audits. Consider using digital tools or software specifically designed for recording and managing engineering designs.
  9. **As-Built Drawings:** Once the disposal system is constructed, update the design plans to reflect any modifications or deviations from the original design. These as-built drawings should accurately represent the installed components and layout of the system. Include details such as actual dimensions, equipment model numbers, and any changes made during construction.
  10. **Operation and Maintenance Manuals:** Prepare operation and maintenance manuals that provide comprehensive instructions on how to operate, monitor, and maintain the domestic treatment plant disposal system. Include information on routine maintenance tasks, troubleshooting procedures, recommended inspection intervals, and contact details for technical support.



### 3.5. Restoring work area

Restoring the work area for designing and sizing domestic treatment plant disposal systems involves several steps to ensure a safe and efficient working environment. The process includes cleaning, organizing, and maintaining the workspace to promote productivity and minimize potential hazards.

There is a detailed guide on how to restore the work area for designing and sizing domestic treatment plant disposal systems:

1. **Clearing the Workspace:** Start by removing any unnecessary items or clutter from the work area. Dispose of any waste materials, empty containers, or obsolete equipment properly. This step helps create a clean and organized space for designing and sizing domestic treatment plant disposal systems.
2. **Cleaning Surfaces:** Thoroughly clean all surfaces in the work area, including countertops, tables, and equipment. Use appropriate cleaning agents to remove dirt, grease, and other contaminants. Pay special attention to areas that come into direct contact with the treatment plant components, such as testing equipment or measurement tools.
3. **Organizing Tools and Equipment:** Arrange all necessary tools and equipment in a logical manner to enhance efficiency during the design and sizing process. Utilize storage solutions such as shelves, cabinets, or toolboxes to keep everything easily accessible and well-organized. Labeling containers or drawers can also help locate specific items quickly.
4. **Inspecting Equipment:** Before starting any design or sizing tasks, inspect all equipment to ensure they are in proper working condition. Check for any signs of damage or wear that may affect their performance or safety. If any issues are identified, repair or replace the equipment as necessary.
5. **Maintaining Safety Measures:** Implement safety measures to protect yourself and others working in the area. Ensure that fire extinguishers are readily available and up-to-date. Install proper ventilation systems to prevent exposure to harmful fumes or gases.



Additionally, provide personal protective equipment (PPE) such as gloves, goggles, or masks when handling chemicals or potentially hazardous materials.

6. **Establishing Work Procedures:** Develop clear work procedures and guidelines for designing and sizing domestic treatment plant disposal systems. This includes defining the steps involved, assigning responsibilities, and setting deadlines. Having well-defined procedures helps streamline the process and ensures consistency in the work area.
7. **Regular Maintenance:** Maintain the restored work area by implementing regular cleaning and maintenance routines. Schedule periodic inspections to identify any potential issues or areas that require attention. Regularly clean equipment, replace consumables, and address any repairs promptly to prevent further damage or safety hazards.

## Self-check 3

**Instruction1:** Choose the best answer from the given alternatives

1. Which of the following is NOT a step involved in developing a disposal system plan for a domestic wastewater treatment plant?
  - A. Identifying the disposal site
  - B. Selecting the disposal method
  - C. Designing the disposal system
  - D. Operating and maintaining the disposal system
  
2. Sustainability principles and concepts that can be applied to the design of a domestic wastewater treatment plant disposal system include:
  - A. Minimizing the environmental impact of the disposal system
  - B. Conserving natural resources
  - C. Promoting economic development
  - D. All of the above
  
3. When specifying and optimizing materials for a domestic wastewater treatment plant disposal system, it is important to consider the following factors:
  - A. The durability of the materials
  - B. The cost of the materials
  - C. The environmental impact of the materials
  - D. All of the above
  
4. When recording plans for a domestic wastewater treatment plant disposal system, it is important to include the following:
  - A. A detailed site plan
  - B. A bill of materials
  - C. A construction schedule
  - D. All of the above
  
5. Restoring the work area after construction of a domestic wastewater treatment plant disposal system is important to:

- A. Protect the environment  
 B. Minimize visual impact  
 C. Ensure the safety of the public  
 D. All of the above

**Instruction2:** Write **True** if the statement is correct and write **False** if the statement is incorrect

1. It is important to consider sustainability principles and concepts when designing a domestic wastewater treatment plant disposal system.
2. The most important factor to consider when specifying materials for a domestic wastewater treatment plant disposal system is the cost of the materials.
3. Recording plans for a domestic wastewater treatment plant disposal system is not necessary.
4. Restoring the work area after construction of a domestic wastewater treatment plant disposal system is only necessary for aesthetic reasons.
5. A domestic wastewater treatment plant disposal system should be designed to minimize the environmental impact of the disposal.

