PLUMBING INSTALLATION

LEVEL – IV

Based on October, 2023, Curriculum Version II

Module Title: Applying sustainable building design principles to water management

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Acronyms

EBCS .....Ethiopian Building Code Standard

ESA.....Ethiopian Standards Agency

ENBC .....Ethiopian National Building Code

EEIS.....Ethiopian Electrical Installation Standard

EPIS.....Ethiopian Plumbing Installation Standard

ECAE.....Ethiopian Conformity Assessment Enterprise

EFPCA .....Ethiopian Fire and Emergency Prevention and Control Authority

NFPA .....National Fire Protection Association

EIAs.....Environmental Impact Assessments

WSUD .....Water Sensitive Urban Design

HDPE.....high-density polyethylene

KPI .....Key Performance Indicators

PVC .....Polyvinyl chloride

Introduction to the Module

Sustainable building design principles play a crucial role in water management by promoting efficient and responsible use of water resources. These principles aim to minimize water consumption, reduce wastewater generation, and maximize the use of alternative water sources. By incorporating sustainable design strategies into buildings, we can mitigate the environmental impact of water usage and contribute to long-term water conservation efforts. One of the key aspects of sustainable building design is the implementation of water-efficient fixtures and appliances.

This module covers the following units:

- Legislative and planning requirements for effective water management
- Opportunities' for improved water management
- Best practice in water management

Learning Objective of the Module

- Applying Legislative and planning requirements for effective water management
- Identifying opportunities' for improved water management
- Apply best practice in water management

Module Instruction

For effective use this 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" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit One: Apply legislative and planning requirements for effective water management

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

- Effective management of water systems.
- Gathering information and negotiating for water management system
- Identifying Ethiopian building standards.
- Environmental and resource efficiency issues.

This guide 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:

- Identifying effective management of water systems.
- Identifying Gathering information and negotiating for water management system
- Identifying Ethiopian building standards.
- Environmental and resource efficiency issues

1.1. Effective management of water system including:-

Water is a transparent, tasteless, odourless, and nearly colourless chemical substance that is essential for all forms of life. It is the most abundant molecule on Earth and covers about 71% of the planet's surface. Water exists in three states: solid (ice), liquid, and gas (water vapour). Its molecular formula is H2O, consisting of two hydrogen atoms bonded to one oxygen atom.

Water plays a crucial role in sustaining life as it is involved in various biological processes and functions. Its importance can be attributed to several key purposes. Water is an indispensable substance for all forms of life on Earth. Its unique properties enable it to fulfill numerous essential functions in biological systems, ranging from hydration and solvent properties to cellular function, transportation, temperature regulation, chemical reactions, maintenance of homeostasis, and support for habitats and ecosystems.

Water is a vital resource for all living organisms on Earth. It is essential for various purposes such as drinking, agriculture, industry, and maintaining ecosystems. The primary sources of water on our planet can be categorized into different types, including surface water, groundwater, and atmospheric water.

Water management refers to the process of planning, developing, distributing, and managing water resources in order to meet various human needs while also ensuring the sustainability of ecosystems. It involves the implementation of strategies and practices to optimize the use of water, prevent water pollution, and mitigate the impacts of water-related hazards such as floods and droughts. Effective water management is crucial for maintaining a reliable supply of clean water for drinking, irrigation, industrial processes, and other essential uses.

Water management encompasses various aspects, including water supply, water treatment, water distribution, wastewater management, storm water management, and water conservation. Each of these components plays a vital role in ensuring the efficient and sustainable use of water resources.

Conduct a water audit: A water audit will help identify areas of water waste and inefficiencies within the system. This will allow for targeted improvements to be made to reduce water consumption and improve efficiency.

Implement water conservation policies: Policies that promote water conservation can be implemented at the local, state, or national level. These policies may include restrictions on water usage during droughts, incentives for water-efficient technologies, and education campaigns to promote water conservation.

Use advanced technologies: Advanced technologies such as smart meters, leak detection systems, and water treatment technologies can help improve the efficiency and effectiveness of water systems.

Develop alternative water sources: Developing alternative water sources such as rainwater harvesting, groundwater recharge and desalination can help increase the availability of water in areas where traditional sources are scarce.

Promote public awareness and education: Educating the public on the importance of water conservation and sustainability can help encourage individuals to adopt practices that reduce water waste and improve the efficiency of water systems

Collaborate with stakeholders: Effective management of water systems requires collaboration between government agencies, private sector organizations, and individuals. Collaboration can help ensure that the best strategies are implemented and that resources are used efficiently.

Water Management-- Key Objects

- Protect water
- Conserve water
- Protect water quality
- Reduce consumption
- Find Alternate Sources

A. Water management strategies

- Use integrated process to assess:
- Existing water resources,
- Opportunities for reducing water demand,
- Alternative water supplies.

B. Promoting green building to encourages

- Innovative water-saving strategies
- That helps projects use water wisely.

C. **Promoting effective water strategies include**:

- Installing efficient plumbing fixtures.
- Use dual plumbing
- Using non-potable water.
- Installing -meters.
- Choosing locally adapted plants.
- Using xeriscaping. a landscaping method developed especially for arid/semi-arid climates that utilizes water-conserving techniques use of drought-tolerant pl mulch, and efficient irrigation

Approach to water management

• Principles for Managing water

Make buildings water efficient over entire life-cycle- embodied and operational use of water

Promoting Slow the flow of water

Promoting Economical and optimal use of water

Minimising wastage

Minimising leakage

Promoting Multiple Usage (reuse and recycling)

- Using water efficient fixtures
- Using native plants and trees

Using low water embodied materials- Using materials requiring less water in making and using

- Using low water construction technologies
- Using water efficient landscape- Using native trees/plants
- Mulching trees- plants to retain moisture, prevent evaporation
- Using alternate sources of water ,Rainwater water harvesting

Management in Green Buildings

Green buildings, also known as sustainable buildings or eco-friendly buildings are designed and constructed with a focus on reducing their environmental impact and promoting sustainability. These buildings aim to minimize energy consumption, water usage, waste generation, and overall carbon footprint throughout their lifecycle. Effective management plays a crucial role in ensuring the successful operation and maintenance of green buildings.

Management in green buildings encompasses various aspects, including facility management, energy management, water management, waste management, indoor environmental quality (IEQ) management, and sustainable procurement. Each of these areas requires specific strategies and practices to optimize the building's performance while minimizing its environmental impact.

Table 1-1 per capita water management

Purpose	**Litres/ person/day**
Drinking	03
Cooking	04
Bathing	20
Flushing	40
Washing clothes	25
Washing utensils	20
Gardening	23
Total	135

1.2. Gathering information and negotiating for water management system

Gathering information and negotiating for a water management system involves the process of collecting relevant data, analysing it, and engaging in discussions to reach agreements or make decisions regarding the management of water resources. This comprehensive task

requires careful planning, research, and effective communication to ensure the development and implementation of an efficient and sustainable water management system.

A. Gathering Information:

The first step in gathering information for a water management system is to identify the specific objectives and requirements of the system. This includes determining the purpose of the system, such as providing clean drinking water, irrigation for agriculture, or industrial use. It is important to consider factors such as population size, water availability, quality standards, and environmental considerations.

To gather information, various sources can be utilized. These may include:

1. **Scientific Research Papers**: Scientific research papers published in reputable journals provide valuable insights into different aspects of water management. These papers often present findings from studies conducted by experts in the field and can cover topics such as water quality monitoring, treatment technologies, and sustainable water resource management practices.

2. **Government Reports**: Government agencies at local, regional, and national levels often publish reports on water resources and their management. These reports provide data on water availability, usage patterns, regulatory frameworks, and policy guidelines. They can offer valuable information on existing infrastructure, legal requirements, and potential funding sources for implementing a water management system.

3. **Industry Associations**: Industry associations related to water management, such as those representing water utilities or environmental organizations, can provide valuable resources and information. These associations often conduct research, publish reports, and organize conferences or workshops where professionals in the field share their expertise and experiences.

Additionally, it is essential to engage with local stakeholders who have knowledge about the specific region or community where the water management system will be implemented. This may include representatives from local government bodies, community organizations, environmental groups, and indigenous communities. Their input can provide valuable insights into local water issues, cultural considerations, and potential challenges.

B. Negotiating for a Water Management System:

Negotiating for a water management system involves engaging with various stakeholders to reach agreements on the design, implementation, and operation of the system. This process requires effective communication, collaboration, and compromise to address the diverse interests and concerns of different parties involved.

a. **Stakeholder Analysis**: Before entering into negotiations, it is crucial to conduct a stakeholder analysis to identify the key individuals or groups who will be affected by or have an influence on the water management system. This analysis helps in understanding their interests, concerns, and potential areas of conflict. Stakeholders may include government agencies, water users (such as households, industries, and agriculture), environmental organizations, and local communities.

b. **Engaging in Dialogue**: Once stakeholders are identified, it is important to engage in open and transparent dialogue with them. This can involve organizing meetings, workshops, or public consultations to discuss the objectives of the water management system and gather input from stakeholders. These discussions should aim to build trust, foster understanding of different perspectives, and explore potential solutions.

c. **Finding Common Ground**: Negotiations often involve finding common ground among stakeholders with conflicting interests. This requires active listening, empathy, and creative problem-solving techniques. Mediation or facilitation by neutral third parties can also be employed to help resolve disputes and reach mutually beneficial agreements.

d. Throughout the negotiation process, it is important to consider technical feasibility, economic viability, environmental sustainability, and social equity aspects of the proposed water management system. Balancing these factors can help ensure that the negotiated agreements are practical and acceptable to all parties involved.

1.2.1. Building and construction design process

In the building and construction design process, there are several key elements that are identified and considered. These elements play a crucial role in ensuring the successful completion of a construction project. They include site analysis, programming, schematic

design, design development, construction documents, bidding and negotiation, and finally, construction administration.

Site analysis is the initial step in the design process. It involves evaluating the site's physical characteristics, such as topography, soil conditions, climate, and surrounding environment. This analysis helps architects and designers understand the constraints and opportunities presented by the site.

Programming is the process of gathering information about the project's requirements and objectives. It involves understanding the client's needs, functional requirements, budget constraints, and any specific design criteria. This information serves as a foundation for the subsequent design phases.

Schematic design is where the initial concepts and ideas take shape. Architects create rough sketches and diagrams to explore different design options. This phase focuses on spatial relationships, circulation patterns, and overall aesthetics. It helps in visualizing how the building will look and function.

Design development is the phase where schematic designs are refined further. Architects work on developing detailed floor plans, elevations, sections, and 3D models. They also consider structural systems, mechanical systems, and other technical aspects of the building. This phase aims to achieve a more comprehensive understanding of the project's design.

Construction documents are detailed drawings and specifications that provide instructions for contractors to build the project. These documents include architectural drawings, structural plans, electrical plans, plumbing plans, and other necessary details. They serve as a legal contract between the client and contractor.

1.2.2. Building design principles for water management

Building design principles for water management are essential to ensure sustainable and efficient use of water resources in the built environment. These principles aim to minimize water consumption, reduce water pollution, and promote water conservation. By incorporating these principles into building design, it is possible to create more resilient and environmentally friendly structures. In this comprehensive response, we will explore various design principles that can be applied to water management in buildings.

1. **Water Efficiency:**

Water efficiency is a fundamental principle in building design for effective water management. It involves reducing the overall demand for water by implementing measures that optimize its use. Several strategies can be employed to achieve water efficiency:

Water-efficient fixtures: Installing low-flow faucets, showerheads, and toilets can significantly reduce water consumption without compromising functionality. These fixtures are designed to deliver adequate performance while using less water.

Greywater recycling: Greywater refers to wastewater generated from activities such as bathing, laundry, and dishwashing. By treating and reusing greywater for non-potable purposes like toilet flushing or irrigation, buildings can reduce their reliance on freshwater sources.

Rainwater harvesting: Collecting rainwater from rooftops and storing it for later use is another effective strategy for reducing freshwater demand. Rainwater can be used for landscape irrigation or other non-potable applications.

Metering and monitoring: Installing water meters and monitoring systems can help track water usage patterns, identify leaks or inefficiencies, and encourage responsible consumption.

