Plumbing Installation Level-II

Based on March 2022, Curriculum Version 1

Module Title: - Install, Service and Maintain Drainage Systems and Components

Module code: EIS PLI2 M04 0322

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Table of Content

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

TQM-Total Quality Management

QA-Quality assurance

NPDES- National Pollutant Discharge Elimination System

SDS- State Disposal System

PCA-Pollution Control Agency

EAW-Environmental Assessment Worksheet

SWPPP-Prepare Storm water Pollution Prevention Plan

RCP-Reinforced Concrete Pipe

VCP-Vitrified clay pipe

FLEX- Future Leaders Exchange

ASTM-Standard Test Methods

EPA-Environmental Protection Agency

FDA-Food and Drug Administration

ATU-Aerobic Treatment Unit

DWV-Drain, Waste and Vent

ESP- Extrasensory perception

ASSY-Assembly (Abbreviation or acronym, shorthand or slang term: ASSY)

Introduction to the Module

The install, service and maintain drainage systems and components helps to know the plan and prepare for drainage system installation, determine installation requirements, install storm water and sub-soil drainage, install pre-fabricated inspection openings and enclosures, install domestic treatment plant, install sanitary drainage systems, install on-site disposal system, perform service and maintenance, locate and clear blockage in plumbing installation work filed.

This module is designed to meet the industry requirement under the plumbing installation work occupational standard, particularly for the unit of competency: Install service and maintain drainage systems and components

This module covers the units :

- Plan and prepare for drainage system installation.
- Determine installation requirements.
- Install storm water and sub-soil drainage.
- Install pre-fabricated inspection openings and enclosures.
- Install domestic treatment plant.
- Install sanitary drainage systems.
- Install on-site disposal system.
- Perform service and maintenance.
- Locate and clear blockage.

Learning Objective of the Module

- Plan and prepare for drainage system installation.
- Determine installation requirements.
- Install storm water and sub-soil drainage.
- Install pre-fabricated inspection openings and enclosures.
- Install domestic treatment plant.
- Install sanitary drainage systems.
- Install on-site disposal system.
- Perform service and maintenance.
- Locate and clear blockage.

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: Plan and prepare for drainage system installation.

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

- Plans and specifications.
- OHS requirements
- Quality assurance.
- Plan and sequence tasks.
- Tools and equipment.
- Work area for efficient installation of the storm water and sub-soil drainage system.

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

- Obtain Plans/Specifications
- Associate OHS requirements with installing storm water and sub-soil drainage systems, and adhere workplace environment throughout the work
- Identify and adhere quality assurance requirements in accordance with workplace requirements
- Plan and sequence tasks in conjunction with others by the work
- Select and check tools and equipment including personal safety equipment for serviceability
- Prepare work area to support the efficient installation of the storm water and sub-soil drainage system

1.1 Plans and specifications

Drainage Plans definition

Drainage Plans means one or more engineering design drawings included in the Construction drawings, which detail the design parameters and solutions for all aspects associated with the management of storm water in and around the Development Area. Supporting these drainage plans are Storm water Management Reports, Staged Master Drainage Plans and Pond Reports.

The following requirements apply to projects that require a drainage permit:

(1) Any work which increases the impervious surface on the property by 500 square feet or more;

(2) Any work in a watercourse;

(3) Installation, expansion, or alteration of a storm water drainage system; or (4) excavating or grading projects subject to a grading permit.

Storm Drainage Plans showing plans and specifications that describe the measures proposed to manage storm water runoff.

Related to Drainage Plans

Drainage work means any watercourse and includes any land which is expected to provide flood storage capacity for any watercourse and any bank, wall, embankment or other structure, or any appliance, constructed or used for land drainage or flood defense;

Drainage means the movement of water to a place of disposal, whether by way of the natural characteristics of the ground surface or by artificial means.

Storm water management plan means the set of drawings and other documents that comprise all the information and specifications for the programs, drainage systems, structures, concepts and techniques intended to maintain or restore quality and quantity of storm water runoff to pre-development levels.

Storm water runoff means water flow on the surface of the ground or in storm sewers, resulting from precipitation.

Drainage area means a geographic area within which storm water, sediments, or dissolved materials drain to a particular receiving water body or to a particular point along a receiving water body.

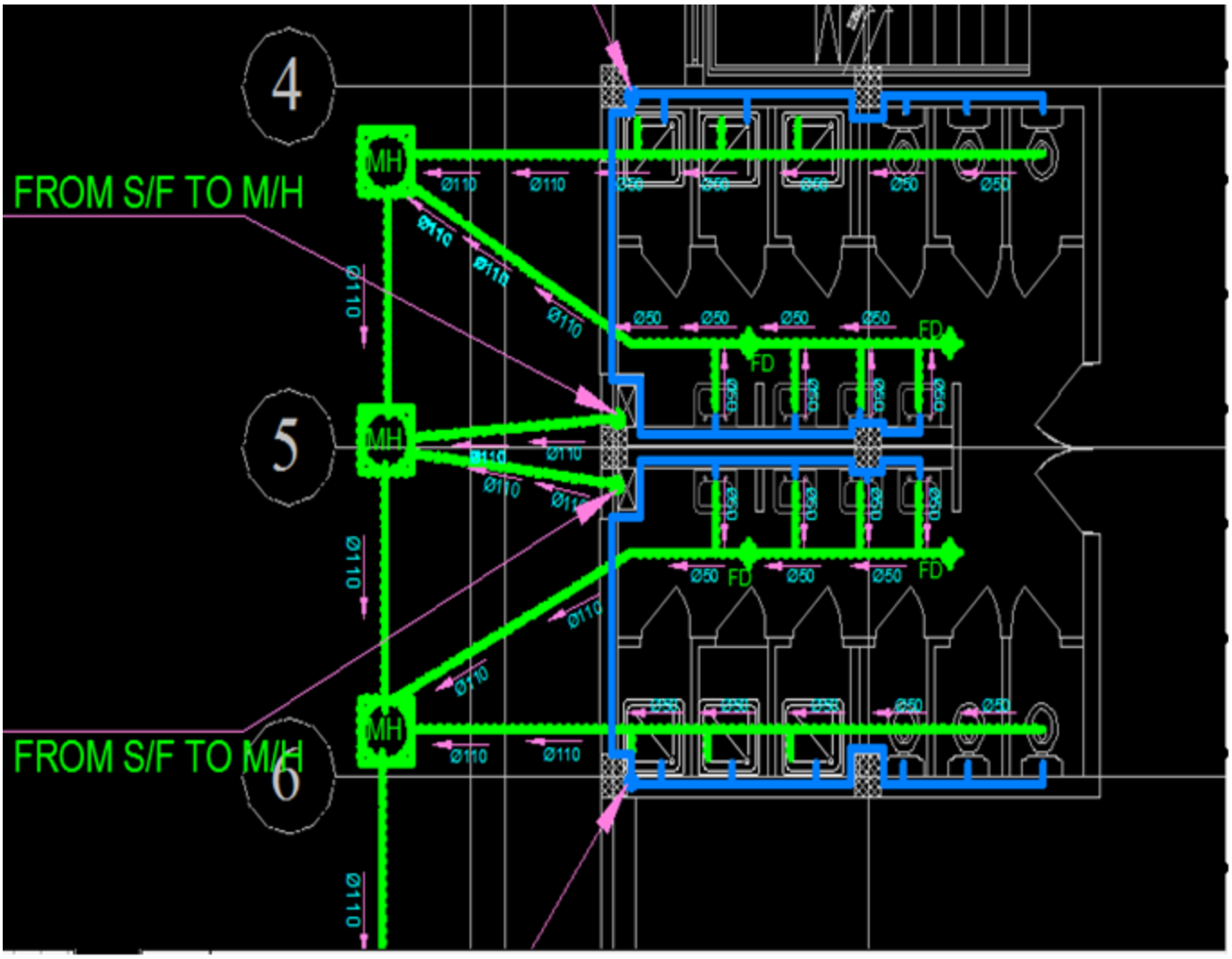


Figure (1.1a) floor sanitary plans

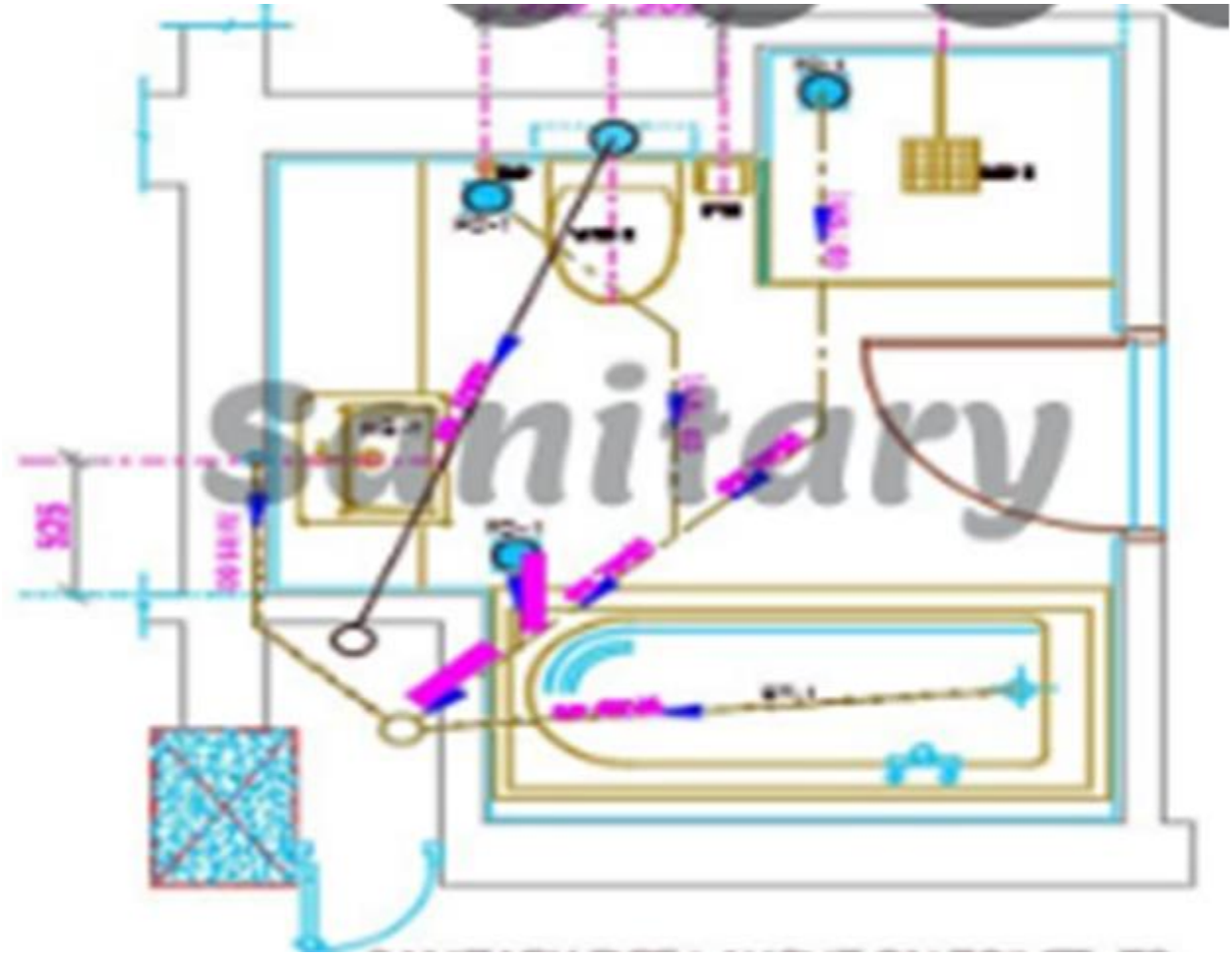


Figure (1.1b) floor sanitary plans

Definition of specifications

Specifications An act of identifying something precisely or of stating a precise requirement.

A detailed description of the design and materials used to make something.

The purpose of a specification is to provide a description and statement of the requirements of a product, components of a product, the capability or performance of a product, and/or the service or work to be performed to create a product.

1.2 OHS requirements

OHS requirements are:

- ✓ Protective clothing and equipment,
- ✓ Use of tools and equipment,
- ✓ Workplace environment and safety,
- ✓ Handling of materials,
- ✓ Use of firefighting equipment,
- ✓ Use of first aid equipment,
- ✓ Hazard control and hazardous materials and substances.

- Personal protective equipment is to include that prescribed under legislation, regulation and workplace policies and practices

- Safe operating procedures are to include recognizing and preventing hazards associated with excavation equipment.

1.3 Quality assurance

Quality assurance (QA):-Is a way of preventing mistakes or defects in manufactured products and avoiding problems when delivering solutions or services to customers. Identifying quality assurance requirements are program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that standards of quality are being met. Quality management focused on providing confidence that quality requirements will be fulfilled". This defect prevention in quality assurance differs subtly from defect detection and rejection in quality control, and has been referred to as a shift left as it focuses on quality earlier in the process. The terms "quality assurance" and "quality control" are often used interchangeably to refer to ways of ensuring the quality of a service or product. For instance, the term "assurance" is often used as follows: Quality assurance (QA) is any systematic process of determining whether a product or service meets specified requirements.

QA establishes and maintains set requirements for developing or manufacturing reliable products. A quality assurance system is meant to increase customer confidence and a company's credibility, while also improving work processes and efficiency, and it enables a company to better compete with others

Importance of quality assurance

- Quality assurance helps a company or contractors create products and services that meet the needs, expectations and requirements of customers.
- It yields high-quality product offerings for drainage system that build trust and loyalty with customers.
- The standards and procedures defined by a quality assurance program help prevent product defects before they arise.

Quality assurance methods

Quality assurance utilizes one of three methods:

- **Failure Testing**, which continually tests a product to determine if it breaks or fails. For physical products that need to withstand, this could involve testing the product under water test.
- **Statistical Process Control, a** methodology based on objective data and analysis .This methodology uses statistical methods to manage and control the follow of activities.
- Total Quality Management which applies quantitative methods as the basis for continuous improvement. TQM relies on facts, data and analysis to support product planning and performance reviews.

Requirements for Drainage System

Plumbing designs and installations are governed by a set of rules and limitations, which provides that all drainage system must conform with a set of requirements enumerated as follows:

1. That all pipe joints must be well fitted and tightly connected with each other to prevent leakage of gas and liquid.
2. That the drainage pipe should be graded properly or inclined for a downward gravity flow of water towards the main sewer line or to the septic tank.
3. That the drainage pipe should be provided with adequate cleanout which is accessible for repair in case of stoppage.
4. That the drainage system must be provided with ventilation pipe which will convey gases to the atmosphere where it can do no harm to human health.
5. That except for water closet, each fixture shall be provided with suitable trap which will prevent back flow of gases.
6. That it must be vented to avoid siphon age or back flow of the water seal.

1.4 Planning & sequencing Tasks

Planning a basic management function involving formulation of one or more detailed plans to achieve optimum balance of needs or demands with the available resources. The planning process in drainage planning and sequencing tasks are**:**

(1) Set out procedure
(2) Prepare tools and equipment
(3) Excavate trench
(4) Adjust pipe reaches.
(5) Fix deferent fittings& lay pipe based on the drawings.
(6) Implements, directs, and monitors all steps in their proper sequence.

Planning and sequencing tasks of construction drainage must complete several steps before completing a permit application and beginning construction. These steps also help owners/operators determine their eligibility for coverage under the general permit.

Step 1: Identify the construction site boundaries, the latitude and longitude for the centroid of the site, and the project's major phases.

Where will the construction occur and what will the project involve? Identifying the construction site boundaries is important to determining which environmental resources may be at risk of being impacted by the project. Identify opportunities to phase the project so that vegetation will remain in those areas that will not have construction activity at the start of the project. Construction phasing can minimize or eliminate negative environmental impacts from the project. The latitude and longitude can be obtained with Bing Maps during the online application process, a GPS unit, using a topographic map (provide scale), or using a range of mapping websites. For more information, read How to Determine Latitude and Longitude.

Step 2: Determine if additional permits are needed.

Contact other state and federal agencies and local units of government to determine what permits are required in addition to the National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) permit issued by the Pollution Control Agency (PCA).

Step 3: Determine if Environmental Review is needed.

Contact the appropriate state agency or local unit of government to determine if the proposed project meets or exceeds the thresholds outlined in the state environmental review rules .Development of an Environmental Assessment Worksheet (EAW) may be required for the project prior to the issuance of any permits and before construction activity can begin

Step 4: Understand the requirements of the general storm water permit for construction activity.

The general storm water permit for construction activity contains many requirements that must be considered during the planning phase of a construction project. Decisions made during planning may make the difference between the projects requiring a more onerous individual permit instead of the general permit.

Step 5: Identify waters that have the potential to receive storm water discharge during or after construction.

Special Waters Search: Use this mapping tool to prepare a list of all the waters located within one mile of the construction site boundary.

Step 6: Determine if discharges from construction site will impact other protected resources.

Step 7. Prepare Storm water Pollution Prevention Plan (SWPPP).

Develop a SWPPP following the requirements of the permit. All waters located within one mile (aerial radius measurement) of the construction site that have the potential to receive a discharge from the site must be identified on the site map component of the SWPPP. Be sure to include any additional requirements needed for discharges to special waters.

Step 8. Identify discharges.

Check waters list in Steps 5 and 6 to determine which surface waters (including wetlands, special waters, impaired waters, calcareous fens, and others) have a potential to receive a discharge after considering water flow and modifications to the construction plans made for the purpose of preventing water resource impacts. The SWPPP must include a map of all surface waters, existing wetlands, and storm water ponds or basins that have a potential to receive a discharge from the site. Where surface waters receiving storm water associated with construction activity will not fit on the plan sheet, they must be identified with an arrow, indicating both direction and distance to the surface water. Discharges of concern for calcareous fens are direct discharges or an indirect discharge to the fen from the construction site within one mile. Keep the list of waters that will receive discharges from the construction site. This information is required on the permit application form.

Step 9. Begin construction.

Owners/operators determine their eligibility for coverage under the general permit.

1.5 Tools and Equipment

Personal safety equipment

Two important safety items essential to drain cleaning are glasses or goggles with side shields and gloves. Eye protection is an important safeguard against flying solid objects or caustic liquids, which can become airborne when the cable under tension is suddenly released

Fig 1.2 Personal safety equipment

Different Types of Drainage Equipment

Drainage equipment usually can be broken down into two categories. First, there are the components of a **drainage system**, which can refer to things like pipes or **septic tanks.** Secondly, there is a large variety of different products that help in the installation, repair, or maintenance of a drainage or maintenance of a drainage system. Some types of drainage equipment primarily are intended for use by drainage specialists, while other types might be available to the homeowner who wants to find a solution to a drainage problem they are having.

The term drainage generally refers to the artificial removal of water from an area. Drainage equipment may help with moisture control, eliminating excess storm water, or alleviating water damage. Unwanted buildup of water sometimes can cause problems like flooding or clogged pipes. This can lead to consequences such as damaging the foundation of a residential home or diminishing the yield of crops on a farm. Drainage equipment might help in realizing the goal of a drainage solution.

A common type of drainage equipment is pipes, which generally are used to help redistribute water from areas that are suffering from drainage problems such as flooding. Some of the common drainage pipes found in homes and gardens are made of PVC plastic and are perforated. These pipes usually are placed in trenches that have been dug in the land with the intent of relocating water to an area that will not cause any property damage. **Copper** drainage pipes often are found in homes and usually are considered to be a good piece of drainage equipment because

they do not corrode as easily as other materials. Perforated clayware pipes are another material that often is used for draining gardens of excess water.

Fig 1.3 PVC pipes are commonly used to make perforated pipes.

Tools and devices used for maintaining and cleaning drains also are examples of drainage equipment. Various types of pumping systems can help clean out drainage pipes that might be clogged. Some drainage equipment is used specifically for cleaning pipes that carry waste. For example, a mini hand snake is a type of small equipment that can be used to unblock drainage pipes located in kitchens or bathrooms. Some of the new technology in draining equipment includes special drainage cameras that can be inserted into a pipe. This allows one to examine the flow of water and detect any potential pipe damage. Such cameras can be invaluable sources for fitting into any manner of pipes, such as toilet pipes or backyard drainage pipes.

1.6 Work area to support the efficient installation of the storm water and sub-soil drainage system

Environmentally sensitive or valuable areas shall be avoided, such as nature reserves, archeological sites, and areas inhabited by sensitive species. Areas adjacent to surface water features are to be avoided to the maximum extent possible. Where possible, and as informed by survey data, construction activities shall avoid Red Data Book plants or ensure their translocation to a safe and suitable area prior to construction. Construction personnel shall be briefed about the location and importance of rare fauna and flora in the area during the induction process.

Site location and design (including route selection for roads and pipelines) shall be optimized in order to minimize the amount of soil to be excavated and disturbed within the site/project boundaries.