**Instruction3:** Write short answer for the following questions

1. What are some of the sustainability principles and concepts that can be applied to the design of a domestic wastewater treatment plant disposal system?
2. What are some of the factors to consider when specifying and optimizing materials for a domestic wastewater treatment plant disposal system?
3. What are some of the information that should be included in the recorded plans for a domestic wastewater treatment plant disposal system?
4. Why is it important to restore the work area after construction of a domestic wastewater treatment plant disposal system?
5. What are some of the benefits of designing a domestic wastewater treatment plant disposal system that minimizes the environmental impact of the disposal?

## Operation sheet 3.1:

**Operation Title:** Design system layout

**Purpose:** To determine the size of a septic tank.

**Conditions or situations for the operations:**

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

**Equipment Tools and Materials:**

- Calculator
- And other writing materials

**Steps in doing the task**

1. Determine the size of a septic tank to serve 200 persons in a commercial establishment.

Refer to the Technical Data in determining the volume of the septic tank. For commercial establishment;

Multiply:

$$200 \text{ person's} \times 0.057 \text{ cu. m. per person} = 11.40 \text{ cu. m.}$$

Assume a 1-meter width of the tank per 100 persons. Thus, for 200 people, divide:

$$\frac{200 \text{ persons}}{100 \text{ person}} \times 1.0 \text{ meter} = 2.0 \text{ meters}$$

The maximum depth of septic tank is 150 centimeters or 1.50 meters. Solve for the length of the septic tank.

$$\text{Length} \times \text{Width} \times \text{Depth} = \text{Volume}$$

$$\text{Length ( L )} = \frac{\text{Volume}}{\text{Width} \times \text{Depth}}$$

$$L = \frac{11.40 \text{ cu.m.}}{2.0 \text{ m} \times 1.50 \text{ m}}$$

$$L = 3.80 \text{ meters}$$

The volume of L is only the length of the digestive chamber. Divide L by 2 then add the result to the value of L. Thus, to compute the total length of septic tank is:

$$\text{Total length of septic tank} = \frac{L}{2} + L = \frac{3.80 \text{ m}}{2} + 3.80 \text{ m} = 5.70 \text{ m}$$

Therefore, the total length of the septic tank to serve 200 persons is 5.70 m by 2.0 m wide. The proportion of the tank can be adjusted by increasing the width to shorten the length.