2. **Storm water Management:**

Proper management of storm water is crucial to prevent flooding, erosion, and pollution of natural water bodies. Incorporating storm water management principles into building design helps mitigate these issues:

Green roofs: Green roofs are vegetated surfaces installed on rooftops that absorb rainwater, reducing storm water runoff. They provide insulation benefits, improve air quality, and create habitat for wildlife.

Permeable paving: Using permeable materials for driveways, parking lots, and walkways allows rainwater to infiltrate the ground instead of becoming runoff. This helps recharge groundwater and reduces the burden on storm water infrastructure.

Rain gardens: Rain gardens are landscaped areas designed to capture and absorb storm water runoff. They typically consist of native plants and engineered soil that filter pollutants and promote infiltration.

Retention ponds: Constructing retention ponds or basins on-site can temporarily store excess storm water during heavy rainfall events. These ponds gradually release the water, reducing the strain on downstream drainage systems.

3. **Water Quality Management**:

Maintaining water quality is essential for both human health and ecosystem integrity. Building design principles can help minimize water pollution and protect water resources:

Source control measures: Implementing measures to prevent contaminants from entering storm water runoff is crucial. This includes proper storage and handling of hazardous materials, as well as effective erosion and sediment control during construction.

Vegetated buffers: Planting vegetation along water bodies or drainage channels acts as a natural filter, trapping sediments and absorbing pollutants before they reach the water. These buffers also provide habitat for wildlife.

Constructed wetlands: Constructed wetlands are engineered systems that mimic natural wetlands' functions. They treat wastewater or storm water by utilizing plants, microbes, and physical processes to remove pollutants before discharge.

Water treatment technologies: Incorporating advanced water treatment technologies within buildings can ensure that discharged wastewater meets stringent quality standards. These technologies may include filtration systems.

1.2.3. Client needs and expectations for the design and use of water management systems

Water management systems play a crucial role in meeting the needs and expectations of clients. These systems are designed to effectively manage water resources, ensure efficient water distribution, and mitigate the risks associated with water-related challenges such as scarcity, pollution, and climate change. Meeting client needs and expectations requires a comprehensive understanding of their requirements, as well as the ability to design and implement solutions that address these needs effectively.

Client needs in water management systems can vary depending on various factors such as location, industry, and specific objectives. However, there are some common needs that clients typically have when it comes to water management:

1**. Reliability**: Clients expect water management systems to provide a reliable supply of clean and safe water. This includes ensuring uninterrupted access to water for domestic, industrial, and agricultural purposes. Reliability also encompasses the ability to handle peak demand periods without compromising the quality or quantity of water supplied.

2. **Efficiency**: Clients seek water management systems that are efficient in terms of resource utilization, energy consumption, and cost-effectiveness. Efficient systems minimize water losses through leakage detection and repair programs, optimize pumping operations to reduce energy consumption, and employ advanced technologies for accurate measurement and billing.

3. **Sustainability**: Clients increasingly prioritize sustainability in water management systems. They expect solutions that minimize environmental impact, promote conservation practices, and support the long-term availability of water resources. This may involve implementing measures such as rainwater harvesting, wastewater recycling, and adopting eco-friendly treatment processes.

4. **Flexibility**: Clients often require water management systems that can adapt to changing circumstances and evolving needs. This includes the ability to accommodate population growth, changing weather patterns, regulatory requirements, and technological advancements. Flexibility also extends to the capacity of the system to integrate with other infrastructure networks such as energy grids or smart city initiatives.

5. **Resilience**: Clients expect water management systems to be resilient in the face of natural disasters, climate change impacts, and other unforeseen events. This involves designing systems that can withstand extreme weather conditions, implementing redundancy measures to ensure continuous water supply during emergencies, and incorporating risk management strategies to mitigate potential disruptions.

Client expectations for the design and use of water management systems are influenced by several factors:

1. **Regulatory Compliance**: Clients expect water management systems to comply with relevant laws, regulations, and standards. This includes meeting water quality standards, adhering to environmental regulations, and ensuring compliance with health and safety requirements.

2. **Cost-effectiveness**: Clients seek cost-effective solutions that provide value for money. They expect water management systems to optimize resource allocation, minimize operational costs, and offer long-term cost savings through efficient water use and reduced maintenance requirements.

3. **Technological Innovation**: Clients expect water management systems to leverage technological advancements to improve efficiency, accuracy, and reliability. This includes the use of advanced sensors for real-time monitoring, data analytics for predictive maintenance, automation for efficient operations, and remote control capabilities for enhanced system management.

4. **Transparency and Communication**: Clients expect clear communication channels and transparent reporting on the performance of water management systems. This includes providing regular updates on water quality, supply reliability, maintenance activities, and any potential disruptions or issues that may arise.

5. **Community Engagement**: Clients increasingly value community engagement in the design and use of water management systems. They expect opportunities for public participation, consultation processes, and education programs that raise awareness about water conservation and sustainable practices.

1.2.4. Implementing a water management system in building

Implementing a water management system in a building is crucial for efficient and sustainable water usage. Such a system helps to conserve water, reduce costs, and minimize the environmental impact associated with water consumption. In this comprehensive response, we will discuss the various aspects of implementing a water management system in a building, including the key components, benefits, challenges, and best practices.

Key Components of a Water Management System:

1. **Water Monitoring**: A water management system should include monitoring devices such as flow meters, pressure sensors, and water quality sensors to track water usage and identify potential leaks or inefficiencies.

2. **Water Conservation Measures:** Implementing water-saving fixtures and appliances such as low-flow toilets, faucets, and showerheads can significantly reduce water consumption in a building. Additionally, rainwater harvesting systems can be installed to collect and reuse rainwater for non-potable purposes like irrigation or toilet flushing.

3. **Leak Detection and Prevention**: Incorporating leak detection systems can help identify leaks early on and prevent water wastage. These systems use sensors to monitor water flow and alert building operators or maintenance staff in case of abnormal usage patterns.

4. **Greywater Recycling**: Greywater refers to wastewater generated from sources other than toilets (e.g., sinks, showers). Implementing greywater recycling systems allows for the treatment and reuse of this water for non-potable purposes within the building.

5. **Smart Irrigation Systems**: For buildings with outdoor landscaping or gardens, smart irrigation systems can be employed to optimize watering schedules based on weather conditions, soil moisture levels, and plant requirements. This helps prevent overwatering and ensures efficient use of irrigation water.

6. **Educational Programs**: Raising awareness among building occupants about the importance of water conservation through educational programs can encourage responsible water usage habits.

1.2.5. Benefits of Implementing a Water Management System:

1. **Water Conservation**: The primary benefit of a water management system is the conservation of this precious resource. By implementing water-saving measures and monitoring usage, buildings can significantly reduce their water consumption.

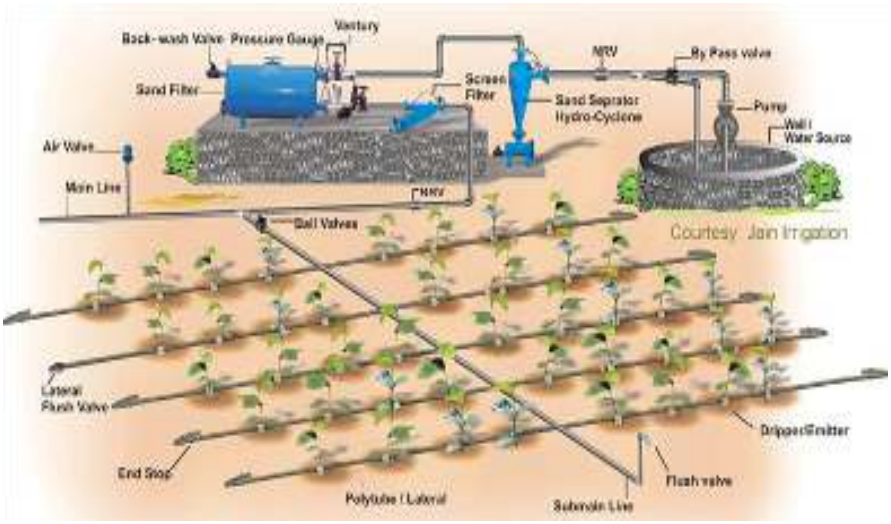


Figure 1-1 Water Conservation

Figure 1-2 Water Conservation method

2. **Cost Savings**: Water management systems can lead to substantial cost savings by reducing water bills. Additionally, proactive leak detection and prevention can prevent costly water damage repairs.

3. **Environmental Impact**: Efficient water management helps minimize the environmental impact associated with water consumption. By conserving water, buildings contribute to the preservation of local water sources and reduce energy consumption associated with water treatment and distribution.

Figure 1-3 Environmental Impact

4. **Regulatory Compliance**: Many jurisdictions have regulations in place to promote water conservation in buildings. Implementing a water management system ensures compliance with these regulations and avoids potential penalties.

1.2.6. Challenges in Implementing a Water Management System

1. **Initial Investment**: Implementing a comprehensive water management system may require an upfront investment in equipment, sensors, and infrastructure upgrades. However, the long-term cost savings and environmental benefits often outweigh the initial costs.

2. **Building Age and Design**: Older buildings may present challenges in retrofitting water-saving fixtures or integrating monitoring systems due to outdated plumbing systems or limited space. In such cases, careful planning and collaboration with experts are necessary to overcome these challenges.

3. **Behavioural Change**: Encouraging behavioural change among building occupants can be a challenge. Education and awareness programs are essential to promote responsible water usage habits and ensure the success of a water management system.

1.2.7. Best Practices for Implementing a Water Management System:

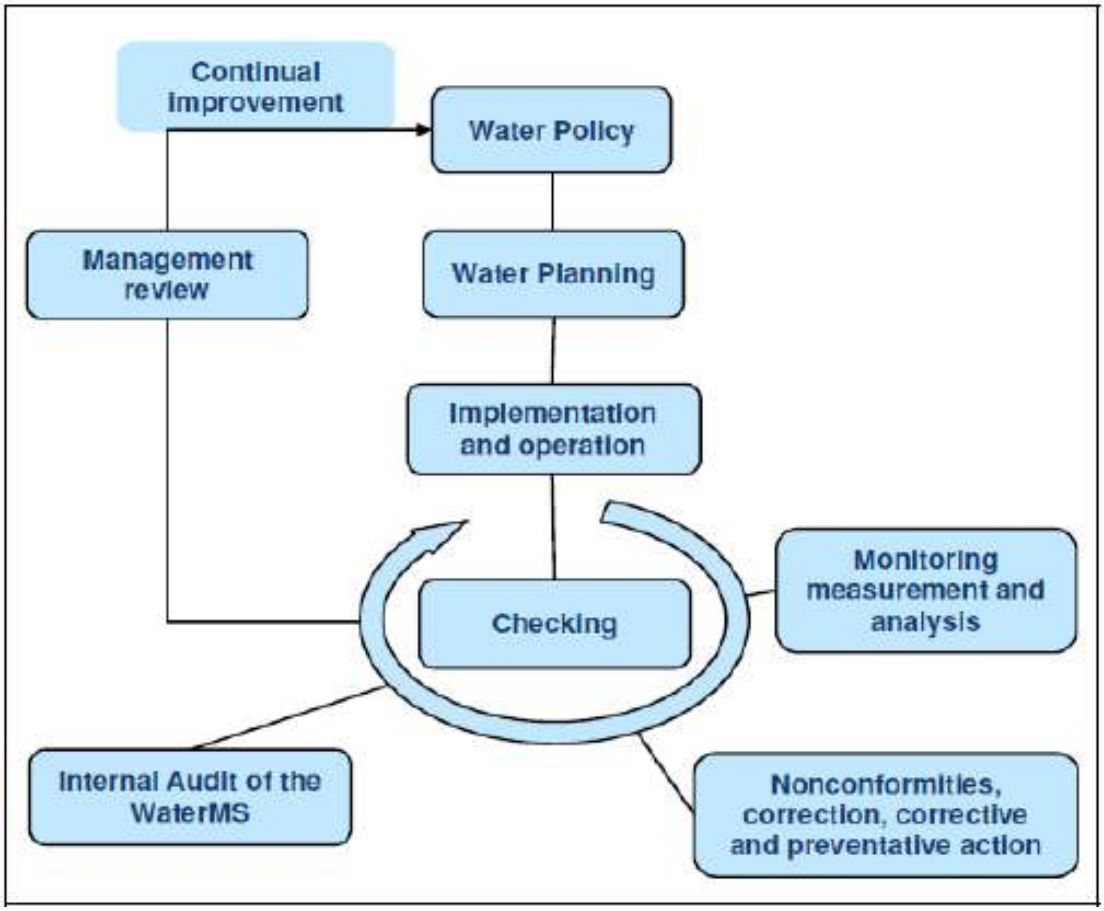
1. **Conduct a Water Audit**: Start by conducting a thorough assessment of current water usage patterns within the building to identify areas for improvement and prioritize interventions.