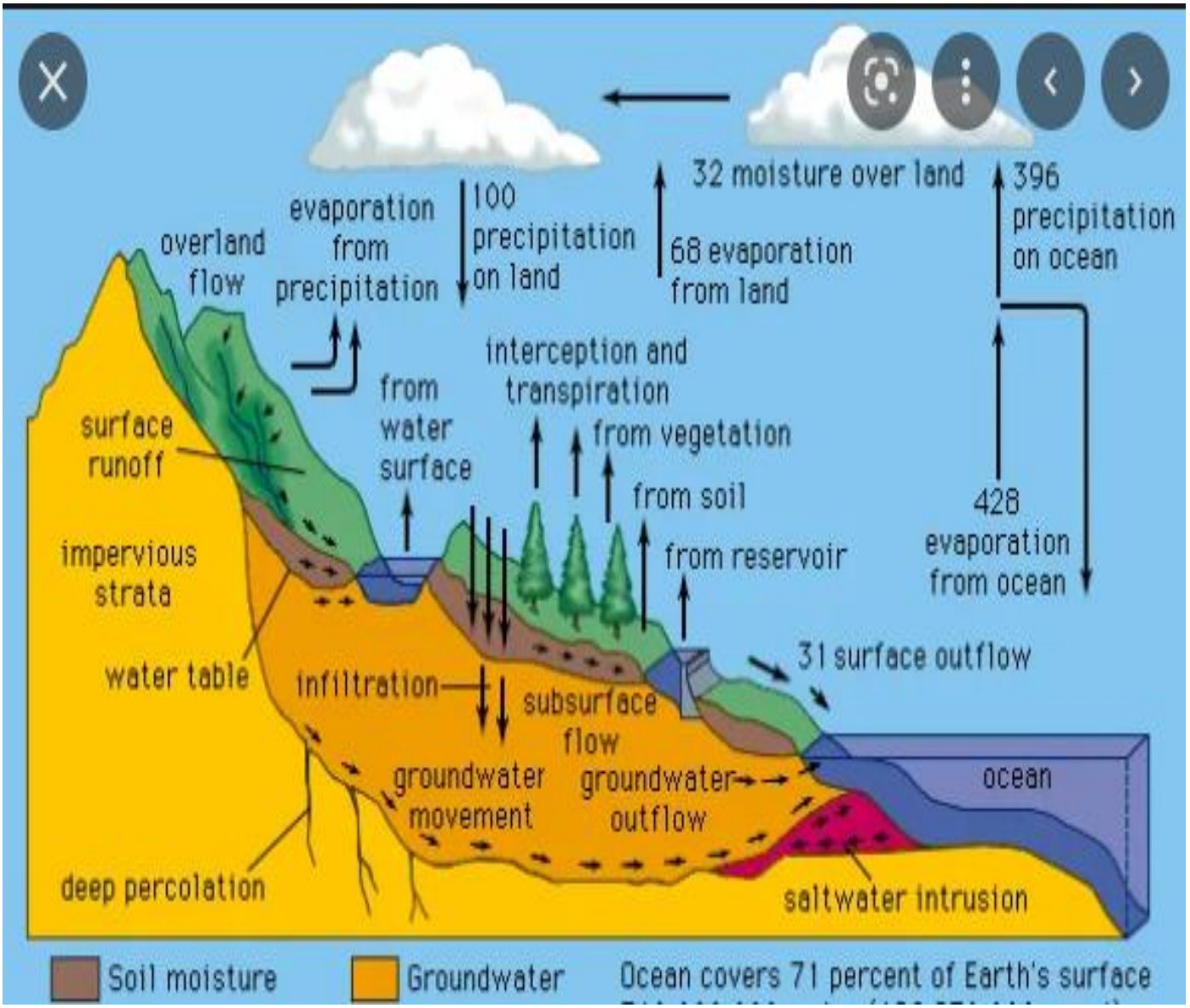


Fig 1.4 Environmentally sensitive or valuable areas

Before, during and after carrying out any work, the workplace must be clean and tidy to prevent tripping and falling. Tree clearance shall be kept to a minimum, and limited to the footprint of the site and any safety buffer zone. Within construction site boundaries existing vegetation shall be retained wherever possible. Trees and areas to be preserved and protected shall be identified and clearly marked as the work area is defined. Construction activities shall be kept strictly to the footprint of designated site boundaries and the pipeline

Self-check-1

I. Choose the best answer from the following alternatives

1. Quality assurance utilizes:

a) Failure Testing

b) TQM

c) Statistical Process Control

d) All

2. Drainage system provides that:

a) all pipe joints must be well fitted and tightly connected with each other

b) the drainage pipe should be provided with adequate cleanout

c) the drainage pipe should be graded properly

d) the drainage system must be provided with ventilation pipe

e) All

3. The planning process in drainage planning and sequencing tasks are**:**

a) Set out procedure

b) Prepare tools and equipment

c) Excavate trench

d) Adjust pipe reaches.

e) All

II. Write <<True or False>>

1. Site location and design shall be optimized in order to minimize the amount of soil to be excavated.
2. Quality assurance helps a company or contractors create products and services.
3. Storm water management plan means water flow on the surface of the ground or in storm sewers, resulting from precipitation.

III. Mach Column "A" with Column "B"

Column "A"	Column"B
___1.Protective clothing and equipment	A. engineering design drawings
___2.Drainage Plans	B. OHS
___3.Specifications	C. is any systematic process
___4.Quality assurance (QA)	D. stating a precise requirement
	E. Storm water

Unit Two: Determine installation requirements

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

- Position of installation
- Quantity and type of materials
- Order of Materials

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

- Determine position of installation in accordance with plans/specifications and site requirements
- Calculate quantity and type of materials from design drawings/specifications
- Identify and order materials in accordance with workplace procedures
- Check materials

2.1 Position of installation

A general principle of drain installation is to **start at the downstream end** so that any free water can drain away immediately. Thus a good drainage base should be secured, which implies that the collector should be in place and should be functioning before the start of the field drain installation.

The Importance of Topography and Landscape Position in Septic System Installation

Topography and landscape position are the first things seen when the site is visited. In the broadest sense, topography describes the physical features of the land surface, including relative elevations and the aspect of the surface. Landscape position describes the location of the site relative to the location on a slope.

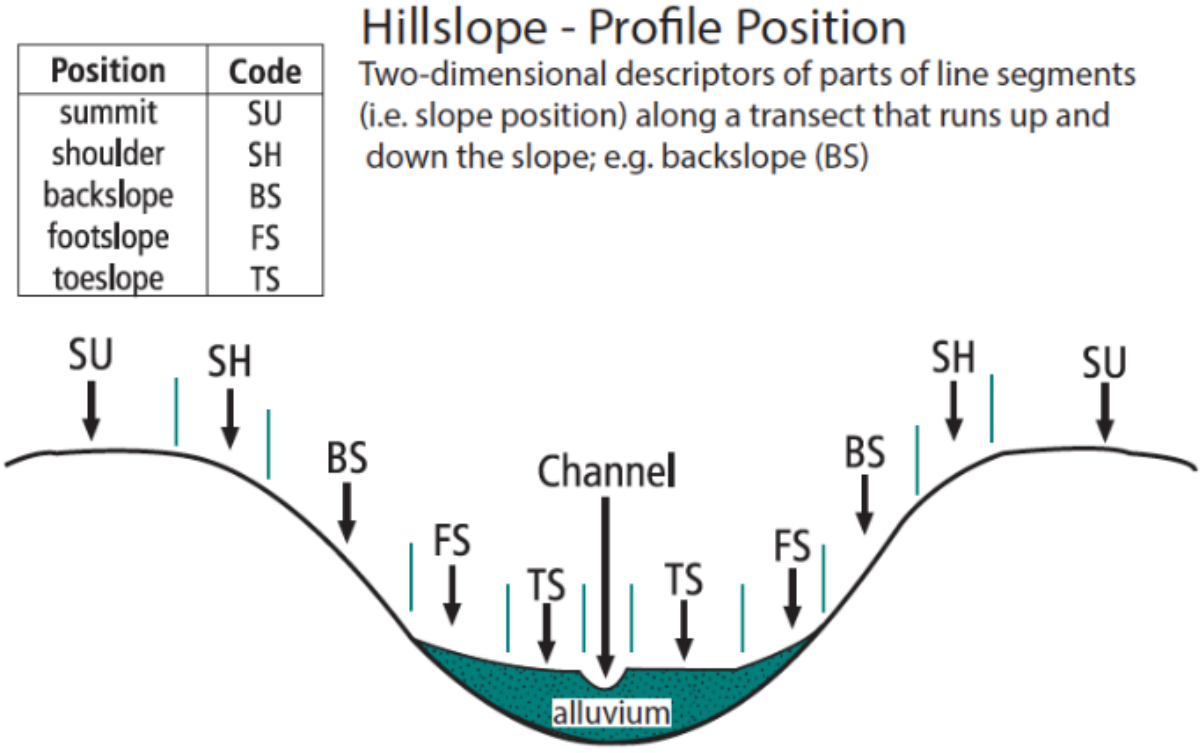


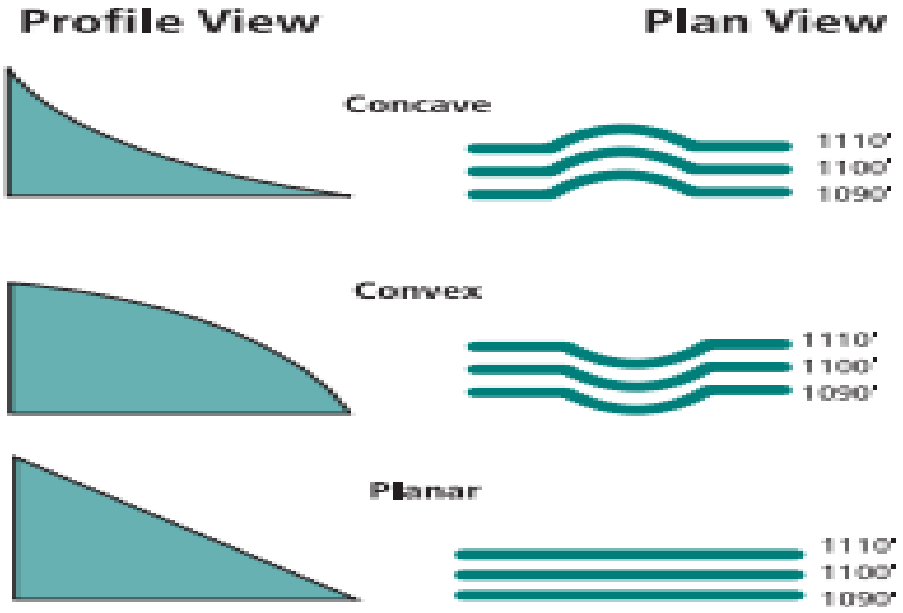
Fig 2.1 hill slope profile position

Fig 2.2 concrete septic tank

Fig 2.3 septic tank

The characteristics of the topography and landscape position influence the way that water moves both on and within the soil. For example, the site may be at the top (summit) or the bottom (toe) of a slope. This determines the nature of surface water movement. The upslope portions of the landscape have good external drainage as water flows away from them. The lower areas have poor external drainage as water flows into them.

The shape of the slope is another important characteristic that predicts water movement on the site. The slope description describes the land surface along and perpendicular to the slope using terms of planer/linear, convex and concave. This information is useful in determining surface and subsurface drainage patterns. For example, sloping convex areas typically have good surface and subsurface drainage away from the area, while concave sloping areas such as potholes, drainage ways, and foot slopes are more likely to possess wetter soil conditions.



If the proposed wastewater treatment area is located at the bottom of a concave type landscape where water flows to one common area, the design should include precautions if the system could not be relocated to an area of less surface water flow. Some of these precautions may include surface water redirection by means of berms and swales to route the surface water around the onsite wastewater treatment system.

Groundwater also moves toward a common area in concave slopes and can raise the seasonal high groundwater table in these areas relative to the rest of the parcel of land. When excavating in these areas, the installer must be careful in assessing if the observed seasonal high groundwater table agrees with the site and soil evaluation report.

Topography and landscape can affect all activities related to the installation. If a site has drainage issues, the timing of the installation may have to be adjusted on the basis of weather delays. Temporary drainage may be needed for access to the installation area or to protect adjacent property. Equipment selection may also be affected. Staging areas must be carefully chosen to ensure access. Sediment and erosion control measures may be required.

2.2 Quantity and type of materials

Calculation for quantity of drainage

Calculating materials requirement in sanitary installation work helps to know the exact quantities that required to the purpose of certain works carried out.

Building a new home is a complicated endeavor that is compounded by the various elements that each individual task requires, such as the costs for plumbing a home. This is completely separate from, say, the framing of a home or installing tile on floors, and is thus normally bid out separately.

If you want to estimate plumbing costs for new construction, it helps to know the complexities you can run into The reality is that every project is much more than just the square or linear footage. For example, a two-story home will require significantly more work than a one-story home, and installers usually include extra money in an estimate to cover the additional work. Add-on buildings or areas can include surcharges related to cleaning, protecting the existing home (such as carpeting and tiling) from dirt and debris during the installation, and beyond. Realize that the root estimate is nothing more than a rough idea and your specific project will have distinct characteristics that can affect that number.

Most brand new additions will require excavation to run drain pipes out of the home as well as run water lines from the city main into the home. This is not a simple shovel-and-dig type of excavation. It requires the use of heavy equipment and the associated skills for using that equipment, which means hiring an excavation crew.

Know the size of your pipes beforehand. Consider little things, such as running 3-inch pipe for showers to accommodate for future renovations when most people only run spec pipe, which is 2 inches for showers. In addition, pipe fittings range greatly in price, depending on the size and type of pipe you are working with. For example, PVC pipe is some of the cheapest you can use and is most commonly seen in residential applications, but larger diameters cost more money, so 2-inch pipes and fittings will cost less than 4-inch pipes and fittings.

To calculate the volume of water that needs to be stored, **multiply the amount of runoff from each drainage zone by 15**. The runoff for each zone was in gallons per minute. Multiplying by 15 minutes leaves you with the amount of gallons to be stored.

How do I calculate pipe size for drainage?

Divide the pipe's internal diameter by 2. For example, if the pipe has an internal diameter of 0.1 meters: 0.1 ÷ 2 = 0.05 m this is the pipe's radius. Square this radius: $0.05^2 = 0.0025$ m². Multiply the result by pi, which is approximately 3.142: 0.0025 × 3.142 = 0.007855 m².

How do you calculate the slope of a drain pipe?

What is a 2% slope in piping?

Minimum Pipe Slope

As a general rule, the recommended slope for most plumbing pipes is **1/4 inch vertical drop over every 1 horizontal foot**, or about 2 percent, reveals Builder's Calculator.

How do I calculate my pipe grade?

Divide the pipe's vertical fall by the length of the pipe, then multiply the result by 100 to find the percentage. The fall and length need to be in the same units (feet or inches) for this to work. For example, if the pipe fell by one foot and was 50 feet long, you divide 1 by 50 to get 0.02.

To determine the pipe slope, **subtract the two manhole inverts and divide the difference by the pipe distance and multiply by one hundred (100) to obtain the percent grade of the pipe**.

Example: Find the Slope of House Sewer:- The height of the rise angle of the pipe line could be determine by using the formula:

$$\textbf{Height} = \frac{\text{Length or distance x \%}}{100}$$

For example: If the distance is 24 meters and the slope is 2%, then

$$\textbf{Height} = \frac{24 \text{ meters x } 2\%}{100}$$

Height = 0.48 meters

To find the slope of the pipe line: **(slope) % =** $\frac{\text{Height}}{\text{Length or distance}}$ **x 100**

For example: If the length is 24 meters and the height is 0.48 meters, then

% = $\frac{\text{0.48 meters}}{\text{24 meters}}$ **x 100**

% = 0.20 x 100

% = 2

Do you design a drainage system?

Fig 2.4 design a drainage system

To Design a Drainage System: 5 Essential Tips

1. Observe Where the Excess Water Comes From
2. Prepare for Your Soil.
3. Survey Your "Lay of the Land"
4. Determine Your Drain Layout
5. Get an Expert Involved.
6. Get Your New Drainage System Planned-Out Today!

Materials used in drainage system

The materials used for manufacturing drain pipes are **clay, concrete, and plastics**. Important criteria for pipe quality and for selecting the most suitable type of pipes are: resistance to mechanical and chemical damage, longevity, and costs.

2.3 & 2.4 (merged) Order /check/ of Materials

Two commonly implemented techniques checking material include smoke testing and dyed water testing.

Smoke testing is a relatively inexpensive and quick method of detecting sources of inflow in sewer systems, such as down spouts, or driveway and yard drains, and works best suited for detecting cross connections and point source inflow leaks. Smoke testing is not typically used on a routine basis. With each end of the sewer of interest plugged, smoke is introduced into the test section, Guide for Evaluating Sanitary Sewer Collection Systems usually via a manhole. Sources of inflow can then be identified when smoke escapes through them.

Areas Usually Smoke Tested

- Drainage paths
- Roof leaders
- Faulty service connections
- Pending areas
- Yard and area drains
- Cellars
- Fountain drains

Dye Testing: - Dyed water testing may be used to establish the connection of a fixture or appurtenance to the sewer. It is often used to confirm smoke testing or to test fixtures that did not smoke. As is the case with smoke testing, it is not used on a routine basis, but rather in areas that have displayed high wet weather flows. Dyed water testing can be used to identify structurally damaged manholes that might create potential problems. This is accomplished by flooding the area close to the suspected manholes with dyed water and checking for entry of dyed water at the frame-chimney area, cone or corbel, and walls of the manhole.

Materials

Type of pipe materials

- Bituminous Fiber Sewer Pipe
- Vitrified Clay Pipe
- Lead Pipe

Type of fitting materials for drainage

An elbow is a pipe fitting installed between two lengths of pipe or tubing to allow a change of direction, usually a 90° or 45° angle, though 22.5° elbows are also made.

Elbows are categorized based on various design features as below:

90 Degree Elbow – where change in direction required is 90°

60 Degree Elbow – where change in direction required is 60°

45 Degree Elbow – where change in direction required is 45°

. It is used to change the direction in piping

A coupling connects two pipes to each other.

A union is similar to a coupling, except it is designed to allow quick and convenient disconnection of pipes for maintenance or fixture replacement.

A **reducer** allows for a change in pipe size

A tee is the most common pipe fitting. It is a type of pipe fitting which is T-shaped having two outlets, at 90° to the connection to the main line. A tee is used for changing the direction of pipe runs.

Cross fittings are also called 4-way fittings. If a branch line passes completely through a tee, the fitting becomes a cross. A cross has one inlet and three outlets, or vice versa.

Cap: A type of pipe fitting, usually liquid or gas tight, which covers the end of a pipe. A cap is used like plug, except that the pipe caps screws or attaches on the male thread of a pipe. A cap may have a solvent weld socket end or a female threaded end and the other end closed off. In plumbing systems that use threads, the cap has female threads.

A plug closes off the end of a pipe. It is similar to a cap but it fits inside the fitting plumbing system, plugs have male threads

Y-branches

Y-branches are used to join one or more sanitary sewer branches or to connect a branch to a main line. This design allows a smoother change in flow direction. The most common y-branches are the 45- and 90-degree types (figure below).

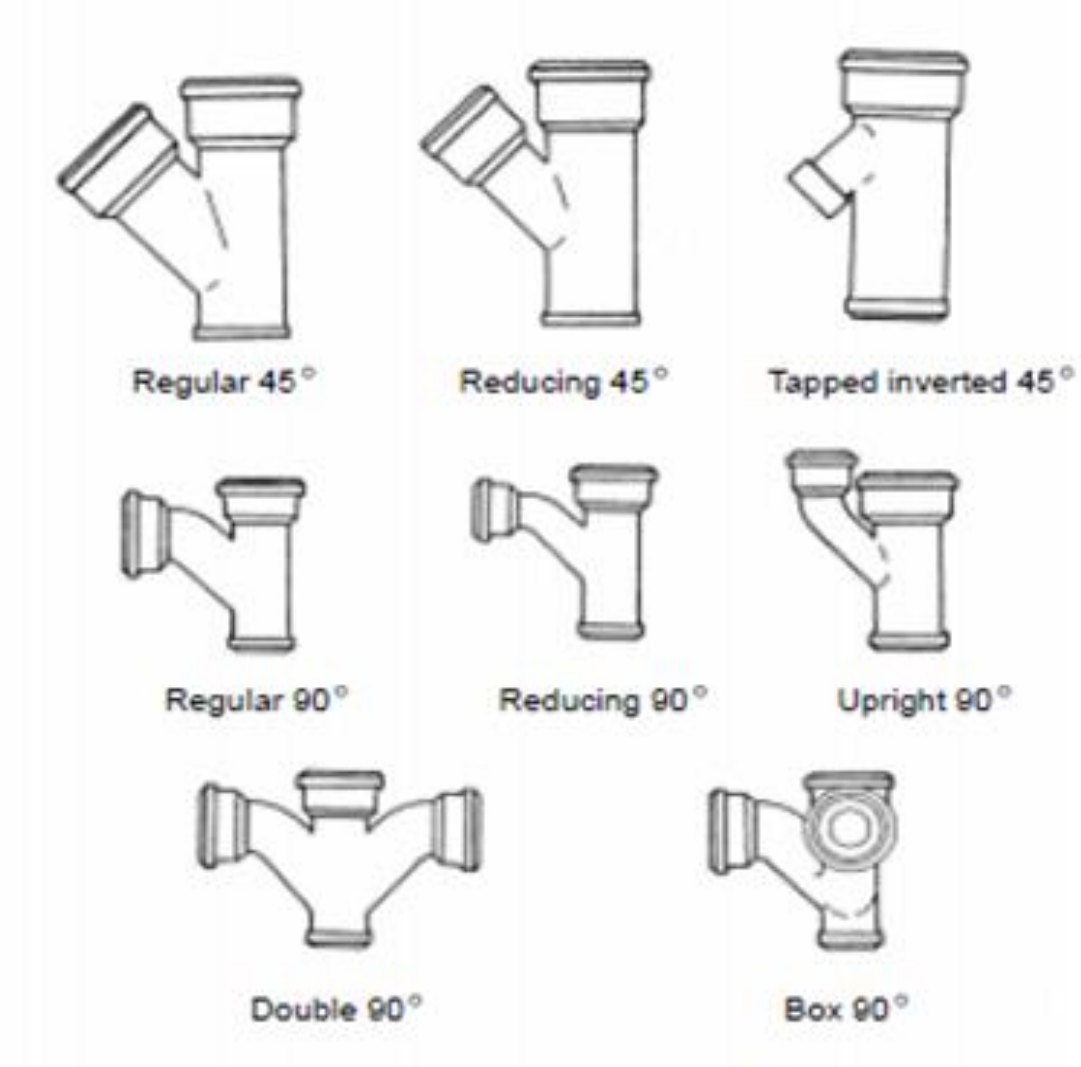


Figure 2.5 Cast-iron 45- and 90-degree Y-branches

- 45-degree. A 45-degree y-branch has a side takeoff entering the through section at a 75-degree angle. The side takeoff may be the same diameter or a smaller diameter. If the takeoff is smaller, it is a reducing y-branch. Other types of 45-degree branches are inverted, tapped, and tapped inverted.
- 90-degree. The 90-degree y-branch, also called a combination y and 1/8 bend or T-Y, is made in several shapes. The double 90-degree y-branch is used extensively in a unit vent installation. The box 90-degree y-branch with a side takeoff on each side is used to install a stack in a room corner. The 90-degree y-branches also have tapped side takeoffs.