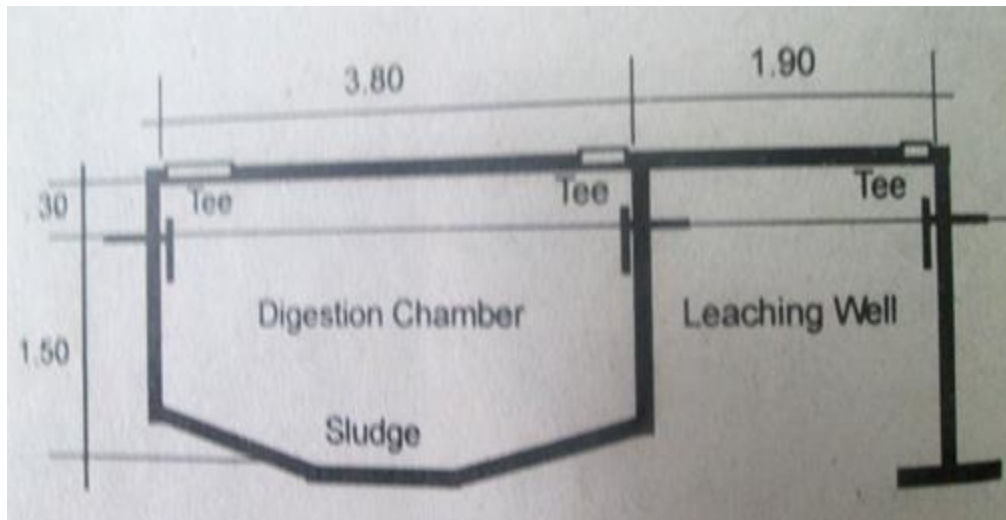


TABLE 3- 1 QUANTITIES OF SEWAGE FLOW

Type of Establishment	Gallons per Person per Day
Small dwelling with seasonal occupancy	50
Single family dwellings	75
Multiple family dwellings ( apartment )	60
Rooming houses	40
Boarding houses	50
Hotels without private bath	50
Hotels with private baths ( 2 persons per room )	60
Restaurants (toilets and kitchen wastes per patron )	7 to 10
Restaurants (kitchen wastes per meal serve )	2.5 to 3
Tourist camps or trailer parks with central bath house	35
Tourist courts or mobile home parks with individual bath	50
Resort camps night and day with limited plumbing	50
Luxury camps	100 to 150
Work or construction camps	50
Day camps no meal serve	15
Day schools without cafeterias, gym, or showers	15
Day schools with cafeterias, gym, or showers	25
Day schools with cafeterias, but no gym, or showers	20
Boarding schools	75 to 100

Hospitals	150 to 250
Institutions other than a hospitals	75 to 125
Factories( exclusive of industrial waste )	15 to 35
Picnic parks with toilet, bath houses	10
Swimming pools and bath houses	10
Luxury residences	100 to 150
country clubs ( per resident only )	100
Motels ( per bed space )	40
Motels with bath, toilet and kitchen wastes	50
Drive in theaters ( per car space )	5
Movie theaters ( per auditorium seat )	5
Airport ( per passenger )	3 to 5
Stores ( per toilet room )	40
Service stations ( per vehicle served )	10
Self-service laundries ( gallon per wash per person )	50



2. A Hotel with toilet, bath and kitchen facilities is to serve a maximum of 100 persons.  
Determine the capacity and dimensions of the septic tank.

Using Table 3-1 and under Hotel with bath, toilet and kitchen waste per person per day is 50 gallons per person per day x 100 persons is equal to 5000 gallons.

Using the formula:

$$V = 1.125 + 0.75 Q$$

V = the liquid volume of the tank in gallons

Q = the daily sewage flows in gallons

1.125 and 0.75 are constant values

$$V = 1.125 + 0.75 \times (5000 \text{ gallons})$$

$$V = 3751 \text{ gallons}$$

Convert V in cubic meter. There are 264 gallons in one cubic meter, therefore divide 3751 gallons by 264 gallons:

$$V = \frac{3751 \text{ gallons}}{264 \text{ gallons}} \times 1 \text{ cu.m.} = 14.2 \text{ cu. m.}$$

To find the dimensions of the septic tank, assume that the width is 3.0 meters and the maximum depth of the tank is 1.50 meters (or 150 centimeters). Then:

$$\text{Length} = \frac{\text{Volume}}{\text{Width} \times \text{Depth}}$$

$$\text{Length} = \frac{14.2 \text{ cu.m.}}{3.0 \text{ meters} \times 1.50 \text{ meters}}$$

$$\text{Length} = 3.50 \text{ meters}$$

## LAP Test:

**Instruction:** Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours each task.

**Note:** Use the Technical Data and Table 3-1 in answering the following questions.

**Task1:** Determine the size of a septic tank to be constructed in a school which will serve 300 students. (Use 0.057 cu. m. per person)

**Task2:** A single family dwelling has a toilet, shower, and kitchen is to serve 10 persons. Determine the capacity and dimensions of septic tank. (Use 1.10 meters as width of septic tank)

**Task3:** A boarding house with showers and toilets has an occupant of 30 persons. Determine the capacity and dimensions of septic tank. (Use 1.20 meters as width of septic tank)

**Task4:** Determine the size of a septic tank to serve 400 persons in an industrial establishment. (Use 0.060 cu. m per person)

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