2. **Set Realistic Goals**: Establish specific, measurable, achievable, relevant, and time-bound (SMART) goals for water conservation to guide the implementation process.

3. **Engage Stakeholders**: Involve building owners, managers, occupants, and maintenance staff in the planning and implementation process. Their input and support are crucial for the success of the water management system.

4. **Regular Monitoring and Maintenance**: Continuously monitor water usage, regularly inspect equipment, and promptly address any leaks or inefficiencies to ensure the system operates optimally.

5. **Continuous Improvement**: Regularly review and update the water management system based on feedback, data analysis, and technological advancements to maximize its effectiveness.



1.3. Ethiopian building standards

In Ethiopia, the construction industry is regulated by various standards and regulations to ensure the safety, quality, and sustainability of building projects. When undertaking a building project in Ethiopia, it is crucial to consult relevant Ethiopian standards to identify the implications for the conduct of the project.

The Ethiopian Standards Agency (ESA) is the national standards body responsible for developing and maintaining standards in Ethiopia. It plays a vital role in ensuring that construction projects adhere to established guidelines and regulations. The ESA has developed a comprehensive set of standards specifically related to the construction industry.

One of the key Ethiopian standards that should be consulted is the Ethiopian Building Code Standard (EBCS). This standard provides guidelines for the design, construction, and maintenance of buildings in Ethiopia. It covers various aspects such as structural design, fire

safety, electrical installations, plumbing systems, and accessibility requirements. Adhering to the EBCS ensures that buildings are constructed in a safe and sustainable manner.

Another important standard is the Ethiopian National Building Code (ENBC). This code provides detailed technical requirements for different types of buildings, including residential, commercial, industrial, and institutional structures. It covers aspects such as building materials, structural design criteria, ventilation systems, lighting requirements, and energy efficiency measures. Compliance with the ENBC is essential to ensure that buildings meet minimum safety and quality standards.

Additionally, it is crucial to consult specific standards related to specialized areas within the construction industry. For example, if the building project involves electrical installations, it is necessary to refer to the Ethiopian Electrical Installation Standard (EEIS). This standard provides guidelines for electrical wiring systems, grounding requirements, electrical equipment installation, and safety measures.

Similarly, if the project involves plumbing systems, it is important to consult the Ethiopian Plumbing Installation Standard (EPIS). This standard outlines requirements for water supply systems, drainage systems, sanitary fixtures installation, and wastewater treatment.

Consulting relevant Ethiopian standards has several implications for the conduct of a building project. Firstly, it ensures that the project complies with national regulations and guidelines, which are designed to protect public safety and welfare. Adhering to these standards minimizes the risk of structural failures, electrical hazards, fire incidents, and other potential dangers.

Secondly, following the standards promotes quality construction practices. The standards provide detailed technical requirements and best practices that contribute to the durability and longevity of buildings. They specify acceptable materials, construction methods, and quality control measures, ensuring that the project meets high-quality standards.

Thirdly, consulting Ethiopian standards helps in achieving sustainability goals. The standards often include provisions for energy efficiency, water conservation, waste management, and environmental protection. By incorporating these requirements into the building project, it contributes to sustainable development and reduces the environmental impact.

In conclusion, when undertaking a building project in Ethiopia, it is essential to consult relevant Ethiopian standards to identify the implications for the conduct of the project. Standards such as the Ethiopian Building Code Standard (EBCS), Ethiopian National Building Code (ENBC), Ethiopian Electrical Installation Standard (EEIS), and Ethiopian Plumbing Installation Standard (EPIS) provide comprehensive guidelines for different aspects of construction. Adhering to these standards ensures compliance with national regulations, promotes quality construction practices, and contributes to sustainable development.

1.3.1. Ethiopia building standards for plumbing work

In Ethiopia, building standards for plumbing work are regulated by the Ethiopian Building Code Standard (EBCS) and the Ethiopian Conformity Assessment Enterprise (ECAE). These standards ensure that plumbing systems in buildings meet safety, health, and environmental requirements. The EBCS provides guidelines for the design, installation, and maintenance of plumbing systems, while the ECAE is responsible for inspecting and certifying compliance with these standards.

1. **Design and Installation Standards**:

The EBCS sets out specific requirements for the design and installation of plumbing systems in buildings. These standards cover various aspects of plumbing work, including water supply, drainage, waste disposal, and venting. Here are some key points related to Ethiopian building standards for plumbing work:

a) **Water Supply**: The EBCS specifies the minimum requirements for water supply systems in buildings. It includes guidelines on the source of water, pipe sizing, pressure regulation, backflow prevention, and water quality.

b) **Drainage:** The EBCS outlines the standards for drainage systems in buildings. It covers aspects such as pipe sizing, slope requirements, fixture connections, venting, and storm water management.

c) **Waste Disposal**: Ethiopian building standards require proper waste disposal systems to prevent environmental pollution and public health risks. The EBCS provides guidelines on

the design and installation of sewage disposal systems, including septic tanks and sewer connections.

d) **Venting**: Proper venting is essential to prevent the build-up of harmful gases and odours in plumbing systems. The EBCS specifies the requirements for venting systems in buildings to ensure adequate air circulation and pressure balance.

e) **Accessibility**: Ethiopian building standards also emphasize accessibility considerations in plumbing design. This includes provisions for accessible toilets, sinks, showers, and other fixtures to accommodate individuals with disabilities.

f) **Materials and Equipment**: The EBCS provides guidelines on the selection and use of plumbing materials and equipment. It includes standards for pipes, fittings, valves, pumps, water heaters, and other components to ensure durability and performance.

Fire Safety Guidelines: Fire safety is a critical aspect of building design and construction. The Ethiopian Fire and Emergency Prevention and Control Authority (EFPCA) is responsible for enforcing fire safety regulations in Ethiopia. They have developed guidelines to ensure that buildings are designed and equipped to prevent and mitigate fire incidents.

The fire safety guidelines cover various aspects such as fire-resistant construction materials, means of egress, fire detection and alarm systems, fire suppression systems, emergency lighting, signage requirements, and evacuation plans. These guidelines are based on international standards such as the National Fire Protection Association (NFPA) codes.

Compliance with the fire safety guidelines is mandatory for all buildings in Ethiopia. Regular inspections are conducted by the EFPCA to ensure that buildings meet the required standards.

2. **Maintenance and Inspection Standards**:

In addition to design and installation standards, Ethiopian building standards also cover maintenance and inspection requirements for plumbing systems. Regular maintenance and inspections are crucial to ensure the continued functionality and safety of plumbing installations. The EBCS specifies the following:

a) **Maintenance**: Building owners and occupants are responsible for maintaining their plumbing systems in accordance with the EBCS. This includes regular cleaning, repair of leaks or damages, and proper disposal of waste materials.

b) **Inspection**: The ECAE conducts inspections to verify compliance with the EBCS. Inspections may be carried out during the construction phase or as part of routine checks for existing buildings. Non-compliance may result in penalties or the requirement for corrective actions.

3. Enforcement and Certification:

The Ethiopian Conformity Assessment Enterprise (ECAE) is responsible for enforcing plumbing standards in Ethiopia. The ECAE conducts inspections, issues certificates of conformity, and ensures that plumbing installations meet the requirements set by the EBCS.

Building owners, contractors, and plumbers are required to obtain certification from the ECAE to demonstrate compliance with Ethiopian building standards for plumbing work. Certification involves submitting design plans, conducting inspections during construction, and providing evidence of adherence to the EBCS.

1.3.2. Advantage of Ethiopian building standards

Ethiopia has been implementing its own building codes and standards since the early 2000s, which have brought numerous benefits to the country's construction industry. Here are some of the key advantages of Ethiopian building standards:

1. **Improved safety**: The Ethiopian building code emphasizes the importance of safety in building design and construction. It requires buildings to be designed and constructed with safety features such as fire-resistant materials, emergency exits, and proper ventilation. This has led to a significant reduction in the number of building collapses and fires in the country.

2. **Enhanced energy efficiency**: Ethiopian building standards prioritize energy efficiency, which helps reduce the country's carbon footprint and dependence on non-renewable energy sources. Buildings are required to meet minimum energy efficiency standards, which includes the use of energy-efficient appliances and insulation materials.

3. **Increased accessibility**: The Ethiopian building code emphasizes the need for accessible buildings, which benefits people with disabilities and the elderly. Accessible buildings are designed with features such as ramps, elevators, and wide doorways, making it easier for people to move around and access facilities.

4. **Improved indoor air quality**: Ethiopian building standards require buildings to have proper ventilation systems, which helps improve indoor air quality. This is particularly important in densely populated urban areas where air pollution is a major concern.

5. **Cost savings**: Adhering to Ethiopian building standards can help reduce construction costs in the long run. By using locally available materials and minimizing waste, builders can save money on materials and labour costs. Additionally, energy-efficient buildings can save occupants money on utility bills over time.

6. **Environmental sustainability**: Ethiopian building standards promote environmental sustainability by encouraging the use of eco-friendly materials and energy-efficient systems. This helps reduce the country's carbon footprint and contribute to global efforts to combat climate change.

7. **Job creation**: Implementing and enforcing building standards can create jobs in the construction industry, from architects and engineers to contractors and skilled tradespeople. This can help stimulate economic growth and development in the country.

8. **Improved property values**: Building standards can increase property values by ensuring that buildings are safe, well-maintained, and energy-efficient. This can lead to higher rental income or resale values for property owners.

9. **Disaster risk reduction**: Ethiopian building standards take into account the country's seismic and weather risks, and require buildings to be designed and constructed to withstand these hazards. This can help reduce the impact of natural disasters on communities and infrastructure.

10. **International recognition**: Ethiopia's building codes and standards are aligned with international best practices, which can help the country attract foreign investment and collaborations in the construction industry. This can also facilitate the exchange of knowledge and expertise between Ethiopia and other countries.

1.4. Environmental and resource efficiency issues

Environmental and resource efficiency issues refer to challenges and concerns related to the sustainable use and management of natural resources, as well as the impact of human activities on the environment. These issues encompass a wide range of topics, including

pollution, climate change, biodiversity loss, deforestation, water scarcity, waste management, and energy consumption.

One of the key environmental issues is pollution, which can take various forms such as air pollution, water pollution, soil contamination, and noise pollution. Air pollution is primarily caused by emissions from industries, vehicles, and burning fossil fuels. It contributes to respiratory diseases, climate change, and damages ecosystems. Water pollution occurs when contaminants are discharged into water bodies, affecting aquatic life and human health.

Soil contamination can result from improper waste disposal or the use of pesticides and fertilizers in agriculture. Climate change is another critical environmental issue that has gained significant attention in recent years. It refers to long-term shifts in temperature patterns and weather conditions due to increased greenhouse gas emissions from human activities. The primary driver of climate change is the burning of fossil fuels for energy production and transportation. The consequences of climate change include rising global temperatures, sea-level rise, extreme weather events (such as hurricanes and droughts), disruption of ecosystems, and threats to human health and food security.

Waste management is an essential aspect of environmental and resource efficiency. Improper waste disposal can lead to pollution of land, water bodies, and air. It also results in the inefficient use of resources as valuable materials are lost instead of being recycled or reused. Effective waste management involves reducing waste generation through sustainable production practices, promoting recycling and composting, and implementing proper disposal methods for hazardous waste.