UPVC stands for unplasticised polyvinyl chloride; it is a strong and low-maintenance but lightweight plastic building material.

Difference between PVC and UPVC

Regular PVC (polyvinyl chloride) is a common, strong but lightweight plastic used in construction. It is made softer and more flexible by the addition of plasticizers. If no plasticizers are added, it is known as uPVC (unplasticized polyvinyl chloride), rigid PVC, or vinyl siding in the U.S.Is an engineered plastic. Its full name is Unplasticised Polyvinyl Chloride. The 'Unplasticised' part of the name means UPVC has no plasticizers, which promote flexibility and reduce brittleness in plastic.

Reinforced concrete

Reinforced Concrete Pipe (RCP)

RCP is a type of piping used for directing the flow of liquids or water underground. These pipes are typically used in roadway and site development, as they are designed to convey a very large amount of liquid volume and built to withstand environmental stressors.

Fig 2.6 Image result for Reinforced concrete for drainage

Cast iron pipe

Is Cast Iron Pipe better than PVC?

Cast iron pipes are extremely resistant to heat and won't melt. Flexibility. Although cast iron is strong, it can be brittle and break when blunt force trauma is applied. PVC is a much more flexible material and can withstand these forces without breaking.

Despite the advantages of strength and durability, though, a big disadvantage of cast iron is that it is **susceptible to rust over time**. In homes that have cast iron piping, if a pipe rusts all the way through, that section can be replaced with plastic piping, like PVC

Fig 2.7 cast iron pipes

- Bends

Bends are used to change the direction of a cast-iron pipeline. The degree of direction change is given as a common math fraction. Bends are designated in fractions of 1/16, 1/8, 1/6, 1/5, 1/4, and 1/2 as they change the direction of 22 1/2, 45, 60, 72, 90, and 180 degrees, respectively. These bends can be regular, short sweep, or long sweep (figure below). A closet bend is a special fitting to connect a soil waste branch line for a water closet (toilet). It can be plain or tapped for waste or venting. Closet bends are made to fit different types of floor flanges (rims for attachment). One type may have a spigot end for caulking, which is marked for cutting to a desired length. Another type has a hub end that connects to the floor flange with a sleeve as shown in figure below.

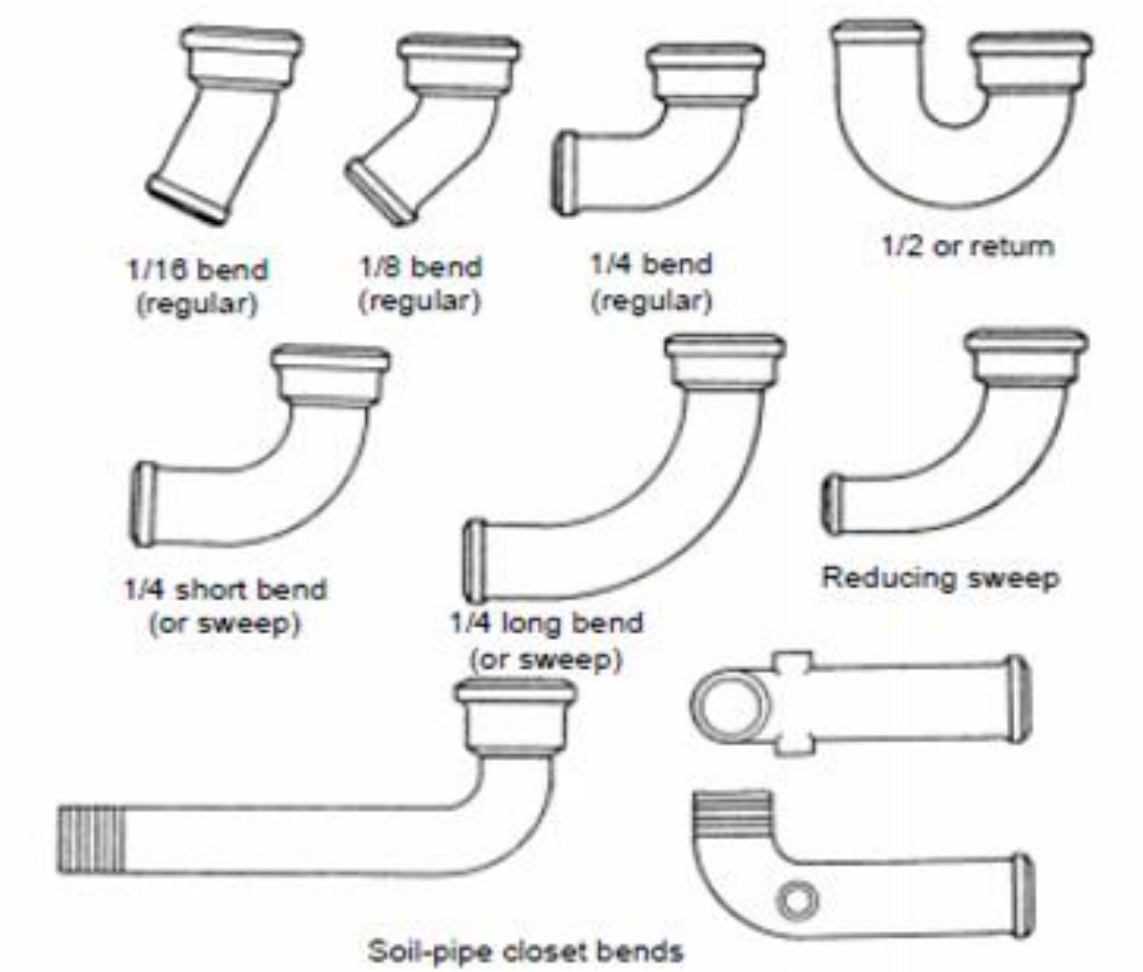


Figure 2.8 Cast-iron bends

Cast-iron Disadvantages

Cast iron has **high brittleness**. White cast iron is non-machinable. It has poor impact resistance and has a high weight to strength ratio. Machinability is poor.

Deteriorating cast iron pipes **develop small cracks that eventually grow into holes and bigger breaks that cannot be patched**. One of the most troubling issues associated with these breaks is "black water" a form of dark, dirty water full of backed-up sewage, bacteria, and fungi.

Fig 2.9 Deteriorating cast iron pipe

Vitreous clay pipes

Vitrified clay pipe (VCP) is pipe made from a blend of clay and shale that has been subjected to high temperature to achieve vitrification,

Homes in the rich areas of town enjoyed hot and cold running water through clay pipes. Clay remained a popular material for city plumbing and drainage systems through the early 1900s. Manufacturing plants popped up in towns wherever there was a need for plumbing and an adequate supply of clay to use as a raw material

Fig 2.10 vitrified clay pipe

Self-check-2

I. Choose the best answer from the following alternatives

1. The materials used for manufacturing drain pipes are:

a) Clay

b) Concrete

c) Plastics

d) All

2. Areas Usually Smoke Tested

a) Drainage paths

b) Pending areas

c) Roof leaders

d) Cellars

e) All

3. Which one of the following is type of pipe materials?

a) Bituminous Fiber Sewer Pipe

b) Vitrified Clay Pipe

c) Lead Pipe

d) None

e) a, b & c

f) All

4. What are the essential Tips to Design a Drainage System?

a) Observe Where the Excess Water Comes From

b) Prepare for Your Soil.

c) Survey Your “Lay of the Land”

d) Determine Your Drain Layout

e) All

f) None

II. Short answer questions

1. Write down difference between PVC and UPVC.
2. Why Cast Iron Pipe better than PVC?.
3. List Cast-iron Disadvantages
4. What is the purpose of calculating materials requirement in sanitary installation work?

III. Mach Column "A" with Column "B"

Column "A"	Column"B
_____1 Cross fittings	A. allow quick disconnection of pipes for maintenance
_____2. union	B. cap
_____3. uPVC	C. is any systematic process
_____4. covers the end of a pipe	D. 4-way fittings
	E. unplasticized polyvinyl chloride

Unit Three: Storm water and sub-soil drainage

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

- Size and location of excavation
- Site excavation
- Pipe work and storm water/subsoil drainage system
- Installation test
- Inspection of openings and covers
- Back-fill of the excavation

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

- Mark size and location of excavation out to comply with drawings/specifications, installation and site requirements
- Excavate Site in accordance with drawings/specifications, site requirements and standards, ensuring minimum damage to surrounding structures or environment
- Install pipe work and storm water/subsoil drainage system in accordance with drawings/specifications, site requirements or job instructions and standards, with consideration to existing pipe work and other services
- Test Installation to comply with standards and relevant authorities' requirements
- Fit Inspection openings and covers in accordance with standards and job specifications
- Back-fill Excavation in accordance with standards and job specifications

3.1 Size and location of excavation

Size and location: - Water is removed to the topic of subsoil drainage for the urban from the conduit at its downstream end, thus maintaining storm water engineer. A flow system.

It can therefore be seen that subsurface drainage involves principles of hydraulics and flow through Subsoil drainage systems are provided to drain the hydraulic gradient and the hydraulic subsurface water in order to: conductivity of the soil governs the rate of subsurface increase the stability of the ground and footings of drainage. buildings by inducing a more stable moisture regime and reducing foundation movements due to the Other Design Considerations variations in the soil moisture content; In evaluating the need to remove subsurface water, mitigate surface water pounding and water logging of consideration must be given to surface water runoff from soils by lowering water tables; buildings, road pavements and sub grades, and other alleviate ground water pressures likely to cause impervious surfaces which is allowed to enter subsurface dampness in below-ground internal parts of buildings zones and contribute to soil saturation. or damage to foundations of buildings, other structures, or pavements; and/or In clay soils, subsoil drains can alter long-term soil increase soil strength by reducing the moisture regimes so that building foundations can be content.

- Entrapped water that is subject to vehicular loadings creates large Consideration should be given to the possible effects of hydrostatic and hydrodynamic pressures within the intermittent or permanent reduction in groundwater levels sub base, reducing its ability to provide stable support for on adjacent lands when designing subsoil drainage. In the pavement correctly designed roads and paved areas soils with clay content exceeding 20%, lowering have a highly permeable base or sub base construction and water tables can cause soil shrinkage and damage to may include subsoil drains to promote the rapid outflow of structures. It is recommended that subsoil drains should subsurface water. Not be placed too close to buildings on clayey sites. One important factor indicating a need for subsoil drainage
- Drain Types: - is the presence of a water table high enough to have an adverse effect on buildings and infrastructure within urban .The types of subsoil drains that are commonly used are developments. Subsoil drainage is particularly important. These may be installed on flat hillside areas due to the potential to create land instability ground, in a sag or depression, or on sloping ground. Drains behind retaining walls are designed basic parts of a subsoil drain using similar principles as other subsoil drains. Which is a trench with fill or filter material

(commonly sand or gravel). This simple arrangement is called a rubble Scope of this Manual drain or French drain. The design principles and methods set out herein will be shows the addition of a geotextile lining to useful for many applications. However, this topic does prevent external fine soil particles being washed into the not provide detailed advice for all situations. Specialist filters material and clogging it. Both this and the unlined advice should be obtained for large or complex rubble drain has only limited effectiveness due to their applications. Some applications, such as road and highway limited ability to convey water. Relevant layouts for the types of subsoil drainage systems shows an external layer of filter material provided around covered in this chapter include the geotextile encompassing the filter material. This might subsoil drains on one or more sides of a building orbed used where there is a likelihood of fine particles or cutting, including cut-off drains for interception of deposits, e.g. iron precipitates, clogging the geotextile. groundwater flows from higher land In general, subsoil drains connect either into a storm water drainage systems for mitigating water logging orbit or an open channel which is part of a lowering water tables on small to medium areas of surface water drainage system, with the subsoil drain pipe land, e.g. less than 500 m2or strip drain penetrating the pit wall. Weep holes with suitable geotextile filter may also be used to admit water these layouts may involve branch subsoil drains from the filter materials into the pit. Connecting to a main subsoil drain. Manholes should be provided at main junction points to facilitate inspection and cleaning.

- Layout: - Suggested maximum spacing's for branch subsoil drains are the layout is directly related to the topography, location of buildings and access points, the geology (nature of subsoil and level of groundwater) and area of a property. Set vertically, as shown in without detailed subsurface investigations involving .the minimum trench width shall be excavations, field observations, and soil tests.

Size selection: - A line of 6-inch Multi-Flow could reach capacity in about 150 feet of water collection. 12-inch Multi-Flow could drain up to 235 feet of length before it reaches capacity. While 18-inch Multi-Flow could extend up to 360 feet. These lengths are based on the assumption that the line is collecting water from a 12 foot wide area during a one inch in one hour rainfall event.

3.2 Site excavation

An excavation is any man-made cut, cavity, trench or depression in the earth's surface formed by earth removal.

Trench excavations are carried out principally to allow installation or repair of public utilities, water pipelines, drains and sewers to serve populated areas. When a trench excavation is being planned for any purpose, a detailed search should be made for information about any existing utilities adjacent tour crossing the line of the planned trench, including their sizes, locations and alignments. Most of the underground utilities are live systems, such as electricity, water, sewer and gas, and can be dangerous to workers when damaged or fractured. Particularly for gas, water mains and sewage rising mains, ground movement resulting from excavation may be sufficient to cause these mains to fracture. If the planned trench is located near slopes, special attention should be paid to the presence of any pressurized water mains as any damage to the pipes could lead to slope failures.

Trench Excavation

A trench is a narrow excavation, not more than 15 feet wide at the bottom. If you install forms or other structures in an excavation that reduce its width to less than 15 feet, measured at the bottom, the excavation is also considered a trench.

Excavation by hand, using pickaxe, spades and shovels are good method for excavating trenches for the pipe installation. If you want to achieve more speed then you can use a back actor. This is a particular good piece of machinery to use if the trenches are quit deeper.

During the course of excavation, the soils or soil properties are not what were expected as noted in the contract, the organization responsible for design should be informed. See Figure 1 for definitions of trench terms. Differential settlements may compromise the structural integrity of a buried pipe. Trench bottoms should be free of large stones, clumps of soil, frozen soil and debris; they should be slightly over excavated to allow for bedding material. If replacement of the soil is not possible, long reaches of soft-to-hard trench bottoms may be managed with a minimum of two short lengths of pipe with gasket joints that will accommodate the tendency of longitudinal pipe rotation in the transition zone. The use of long lengths of pipe across the transition zone carries the risk of a pipe's joints opening, or cross-sectional distortion in response to unavoidable rotation.

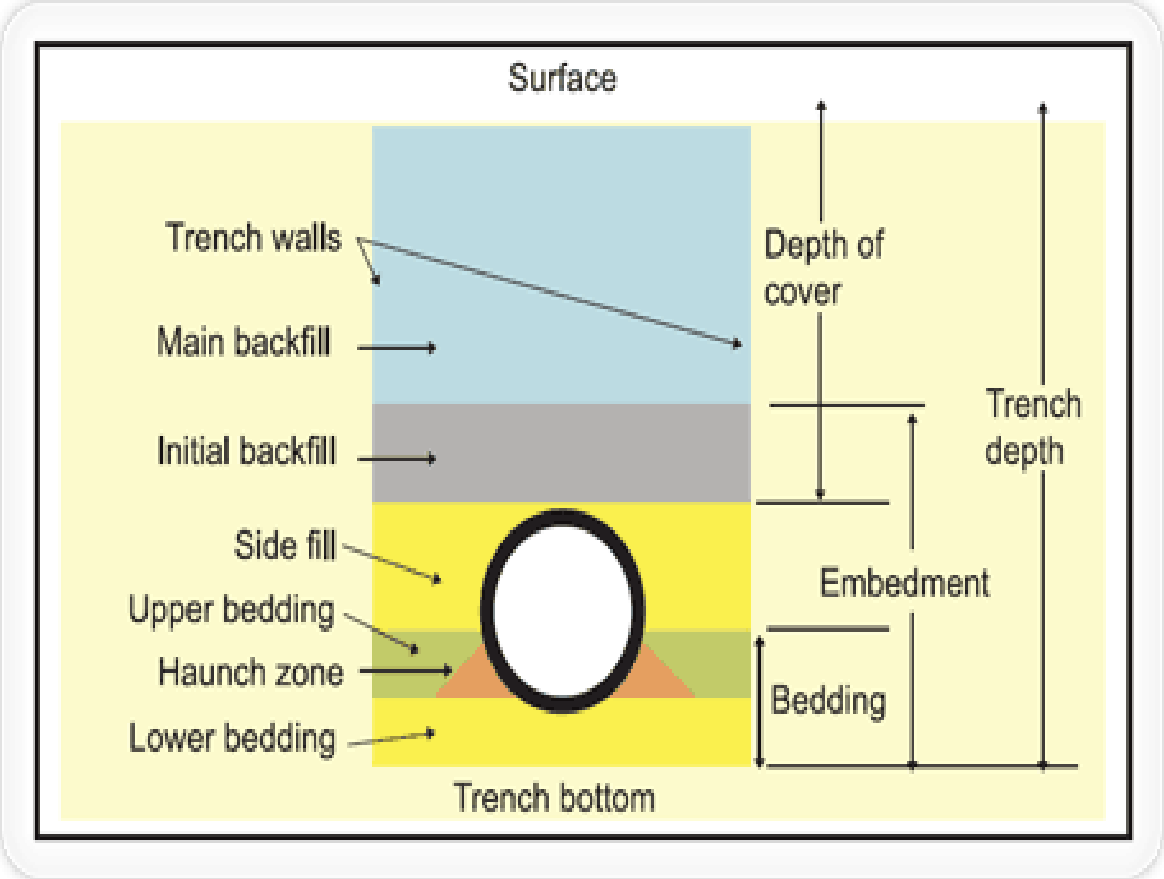


Figure 3.1 Trench Terms

Trench Dimensions

- The minimum cover over the pipe crown in moderate climates:
  - 1.0 m, for transmission lines,
  - 0.8 m, for distribution pipes,
  - 0.6 m, for laterals and service pipes

- The width of the trench at the bottom depends on the pipe diameter. An additional space of 0.3-0.6 m around the pipe (external diameter) should be provided for shoring and jointing works.

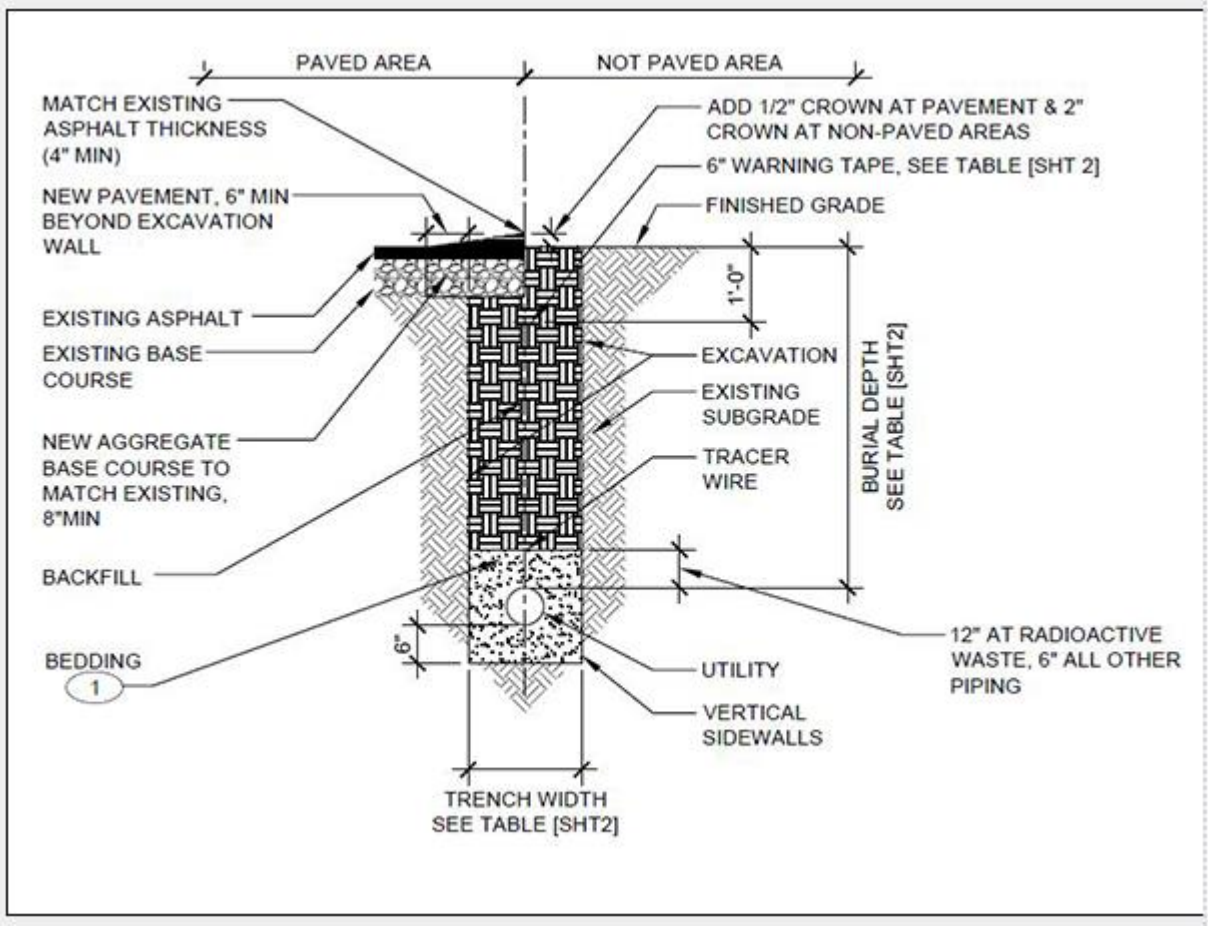


Fig 3.2 excavation site

For two, or more, parallel pipes in a common trench, properly compacted backfill are required between pipes. Minimum spacing between pipes may be satisfied by the following (see Table blow-)

Table1: Minimum Spacing of Parallel Pipes in a Single Trench

Normal Diameter (D) in. (mm)	**Minimum Spacing in. (mm)**
≤24 (600)	12 (300)
> 24 (600)	D/2

3.3 Pipe work and storm water/subsoil drainage system

Storm Drain is that portion of the plumbing system which conveys rain or storm water to a suitable terminal. Storm water is normally discharged into a street gutter conveyed by public drain system and carried to some natural drainage terminal like canals, rivers, lakes and the like. As a general rule, storm drain is never permitted to discharge into a septic tank or to the main sewer line. The collection and disposal of storm water is an important aspect of plumbing system which would not be ignored, otherwise, water coming from roof if not properly diverted will create the following problems:

1. Cause settlement of the structure by washing the soil away from the foundation.
2. Subject basement walls to unnecessary ground water pressure and possible leakage.
3. Run down water may create wall and window leakage.
4. Water may spill on people passing by or approaching entry door.
5. Erode the surrounding grounds and cause disfiguring of landscape areas.