1.4.1. Source and analyses legislative and planning requirements for water management in the building process

Water management in the building process involves the implementation of various legislative and planning requirements to ensure the sustainable use and conservation of water resources. These requirements are put in place to address issues such as water scarcity, pollution, and the efficient use of water in buildings. In this response, we will explore the legislative and planning requirements for water management in the building process.

Legislative Requirements:

1. **Building Codes and Regulations**: Building codes and regulations play a crucial role in ensuring that water management practices are incorporated into the design, construction, and operation of buildings. These codes often include provisions related to plumbing systems, rainwater harvesting, wastewater treatment, and water-efficient fixtures. They set minimum standards that builders must adhere to when it comes to water management.

2. **Water Conservation Laws**: Many jurisdictions have enacted laws specifically aimed at conserving water resources. These laws may include restrictions on outdoor water use, requirements for water-efficient landscaping, and regulations on the use of potable water for non-potable purposes. Water conservation laws encourage builders to adopt sustainable practices that reduce water consumption in buildings.

3**. Storm water Management Regulations**: Storm water runoff from buildings can contribute to water pollution and strain local drainage systems. To mitigate these issues, many regions have implemented storm water management regulations. These regulations typically require builders to implement measures such as rain gardens, permeable pavements, or detention ponds to manage storm water on-site and reduce its impact on surrounding ecosystems.

4. **Water Quality Regulations**: Water quality regulations aim to protect both human health and the environment by setting standards for the discharge of pollutants into water bodies. Builders must comply with these regulations by implementing appropriate wastewater treatment systems and ensuring that construction activities do not result in the contamination of nearby water sources.

5. **Environmental Impact Assessments** (EIAs): In some cases, large-scale building projects may be subject to environmental impact assessments. These assessments evaluate the potential environmental effects of a project, including its impact on water resources. EIAs help identify potential risks and guide the implementation of mitigation measures to minimize adverse effects on water quality and availability.

Planning Requirements:

1. **Water Sensitive Urban Design** (WSUD): WSUD is an approach to urban planning that aims to integrate water management into the design and development of cities. It involves strategies such as green infrastructure, decentralized storm water management, and water-sensitive landscaping. Incorporating WSUD principles into planning requirements helps create more sustainable and resilient urban environments.

2. **Water Efficiency Plans**: Some jurisdictions require builders to develop water efficiency plans as part of the building permit process. These plans outline strategies for reducing water consumption in buildings, including the use of water-efficient fixtures, rainwater harvesting systems, and greywater recycling. Water efficiency plans ensure that water management practices are considered from the early stages of the building process.

3. **Land Use Planning**: Land use planning plays a crucial role in managing water resources in urban areas. By designating appropriate areas for development, planners can minimize the impact on sensitive water bodies and promote sustainable water management practices. Land use planning may include provisions for protecting riparian zones, wetlands, and groundwater recharge areas.

Self-check-1

Part I

Instruction: Chose the correct answer from the given alternatives

1. Which one is the effective management of water system?

A, Conduct a water audit B. Use advanced technologies C, Develop alternative water sources D All

2. Water management strategies is

A. Use integrated process to assess:

B. Existing water resources,

C. Opportunities for reducing water demand,

D. Alternative water supplies. E all

3. Promoting Multiple Usage or reuse and recycling of water is ----------?

A. Using water efficient fixtures

B. Using native plants and trees

C. Using low water construction technologies D. All

Part II

Match column A with column B

A	B
1. Water Efficiency	A. Rainwater harvesting system
2. Water Quality Management	B, Water treatment technologies
3. Benefits of a Water Management System,	C. Cost Savings
4. Challenges a water management System	D, Behavioural Change
5. Environmental issues	E, pollution

Part III

Instruction: Give short answer for the following questions

1. How gathering Information about water management system
2. Identify negotiating for a Water Management System
3. Building design principles for water management
4. What is Water Quality Management?
5. List key Components of a Water Management System

Unit Two: Opportunities' for improved water management

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

- Identifying resident behavior on effective water management.
- Efficient water management fixtures and appliance.
- Quantifying and communicating relative installation and ongoing usage.

This guide 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:

- Identifying resident behaviour on effective water management.
- Apply efficient water management fixtures and appliance. (coppering materials, select
- Quantifying and communicating relative installation and ongoing usage.

2.1. Identifying resident behaviour on effective water management

Effective water management and use in a client and resident setting can be significantly influenced by their behavior. The way clients and residents interact with water resources, such as their consumption patterns, conservation practices, and overall awareness of water usage, can have a direct impact on the efficiency and sustainability of water management efforts. Understanding and addressing these behavioral factors is crucial for promoting responsible water use and achieving effective water management outcomes.

One of the key aspects of client and resident behavior that affects water management is their consumption patterns. The amount of water used by individuals in daily activities such as bathing, cooking, cleaning, and irrigation can vary greatly depending on their habits and practices.

Clients and residents who are mindful of their water consumption tend to use water more efficiently, reducing wastage and conserving resources. On the other hand, those who are unaware or indifferent to their water usage may engage in excessive consumption, leading to unnecessary strain on local water supplies.

Another important factor is the adoption of conservation practices by clients and residents. This includes actions such as fixing leaky faucets or pipes, using efficient appliances and fixtures, implementing rainwater harvesting systems, and practicing water-wise landscaping techniques.

Clients and residents who actively engage in these conservation practices contribute to effective water management by minimizing losses due to leaks, reducing overall demand for water, and maximizing the utilization of available resources.

Awareness and Education

One key aspect of resident behavior on effective water management is their level of awareness and education regarding water conservation. Residents who are knowledgeable about the importance of water conservation are more likely to engage in sustainable practices. This includes understanding the scarcity of freshwater resources, the impact of excessive water consumption on the environment, and the benefits of conserving water.

To assess resident awareness, surveys and questionnaires can be conducted to gauge their knowledge about water conservation practices. These surveys can cover topics such as understanding the water cycle, knowing how much water is used for different activities (e.g., showering, washing dishes), and recognizing the importance of fixing leaks promptly.

Conservation Practices

Another crucial aspect of resident behavior on effective water management is their actual conservation practices. Residents who actively engage in water-saving behaviors contribute significantly to overall water management efforts. Some common conservation practices include:

1. **Reducing Water Consumption**: Residents can reduce their daily water consumption by adopting simple habits such as taking shorter showers, turning off faucets while brushing teeth or washing dishes, and using efficient appliances like low-flow toilets and showerheads.

2. **Collecting Rainwater**: Rainwater harvesting systems can be installed to collect rainwater for non-potable uses such as watering plants or flushing toilets. This reduces reliance on treated freshwater sources for these purposes.

3. **Landscaping Choices**: Residents can choose drought-tolerant plants for their gardens and implement efficient irrigation systems like drip irrigation to minimize outdoor water usage.

4. **Fixing Leaks**: Promptly repairing leaks in faucets, toilets, and pipes is crucial to prevent water wastage. Regular maintenance and inspections can help identify and address leaks promptly.

Technology Adoption

The adoption of technology plays a significant role in effective water management. Various technological solutions can assist residents in monitoring and managing their water usage more efficiently. These technologies include:

1. **Smart Water Meters**: Smart meters provide real-time data on water consumption, allowing residents to track their usage and identify areas where conservation efforts can be improved. This data can also be used by utility companies to detect leaks or unusual patterns.

2. **Water-Efficient Appliances**: Residents can invest in water-efficient appliances such as washing machines, dishwashers, and faucets that are designed to use less water without compromising performance.

3. **Irrigation Controllers**: Smart irrigation controllers use weather data and soil moisture sensors to optimize watering schedules, ensuring that plants receive adequate water without over-irrigation.

4. **Greywater Systems**: Greywater systems collect and treat wastewater from sources like showers and laundry, making it suitable for non-potable uses such as toilet flushing or irrigation.

Community Engagement

Community engagement plays a vital role in promoting effective water management practices among residents. By fostering a sense of collective responsibility, communities can work together towards sustainable water usage. Some strategies for community engagement include:

1. **Education Programs**: Organizing workshops, seminars, or awareness campaigns on water conservation can help educate residents about the importance of responsible water management.

2. **Incentive Programs**: Implementing incentive programs such as rebates for installing water-efficient appliances or rainwater harvesting systems can encourage residents to adopt sustainable practices.

3. **Community Gardens**: Establishing community gardens that utilize efficient irrigation systems and promote drought-tolerant plants can serve as examples of sustainable landscaping practices.

4. **Collaboration with Local Authorities**: Collaborating with local authorities to develop and implement water management plans can ensure that community efforts align with broader conservation goals.

2.2. Efficient water management fixtures and appliance

Efficient water management fixtures and appliances refer to devices and systems that are designed to minimize water consumption and maximize water efficiency in various settings such as households, commercial buildings, and industries. These fixtures and appliances are specifically engineered to reduce water waste, conserve resources, and promote sustainable water usage practices.

Efficient water management fixtures include a wide range of products that are commonly used in residential and commercial settings. These fixtures are designed to optimize water usage by incorporating innovative technologies and features.

Some examples of efficient water management fixtures include:

1. **Low-flow toilets**: Low-flow toilets are designed to use significantly less water per flush compared to traditional toilets. They typically use around 1.6 gallons (6 litters) of water per flush, whereas older models can use up to 3.5 gallons (13 litters) or more. Low-flow toilets achieve water savings by utilizing improved flushing mechanisms, redesigned bowl shapes, and efficient trap way designs.

Figure 2-1. Low-flow toilet

2. **Water-efficient faucets**: Water-efficient faucets are equipped with aerators or flow restrictors that reduce the flow rate of water without compromising performance. These devices mix air with the water stream, maintaining a steady flow while reducing overall water consumption. Water-efficient faucets can save significant amounts of water in both residential and commercial applications.

Figure 2-2 Water-efficient faucets

3. **Water-saving showerheads**: Water-saving showerheads are designed to deliver a satisfying shower experience while using less water compared to conventional showerheads. They achieve this by incorporating technologies such as aerating nozzles, pulsating sprays, or adjustable flow rates. Water-saving showerheads can reduce water consumption by up to 50% without sacrificing comfort or performance.

Figure 2-3 Water-saving showerheads

Waterless urinals: Waterless urinals are a type of urinal that do not require water for flushing. They are designed to conserve water and reduce the environmental impact associated with traditional flush urinals. Instead of using water, these urinals utilize various technologies to collect and dispose of urine without the need for flushing.

Waterless urinals typically consist of a bowl or receptacle that is connected to a waste pipe. The bowl is designed to allow urine to flow through while preventing odours from escaping. There are several different types of waterless urinals available on the market, each employing different mechanisms for urine collection and odour control.

Figure 2-4 Waterless urinal

Some examples of efficient water management appliances include:

1. **High-efficiency washing machines**: High-efficiency washing machines are designed to use less water and energy compared to traditional top-loading washers. These machines incorporate features such as load sensing, which adjusts the water level based on the size of the load, and advanced agitation techniques that reduce the need for excessive water usage.

2. **Water-efficient dishwashers**: Water-efficient dishwashers are equipped with sensors and advanced spray technologies that optimize water usage during the cleaning process. These appliances can adjust water levels based on the load size and soil level, resulting in significant water savings compared to older models.

3. **Smart irrigation systems**: Smart irrigation systems utilize weather data, soil moisture sensors, and advanced scheduling algorithms to optimize outdoor watering practices. These systems automatically adjust watering schedules based on real-time conditions, ensuring that plants receive adequate moisture while minimizing water waste.

2.2.1. Application of efficient water management fixtures and appliances:

1. Building codes and regulations: Many jurisdictions have implemented building codes and regulations that require or incentivize the use of efficient water management fixtures and appliances. Architects, engineers, and builders should familiarize themselves with these codes to ensure compliance and take advantage of any available incentives.

2. **Design integration**: Efficient water management fixtures and appliances should be integrated into the building design from the early stages. This includes considering plumbing layouts, pipe sizing, and location of fixtures to optimize water distribution efficiency. Collaboration between architects, engineers, and plumbing professionals is essential to ensure seamless integration.