Classification of Storm Drain

Storm Drain is classified into three types:

1. The Inside storm drain
2. Outside storm drain
3. Overhead storm drain

The **Inside Storm Drain** – is sometimes located under the basement floor or within the walls of building. This type of storm drain is commonly found in a building that occupies the entire frontage of lot wherein the storm drain has to be laid under the floor or walls of the structure.

Outside Storm Drain – is installed outside the foundation wall of building. This type of drainage is possible on places where the lot is not totally occupied by the building.

Overhead Storm Drain – is adopted when the street drainage line is higher in elevation than the basement floor of the building. To avail of the gravity flow of water, the pipe is well fitted and suspended from the ceiling by suitable hanger spaced at close intervals.

Size of Storm Drain

The size of Storm Drain could be determined under the following considerations:

1. Gauging the rainfall over a given period, whether it is constant or exceedingly heavy shower of short duration.

2. The varying roof area and its slope including the distance of water travel before it reaches the conductors or downspout of the roof.
3. Water drains faster on higher roof pitch. Thus, requires a larger drainage pipe than that of a flat roof.
4. The height of the building is a factor that contributes to the velocity of water in a vertical pipe conductor. It accelerates the flow of water entering the storm drain.
5. The use of short offsets and indiscriminate use of fittings will affect the flow of water and should be avoided.

Installation drainage

Drain Pipe Installation Preparation: - To prepare for your Future Leaders Exchange FLEX-Drain project the first thing you want to do is measure the job site out, make sure you get enough pipe and enough fittings to do the project. Also measure your downspouts; make sure you've got the right size opening for your downspout adapter that connects to your gutter. There are several sizes, make sure you choose the right one. You want to also make sure that all of your utilities are marked out before you dig and if there are permits required to dig in that area that you get the right permits and all the utilities are marked out. You also want to make sure you've got the right slope. So you make sure that the water can be sloped away from the house, and will be brought off in the right area. The last thing you want to do is make sure that you've got all your supplies and gravel in advance so that when you're doing the job you've got everything there for it.

- **Installation:-**The last thing we have to do before back filling our pipe is to install a simple end cap to make sure that you've got a decent looking end. There are lots of different ones available from several different manufacturers. Things like this one with a pop up, which we could use here. However, there's no curb here so we're going to go ahead and just use a simple 4-inch PVC with an end cap. And to install this, again you need to take a couple, install it over the male end of our pipe. And then simply snap it in the back; it'll give you a nice, clean finish. And then you just back fill the pipe.
- **Storm water:-**The function of storm water drainage systems is to collect minor design storm runoff and convey major design storm (flood) runoff to a discharge point. A storm water drainage system can be as simple as a ditch that outlets to a stream or as complex as a system comprising numerous intakes, manholes, and pipes along with ditches, storm water retention or detention basins, and pump stations. Storm water drainage systems consist of two components: the minor system and the major system.

- **Minor Systems: -** Minor systems (or "convenience" systems) are designed to carry runoff from a minor design storm event. In this manual, a minor design storm is generally taken to be a storm event that has a 10% probability of being equaled or exceeded in any year (often referred to as the 10-year storm). Minor systems consists of curbs, gutters, inlets, pipe and other conduits, open channels, pumps, detention basins, water quality control systems, etc.
- **Major Systems:-**Major systems are designed to convey storm water flow that exceeds the capacity of the minor system. This usually occurs during a major storm event. In this manual, a major design storm is generally taken to be a storm event that has a 1% probability of being equaled or exceeded in any year (often referred to as the 100-year storm). Major systems consist of designated overland flow routes such as streets, ditches, and swales which direct runoff to natural or manmade channels. Routing paths should be evaluated and appropriate flowage easements obtained for major storm runoff. Storm probabilities and recurrence intervals are discussed in more detail in Section.
- The objective for roadway storm water drainage systems is to provide safe passage for vehicular and pedestrian traffic.
- Quickly drain minor design storm runoff from the pavement surface, and convey this runoff through the minor system to a discharge point, without the system backing up at collection points (intakes) creating the potential for flooding.

  Convey major design storm (flood) flows through the major system to a discharge point.
- Discharge storm water without adverse on- or off-site impacts and without increasing downstream erosion or sedimentation.
- **The Design Process** A preliminary design field review of the storm water drainage system location and associated watershed is advised. This allows designers to become familiar with the area and special drainage concerns that may exist.

3.4 Installation test

Test for leakage a drain that carries sewage must not leak in to the surrounding ground. To make sure that the joints are secure, drains should be tested before they are covered up. The test is usually set up by the builder and checked by a building inspector.

There are three methods testing:

- Water test
- Air test
- Smock test

Water test

Use the following steps to do a water test:

Step 1. Seal the branches and vent lines and place a test plug in the test t.

Step 2. Fill the system with water and check for a drop in the water level.

Step 3. Check each joint for leaks if the water level drops noticeably. The test is satisfactory if the water level does not fall more than 4 inches in a 30- minute period.

Step 4. Make leaking joints watertight and replace any defective material.

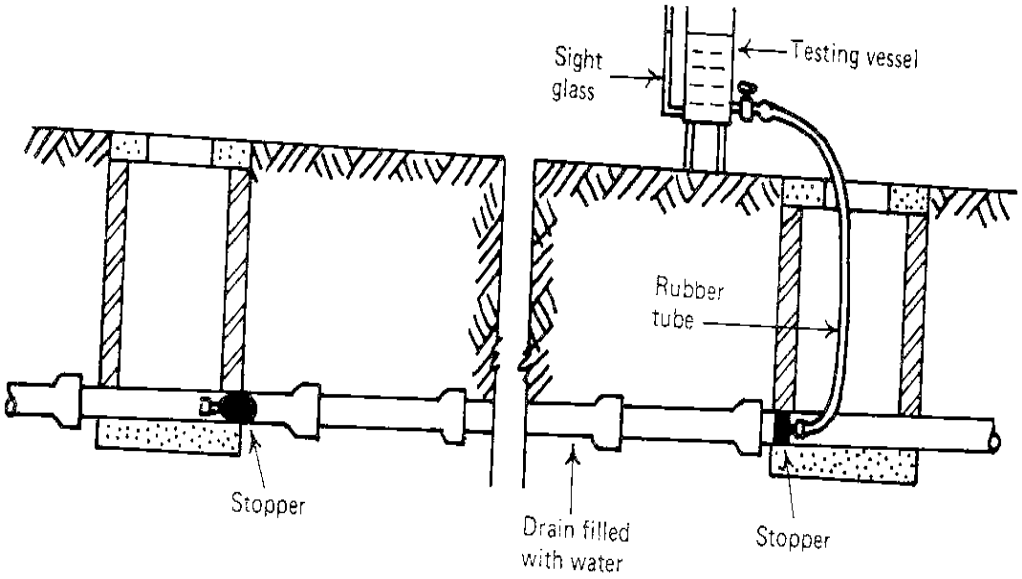


Figure 3.3 Water test on drainage pipe

Air test

A special plug, through which air is pumped into the system, is required for this test. In a cast-iron soil pipe system, close all openings after you have drained the water. Use the following steps to do an air test:

Step 1. Apply an air pressure of about 5 psi (measured by a gauge).

Step 2. A drop in the mercury column on the gauge shows a leaky joint. In a satisfactory test, the line should hold 5 psi for 15 minutes.

Step 3. Listen for the sound of escaping air to help locate leaks. If no sound is heard and pressure is falling, apply a soap solution to the joints in the area of the leak. If there is a leak, bubbles will form.

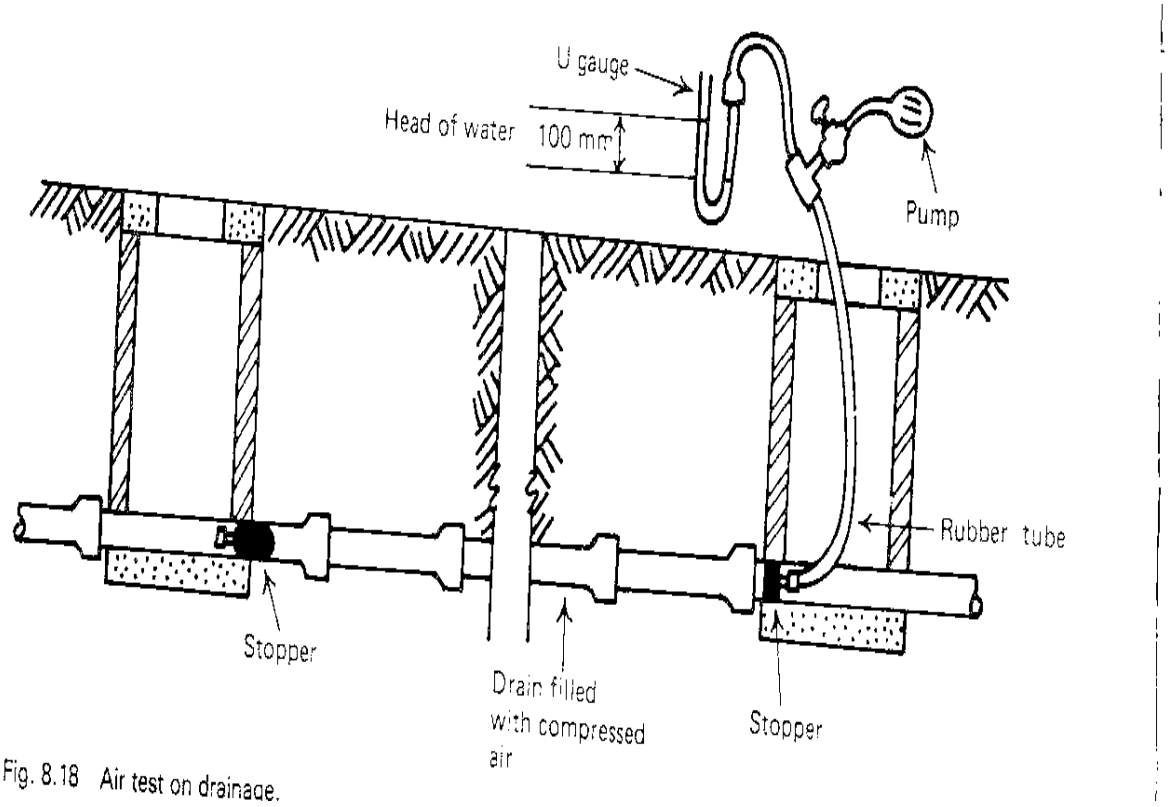


Fig. 8.18 Air test on drainage.

Figure 3.4 Air test on drainage pipe

Smoke machine during testing.

- Test for straightness and obstruction

This test can carry out by placing a mirror at one end of the drain and a lamp at the other end. It will be seen by looking through the mirror whether or not the drain is straight or has an obstruction.

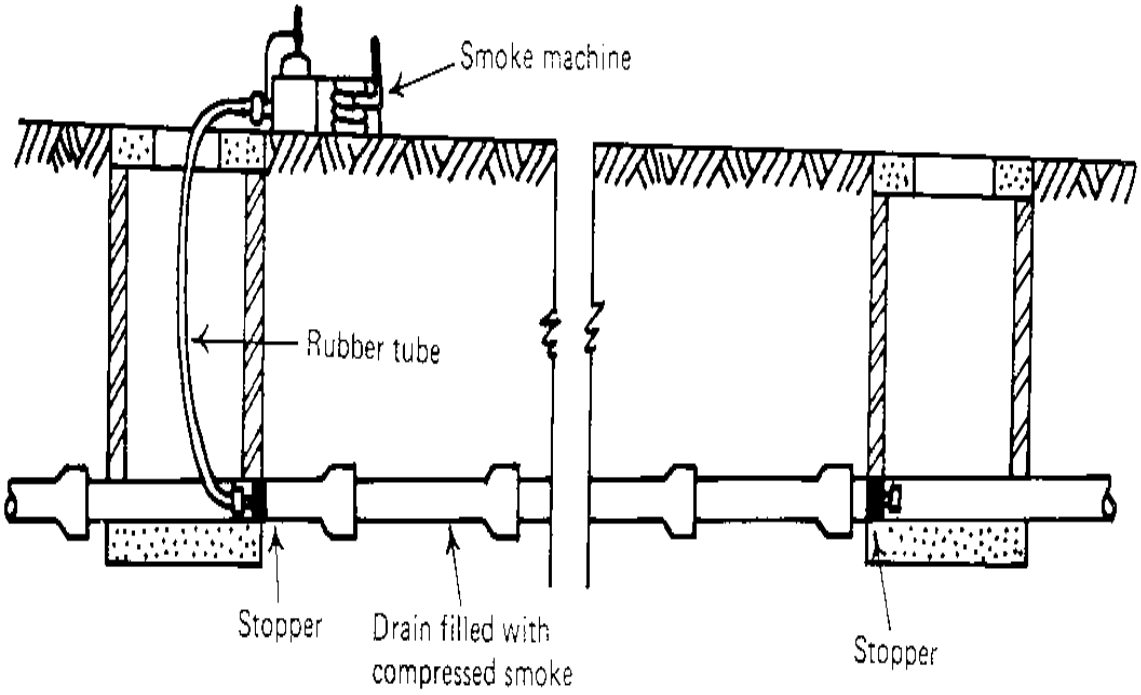


Figure 3.5 smoke test

Note To test these types of piping, choose either the water or the air test.

3.5 Inspection of openings and covers

Drainage Inspection

Drain maintenance is crucial in order to ensure that your drainage system is running smoothly and prevent problems down the road and the most crucial part of maintenance that is inspection. This is because drainage inspection can diagnose any issues in your drainage system even before you would notice them, potentially saving you money as simpler problems are easier and cheaper to fix than those that have been developing for a long time. That is why we offer drainage inspections to homes and businesses in the. we want you to have the best drainage system available to help save you money in the long run by avoiding future repairs.

During Drainage Inspection

As mentioned earlier, drainage inspection can be a difficult process as there are many areas that you need to examine and only a professional will have the training necessary to do so., we will investigate areas such as vents, traps, floor drains and any leaking areas. If you are aware of any bad odor or leaks, we will know what may have caused that problem and check that area. We will also check around your home's foundation to ensure that there is no damage due to water problems. Additionally we will be sure to check any areas of your yard that are wetter than normal to ensure that the drainage is functioning smoothly in those areas.

Inspection

(I) Visual inspections shall be carried out at both interim and final testing in order to detect faults in construction or material not shown up under test but which could lead to failure at a later date, possibly after expiry of the contractual maintenance period.

(2) (a) All internal pipe work shall be inspected to ensure that it has been securely fixed.

(b) All cisterns, water heaters.etc shall be. Inspected to ensure that they are properly supported and secured, that they are clean and free from swarf and that cisterns are provided with correctly-fitting covers before testing takes place.

(3) (a) Trenches shall be inspected to ensure that excavation is to the correct depth to guard mechanical damage due to traffic or other activities.

(b) In visual inspection. Of pipe lines laid in open trenches, particular attention shall be paid to the pipe bed, the line and the level of the pipe, irregularities at joints, the correct fitting of valves, the correct installation of thrust blocks where required, and ensure that protective coatings are undamaged.

3.6 Back-fill Excavation

Backfilling is the process of putting soil back inside a trench or in a foundation when the excavation has been completed. The backfill process requires skills and knowledge on the specifications, contract requirements and understanding soil conditions. Backfilling is used in tasks such as protecting foundations, landscaping, or filling in voids in underground structures. Every soil has unique characteristics requiring different construction techniques to ensure optimum performance.

Impact loading of the pipeline, shafts, structures, and appurtenances must be avoided during the placement of backfill. Backfilling can be done using the following techniques.

Backfill Using Water Jetting: - **Water jetting** is a technique that relies on specific material but no compaction. Backfilling with jet allows the contractor to leave the trench and come back later forcing pressurized water into the trench using a long metal device. Water jetting should be avoided on plastic soils or heavy clay soils, however, it is recommended in sand or in highly fissured bedrock. In jetting, you pump the water under pressure and use the force of the jetted water to move the bedding or backfill material around. Flooding or 'jetting' backfill generally produces poor to very poor compaction. It is necessary to take preventive measures to contain water containing sediment, and in particular, prevent it entering drains and water courses. If the water cannot drain from the backfill soils, the material will be setup for future collapse.

Flow able Fill Used to Backfill: - Backfill can also be done using flow able fill, a cementations material with a low water/cement ratio, delivered to the job site by a ready mix truck. The material is then placed as backfill directly from the truck, just like regular concrete. Backfilling with flow able fill should be done carefully, making sure that the utility pipe is covered first with an aggregate material. Allowing flow able fill to engulf the pipe can create problems for those needing to hand dig around the pipe in the future. The other challenge when using flow able fill is that the material does flow so the contractor must block or prevent the backfill material to flow continuously to other trench areas.

Properly Backfill Utility Trenches:- Follow these steps when backfilling utility trenches:

1. Backfill trenches and excavations immediately after the pipe are laid, unless other protection is directed or indicated.
2. Select and deposit backfill materials with special reference to the future safety of the pipes.

3. In the lower portion of the trench, deposit approved backfill and bedding material in layers of 6" maximum thickness, and compact with suitable tampers to the density of the adjacent soil until there is a cover of not less than 12" using special care not to damage pipe and pipe coatings.
4. Except for special materials for pavements, backfill the remainder of the trench with material free from stones larger than 6" or ½ the layered thickness, whichever is smaller, in any dimension.
5. **Under roads, streets, and other paved areas:**
    - Mechanically tamp in 6" layers using heavy duty pneumatic tampers or equal.
    - Tamp each layer to a density equivalent of not less than 100% of an ASTM D698 Proctor Curve (Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))
    - Provide additional compaction by leaving the backfilled trenches open to traffic while maintaining the surface with crushed stone.

Fig 3.6 back-filing

Self-check-3

I. Write True or False if the statement is correct and incorrect respectively

1. Test for leakage a drain that carries sewage leak in to the surrounding ground.
2. Drain maintenance is crucial in order to ensure that your drainage system is running smoothly and prevent problems
3. The last thing we have to do before back filling our pipe is to install a simple end cap.

II. Choose the best answer from the following alternatives

1. Which one is the presence of a water table high enough to have an adverse effect on buildings and infrastructure within urban

a) Size and location
b) Size selection
c) Drain types
d) All

2. Which one is designed to convey storm water flow that exceeds the capacity of the minor system?

a) Minor Systems
b) Major Systems
c) a & b
d) All

3. What are the methods of installation testing?

a) Water test
b) Smock test .
c) Air test
d) None

III. Mach Column "A" with Column "B"

Column "A"	Column"B
_____1 Water jetting	A. Visual inspections shall be carried out
_____2. Backfilling	B. is adopted street drainage line is higher in elevation
_____3. Inspection	C. is a technique that relies on specific material
_____4. Overhead Storm Drain	D. is a narrow excavation
_____5. Trench	E. is the process of putting soil back inside
	F. Cast-iron

Operation Sheet	Installing pipe work

Follow Procedures for installing pipe work;

1. Wear appropriate PPE
2. Obtain prepared plan or drawing
3. Set out site for excavation
4. Select excavation tools and equipment
5. Identify appropriate pipe and fitting
6. site clean and put sand
7. Install the pipe

LAP Test	**Practical Demonstration**

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --------- hours.

Task : Installing pipe work and storm water/subsoil drainage system

Unit Four: Install pre-fabricated inspection openings and enclosures

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

- Site and location of the excavation
- Site excavation
- Inspection of pre-fabricate opening/enclosure

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:

- Mark Site and location of the excavation in accordance with plans/specifications ensuring and not disturb existing services
- excavate and prepare site for installation in accordance with plans/specifications and regulatory authorities' requirements with minimal damage to surrounding structures or the environment
- install pre-fabricate inspection opening/enclosure in accordance with plans/specifications and the regulatory authorities' requirements

4.1 Site and location of the excavation

Drainage site

Site Drainage, by definition, is the movement of water to another area away from the site. For purposes of this manual, we are dealing with standing water on sites caused by poor drainage. Site Drainage measures help prevents the flooding of property, drainage structures, waterways and roadways.

Fig 4.1 Drainage site

Excavators can help prevent unintentional damage to pipelines and other underground utilities by accurately white lining the excavation area, calling to have lines marked prior to digging, waiting the appropriate time to have lines marked and digging with care near lines using appropriate techniques and equipment.

Excavators can help ensure that pipelines and other underground utilities are properly marked prior to digging by white lining, or pre-marking, a job site with white paint, flags or stakes to show the exact excavation area before calling the One Call center.

- White lining is not required in all states, but it is a recommended best practice. Listed below are steps for how to white line an excavation area:
  - ✓ Identify the area you plan to excavate
  - ✓ Obtain white paint, flags or stakes

- ✓ Use the paint, flags or stakes in a continuous line, dots marking the radius, dashes in each of the four corners or dashes outlining the project perimeter
- ✓ Make each dot at least one inch in diameter Excavators are responsible for providing access to the excavation site.
- ✓ Make sure that gates are unlocked or that personnel are on site to provide access for lining locating.
- ✓ Pipelines that are maintained and owned by the resident or building owner rather than a pipeline operator are typically not located through the One-Call process.

4.2 Site excavation

Centerline drawing or gridline drawing

Gridline drawings represent the grids marked in numbers and alphabets whose measurements are shown for site marking out reference. These grid lines are so aligned that the line falls on the excavation.

Excavation drawing

Excavation drawing represents the length, width and depth of the excavation. Excavation line is marked in dotted line.

When working with an excavation deep it would be necessary for you to be competent for trenching operations. To provide practical guidance on the things that you want to do and follow the following procedures.