3. **Education and awareness**: Promoting education and awareness among building occupants is crucial for maximizing the benefits of efficient water management fixtures and appliances. Providing information on proper usage, maintenance, and potential water-saving practices can empower occupants to actively participate in water conservation efforts.

2.2.2. Water efficiency through building design

1. **Recognize environmentally preferable design** —for site/ storm water management

2. **Design buildings** - respecting existing natural flows / features of land,
3. **Strategically locate buildings**- to preserve key natural hydrological features.
4. **Preserving areas of site**- that serve as natural storm water retention ground water infiltration I recharge systems.
5. **Preserve existing mature vegetation**— absorbing/ disbursing up to 30% of a site's rainwater

Site planning-impact of buildings

Site planning refers to the process of designing and organizing the layout of buildings, infrastructure, and open spaces within a specific site or location. It involves considering various factors such as the natural environment, topography, accessibility, zoning regulations, and the intended use of the site. The impact of buildings on site planning is significant as they play a crucial role in shaping the overall design and functionality of a site.

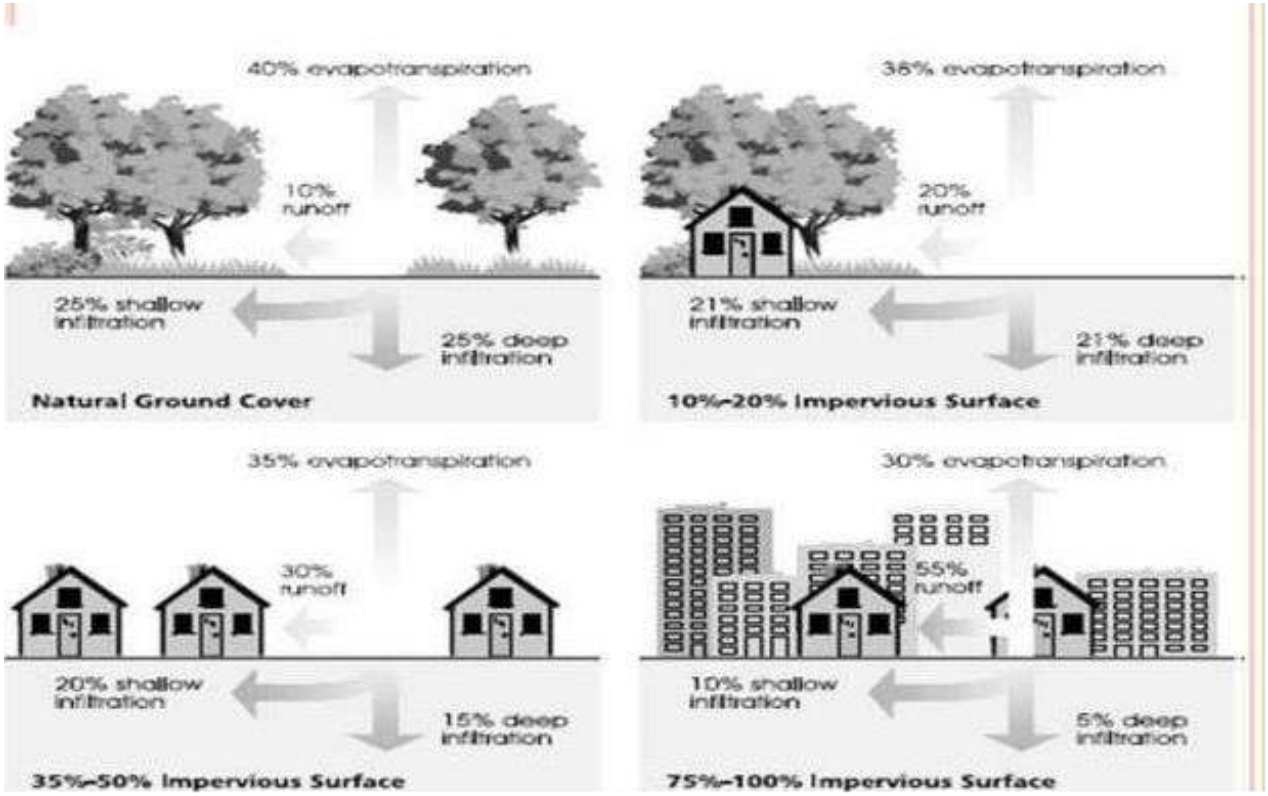


Figure 2-5 Site planning-impact of buildings

2.2.3. Installation and usage costs of efficient water management fixtures and appliances

Efficient water management fixtures and appliances can provide significant benefits in terms of water conservation and cost savings. However, it is important for clients to understand the relative installation and ongoing usage costs associated with these fixtures and appliances before making a decision.

When considering the installation costs, it is essential to take into account the specific fixture or appliance being considered, as well as the complexity of the installation process.

To communicate the relative installation and ongoing usage costs to clients, it is important to provide them with accurate information and cost estimates specific to their situation. This can be done through detailed product descriptions, brochures, or consultations with professionals who specialize in water management systems.

Establish a water budget for building and implement design that minimizes the use of potable water by

- using low-flow plumbing fixtures and toilets
- Using waterless urinals.
- Harvest, process and recycle rainwater,
- Site storm water,
- Building grey water and identify appropriate uses within the building and site.
- Use on-site treatment systems that enables — use of rain water for hand washing,
- grey-water for toilet flushing
- Rain and storm water for site irrigation, cooling tower make-up etc

WATER MANAGEMENT

- Optimizing water usage:
- Water efficient fixtures

WATER EFFICIENCY IN %

Figigur2-6 water efficiency

2.3. Quantifying and communicating relative installation and ongoing usage

Quantifying and communicating relative installation and ongoing usage can be a complex task that requires careful consideration of various factors. In order to accurately measure and communicate the installation and ongoing usage of a particular product, service, or system, several key metrics and methods can be utilized**.**

1. **Installation Metrics:**

When quantifying the installation of a product or system, it is important to consider the following metrics:

a. **Number of Installations:** This metric simply refers to the total count of installations performed. It provides a basic measure of the overall adoption or deployment of the product or system.

b. **Installation Time:** This metric measures the time taken to complete the installation process. It can help assess the efficiency and effectiveness of the installation process, as well as identify any potential bottlenecks or areas for improvement.

c. **Installation Success Rate:** This metric indicates the percentage of successful installations out of all attempted installations. It helps evaluate the reliability and compatibility of the product or system with different environments or configurations.

d. **Installation Cost:** This metric quantifies the financial resources required for installation, including labour costs, equipment costs, and any additional expenses incurred during the process. It provides insights into the economic feasibility and affordability of the product or system.

b. Ongoing Usage Metrics:

a. Once a product or system is installed, ongoing usage metrics can provide valuable insights into its performance and effectiveness. Some key metrics for quantifying ongoing usage include:

b. **Usage Frequency:** This metric measures how often the product or system is being used over a specific period of time. It helps gauge its level of adoption and integration into daily operations.

c. **Usage Duration:** This metric quantifies the length of time for which the product or system is actively used during each session. It can indicate user engagement levels and identify any patterns or trends in usage behaviour.

d. **User Satisfaction:** Measuring user satisfaction through surveys, feedback forms, or other means can provide valuable insights into how well the product or system meets user expectations and requirements. It helps identify areas for improvement and potential enhancements.

e. **Error Rates:** Tracking the frequency and severity of errors or malfunctions encountered during usage can help assess the reliability and stability of the product or system. Lower error rates indicate a higher level of performance and user satisfaction.

f. **System Performance:** Monitoring various performance indicators such as response time, throughput, and resource utilization can provide a comprehensive view of the product or system's efficiency and effectiveness in delivering its intended functionality.

Communication Methods:

Effectively communicating the installation and ongoing usage metrics is crucial for stakeholders to understand the value and impact of a product or system. Some common methods of communication include:

Reports: Generating regular reports that summarize the installation and ongoing usage metrics can provide a comprehensive overview of the product or system's performance. These reports can be shared with relevant stakeholders, such as management, customers, or investors.

Dashboards: Interactive dashboards can be created to visualize and present the installation and ongoing usage metrics in real-time. This allows stakeholders to monitor key performance indicators and track progress over time.

Presentations: Creating presentations that highlight the installation process, ongoing usage metrics, and their implications can be an effective way to communicate with different audiences. Visual aids such as charts, graphs, and diagrams can enhance understanding and engagement.

Case Studies: Developing case studies that showcase successful installations and demonstrate the positive impact of ongoing usage can be a persuasive way to communicate the value proposition of a product or system.

2.3.1. Efficient water management and communicated to the client

Clear and direct communication is essential in various aspects of life, including personal relationships, professional settings, and everyday interactions. It plays a crucial role in enabling effective understanding, collaboration, and problem-solving. To facilitate clear and direct communication, several strategies can be employed, such as questioning to identify and confirm requirements, sharing information, actively listening, and seeking understanding.

Questioning is a powerful tool that helps to gather information, clarify doubts, and ensures that both parties are on the same page. By asking relevant questions, individuals can gain a deeper understanding of the topic at hand and uncover any hidden or unspoken requirements. Open-ended questions encourage detailed responses and allow for a more comprehensive exploration of ideas. On the other hand, closed-ended questions are useful for seeking specific information or confirming details.

In addition to questioning, sharing information is vital for clear and direct communication. It involves providing relevant facts, data, or explanations to convey ideas or concepts effectively. Sharing information ensures that all parties involved have access to the same knowledge base, reducing misunderstandings and promoting alignment. This can be done through various means such as verbal communication, written documents, presentations, or visual aids.

Active listening is another crucial aspect of clear and direct communication. It involves fully focusing on the speaker or sender of the message and paying attention to both verbal and non-verbal cues. Active listening requires concentration, empathy, and an open mind. By actively listening, individuals can better understand the speaker's perspective, identify underlying emotions or concerns, and respond appropriately.

Overall, clear and direct communication is facilitated by employing strategies such as questioning to identify and confirm requirements, sharing information, actively listening, and seeking understanding. By utilizing these techniques, individuals can enhance their communication skills and foster effective and meaningful interactions

Self-check-2

Part I

Instruction: Chose the correct answer from the given alternatives

1. What are the advantages of technology adoption

   A. Using Smart Water Meters

   B. Irrigation Controller

   C. Greywater Systems

   D. D. All E. None of the above

2. One of the efficient of water management fixtures system are----?

   A. Use Low-flow toilets

   B. Use Water-saving showerheads

   C. Use Water-efficient faucets D. All

3. One of the effectively communicating the installation and ongoing usage metrics is—

   A. Reports

   B. Presentations

   C. Case Studies D. All

Part II

Instruction: **Give short answer for the following questions**

1. Identifying resident behaviour on effective water management.
2. List typed of Conservation Practices
3. Identify Community Engagement for effective water management

Unit three: Best practice in water management

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

- Roof water harvesting
- Reusing grey water
- Evaluate cost and performance of water management system.

This guide 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:

- Use roof water harvesting
- Reuse grey water
- Evaluate cost and performance of water management system

3.1. Roof water harvesting

Rainwater harvesting is a technology used for collecting and storing rain water from rooftops, the land surface or rock catchments using simple techniques such as jars and pots as well as more complex techniques such as under ground check dams.

Uses of Rain water

- Gardening
- Drinking
- Irrigation
- Livestock
- Groundwater Recharge
- How Rain Water can be harvested

Broadly there are two ways of harvesting rain water

1. Surface run off Harvesting

2. Rooftop Harvesting

Surface runoff harvesting:-

In urban areas run water flows away as surface runoff. This runoff could be caught and used for recharging aquifers.

Roof top rainwater harvesting:-

- It is a system of catching rainwater where it falls.
- In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house / building
- Less expensive and very effective

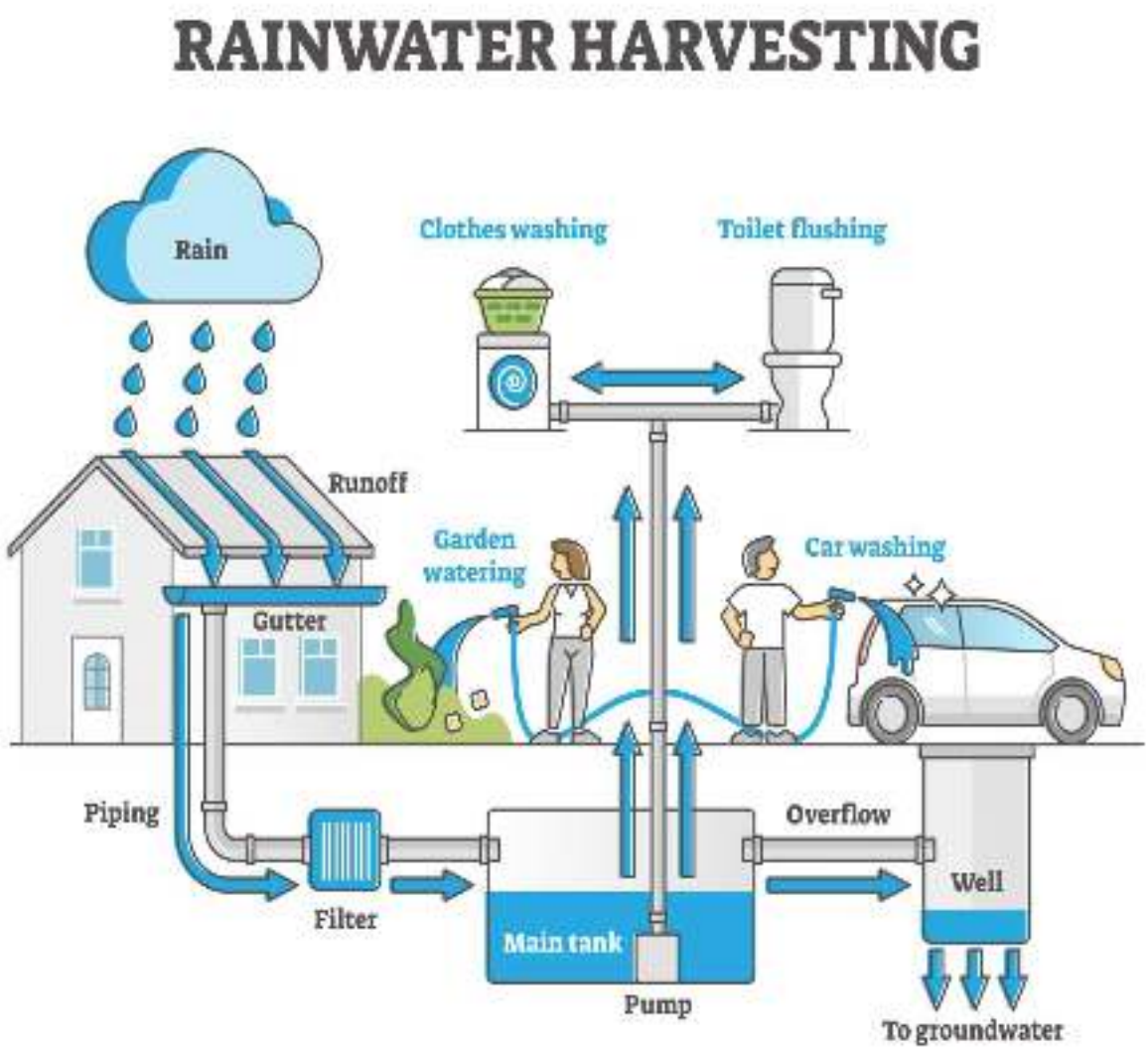


Figure 3-1 Roof top rainwater harvesting:-

3.1.1. Selection, location and installation of tanks to optimize the reuse of roof water

The selection, location, and installation of tanks to optimize the reuse of roof water involve several considerations to ensure efficient and effective utilization of this valuable resource. This process involves evaluating various factors such as tank capacity, material, design, location, and installation techniques. By carefully considering these aspects, individuals and organizations can maximize the benefits of rainwater harvesting systems.

Tank Selection:

When selecting a tank for roof water reuse, several factors need to be taken into account. The first consideration is the tank capacity, which should be determined based on the anticipated water demand and the available roof area for collection. It is essential to choose a tank size that can accommodate the expected volume of harvested water without overflow or excessive emptying.

Another crucial factor in tank selection is the material used in its construction. Common materials for rainwater tanks include polyethylene (plastic), fiberglass, concrete, and steel. Each material has its advantages and disadvantages in terms of durability, cost, maintenance requirements, and potential impacts on water quality. For example, plastic tanks are lightweight, easy to install, and resistant to corrosion

Tank Location:

The location of the tank plays a significant role in optimizing roof water reuse. Ideally, the tank should be situated close to the collection area to minimize piping lengths and reduce pressure losses. Placing the tank at a higher elevation than the points of use can also provide gravitational flow without requiring additional pumping.

However, it is essential to consider other factors when determining the tank's location. Local building codes and regulations may impose restrictions on tank placement, such as setback requirements from property lines or proximity to wells or septic systems. Additionally, the tank should be positioned in an area that is easily accessible for maintenance and cleaning purposes.

Tank Installation:

Proper installation of the tank is crucial to ensure its functionality and longevity. The installation process involves several steps, including preparing the foundation, connecting the tank to the downspouts, and integrating the necessary plumbing components.

The tank's foundation should be stable and level to prevent shifting or settling over time. This may involve excavating a suitable area, compacting the soil, and providing a base layer of gravel or concrete. The tank should then be securely placed on the foundation, ensuring it is level and properly supported.

Connecting the tank to the downspouts requires diverting the flow of rainwater from the roof into the tank. This can be achieved using various methods such as gutter extensions, rain chains, or downspout diverters. It is important to ensure that these connections are watertight and properly sealed to prevent leaks or water loss.

Integrating plumbing components such as inlet filters, overflow outlets, and outlet pipes is also essential. Inlet filters help remove debris and contaminants from the collected water before it enters the tank. Overflow outlets allow excess water to be safely discharged when the tank reaches its capacity. Outlet pipes connect the tank to points of use or additional treatment systems if necessary.

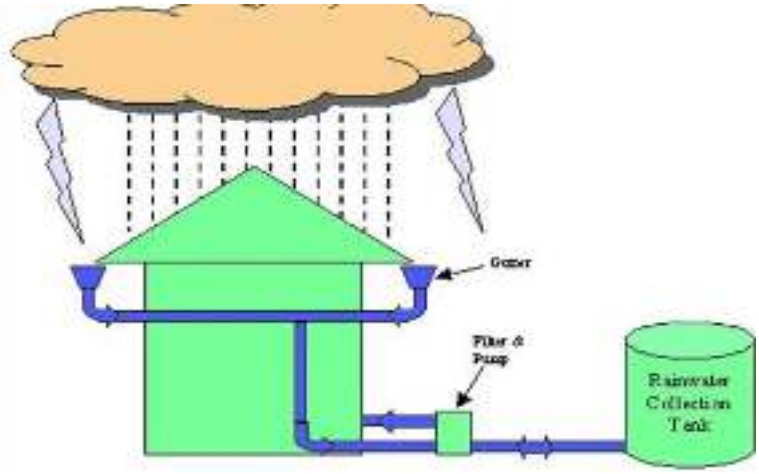


Figure 3-2 Tank Installation

Components of roof top rain water harvesting system

Figure 3-3 Roof top rainwater harvesting

Rain water harvesting can be used to recharge ground water aquifer

Commonly used recharging methods are:-

i. Recharging of bore wells

ii. Recharging of dug wells

iii. Recharge pits

iv. Recharge trenches

v. Percolation tanks of bore wells

Recharging of bore wells

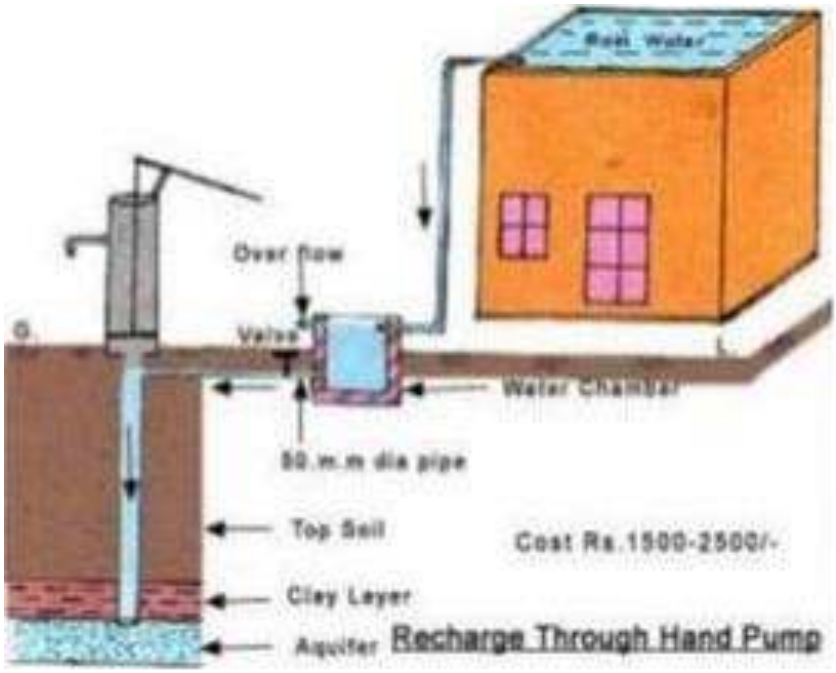


Figure 3- 4 recharging of bore wells

Recharge pits

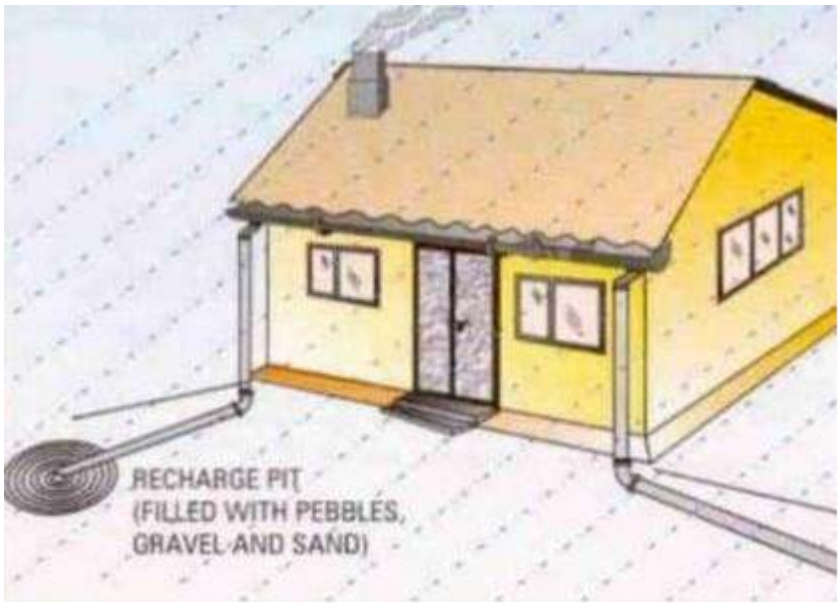


Figure 3-5 Recharge pits

3.1.2. Advantages of Rain Water Harvesting

- Easy to install and operate
- Construction materials are readily available
- No need of skilled labour for operation Cost effective
- Water collected from roof tops can be used for domestic purposes.

Water Management is important since it helps determine future Irrigation expectations.

Water management is the management of water resources under set policies and regulations.