- Check with supervisor state legislation and drawings.
- You will need to excavate the hole in accordance with the plans or specifications, regulatory requirements.
- From the painted surface markings, clear the topsoil and place to one side.
- Excavate the hole to the required depth using the reference level peg to check the depth and the position by checking against the alignment stakes: do not enter the excavation whilst a machine is operating if the hole is over 1.5 m deep, do not enter the excavation if it can be defined as a trench before proper shoring and Work Cover notification has been done use steps ladders to enter and exit the excavation and do not climb up the sides
- Monitor machine activity to avoid damage to other services works or buildings. Make sure all regulations are complied with if working near power lines. Do not enter the

excavation unless all precautions have been taken, especially if surrounding area is showing signs of movement.

- Excavated material should be contained on the worksite with suitable bund walls or silt fences erected to prevent contaminated run-off:
- silt in public walkways or roads must not be allowed to occur, forward planning should make provisions for wet weather conditions.
- Trim by hand, any small areas which may interfere with the forms. Do not enter the hole until all safety precautions have been taken
- Check the base is level and if necessary place sand bedding to provide a level surface to the underside of the pit floor.
- Erect a suitable barrier around the site to prevent entry by unauthorized persons or vehicle.
- Check excavation effects on adjacent works at regular intervals as it may take some time for effects to become visible.
- If the hole is making water do not enter unless all safety precautions have been taken. Remember this is the time when it could collapse. Monitor the surrounding area if pumping is extracting significant water.
- When an excavation is near buildings check the condition of the structure before excavating and then for movement, indicated by cracking, during and after the hole has been dug.
- Remember to be clear about who is responsible for security at the site and what is involved, as temporary fencing may be needed to protect the works.
- Stockpile material in a location that will not interfere with work and be far enough away from the excavation so as not to create a surcharge on the excavation wall and cause a collapse.

4.3 Inspection of pre-fabricated opening/enclosure

Pipe Distribution System

A piped system can vary from simple to extremely complicated. Most piped systems have the same basic components: pipes, valves, fire hydrants, service connections, and reservoirs.

Thrust Block –A concrete wedge placed between a fitting and the trench wall, used to transfer the force from the fitting to the trench wall, and thus prevent the fitting from being pushed away from the pipe. Thrust forces are created in a pipe line where it changes direction, changes size, or dead-ends or at valve and hydrant locations. To prevent pipe joints from uncoupling and other damage from internal pressure or water hammer, **thrust block** may be used. Thrust blocks are often made of concrete and steel reinforcement rods cast in place or large precast concrete blocks. It is important that thrust blocks rest against undisturbed soil with sufficient bearing area.

Purposes of thrust block

- Important to hold pipe in place
- Plans show locations
  - end block keeps pipe joints from pulling apart
  - corner blocks resist thrust as water flow changes direction
- Place against undisturbed soil
- Contact area against undisturbed soil is typically shown on the plans

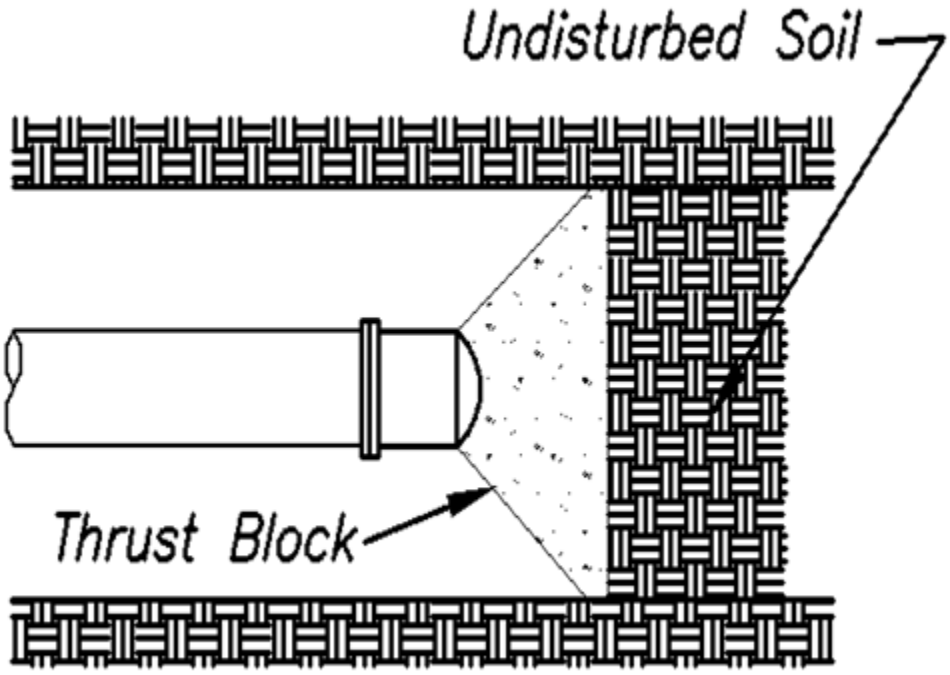


Figure 4.2 Thrust block

Pressure Testing and Disinfection

Water should be delivered to the consumer at a minimum pressure of 35 psi measured at the property line or meter. A typical working pressure in most systems is 60 psi. The absolute minimum pressure at all points in the distribution system is 20psi, while 100psi is the maximum pressure desirable. Excess pressure will potentially damage water heaters, fixtures, and appliances.

Self-check-4

I. Mach Column "A" with Column "B"

Column "A"	Column"B
____1 Thrust Block	A. represent the grids marked in numbers and alphabets
____2. Excavation drawing	B. is adopted street drainage line is higher in elevation
____3. Gridline drawings	C. placed between a fitting and the trench wall
	D. is a narrow excavation
	E. represents the length, width and depth of the excavation

II. Write <True or False> if the statement is correct and incorrect respectively

1. Water should be delivered to the consumer at a minimum pressure of 35 psi measured at the property line or meter
2. Drainage site is the movement of water to another area away from the site.
3. A piped system cannot vary from simple to extremely complicated.

III. Choose the best answer from the following alternatives

1. One of the following is purposes of thrust block

a) Important to hold pipe in place
b) Plans show locations
c) Contact area against undisturbed soil is typically shown on the plans
d) All
e) None

2. One of the following is true about thrust block

a) Prevent the fitting from being pushed away from the pipe.
b) Thrust forces are created in a pipe line
c) a & b
d) All

Unit Five: Install domestic treatment plant

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

- Size and location of excavation
- Site preparation and excavation
- Domestic treatment plant
- Plant water to prevent flotation
- Back-fill of the excavation

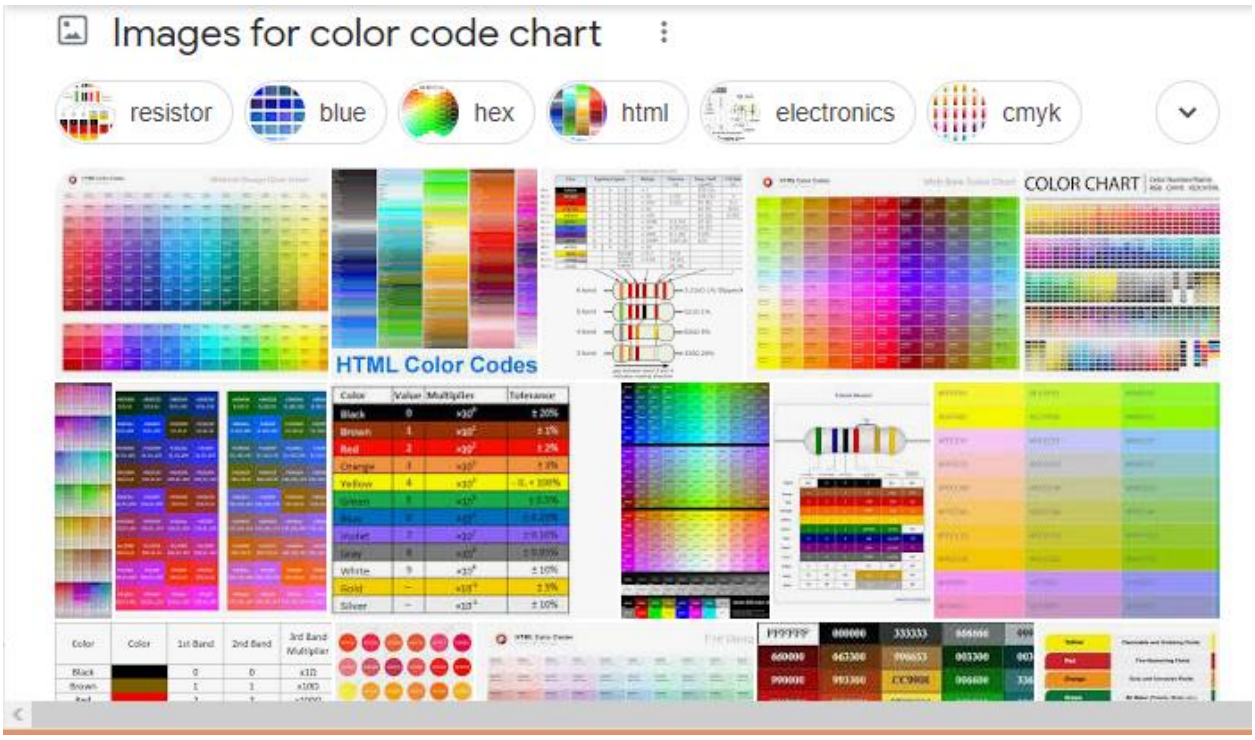
This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Mark Size and location of excavation out to comply with drawings/specifications, installation and site requirements
- Prepare and excavate site for installation in accordance with installation requirements for the plant, plans, permits and site requirements, ensuring minimal damage to surrounding structures or environment
- Install and secure domestic treatment plant to prevent movement or damage to plant in compliance with requirements of the responsible authority for the installation and inspection of domestic treatment plants
- Fill plant with water to prevent flotation
- Backfill Excavation to specifications

5.1 Size and location of excavation

Flags, Paint & Temporary Markings

Operators normally mark the location of underground pipelines using yellow flags, paint or stakes. Other types of underground lines will be marked in different colors. **Refer to the color code chart** for more information regarding what each color represents. Respect the marks and dig with care. Consider the following methods when digging near a pipeline: hand digging, soft digging, vacuum excavation methods and pneumatic hand tools. If you have questions regarding proper digging techniques near a pipeline, ask the pipeline operator for assistance.



Color	Value	Multiplier	Tolerance
Black	0	$\times 10^{0}$	± 20%
Brown	1	$\times 10^{1}$	± 1%
Red	2	$\times 10^{2}$	± 2%
Orange	3	$\times 10^{3}$	± 3%
Yellow	4	$\times 10^{4}$	- 0, + 100%
Green	5	$\times 10^{5}$	± 0.5%
Blue	6	$\times 10^{6}$	± 0.25%
Violet	7	$\times 10^{7}$	± 0.10%
Gray	8	$\times 10^{8}$	± 0.05%
White	9	$\times 10^{9}$	± 10%
Gold	–	$\times 10^{-1}$	± 5%
Silver	–	$\times 10^{-2}$	± 10%

Color	Color
Black	
Brown	
Red	
Orange	
Yellow	
Green	
Blue	
Violet	
Grey	
White	
Gold	
Silver	

Fig 5.1 color code chart

Figure 5.2 Temporary Markings

Many pipeline operators request to be present during excavation that occurs close to their pipeline. Coordination with the operator keeps everyone safe and prevents project delays.

Permanent Pipeline Markers: - Operators place signs along the pipe line route to identify the general location of a pipeline and specify the type of product transported the operator's name and an emergency contact number. Pipeline markers do not identify the exact location of a pipeline and should not be used to locate pipelines prior to excavation

5.2 Site preparation and excavation

Working in excavations. As a plumber you may occasionally be required to work in excavations. When working in or around the excavations, it is necessary to work in accordance with the specific Health and Safety guidelines that apply. The Health and Safety legislation that exists is mainly designed to prevent the following eventualities

Collapse of the excavation walls

Persons falling into the excavation. Excavations are often classed as confined spaces and control measures may include a permit to work system.

. When an excavation is deeper than 1.2m the sides should be either sloped or shored. Where shoring is required strong wooden timbers or steel plates should be used (steel plates are usually found in deeper excavations). The amount of these materials required will normally depend upon the soil/ground type in a particular area or the depth of the excavation. It is recommended that excavations should be inspected by a competent person:

At the start of each shift before work

befall prevention Fencing must be erected around any excavation into which someone could fall more than 2m, but it stands to reason that precautions should also be taken for holes/trenches less than this depth in order to protect the safety of workers and the public.

Pre-construction Planning & site excavation:-Prior to installation, consider making a video record along the job site. The water main should be installed to the line and grade established by the engineer. This precaution is usually required in metropolitan areas where sub-surface utilities located in the streets must be avoided by going over, under, or around them. The engineer establishes the location of these structures and provides a detailed plan and profile. The pipe laying foreman should plan excavation work, equipment, and manpower to fit the plans provided as well as carefully investigate the construction site before moving equipment to the site. When equipment space is limited, small trenchers may be needed. Some urban streets and alleys may be so narrow that hand work or a small backhoe or trenching machine may be required to install the pipeline. The reverse of these conditions is found on cross-country installations where pipe may be strung for a long distance ahead of the actual excavating operation. More trenches can be opened ahead of the pipe-laying crew, and safety conditions are more easily controlled. Work crews can be organized on the assumption that long stretches of main will be installed each day. If lengths of pipe and fittings have not been strung along the route in advance, plans should be made for their Delivery as needed.

5.3 Domestic treatment plant

The selection of various water-treatment methods to partially remove and replace various chemical and suspended agents from a feed-water stream. It also discusses water conditioning chemicals used to control the impact of ionic compounds, adjust pH, and inhibit corrosion; and pure-water systems that remove impurities from the feed water to a level at or below the limits desired by the end user. Information on basic water chemistry, impurities found in water, water analysis, and impurity measurement is presented.

General selection criteria for the removal or reduction of specific impurities from water are also discussed. Explanations on water-conditioning systems for boiler feed water, water-conditioning systems for cooling water, and the generation of purified water are also found in this Information Sheet-3. For the purposes of discussion in this Information Sheet-3, the term “water treatment” is

intended to mean the chemical or mechanical removal and /or replacement of ionic or non-ionic substances in feed water to produce water for a predefined use. “Water conditioning” is intended to mean the addition of chemicals to water for the purposes of inhibiting corrosion, chelating hardness, chelating trace metals, suspending colloids, and adjusting ph. “Pure-water systems” are intended to mean systems designed to produce water pure enough for use in pharmaceutical plants, laboratories, high-density semiconductor manufacturing, and very high-pressure boilers

The explanations and definitions given are simplified but suffice for the purposes

1 Potable water treatment shall comply with the 1986 Safe Drinking Water Act and amendments.

2. The Environmental Protection Agency (EPA) has identified treatment technologies with given contaminant removal efficiencies for potable water.

3. Pure-water treatment shall comply with one or more of the following, depending on the purity of the water desired.

4. Water treatment for boiler feed water, cooling water and process water.

5. Food and Drug Administration (FDA)

5.4 Plant water to prevent flotation

There are two methods of preventing flotation

1. **Pipe Plugs**: - at times when pipe lying is not in progress, the open ends of the pipe should be closed with a watertight plug or other means approved by the owner. The plug should have a means of venting and, when practical, should remain in place until the trench is pumped dry. Air or water pressure in the pipeline must be released prior to removal of the plug. Care must be taken to prevent pipe flotation if the trench floods.
2. **Push-on Joints**: - The push-on joint consists of a special bell, plain end, and rubber gasket. The bell is provided with an internal groove in which the appropriate gasket is seated. The plain end is beveled, and the joint is assembled by pushing the plain end into the bell, which compresses the gasket and forms a watertight seal. Different push-on joint designs are used by various Ductile Iron Pipe manufacturers.

Consequently, the bell socket is different for each type of gasket, and the gaskets are not interchangeable. The outside diameter of all Ductile Iron Pipe of the same size, however, is standardized, regardless of the manufacturer. Care must be exercised to make certain that the correct gasket is being used for the joint design being installed and that the gasket faces the

proper direction. The following illustrations highlight the steps followed in making up the joint. When pipe is cut in the field, bevel the plain end with a heavy file, an air-driven grinder, or other suitable device and remove all sharp edges. Within regulations do not allow the bevel to be made using the blade of a saw used to cut the pipe. Refer to a shop-manufactured bevel as a guide for proper shape. Either push-on joint or mechanical joint fittings May be used with push-on joint pipe. The plain end of the pipe is provided with either one or two painted gauge lines that can be used to determine if the plain end has been properly positioned in the bell socket. The pipe manufacturer's instructions regarding the Location of these lines after assembly should be followed.

5.5 Back-fill of the excavation

Carefully backfill the trench accords to the procedures in Standard. To prevent damage during backfilling, allow adequate slack in the tube at the joint. Backfill should be free of cinders, rocks, boulders, nails, or other materials that might damage the polyethylene. Avoid damaging the polyethylene when using tamping device.

Fig 5.3 Backfilling the excavated soil

Self-check-5

I. Choose the best answer from the following alternatives

1. To prevent damage during backfilling

a) Allow adequate slack in the tube at the joint

b) Should be free of cinders, rocks, boulders, nails,

c) A & B

d) All

2. Which method used when digging near a pipeline:

a) Hand digging

b) Soft digging

c) Vacuum

d) All

II. Short answer questions

1. In preventing flotation the push-on joint consists of:

2. As a plumber you may occasionally be required to work in excavations, what you can apply

III. Mach Column "A" with Column "B"

Column "A"	Column"B
_____1 EPA	A. Operators place signs to identify the general location
_____2. Permanent Pipeline Markers	B. is any systematic process
	C. The Environmental Protection Agency

Unit Six: Install sanitary drainage systems

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

- Pipe work set out
- Pipe work services
- Connections for alterations, additions or repair
- Checking of installation
- Testing of Installation

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:

- Set out pipe work in accordance with drawings/specifications, site requirements or job instructions, with consideration to the location of existing services
- Install pipe work in accordance with plans/specifications, standards and workplace procedures and without damage to surrounding environment, existing pipe work or other services
- Made connections for alterations, additions or repair to existing systems in accordance with standards and manufacturers' specifications
- Check installation for compliance with design drawings, specifications, site requirements, standards and authorities' requirements
- Test installation to comply with standards and relevant authorities' requirements

6.1 Pipe work set out

The preliminary site work for piping system usually begins after the site facilities are set up. Clearing the site is essential; first, all vegetation such as bushes and scrub should be removed. The site heeds to be clear of rocks and boulders in the excavation area. Site clearance is done by a combination of manual and mechanical methods.

The points to be considered for the sitting out of piping system

- Work should begin after official permission has been given by the local authority
- The working drawing and specification should contain all the information that the plumber needs to complete the setting out.
- The site should be prepared before the work starts
- The tools and materials should be prepared before the work starts.

Setting out pipe system is planned for different considerations and criteria's. Some of them are listed below:-

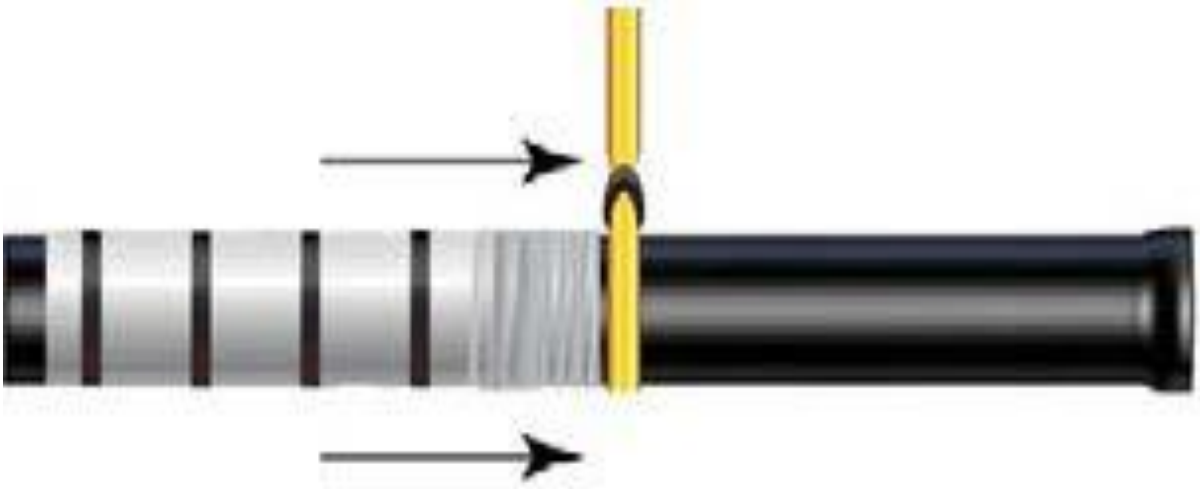
- types/quality of material
- cost of material
- liquid type
- pressure

6.2 Pipe work services /installation/

Pipework services include condensate, water and gas, heating, and compressed air distribution systems in a wide range of commercial applications.

Wet Trench Conditions: - In wet, sloppy trench conditions, the pipe should be completely covered by the polyethylene tube before it is lowered into the trench. This alternate method is illustrated below.

Step 1:- Cut a section of polyethylene tube approximately 2-feet longer than the pipe section. Remove all lumps of clay, mud, cinders, or other material that might have accumulated on the pipe surface during storage. Slip the polyethylene tube around the pipe, starting at the spigot end. Bunch the tube accordion fashion on the end of the pipe. Pull back the overhanging end of the tube and circumferentially tape it to the barrel of the pipe outside of the insertion line, approximately 12 inches from the spigot end.



Step2: - Take up the slack in the tube along the barrel making a snug fit and fold over the excess polyethylene. Apply circumferential wraps of tape every two feet until you run out of room. This is extremely important to avoid the sagging of the film at bottom of the pipe.

Step 3:- Dig a shallow bell hole in the trench bottom, lower the pipe and make up the joint. Slide the sling to the bell end and lift slightly to provide clearance to slide the encasement to the end. Continue to snugly fold over and tape at 2 foot intervals to secure the polyethylene.