Water, once an abundant natural resource, is becoming a more valuable commodity due to droughts and overuse

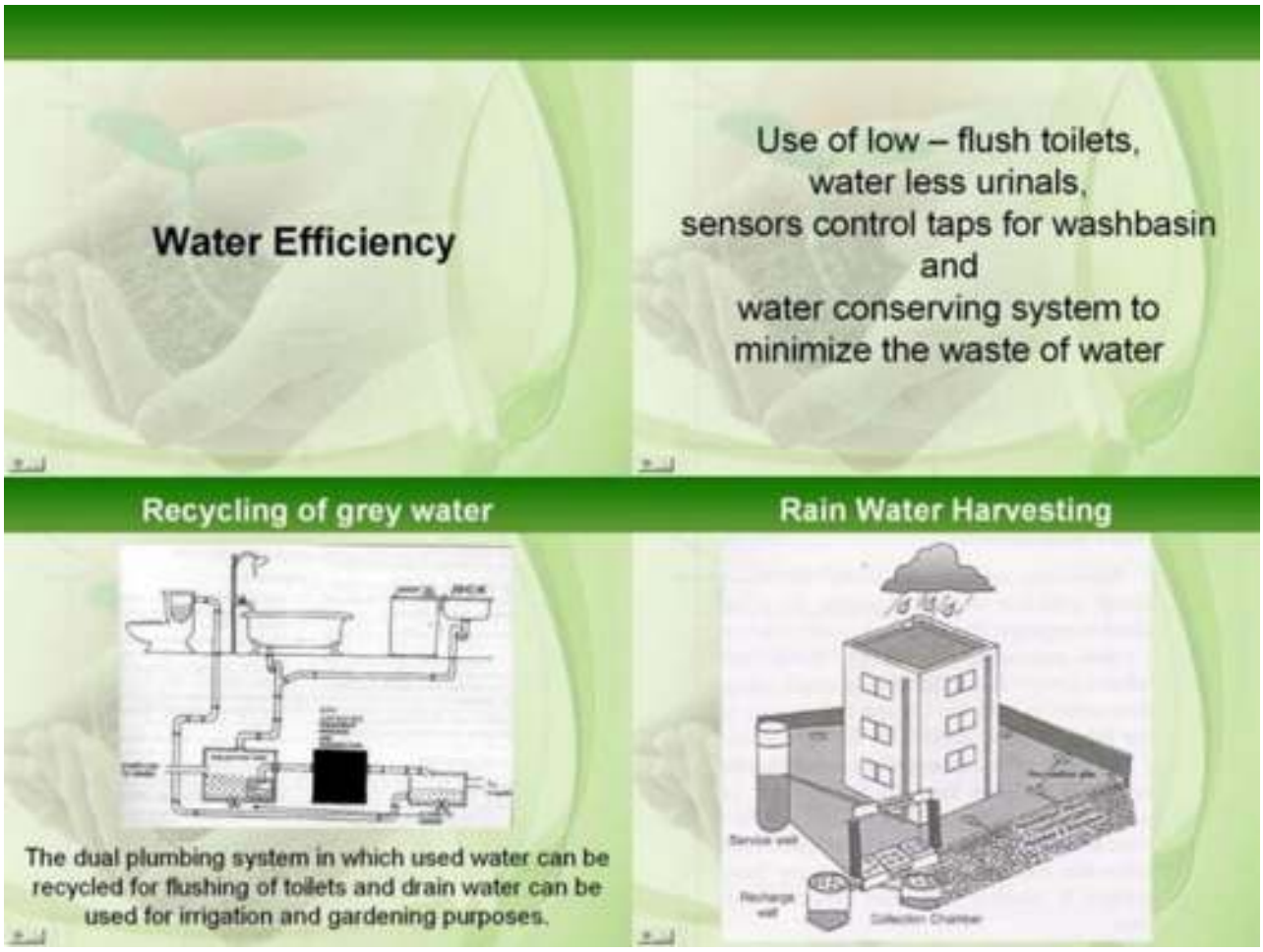


Figure 3-7 water efficiency

Greywater is gently used water from your bathroom sinks, showers, tubs, and washing machines. It is not water that has come into contact with faces, either from the toilet or from washing diapers.

Greywater may contain traces of dirt, food, grease, hair, and certain household cleaning products. While greywater may look "dirty," it is a safe and even beneficial source of irrigation water in a yard. Keep in mind that if greywater is released into rivers, lakes, or estuaries, its nutrients become pollutants, but to plants, they are valuable fertilizer. Aside from the obvious benefits of saving water (and money on your water bill), reusing your greywater keeps it out of the sewer or septic system, thereby reducing the chance that it will pollute local water bodies. Reusing greywater for irrigation reconnects urban residents and our backyard gardens to the natural water cycle.

The easiest way to use greywater is to pipe it directly outside and use it to water ornamental plants or fruit trees. Greywater can also be used to irrigate vegetable plants as long as it doesn't touch edible parts of the plants. In any greywater system, it is essential to use "plant friendly" products, those without lots of salt, boron, or chlorine bleach. The build-up of salts and boron in the soil can damage plants. While you're at it, watch out for your own health: "natural" body products often contain substances toxic to humans (see resource pages below for details). **Figure 5**

Figure 3-7 Recycle water inside and outside

3.2.1. Basic Greywater Guidelines

Greywater is different from fresh water and requires different guidelines for it to be reused.

1. **Don't store greywater** (more than 24 hours). If you store greywater the nutrients in it will start to break down, creating bad odours.
2. **Minimize contact with greywater.** Greywater could potentially contain a pathogen if an infected person's faces got into the water, so your system should be designed for the

3. **Keep your system as simple as possible, avoid pumps, and avoid filters that need upkeep**. Simple systems last longer, require less maintenance, require less energy and cost less money.

Types of Simple Systems

From the Washing Machine

Washing machines are typically the easiest source of greywater to reuse because greywater can be diverted without cutting into existing plumbing. Each machine has an internal pump that automatically pumps out the water- you can use that to your advantage to pump the greywater directly to your plants.

This is the cheapest and easiest system to install, but requires constant moving of the hose for it to be effective at irrigating

Laundry Drum:

Figure 3-8. Laundry drum.

Laundry-to-Landscape: for a system that gives you flexibility in what plants you're able irrigate and takes very little maintenance, we recommend the laundry-to-landscape system.

This system is low cost, easy to install, and gives flexibility for irrigation. In most situations this is the number one place to start when choosing a greywater system!

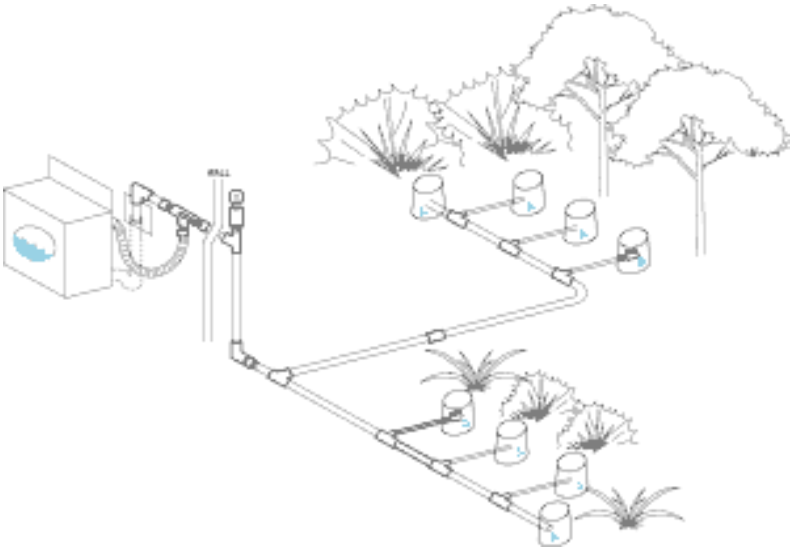


Figure 3-9 landscape system

From the Shower: Showers are great sources of greywater- they usually produce a lot of relatively clean water. To have a simple, effective shower system considers a gravity-based system (no pump).

Branched Drain: The branched drain system was also invented by Art Ludwig. Greywater in this system flows through standard (1 1/2″ size) drainage pipe, by gravity, always sloping downward at 2% slope, or 1/4 inch drop for every foot travelled horizontally, and the water is divided up into smaller and smaller quantities using a plumbing fitting that splits the flow.

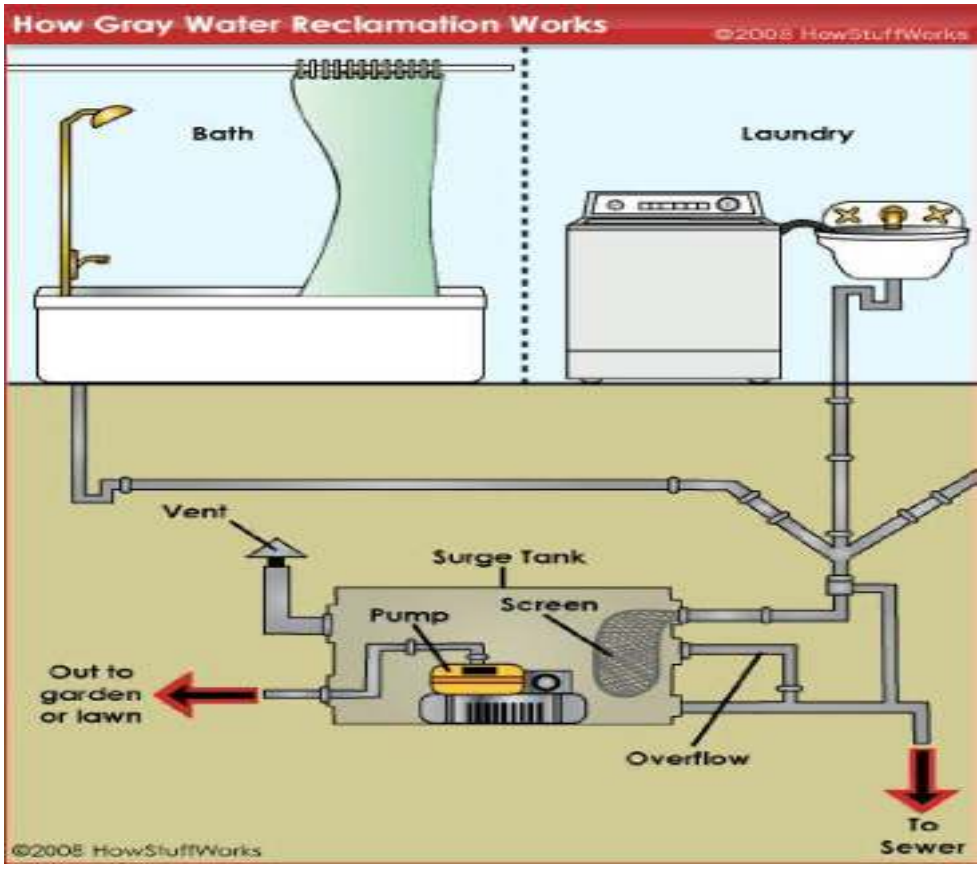


Figure 3-10 Branched Drain

Constructed Wetlands: Constructed wetlands are used to "ecologically dispose" of greywater. If you produce more greywater than you need for irrigation, a constructed wetland can help use up some extra greywater. Wetlands absorb nutrients and filter particles from greywater, enabling it to be stored for longer or sent through a properly designed drip irrigation system (though more filtration and pumping is also required). Greywater is also a good source of irrigation for beautiful, water loving wetland plants..

Figure 3-11 Constructed Wetlands

Pumped Systems: using a gravity to transport the greywater (your yard is sloped uphill, or it's flat and the plants are far away) you will need to pump greywater uphill. In a basic pumped system greywater flows into a large (usually 50 gallon) plastic barrel that is either buried or located at ground level. Inside the barrel an effluent pump pushes the water out through irrigation lines (no emitters) to the landscape. Pumps add cost, use electricity, and will break, so avoid this if you can.

Figure 3-12 Pumped Systems

Indoor Greywater Use: In most residential situations it is much simpler and more economical to utilize greywater outside, and not create a system that treats the water for indoor use. The exceptions are in houses that have high water use and minimal outdoor irrigation, and for larger buildings like apartments. There are also very simple ways to reuse greywater inside that are not a "greywater system". Buckets can catch greywater and clear water, the water wasted while warming up a shower. These buckets can be used to "bucket flush" a toilet, or carried outside. There are also simple designs like Sink Positive, and more complicated systems like the Brace system. Earth ships have an interesting system that reuse greywater inside with greenhouse wetlands

Figure 3-13 Sink Positive toilet lid

3.2.2. Grey water treatment plant

A grey water treatment plant is a facility designed to treat and recycle grey water, which refers to the wastewater generated from domestic activities such as bathing, laundry, and dishwashing. Unlike black water (sewage), grey water does not contain focal matter and is relatively less contaminated. By treating and reusing grey water, these plants aim to conserve freshwater resources and reduce the strain on sewage treatment systems.

Grey water treatment plants employ various processes to remove impurities from the wastewater before it can be reused for non-potable purposes such as irrigation, toilet flushing,

and industrial processes. The treatment process typically involves several stages, including filtration, disinfection, and sometimes additional advanced treatment methods.

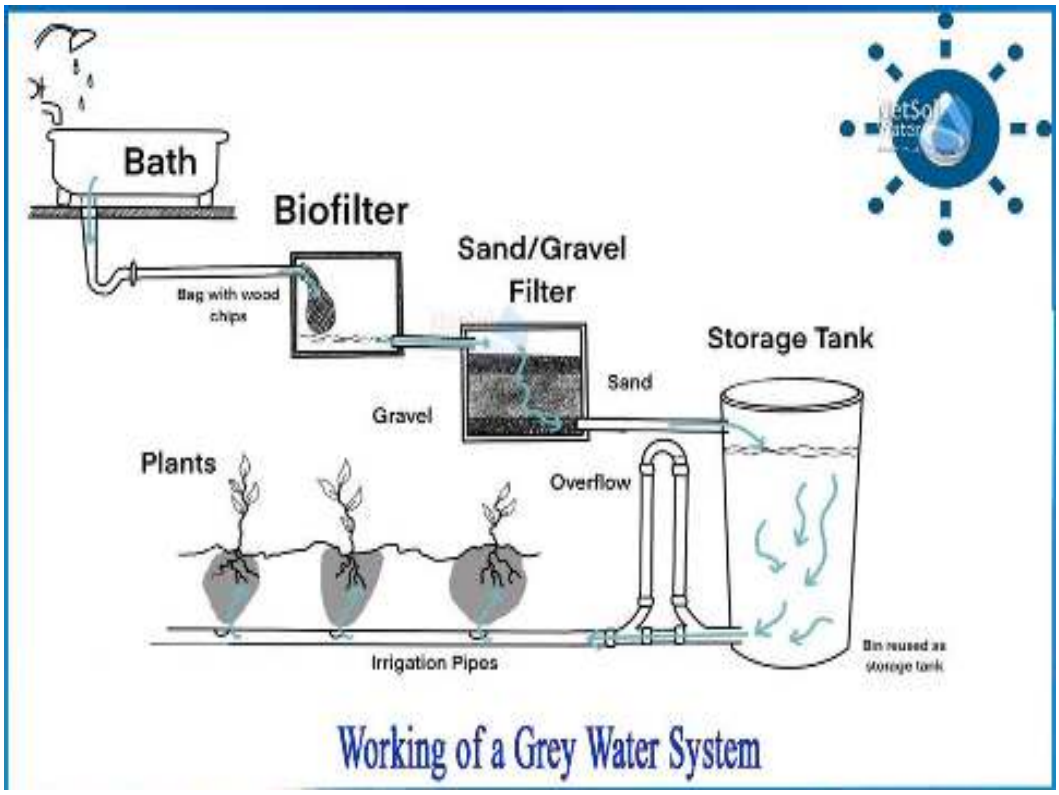


Figure 3-14 Grey water treatment plant

3.3. Evaluate cost and performance of water management system.

Evaluating the cost and performance of a water management system involves analysing the financial investment required to implement the system and measuring the effectiveness of the system in reducing water consumption and improving water quality.

A water management system refers to the set of practices, technologies, and infrastructure used to efficiently and effectively manage water resources. It encompasses various aspects such as water supply, distribution, treatment, and wastewater management. Evaluating the cost and performance of a water management system is crucial in determining its overall effectiveness and sustainability. In this comprehensive response, we will delve into the factors that influence the cost and performance of such systems.

3.3.1. Cost Evaluation:

The cost evaluation of a water management system involves assessing both the initial investment required for implementation and the ongoing operational expenses. Several key factors contribute to the overall cost:

1. **Infrastructure Development**: The construction or upgrade of infrastructure, including dams, reservoirs, pipelines, treatment plants, and distribution networks, can be a significant expense. The size and complexity of the system, as well as the geographical location and terrain, can impact costs.
2. **Technology and Equipment**: The selection of appropriate technologies and equipment for water treatment, distribution, and monitoring also affects costs. Advanced technologies may offer higher performance but at a higher price point.
3. **Maintenance and Operation**: Regular maintenance activities such as repairs, inspections, and cleaning are necessary to ensure the proper functioning of the system. Operational costs include energy consumption for pumping stations, chemical usage for treatment processes, labour costs for monitoring and maintenance personnel, and administrative expenses.
4. **Water Source**: The availability and quality of the water source influence costs. Accessing alternative sources or implementing additional treatment processes to meet quality standards can increase expenses.
5. **Regulatory Compliance**: Compliance with environmental regulations and standards may require additional investments in monitoring equipment, data collection systems, and reporting mechanisms.
6. **Climate Factors**: Climate conditions can impact costs due to factors such as extreme weather events (floods or droughts), which may necessitate additional infrastructure or emergency response measures.
7. **Scale and Population Density**: The scale of the water management system and population density served affect costs. Larger systems serving densely populated areas may require more extensive infrastructure and resources.

8. **Timeframe**: The timeframe for implementing the water management system can also impact costs. Rapid deployment or urgent upgrades may incur higher expenses compared to phased or long-term development plans.

3.3.2. Performance Evaluation:

The performance evaluation of a water management system involves assessing its effectiveness, efficiency, reliability, and environmental impact. Several key factors contribute to the overall performance:

1. **Water Supply Reliability**: The system's ability to consistently provide an adequate and reliable water supply is crucial. Factors such as source availability, storage capacity, distribution network resilience, and emergency response mechanisms influence performance.

2. **Water Quality**: Ensuring the provision of safe and potable water is essential for public health. Treatment processes, monitoring systems, and adherence to quality standards determine the system's performance in maintaining water quality.

3. **Efficiency and Conservation**: The efficient use of water resources is vital for sustainable management. Evaluating factors such as water loss during distribution, energy consumption, and the implementation of conservation measures helps assess performance.

4. **Response to Demand Variability**: The system's ability to adapt to varying water demand patterns is important. Performance can be evaluated based on the system's capacity to meet peak demand periods without compromising supply or quality.

5. **Environmental Impact**: Assessing the environmental impact of a water management system involves considering factors such as energy consumption, greenhouse gas emissions, habitat disruption, and potential pollution from treatment processes or infrastructure construction.

6. **Resilience and Adaptability**: Evaluating the system's resilience to climate change impacts, natural disasters, or other disruptions helps determine its long-term performance.

7. **Monitoring and Data Management**: Effective monitoring systems that provide real-time data on water quality, flow rates, pressure levels, and infrastructure conditions are essential for proactive management and timely response to issues.

8. **Stakeholder Engagement**: Involving stakeholders such as local communities, government agencies, and water users in the decision-making process and incorporating their feedback can enhance the system's performance and acceptance.

When it comes to the installation of water management systems, there are various materials that can be used, each with its own costs and performance characteristics. These materials are identified and negotiated with the client based on factors such as durability, cost-effectiveness, environmental impact, and specific project requirements.

One commonly used material in water management systems is PVC (polyvinyl chloride). PVC pipes are known for their affordability and ease of installation. They are lightweight, corrosion-resistant, and have a long lifespan. PVC pipes also have good flow characteristics, allowing for efficient water transportation.

Another material often used is HDPE (high-density polyethylene). HDPE pipes are known for their strength and durability. HDPE pipes are also lightweight and flexible, making them easy to handle and install.

Ductile iron is another material commonly used in water management systems, particularly for larger diameter pipes. Ductile iron pipes have high tensile strength and can withstand high pressure and heavy loads. They are also highly resistant to corrosion and have a long lifespan. Ductile iron pipes are known for their reliability and durability in demanding environments. However, they tend to be more expensive than PVC or HDPE pipes.

Concrete is another material used in the construction of water management systems, particularly for structures such as reservoirs or storm water detention basins. Concrete offers excellent durability and strength.

3.3.3. Benefits of Evaluating Water Management Systems

Evaluating water management systems can provide numerous benefits, including:

1. **Improved system performance**: Regular evaluation can help identify areas for improvement, leading to better system performance and more effective service delivery.

2. **Increased efficiency**: Evaluation can help identify opportunities to reduce costs and improve resource allocation, leading to more efficient use of resources.

3**. Better decision-making**: Evaluation can provide the data and insights needed to make informed decisions about investments and upgrades, ensuring that resources are allocated effectively.

4. **Compliance with regulations**: Evaluation can help ensure that water management systems are in compliance with relevant regulations and standards, reducing the risk of fines and other penalties.

5. **Improved public health and safety**: Effective evaluation can help ensure that water management systems are providing safe and healthy water to the community, reducing the risk of waterborne illnesses and other health risks.

3.3.4. Approaches to Evaluating Water Management Systems

There are several approaches to evaluating water management systems, including:

1. **Life cycle cost analysis**: This approach evaluates the total cost of owning and operating a water management system over its entire life cycle, including design, construction, operation, and maintenance.

2. **Benefit-cost analysis**: This approach evaluates the benefits of a water management system against its costs, including both direct and indirect benefits.

3. **Performance metrics**: This approach uses specific metrics to evaluate the performance of a water management system, such as water quality, flow rates, and system reliability.

4. **Risk assessment**: This approach evaluates the risks associated with a water management system, such as the risk of failure, the risk of non-compliance with regulations, and the risk of waterborne illnesses.

3.3.5. Key Performance Indicators (KPIs) for Water Management Systems

The following KPIs are commonly used to evaluate the performance of water management systems:

1. **Water quality**: This KPI evaluates the quality of the water being supplied to the community, including parameters such as pH, turbidity, and bacterial contamination.

2. **Flow rates:** This KPI evaluates the volume of water being supplied to the community, including both peak flow rates and average flow rates.

3. **System reliability**: This KPI evaluates the reliability of the water management system, including the frequency and duration of outages and the time required to repair or replace components.

4. **Energy consumption**: This KPI evaluates the energy usage of the water management system, including both electrical and thermal energy.

5. **Maintenance costs**: This KPI evaluates the costs associated with maintaining the water management system, including both labour and materials.

6. **Capital costs**: This KPI evaluates the costs associated with designing, constructing, and upgrading the water management system.

Figure 3-15 cost effective

Self-check-3

Part I

Chose the correct answer

1_____is a technology used for collecting and storing rain water from rooftops

A. Groundwater

B. Rain water harvesting

C. Storm water

D. D. All

2. The advantages of Rain Water Harvesting system is.

A. Easy to install and operate

B. Construction materials are readily available

C. No need of skilled labour for operation Cost effective

D. Water collected from roof tops can be used for domestic purposes.

E. All

Part II

Give short answer

1. Identify proper installation of water tank for harvesting system
2. List the components of roof top rain water harvesting system
3. List a key performance Indicators (KPIs) for water management Systems

Operation sheet 3

Operation Title: - practice harvesting work

Purpose: - To understand how prepare harvesting system in home

Instruction:-prepare harvesting project

Requirements of Hand tools and Materials

- Hacksaw
- Tape
- Different size of P.v.c pipe and its fitting

Procedure

- Read & interpret the drawing (storm water layout)
- Measure and cut the length of pipe properly
- Install the line project according to drawing
- Install drain line and tank

Quality Criteria: Assured performing of all the activities according to the procedures.

Precautions:

- Wearing proper clothes, eye glass, glove, safety shoes
- Make working area hazard free.
- Read and interpret manual which guide you how to use tools and equipment.
- Using hand tools for certain work for certain function

Practical Project design

Lap test

Instructions: - Given necessary tools and materials you are required to perform the following tasks accordingly.

Task 1: Perform Assemble the project according to drawing

Task 2: Perform to given properly collect roof water

Task 3: Perform the project test

Task 4: Perform the project quality

Reference book

1. United Nations Water: www.unwater.org

2. World Bank Group: www.worldbank.org/water

3. International Water Association: www.iwa-network.org

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