Step 4:- Make the overlap of the polyethylene tube by pulling back the bunched polyethylene from the preceding length of pipe and ensure there is at least a 12” overlap. Secure the polyethylene with a circumferential wrap of tape at the overlap and behind the preceding bell.

Step 5:-Repair any damage to the polyethylene and backfill according to the standard.

Figure 6.1 lying pipes

Special Installations

- ✓ **Pipe through Walls:** Wall pipes or wall sleeves should be used where Ductile Iron water mains pass through concrete walls of meter vaults, large valve pits, or other walls to eliminate a rigid connection between the pipe and wall. The sleeve or wall pipe provides flexibility to prevent the pipe from being subjected to heavy beam loading. Additionally, it is good practice to locate a flexible joint about 18-inches from the outside face of the wall. The trench bottom under the pipe leading into a building or vault should be firmly tamped to minimize settlement under the pipe. If soil conditions indicate that significant settlement will occur, at least 2-inches of crushed stone should be compacted to provide a permanent support under the pipe. Remember, all pipes entering walls from the outside must be protected from cantilever beam action.

6.3 Connections for alterations, additions or repair

Splash leaks in the shower & tub

You should test your shower door to know whether water is splashing around it. In case there's water seeping behind the door frame, then you'll need to caulk the door frame from inside the shower area. Also, apply new caulking on the joint where the tub meets the floor.

Splash leaks occur when water escapes beyond the shower door or shower curtain. Plumbers argue that this is the most prevalent bathroom leak. While you might assume that splash leaks are a minor thing, they can lead to extensive damage in the subfloor area where the floor meets the shower or tub. The result will be loosening of the tiles or vinyl flooring. Even worse, your plywood subfloor may delaminate and rot, thereby demanding replacement of which may be expensive.

Signs of problems:

- Water stains around the joists or ceiling.
- Flaking or peeling paint and chalky-looking wooden finishing around the shower.
- Loose tiles or curling vinyl floor around the tub.
- Water seeping past the shower curtain.
- Mold on the bathroom floor or the wall near the shower or tub.

Finding the source of the leak:

- In case your shower area has a door, splash some water around the shower door frame and the door itself. Leaks should take around 5 minutes to appear.
- In case the shower door has a door sweep made of rubber, check whether it has some gaps. If the shower door has some rubber gaskets, also check them for gaps.
- Check whether the caulk has any gaps, especially the area where the tub or shower meets the floor.

Fixing the leak:

- If your shower has a shower area curtain instead of a door, then ensure it's completely closed when taking a shower. Else, install a fitting splash guard.
- Ensure overlapping sliding doors close properly. Ensure the inner sliding door is as close as possible to the shower faucet.
- Replace worn out door sweeps or gaskets. Take the old door sweep or gasket with you when shopping for a replacement to get a matching size.

- Seal the leaking frame with new caulking on the frame surface inside the bathroom. Seal any gaps with caulk. Wipe any excess caulk immediately. Once the new caulk dries up, test for leaking.
- In case the old caulking on the bathroom floor has some gaps, remove it and apply new caulk.

Drain leaks in the bathroom

The area where the drain is attached to the shower or tub is highly prone to leaks. Such leakage is common with fiberglass or plastic shower pans and tubs since they flex a little bit when standing on them. They may break the sealing surrounding the drain connection as they flex. These leaks may stain the ceiling beneath or even destroy it. The leaks may also make the floor joists to rot.

If your tub is installed on a slab, the leaks may destroy the flooring within the bathroom and even damage the adjoining rooms.

Indicators of drain leak problems:

- Loose flooring around the tub or shower, or damp flooring in the adjoining rooms where a tub is installed on a slab.
- Stained joists or ceiling below the shower area or tub.

Finding the source of drain leaks:

- If you're able to view the underside part of the bathroom drain through the ceiling or access panel, fill your tub with water and release it. For the shower, close the drain opening with a cloth or rag and release water. As soon as you release water, inspect the drain and drain traps for any leakage from beneath through the ceiling or access panel.
- In case there's no access area to the drain, then close the drain opening and pour some water to create a small water puddle around it. Mark along the puddle edges by setting something like a bottle. Allow for the puddle to settle for an hour. In case the puddle reduces in size, then it's a sign that your drain has some leakage. Avoid relying on a tub stopper when doing this test since the stopper may leak some water. You should rather use a test plug for the tub (1.5 inches in size) and a 2-inch test plug for the shower.

Fixing a leaking drain:

- To repair the tub drain, start with unscrewing the drainage flange from the top. Clean it and apply some silicone caulk. You should also detach the gasket below the drain opening and carry it along with you when shopping for a replacement gasket to get a matching size. Install the new rubber gasket and reattach the flange.

- In case you can access the drain from underneath, tighten the nut locking it onto the pan. If this fails to work, then replace the entire drain assembly. In case you can access the drain from beneath, then make a hole through the ceiling underneath. Then replace the leaking drain with a new unit.

Tile leaks in the bathroom

Tile leaks usually occur when some water penetrates through the worn out caulk or grout, thereby reaching the wall area behind the tiling. Some tiling may fall off and severe rotting may be seen in the wall frame. The ceiling underneath, joists, and subfloor can also get damaged.

Indicators of leaks in your bathroom:

- Persistent mold.
- Loose tiles.
- Stained ceiling below the shower.
- In case your shower is installed against the exterior wall, then there may be peeling of paint outside.

Finding the source of the leak:

- In case there's some loose tiling behind the faucet or tub spout, check through the access area for stains or dampness.

Fixing tile leaks:

- Remove any old caulk, grout, and loose tiling.
- In case the area behind the tiling is still in good condition and solid, then you can fix the leak by reattaching the tiles and applying new grout and caulk.
- In case there're some loose tiles or the wall looks spongy, then install new tiling and a high-quality backer board or fiberglass surround.

Leaks around the toilet flange

These leaks usually occur around the area where the waste pipe connects to the toilet. A leaking flange means that wastewater will leak at each and every flush. The leaks may wreck the floor and lead to damages on the ceiling below. It may also lead to rotting of the joists and subfloor.

Indicators of a leaking toilet flange:

- Stained ceiling below the toilet.
- Water seeping around the toilet base.
- Damaged or loose flooring.

The toilet is rocking slightly when pushed. Such movement may eventually damage the wax sealant that sits between the flange and toilet.

Finding the leak:

In case you have noticed stains on your ceiling, simply take measurements from the wall to the stained area before removing your toilet.

In case you take measurements and realize that the ceiling stain is around the toilet above, then a leaking toilet flange might be the cause of the problem. Simply remove your toilet and check for these signs:

- A loose flange, especially one that's not screwed tightly onto the floor.
- The flange appears to be below or in level with the floor surface.
- The flange is cracked.
- The slots into which bolts fit or the bolts themselves are broken.

Fixing a leaking flange:

In case you can't notice the aforementioned signs, then you'll need to replace the old wax ring. In case the flange's level is extremely low, you'll need to add another flange over the old one. Use a high-quality plastic flange on top on the old one. If the bolt slots or flange are broken, then install a metallic repair flange. In case your toilet is rocking due to an uneven floor, then add some shims below it when reinstalling it.

6.4 Checking of installation

If after running an installation, you need to verify that a particular feature, component Installation is checked for compliance with design drawings, specifications, site requirements, standards and authorities' requirements.

1. **Check the bathtub**: - Check whether dripping after the bathtub filled with water.

Bath installation checking is important, not only need to meet use standard, if there is any leakage accidents will bring trouble to your neighbor. So bathtub checking should be divided into two phases:

First, Should take water testing several times after installation is finished. Flushing is unobstructed, look around if there is leakage, no leakage can pass.

Second, Bathtub outfall should be directly connect with drain, avoid connect by plastic hose, not to make a open trench drain away water and sealed by silica gel (The place against the wall may come out fine draw after a long time service for human body overloading and Water dynamic load)

2. Floor drain checking

Eligibility requirements or not, blabber on the ground, the water should flow to the floor drain, and no residue.

Shower room assembly process should be in strict accordance

The assembled shower room is neat and bright appearance, the doors is parallel, perpendicular, bilateral symmetry, the two doors should be open convenient, without aperture and no leakage. the gap between shower room and shower tub should be sealed by silica gel, to prevent water seepage.

3 Basin checking

Basin 'surface should be level, cold and hot water connector should be located in the basin bottom, cold and hot water on-off or faucet has obvious identification marks. Top mount basin should be firm, and under mount basin should be support stably by solid wood cabinets, if no cabinet, should be fixed it on the wall by iron stand, at the same time, need to make a 8-12cm breakwater, at last, sealed around the basin and wall by silica gel, no leakage.

4 Toilet checking

Mainly checking the distance of toilet hole from pipeline is reasonable or not, if the distance too small, water tank will into wall, if too far, will left a big distance between the toilet and wall.

Toilet should be fixed by expansion bolt, no wood screw; the toilet bottom cannot fixed by cement, the right way is to use silica gel, to ensure watertight performance.

Some toilet use sealing rubber gasket to fixed, and sealed by silica gel. Checking can use manual test method, pay attention to if there is oscillation phenomenon. Toilet and tank installation position should be accurate. Distance random error should not be over than 10m

6.5 Testing of Installation

- **Testing/Inspecting Valves:-** Prior to installation, valves should be inspected for direction of opening, number of turns to open, freedom of operation, tightness of test plugs, cleanliness of valve ports and seating surfaces, handling damage, and cracks. Defective valves should be corrected or held for inspection by the owner. All bolts and nuts should be checked for proper tightness with the exception of seat-adjusting bolts or screws in butterfly valves, which should be adjusted only on the manufacturer's recommendation.
- **Testing hydrostatic Pressure: -** Newly installed pipelines are normally pressure tested to confirm proper installation of joints and fittings. When the new pipeline is initially filled, a calculation of a volume of make-up water is determined according to the size and length of the pipeline being tested. The make-up water allowance accounts for the absorption of water by the lining and the extension (lengthening) of pipe joints due to the thrust forces that occur when the pipeline is first pressurized. The allowance is not a measure of leakage through improperly installed joints. The pressure test is normally performed after backfilling. When unusual conditions require that pressure testing be accomplished before backfilling or with pipe joints accessible for examination, sufficient backfill material should be placed over the pipe barrel between the joints to prevent movement and consideration should be given to restraining thrust forces during the testing. In particular, restrained joint systems, which derive stability from the interaction of the pipe and soil, should be backfilled prior to testing. The consulting engineer or utility should state the test pressure in the specifications. At least 1.5 times the stated working pressure at the lowest elevation of the test section for duration of two hours is recommended. The pipeline should be filled slowly and care should be taken to vent all high points and expel all air. Vents should remain open until water flows from them at a steady flow. In addition, fittings and hydrants should be properly anchored and all valves should be:-

- **Completely closed before applying the test pressure**. When using a valve for a closure piece of test section, the rated pressure of the valve should not be exceeded. After the air in the pipe has been expelled and the valve or valves segregating the part of the system under test have been closed, pressure is then applied with a hand pump or gasoline-powered pump or, for large lines, fire department pumping equipment. After the main has been brought up to test pressure, it should be held for at least two hours and the make-up water measured with a displacement meter or by pumping the water from a vessel of known volume. Any exposed pipe, fittings, valves, hydrants, or joints should be examined carefully during the test. Damaged or defective pipe, fittings, valves, or hydrants that are discovered during the pressure test should be repaired or replaced with sound material and the test repeated until it is satisfactory to the owner. If blocking or concrete piers have been used behind fittings, the concrete should be cured sufficiently before hydrostatic tests are conducted. If tests are conducted daily at the end of the work shift, a temporary plug should be inserted in the bell and the pipeline restrained against thrust created by the test pressure. Do not depend on the weight of a few lengths of pipe to prevent the joints from separating

Self-check-6

I. Choose the best answer from the following alternatives

1. Installation is checked for compliance with:

a) Design drawings

b) Specifications

c) Standards and authorities'

d) All

2. The points to be considered for the sitting out of piping system:

a) Work should begin after official permission has been given by the local authority

b) The working drawing and specification should contain all the information that the plumber needs to complete the setting out.

c) The site should be prepared before the work starts

d) The tools and materials should be prepared before the work start

e) All

II. Short answer questions

1. What points that tells testing of installation
2. What are the indicators of drain leak problems?

III. Mach Column "A" with Column "B"

Column "A"	Column "B
_____1. Wet Trench Conditions	A. Inspecting Valves
_____2. Pipe through Walls	B. the pipe should be completely covered by the Polyethylene tube
	C. Ductile Iron water mains pass through concrete

Unit Seven: Install on-site disposal system

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

- Set out disposal system
- Underground services
- Excavation of site
- On-site effluent disposal system
- Correct operation 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:

- Check set out for compliance with plans/specifications and authorities' requirements
- Identify and mark underground services within excavation area
- Excavate site in accordance with requirements for system, plans, permits and site requirements, ensuring minimum damage to surrounding structures or environment
- Install On-site effluent disposal system in accordance with plans/specifications, standards and regulatory requirements
- Check correct operation System for compliance with standards and regulatory authorities' requirements

7.1 Set out disposal system

Collection simply refers to how waste is collected for transportation to the final disposal site. Any collection system should be carefully planned to ensure.

7 Steps to Shrink Your Trash

Step 1: Reduce. Make less waste in the first place! ...

Step 2: Reuse

Step 3: Recycle.

Step 4: Compost.

Step 5: Burn trash to make energy

Step 6: Throw it away in a landfill

Step 7: Burn without making energy

- ✓ No single step can solve our waste disposal problems.

4 types of waste disposal:

These include:

Landfill.

Incineration.

Waste compaction.

Composting.

Vermicomposting.

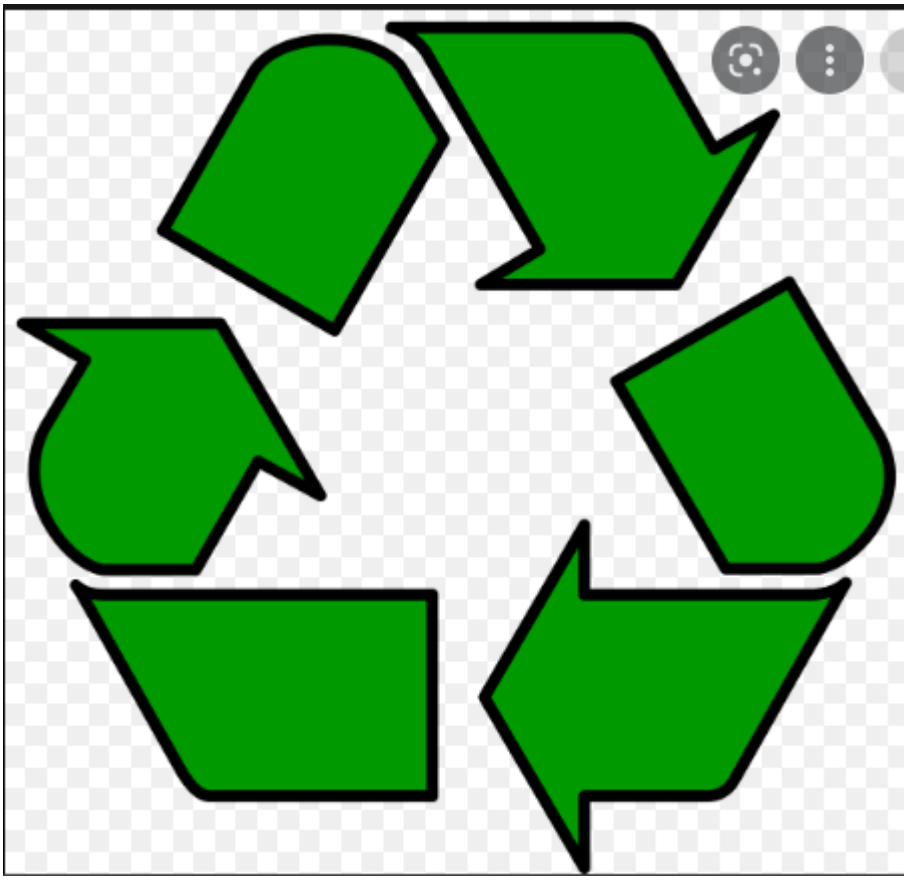


Fig 7.1 recycling waste disposal

7.2 Underground services

Drains laid under the ground should be a sufficient diameter to carry the anticipated flow, and should be laid to a regular fall or gradient to carry the foul water and its content to Adding flexible pipe

Flexible pipes should be laid in a narrow touch, on granular material such as clean, natural aggregate. This granular material is spread in the base of trench that has been excavated and roughly leveled to the gradient or fall of the drains; the granular material is spread and finished to a thickness of100mm to the drain gradient. Lengths of drain pipe are then lowered in to the French and set in position by scooping out the granule or bed from under the collars of pipe ends. To set the pipe line in place in the Center of the trench, further granular material is then spread and lightly packed each side of the pipe line, to supports.

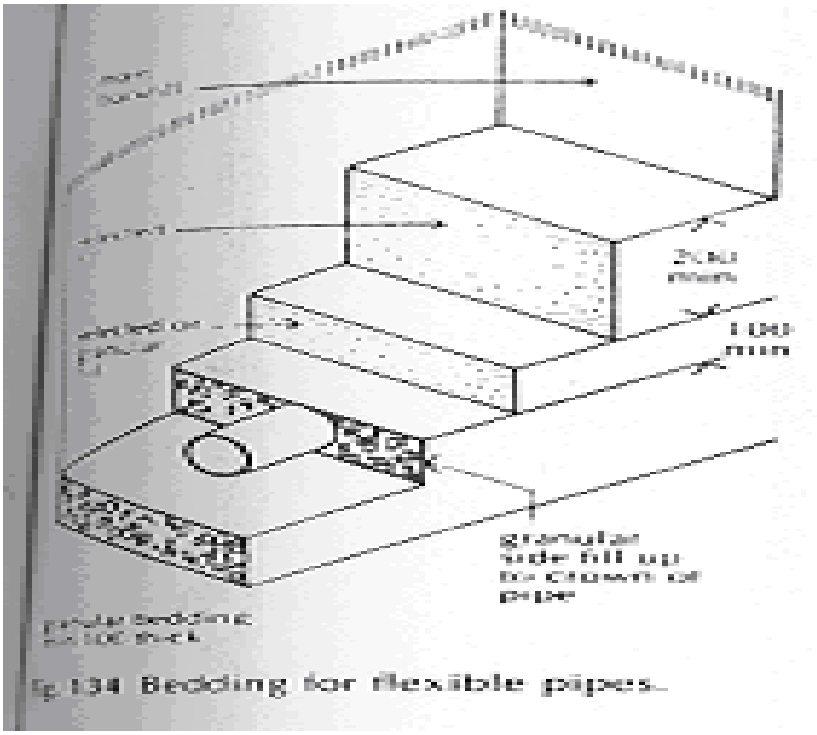


Fig 134 Bedding for flexible pipes

Fig 7.2 lying pipe underground services

A layer of granular material or selected fill taken from the excavated material, is then spread oxen the pipe line to a die of 100 A further layer of selected fill, free from stones lumps of clay or other material larger than 40mm, is spread in the French to a thickness of 200 mm, The French is then back filled with excavated material up to ground level, and considered.

This drain laying operation requires car and some skill to bed, the drain line correctly and further care in backfills of to avoid disturbing the drain in the form of a ‘’V’’ Sloping out form the center for ease of access.

Where a drain trench is excavated in some Cohesion soil such as clay for laying rigid pipe lines of claymore, for example, it is possible to lay the pipes directly on the trench bottom which has been finished to the required pipe gradient by hand framing by shovel. The pipe lengths are lowered in to the trench and soil from the trench bottom is scooped out under each socket and of pipe so that the pare of the pipes bears on the trench bottom and the collar keep the drain line in

plat his operation to be successful the trench 4 needs to be sufficiently wide for a man to stand in the trench a straddle the pipe line to scoop soil out from below the pipe collars. Once the pipe line is in place, a cover of selected fill from the excavation, free from large stokes or lumps of clay, is spread in the French to a debt he of 150 mm above the crown of the pipes, and the trench is back filled to surface level.

This bedding system is suited to the use of socket and spigot and clay pipes with one of the flexible joints that can be used in all weather conditions.

When the bed of a drain trenches cannot be trimmed to the pipe gradient, a bed of granular material is spread in the bed of the trench and leveled to the pipe gradient to a thickness of 100mm.

As an alternative the granular bedding is spread 100mm thick in the bed of the trench, the pipes are lowered in to the trench and granular bedding is stopper out under the collar ends of pipes. The granular material is then spread around the pipes. Up to half outside diameter of pipe as shower. Selected fill is then spread in the trench to a depth of 150mm above crown of the pipes, and trench is back filled to the surface.

7.3 Excavation of site

Refer Lo 3, 4 and 5 (3.2, 4.2, and 5.2)

Fig 7.3 Stability of Trench Walls

7.4 On-site effluent disposal system

Natural groundwater levels may be an important factor when determining the appropriate position and type of onsite Effluent Disposal System. The property will be located in the Resource Zone in most cases where these levels are close to the natural ground level. Within the Resource Zone, a minimum vertical separation of 2.0 meters is required between the base of a conventional onsite effluent disposal system and the highest known groundwater level. If this minimum separation cannot be achieved, either an Aerobic Treatment Unit (ATU) or Nutrient Retentive leaching system must be used. Where the property is **outside** the Resource Zone a minimum vertical separation of 1.2 meters between the highest known groundwater level and the base of the leach drain/soak well applies.

Horizontal separation guidelines for effluent disposal systems

Each effluent disposal system must:

- Be thirty (30) meters from a potable bore or other potable water source (used for drinking and domestic purposes)
- Six (6) meters from any subsoil drainage system or any open drainage channel
- 100 meters from any wetland area.

Standard requirements for conventional septic systems

Conventional septic systems have the following standard requirements:

- Installations are comprised of a 1520mm and a 1220mm diameter septic tank
- Wastewater flows from the secondary tank to the onsite effluent disposal system via a diverter box
- The onsite effluent disposal system will consist of a pair of either leach drains or a number of soak wells in two series
- Where estimated wastewater flows may be above 1400L per day, the size of tanks and disposal systems requires individual assessment and approval
- All leach drains or soak wells are to be situated a minimum of 30m from any well or bore intended for human consumption, a minimum of 6m from any sub-soil or open drainage system, and a minimum of 100m from any wetland
- Or public water supply bore.

Effluent disposal system site plans

Site plans must be drawn to a scale of 1:100, be labeled with all dimensions and include:

- Location of the effluent disposal system and all drains and pipe work
- Distance of the system from all buildings, boundaries, trafficable areas, bores, waterways and water bodies
- Site contours or spot heights in Australian Height Datum
- Volume of spa (if provided). Where the volumes of the spa exceed 350L, a separate septic tank and effluent disposal system is required.

Maintain an effluent disposal system

Property owners must:

- Pump out the tanks on a regular basis. This equates to every four years for an average four person household or every eight to nine years for a two person household
- Alternate leach drains each year. All domestic systems approved from 1990 and onwards have two leach drains and an alternating device to allow systems to rest.

Property owners must not:

- Dispose of materials that do not break down readily (e.g. plastic bags, kitchen sponges, sanitary napkins, tampons, disposable nappies).
- Dispose of old medicines, large amounts of disinfectant or other strong chemicals down the pipes leading to the septic tank. (Bleaches and detergents are acceptable if used in moderation).

7.5 Correct operation System

The purpose of testing a non-pressure pipeline is to ensure that the line has been correctly laid to line and grade, will flow satisfactorily and is sealed at each joint and fitting.

The recommended Test Methods for PVC DWV (Drain, Waste and Vent) and gravity sewer pipelines are to be found. In the case of a sewer pipeline system, three distinct areas require testing.

1. The sewer rising mains
2. The gravity pipeline sections
3. The gravity reticulation sections

Preparing for the Test

During the installation careful checking and adequate supervision will ensure that sewer lines are laid to line and grade. If an installation specification exists it should be followed. Otherwise the pipeline section to be tested should be backfilled Leaving all couplings and fittings exposed for inspection during testing. In solvent weld PVC-U jointed non-pressure Pipelines, at least 24 hours should have elapsed since the last joint was made before testing commences.

Test Procedures

All new sewers and sanitary drainage and other non-pressure installations shall be tested using either hydrostatic test, low pressure air test or vacuum testing. The tests shall also be applied to any section of existing pipeline or drain that has been repaired or replaced. All openings in the pipeline below the top of the section under test shall be sealed.

Hydrostatic Testing

The pipeline shall be filled with water to a height of not less than 1m above the natural ground level at the highest point of the section being tested, or to the flood level of the lowest sanitary fixture, but not exceeding 5m at the lowest point of the test section.

The pressure shall be maintained without leakage for at least 15 minutes. The source of any leaks shall then be ascertained and any defects repaired. The pipeline shall then be rested.

For a guide as to the amount of water required to fill the test section of sewer line, the following table has been calculated. The amount of water required in practice will vary slightly from the tabulated figures due to variations in pressure and temperature.

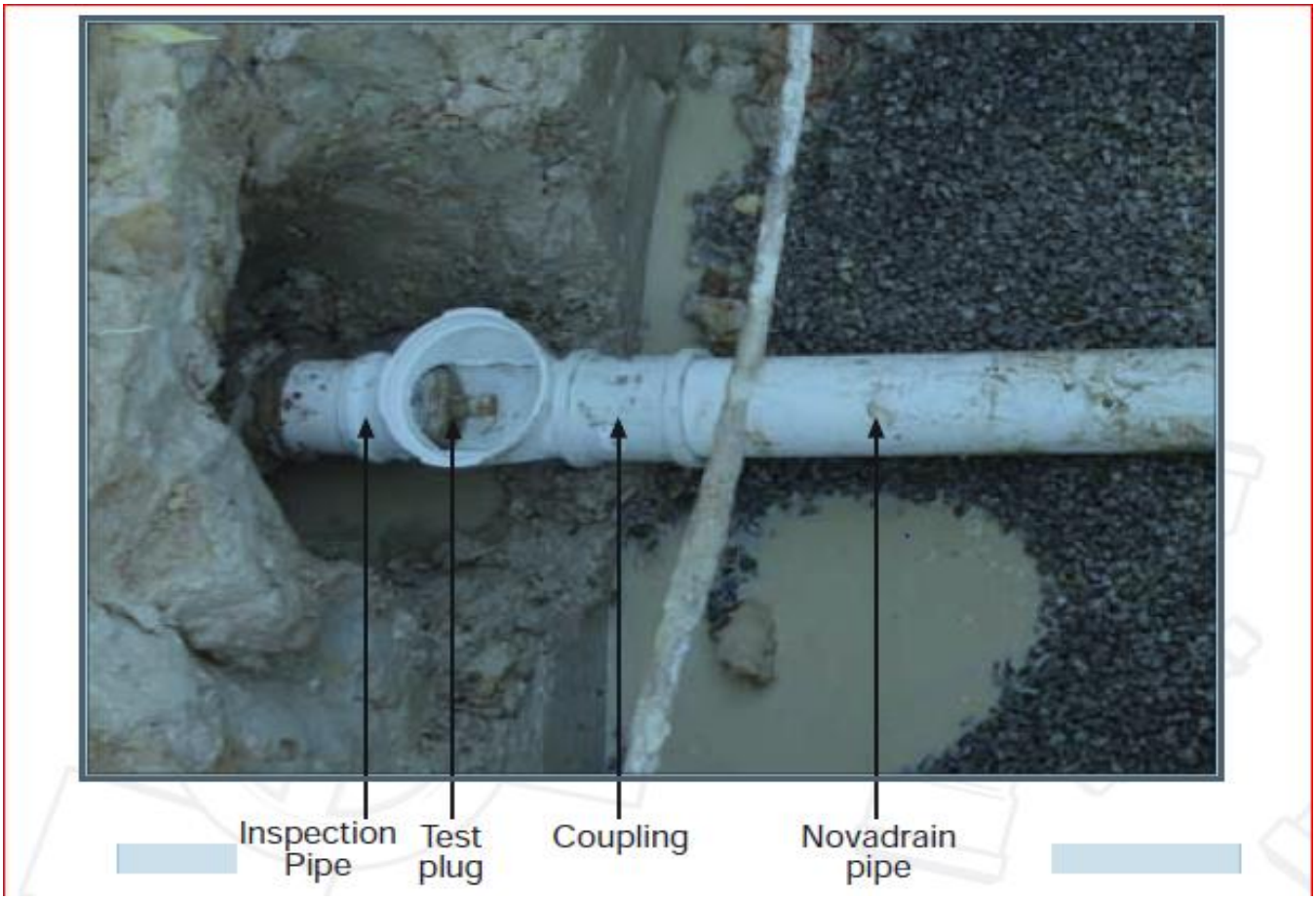


Fig 7.4 hydrostatic Testing

Completing Final Backfield

After testing of the pipeline, selected material should be hand shoveled over each exposed joint and tamped to give 300mm minimum cover. Final backfilling to ground level can be completed by hand or machine, using the soil originally excavated from the trench. Care should be taken to exclude large rocks and stones from the final backfill.

Low Pressure Air Testing

All inlets, outlets and access points shall be capped and sealed. Apply an initial test vacuum (negative gauge pressure) of approximately 15kPa. Close the valve on the vacuum line and Shut off the vacuum pump. Allow the air pressure to stabilize for at least 3min to identify any initial leakage. When the vacuum has stabilized and is above the starting test vacuum of 10kPa, commence the test by allowing the Vacuum to drop to 10kPa, at which point initiate time recording. Record the drop in vacuum over the test period. The length of drain under test is

considered to pass if the test vacuum loss is ≤3kPa for the relevant time interval specified in table below.

Vacuum Air Testing

All inlets, outlets and access points shall be capped and sealed. Air shall be introduced slowly, since rapid pressurization can cause significant air temperature changes that may affect testing accuracy. Apply an initial test pressure of approximately 15kPa. Close the valve on the pressure line and shut off the pump. Allow the air pressure to stabilize for at least 3min to identify any initial leakage. When the pressure has stabilized and is at or above the starting test pressure of 10kPa commences the test by allowing the gauge pressure to drop to 10kPa, at which point initiate time recording. Record the drop in pressure over the test period

Inspecting Hydrants:

Prior to installation, hydrants should be inspected for direction of opening, nozzle threading, operating nut and cap nut dimensions, tightness of pressure-containing bolting, cleanliness of inlet elbow, handling damage, and cracks. Defective hydrants should be corrected or held for inspection by the owner.

Self-check-7

I. Choose the best answer from the following alternatives

1. The distinct areas require testing.

a) The sewer rising mains

b) The gravity pipeline sections

c) The gravity reticulation sections

d) All

2. Each effluent disposal system must be:

a) (30) meters from a potable bore or other potable water source

b) Six (4) meters from any subsoil drainage system

c) 80meters from any wetland area.

d) All

II. Short answer questions

1. Write down some conventional septic systems standard requirements
2. What are the types of waste disposal?

III. Mach Column "A" with Column "B"

Column "A"	Column "B
_____1. The purpose of testing	A. (hydrostatic, low pressure air or vacuum) testing
_____2. Test Procedures	B. wetland area.
	C. line has been correctly laid to line and grade

Unit Eight: Perform service and maintenance

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

- Service and maintenance of drainage system
- Components of service and maintain effective operation 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:

- Carry out service and maintenance activities of drainage system using procedures which comply with industry requirements
- continue service and maintain system components to ensure effective operation of the system

8.1 Service and maintenance of drainage system

Requirements:

Costs

an aggressive catch basin cleaning program could require a significant capital and O&M budget. A careful study of cleaning effectiveness should be undertaken before increased cleaning is implemented. Catch basin cleaning costs are less expensive if vacuum street sweepers are available; cleaning catch basins manually can cost approximately twice as much as cleaning the basins with a vacuum attached to a sweeper.

Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary. Encouraging reporting of illicit discharges by employees can offset costs by saving expense on inspectors and directing resources more efficiently. Some programs have used funds available from "environmental fees" or special assessment districts to fund their illicit connection elimination programs.

Maintenance

Two-person teams may be required to clean catch basins with vactor trucks.

Identifying illicit discharges requires teams of at least two people (volunteers can be used), plus administrative personnel, depending on the complexity of the storm sewer system. Arrangements must be made for proper disposal of collected wastes. Requires technical staff to detect and investigate illegal dumping violations, and to coordinate public education.

Storm Drain flushing.

Sanitary sewer flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in sanitary sewer systems. The same principles that make sanitary sewer flushing effective can be used to flush storm drains. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as to an open channel, to another point where flushing will be initiated, or over to the sanitary sewer and on to the treatment facilities, thus preventing re-suspension and overflow of a portion of the solids during storm events.

Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. The deposits can hinder the designed conveyance capacity of the storm drain system and potentially

cause back water conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, releasing the backed up water and resulting in the cleaning of the storm drain segment.

Flow Management

Flow management has been one of the principal motivations for designing urban stream corridors in the past. Such needs may or may not be compatible with the storm water quality goals in the stream corridor.

Downstream flood peaks can be suppressed by reducing through flow velocity. This can be accomplished by reducing gradient with grade control structures or increasing roughness with boulders, dense vegetation, or complex banks forms. Reducing velocity correspondingly increases flood height, so all such measures have a natural association with floodplain open space. Flood elevations laterally adjacent to the stream can be lowered by increasing through flow velocity. However, increasing velocity increases flooding downstream and inherently conflicts with channel stability and human safety. Where topography permits, another way to lower flood elevation is to lower the level of the floodway with drop structures into a large but subtly excavated bowl where flood flows we allowed to spread out.

Description

As a consequence of its function, the storm water conveyance system collects and transports urban runoff that may contain certain pollutants. Maintaining catch basins, storm water inlets, and other storm water conveyance structures on a regular basis will remove pollutants, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

A maintenance program needs records. Typically, these include

- Complaint or inquiry forms for recording reports of problems,
- Inspection forms that show everything that was checked,
- Work orders that task an office to clear debris or correct a problem, and
- Maintenance records that show the work that was done.

8.2 Components of service and maintain effective operation system

Servicing and maintaining system components is rainwater drainage system consists of a network of collectors, accessories and final discharge devices, which direct the water to the public network.

Components of a drainage system

Drainage systems, particularly in the minor system network, might include pipelines, open channels, natural surface channels and canals. The major drainage system would almost certainly include open channels and natural watercourses within an urbanized (or urbanizing) catchment.

Understanding the Types of Drainage Systems

- Surface Drainage System. Surface drainage systems remove excess water from the land's surface through channels or ditches.
- Subsurface Drainage System. Subsurface drainage systems are implemented beneath the top layer of soil.
- Slope Drainage System.
- Downspouts and Gutter Systems

The complete system will be referred to as a storm drain system and will normally consist of **curbs and/or gutters, inlets or catch basins, laterals or leads, trunk lines or mains, junction chambers, manholes, and ponds**.

These elements are described in table below.

Table 8.1

Elements	Description
Gutters	Open ducts of slight slope, designed to collect and conduct rainwater to discharge branches or downpipes.
Outlets	Outlets designed to channel water from collection devices to downpipes, when existing, or to drains, sanitary wells, ditches or any other appropriate reception areas.
Downpipes	Plumbing designed to collect and transport water from discharge branches to building collectors or ditches.
Drains	Plumbing designed to collect the water from downpipes, or discharge branches if downpipes do not exist, and to channel it to the final building network branch connecting to the public collector.
Accessories	Auxiliary devices designed to ensure maintenance and operation conditions, sometimes used for retention of heavy or light materials.
Complementary Installations	Installations designed to improve the performance of the system (pumps and retention systems which prevent the discharge of forbidden residues to the public network are examples).

Designing

Design of rainwater drainage systems requires the use of adequate and sufficiently accurate methods for a number of estimates. The first quantity which has to be assessed is the rainwater flow rate. This quantity depends directly on the rainfall intensity, thus varying according to the building location. Sizing system components depends on the quantity of runoff rainwater. Sizing includes definition of pipe diameters, discharger areas and orifices, and also pumps or separator chambers characteristics when these devices are required.

System comfort and quality rainwater drainage

The quality of rainwater drainage systems in buildings and the comfort provided by the systems to building occupants should be considered carefully. This is often forgotten thus leading to complaints from occupants. Comfort and quality issues of rainwater drainage systems, such as

smells or noise, should not depend on the social status of the occupants. The only acceptable exceptions are those related to aesthetic considerations.

In the following are list some of the main factors which affect comfort and quality:

- Noise generally generated by flow impact on piping turns.
- System accessibility for maintenance and inspection operations minimizes the disruption caused by eventual anomalies, thus preventing the obstruction of private or common spaces for long periods.
- Smelling normally is not a problem of rainwater, although it can occur in cases of connection with public collection of domestic sewage. The quality of rainwater drainage systems buildings can be improved by:
- Sephora drainage systems are relatively new systems that provide a more effective drainage. When water flows down pipes, negative pressures occur at the top thus generating a suction effect which increases the flow rate. Like in siphons, the negative pressure is created by the absence of air inside the pipe.
- Rainwater recycling systems use rainwater for non-potable functions, like garden irrigation, washing machines and toilet flushes.

Drainage systems for groundwater

Groundwater is rainwater infiltrated into the ground. This water flows down through the ground until it finds a waterproof layers on top of which aquifers will be formed. Buildings are often constructed with basements or underground floors, usually used for car parking. This option, justified by the rationalization of the available space, requires that possible, if not almost certain, presence of groundwater is taken into account. Perhaps because construction of underground structures was not so common 20 years ago, there are no regulations in Portugal ensuring the quality of groundwater drainage systems and, as a consequence, there are many buildings in which such systems are totally absent. Groundwater drainage systems are designed to collect and conduct infiltrated waters to a pumping chamber. As these waters are often conducted to the rainwater drainage public network, the pumping chamber can actually be shared by rainwater and groundwater drainage systems in the building.

Materials

Selection of materials for rain and groundwater drainage systems in buildings is mainly driven by economy and durability. There are no concerns about the quality of the water and therefore

the chemical behavior of piping materials is not as important as it is in water distribution systems. The same type of materials are used both for rainwater and groundwater systems, although normally metal pipes are not use in groundwater systems. The most common materials are:

- Metal: galvanized steel, cast iron, cast aluminum;
- thermoplastic: Polyvinyl chloride (PVC), polyethylene (PE), polypropylene (PP);
- Vitrified clay;
- Concrete.

Municipal staff should regularly inspect facilities to ensure the following:

- Immediate repair of any deterioration threatening structural integrity.
- Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
- Stenciling of catch basins and inlets.
- Clean catch basins, storm drain inlets, and other conveyance structures in high pollutant load areas just before the wet season to remove sediments and debris accumulated during the summer.

❖ **Drainage System Maintenance**

- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed:-
- Keep accurate logs of the number of catch basins cleaned.
- Record the amount of waste collected.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed of. Do not dewater near a storm drain or stream.
- Except for small communities with relatively few catch basins that may be cleaned manually, most municipalities will require mechanical cleaners such as educators, vacuums, or bucket loaders. *Storm Drain Conveyance System*

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect flushed effluent and pump to the sanitary sewer for treatment. *Pump Stations*
- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- do not allow discharge from cleaning a storm drain pump station or other facility to reach the storm drain system.
- Conduct quarterly routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.
- Sample collected sediments to determine if landfill disposal is possible, or illegal discharges in the watershed are occurring.

Open Channel

- Consider modification of storm channel characteristics to improve channel hydraulics, to increase pollutant removals, and to enhance channel/creek aesthetic and habitat value.

Self-check-8

I. Short answer questions

1. Servicing and maintaining system components is rainwater drainage system consists of
2. What are the records that needs maintenance program?

II. Mach Column "A" with Column "B"

Column "A"	Column "B
_____1. Sanitary sewer flushing	A. Costs/budget/
_____2. Service and maintenance requirement	B. Used to improve pipe hydraulics
3. Downstream flood peaks	C. Suppressed by reducing through flow velocity

III. Choose the best answer from the following alternatives

1. One of the following is characteristics of storm channel modification, , and.

a) to improve channel hydraulics

b) to increase pollutant removals

c) to enhance channel/creek aesthetic and habitat value

d) All

2. Drainage System Maintenance

a) Conduct inspections more frequently during the wet season for problem areas

b) Clean and repair as needed

c) Record the amount of waste collected.

d) Store wastes collected from cleaning activities in appropriate containers

e) All

Unit Nine: Locate and clear blockage

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

- Blockage contain Section
- Blockage clearing equipment
- Mechanical drain clearing equipment
- Blockage clearing
- Pipe work test
- Normal pipe work
- Authorities of work completion

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:

- Section containing blockage is located and isolated
- Blockage clearing equipment is selected in accordance with the job
- Where necessary, mechanical drain clearing equipment is assembled and used in accordance with manufacturers' instructions
- Blockage is cleared without causing damage to pipe work and fittings
- Pipe work is tested to confirm blockage is cleared from pipe system
- Pipe work is repaired/resealed to permit normal use
- Authorities are advised of work completion

9.1 Blockage contain Section

The problem of blocked drains occurs when foreign materials such as soap, hair, food, and fats build up between the drain-pipe and other pipes that flow at the bottom. In the beginning, the materials are in a small amount. With time, as the amount of objects increases, it stops water to flow freely.

Locating a Blockage Concrete pumping crews and the concrete pumper must be constantly aware of the possibility of a pump line blockage, or rock jam, and be able to remove them promptly and safely. Variations in the mix, whether too rocky, wet or dry, foreign matter in the mix (such as old concrete that has broken away from mixer fins, or unmixed clumps of concrete), and other mix anomalies are tip-offs that problems may have occurred, or may be about to occur.

A rising in line resistance, as shown on the pump pressure gauge, indicates line blockage. The first suspect spot for blockage is the reducer, which connects the concrete pump to the pipeline system. A quick build-up in pressure prior to the jam indicates the blockage is most likely in the pump area. Slow pressure build-up is indicative of a jam further down the line, nearer the delivery end.

The operator needs to examine the system, especially at the elbows or discharge hose. This can be done by tapping the hammer along the pipeline. Where concrete is jammed, the hammer will produce a dull thud, as opposed to a more ringing sound where the line is clear.

All pipe joints should also be inspected for grout leakage, as well, as this can be indicative of grout loss and subsequent blockage.

By carefully walking over or stepping on the discharge hose to depress it, a blockage may be located where the soft hose becomes firm, indicating jammed aggregate.

Causes of Blockages There are basically three main causes of pump line blockages: a deficiency in the mix design, problems with the pipeline itself and the human factor, or operator error.

The Wrong Mix

The most common mix problem is concrete that does not retain its mixing water. Concrete can bleed due to poorly graded sand that allows water to bleed through the small channels formed due to voids in the sand, or if the concrete is too wet.

Insufficient mixing can cause segregation in the mix. For successful pumping, aggregate must have a full coating of cement grout to lubricate the mix as it is being pumped.

A delay in placing the concrete due to traffic or job site problems, as well as hot weather conditions, may cause the concrete to begin to set prematurely. This creates a mix that may be

too stiff to pump, because it won't fill the pumping cylinders, causing excessive pumping pressures.

Problems with the Pipeline

The entire pumping system must be evaluated for the job it is to perform. Considerations include a properly sized system including pump capacity and motor horsepower to move the concrete through the full length of the pipeline.

Pipes that have been improperly cleaned may cause blockages where old concrete has set, and may cause bleeding and segregation. Defective couplings, gaskets, or weld collars also can result in the loss of grout.

Another thing to look for are bends that are too short, too sharp, or too numerous, all of which increase concrete pumping pressure. Variations of pipeline diameter, such as when a larger diameter hose is coupled with a smaller one, may cause blockages or rock jams because the concrete cant flow as quickly through the smaller diameter pipeline.

Operator Error

The most common error from inexperienced operators is setting up the pumping system improperly. Operators must know to set up each job so that pipe or hose only needs to be removed, not added on. This is because if the placing crew has to add hose once the pour is in progress, the dry conditions inside the added hose is likely to cause a blockage.

Careless handling of flexible rubber discharge hoses can also be a problem, since kinking can occur. A rock jam is likely to be the end result of a kinked hose, as the inside hose diameter is reduced, which restrains the aggregate in the line while the lubricating grout is allowed to pass. Premature localized wear of the hose, and eventual rupture of the hose, may also occur at the point where the hose is kinked

9.2 Blockage clearing equipment

Use the following equipment that clear blockage of the drainage pipe systems and Fixture stoppages usually occur in the fixture's trap causing the waste disposal to overflow. The stoppage has to be located and cleared using the proper plumbing tool or tools. Stoppage clearing tools and equipment are shown below.

Hand Tools

Combination Auger

Grappler Hook

Toilet/ Urinal Augers

Hand Spinners

Sewer Tape

Equipment's:-

- Sink Machines
- Drum Machines
- Sectional Machines
- Rodder Machines
- Water Jetting Machines
- Cables and Tools

Sink Machines

K-40 Sink Machine

Auto-Clean™/K-30 Sink Machine

K-45 Sink Machine

Power Clear™ Drain Cleaning Machine .

9.3 Mechanical drain clearing equipment

The following are the various equipment and devices used for clearing sewers:

1. Portable Pump-Set
2. Sectioned Sewer Rods
3. Flexible Sewer Rod
4. Ferret Used in Conjunction with a Fire Hose
5. Sewer Cleaning Bucket Machine
6. Rodding Machine with Flexible Sewer Rods
7. Dredger
8. Scraper
9. Hydraulically Propelled Devices.

1. Portable Pump-Set:

This device is used in situations where sewers are blocked completely and sewage has accumulated in manholes, for pumping the collected sewage out to tackle the sewage blockage. These pumps should be of non-clogging type, preferably on four wheel trailers for the largest size and should be provided with a self-priming unit to save time and effort.

2. Sectioned Sewer Rods:

These rods are used for cleaning small sewers. These may be bamboo or teak wood or light metal usually about 10 m long at the end of which is a coupling which remains intact in the sewer but can be easily disjointed in the manhole. Sections of the rods are pushed down the sewer until the obstruction is reached and dislodged.

The front or the advancing end of the sewer rod is usually fitted with a cutting edge to cut and remove the obstruction. These rods are also used in locating the obstruction from either manhole in case the particular portion of the sewer is to be repaired/exposed.

This is made by sandwiching a manila rope between bamboo strips and tying at short intervals. The flexible rod is first introduced from one manhole to the other, its end being connected to a thicker rope when dragged down the sewer, draws out sand and detritus into the downstream manhole. The flexible sewer rod is used in routine sewer cleaning works.

4. Ferret Used in Conjunction with a Fire Hose:

This is used for breaking and removing sand stoppages. The high velocity jet stream, of water is used from the hose-connected to the fire-hydrant towards upstream and downstream sides of the

sewer. The forward stream loosens the accumulated debris ahead of the tool and the rear jets of the ferret admit water to wash the sand back downstream, where it can be removed from the manhole manually.

5. Sewer Cleaning Bucket Machine:

This machine consists of two powered winches with cables in between. In cleaning a section of the sewer, the winches are centered over two adjacent manholes. To get the cable from one winch to the other, it is necessary to thread the cable through the sewer line by means of sewer rods

The cable from the drum of each winch is fastened to the barrel on each end of an expansion sewer bucket fitted with closing device, so that the bucket can be pulled in either direction by the machine on the appropriate end. The bucket is pulled into the loosened. Material in the sewer until the operator feels that it is loaded with debris.

The motor is then thrown out of gear and the opposite winch is put into action. When the reverse pull is started, the bucket automatically closes and the dirt is deposited in a truck of sewer cleaning. trailer. This operation is repeated until the line is clear. This machine is also used along with other scraping instruments for loosening sludge banks of detritus or cutting roots and removing obstructions from the sewer line.

6. Rodding Machine with Flexible Sewer Rods:

This machine consists of a flexible rod to which cleaning tools are attached. The flexible rod consists of a series of steel rods with screw couplings. The flexible rod is guided through the manhole by a vent pipe. The machine rotates the rod with the tool attached to one end.

The rotating rod is thrust into the bent pipe manually with clamps with long handles holding the rod near the coupling. The rod is pulled in and out in quick succession when the tool is engaging the obstruction, so as to dislodge or loosen it. When the obstruction is cleared, the rod is pulled out by means of clamps keeping the rod rotating to facilitate quick and easy removal.

7. Dredger:

For cleaning the larger manholes, dredgers are used. It consists of a crane and a pulley, with the help of which a grab bucket is lowered. This scrapes the bottom deposits and brings it to the ground, where the bucket opens and the silt is automatically dropped into truck or trailer. The dredger cannot clean the corner deposits of the manhole.

8. Scraper

For larger diameter sewers more than 750 dia scrapers is used for cleaning the sewers. It consists of an assembly of wooden planks of slightly smaller size than the sewer to be cleaned. If the scraper cannot be lowered through the manhole opening, it has to be assembled inside the manhole. The scraper chain, being attached to a control chain in the manhole, where it is lowered, is then connected to a winch on the next downstream man-hole by means of chains.

The winch is then revolved to push the debris ahead of the scraper. The heading up of the flow behind the scraper will also assist in pushing it in the forward direction. This ensures that the bottom and the sides of the sewer are cleaned thoroughly. The scraped debris is manually removed from the manhole.

9. Hydraulically Propelled Devices:

The device takes advantage of the force of impended water to effectively clear sewers. Efficiency depends on the hydraulic principle that an increase in velocity in a moving stream is accompanied by a greatly increased ability to more entrained material. The transporting capacity of water varies as the sixth power of its velocity.

9.4 Clearing blockage

There are several methods you can use to clear stoppages. All of the methods take time and require a certain procedure to accomplish the job.

Clearing a lavatory stoppage (plain plunger).

Before using a plain plunger to clear a stoppage, place a wet cloth in the overflow opening.

Then:

1. Remove the stopper or set it in a fully open position.
2. Place the plunger over the drain opening and push it up and down several times.
3. Then, lift plunger off the drain opening.
4. If the water in the bowl flows down the drain, the stoppage is cleared.
5. Turn on the water to double check that the stoppage is cleared.
6. If the stoppage is cleared, replace or reset the stopper.

   If the stoppage is not cleared, use a drain snake.

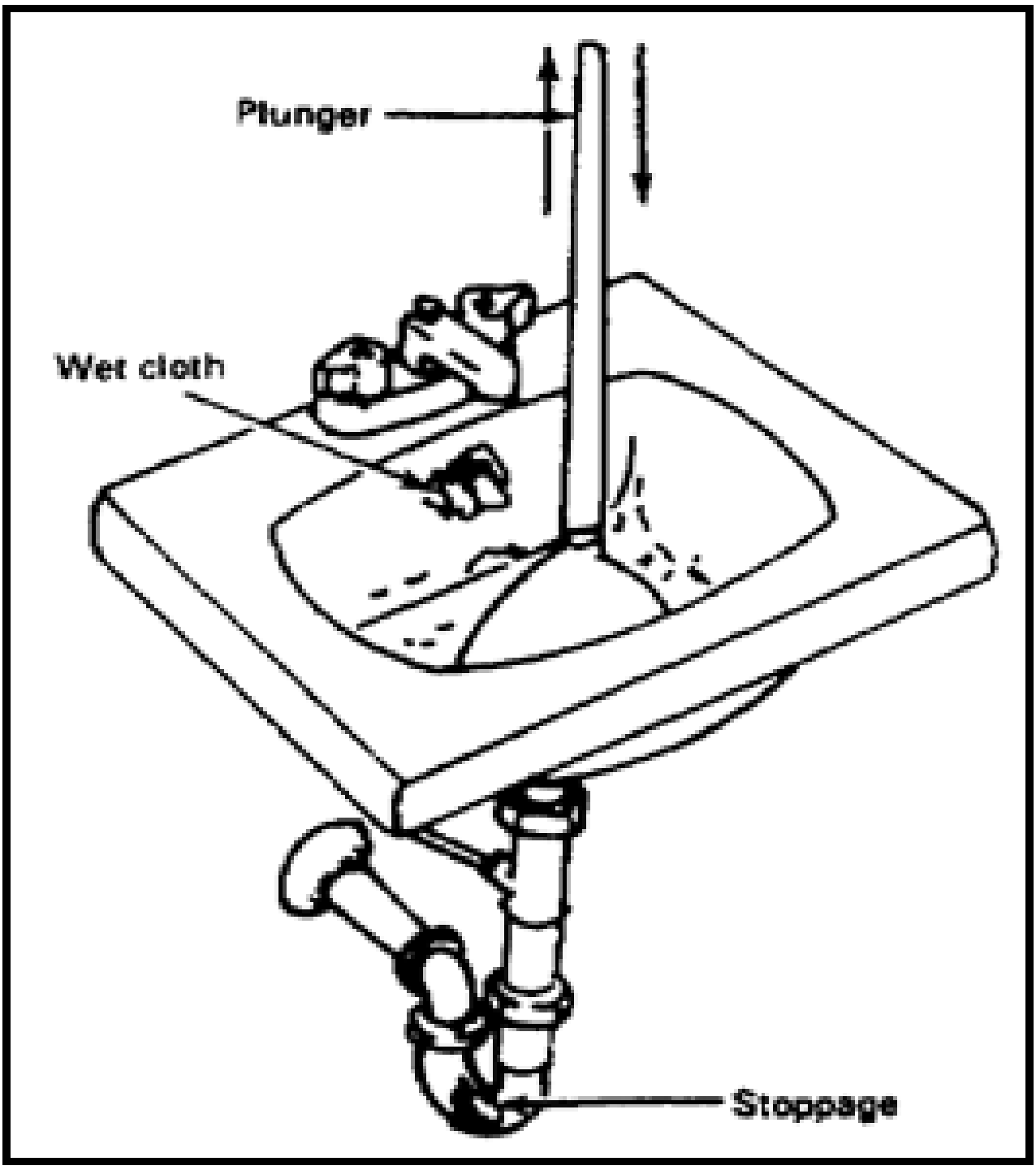


Fig 9.1 lavatories

Clearing a lavatory stoppage (drain snake).

To clear a stoppage with a drain snake:

1. Remove the stopper.
2. Push the snake into the drain opening until it meets resistance.
3. Turning the handle in one direction only, push and pull the snake until it moves freely in drain.
4. Then run water into the drain opening.
5. If it flows freely down the drain, the stoppage is cleared.
6. Remove the snake and replace the stopper.

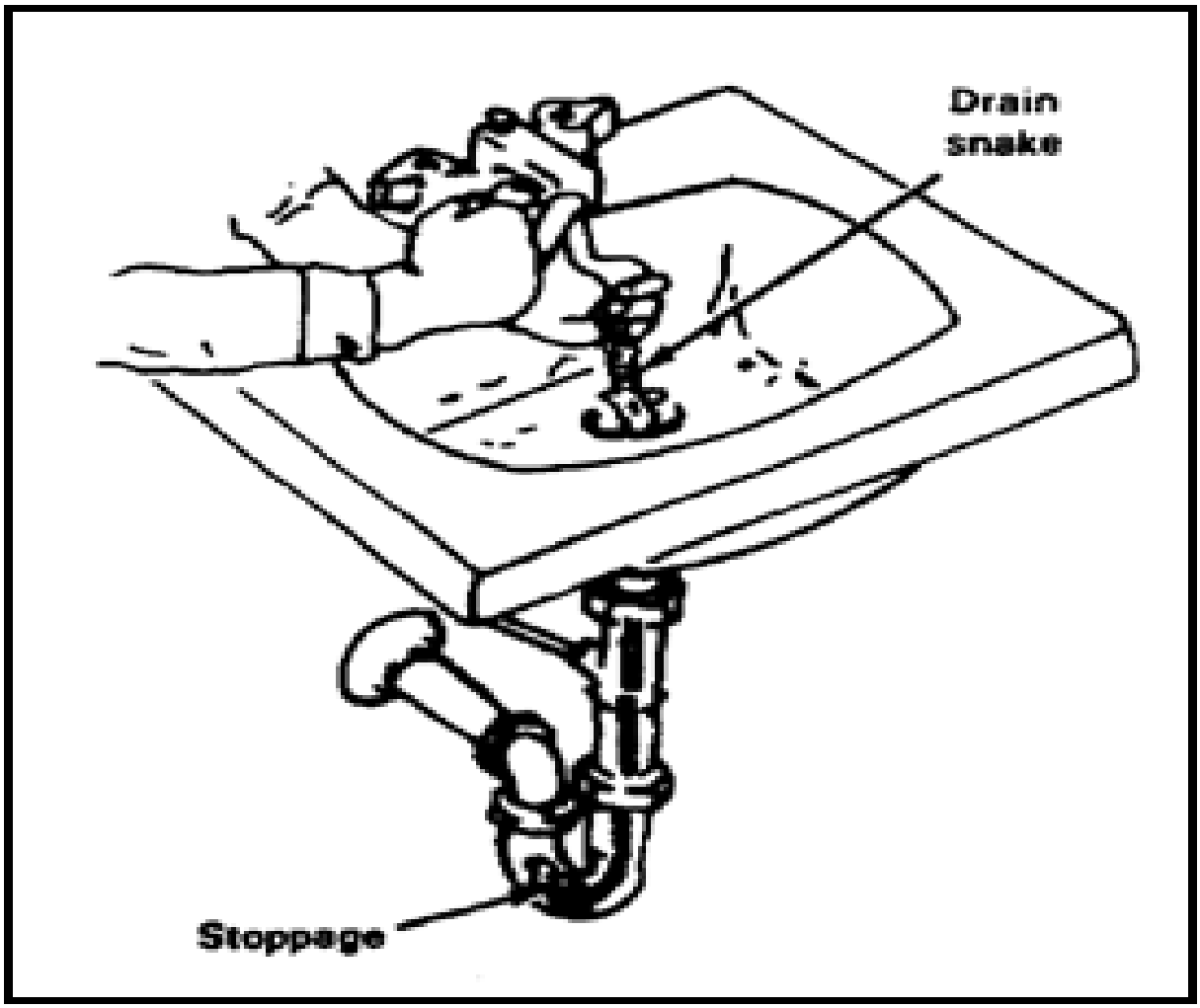


Fig 9.2 Drain snake method-drain opening

Clearing a lavatory drain line.

If the stoppage is not in the trap but in the lavatory's drain line:

1. Remove the trap.
2. Push the drain snake into the drain line.
3. Turn the handle in one direction only. Push and pull the snake until it moves freely.
4. Remove the snake and replace the trap.
5. Run water into the drain to make certain that the stoppage is cleared.

NOTE:

- If the stoppage cannot be cleared, the stoppage is in the building's drainage system.
- Sink stoppages are cleared in the same manner as lavatory stoppages.

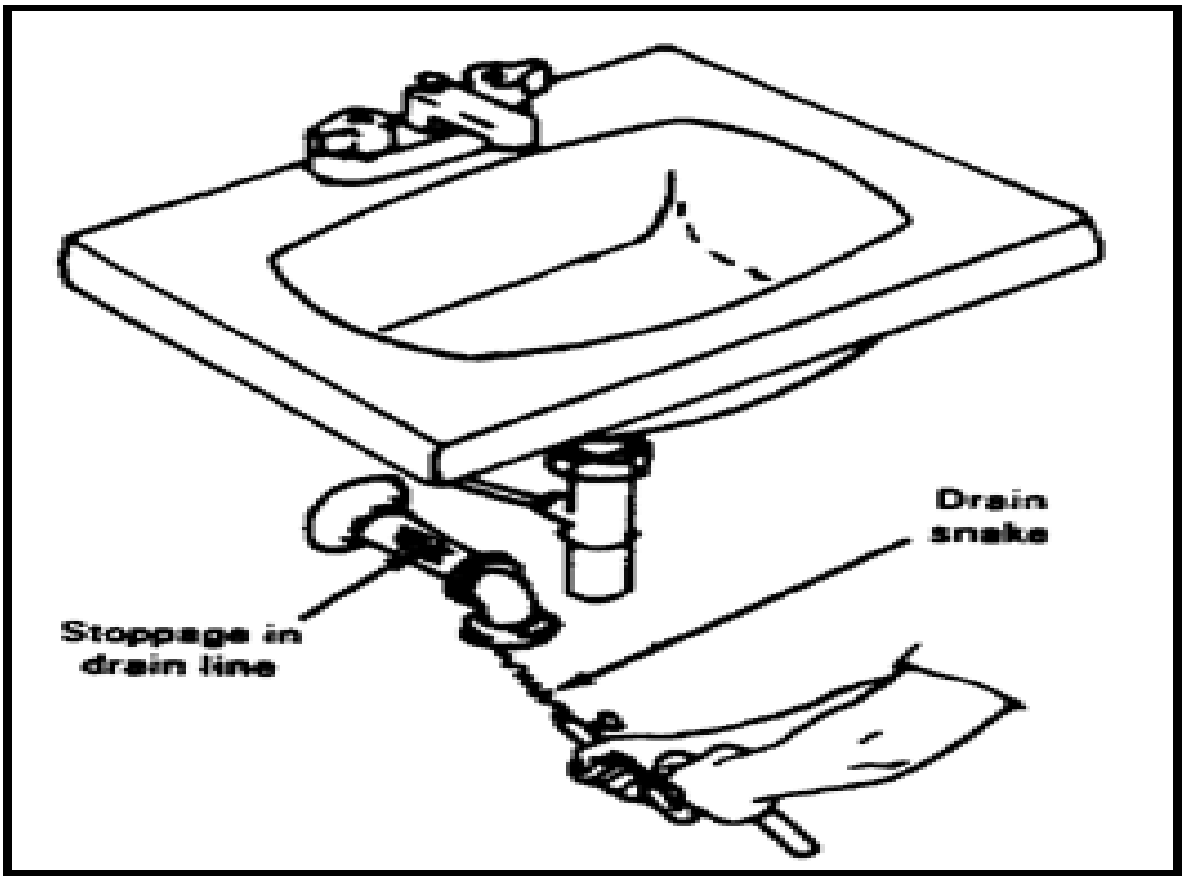


Fig 9.3 Drain Snake Method-Drain Line

Clearing a water closet stoppage (cone plunger).

A stoppage can be removed from a water closet with a cone-type plunger.

1. Place the plunger over the trap and push it up and down often until the water level returns to normal.
2. Throw a piece of toilet paper in the bowl and flush the water closet to assure that the stoppage is cleared.

NOTE: If a plunger cannot clear the stoppage, use a water closet auger.

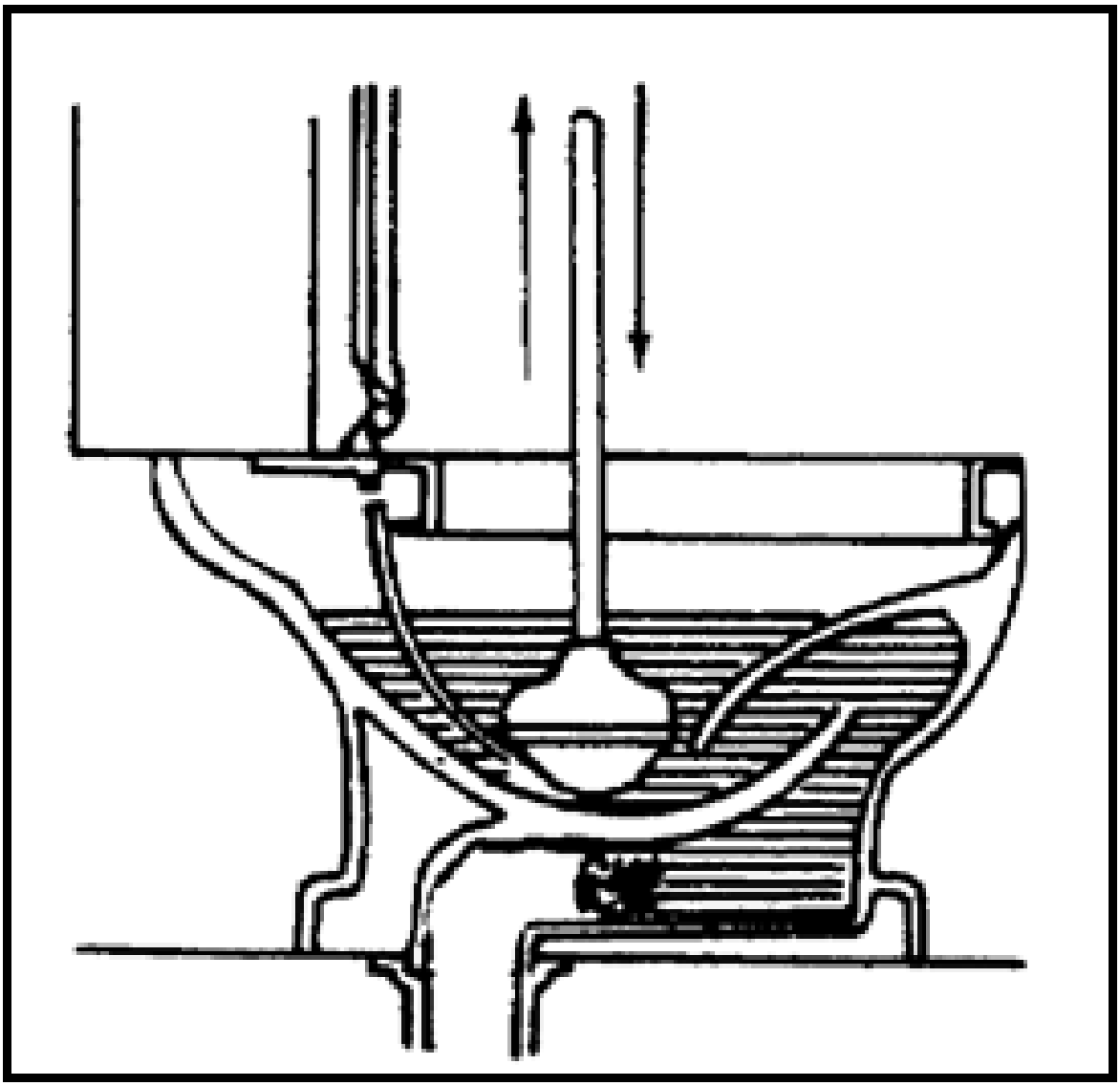


Fig 9.4 cone plunger methods

Clearing a water closet stoppage (auger)

To remove a stoppage using a water closet auger:

1. Push the auger into the water closet's trap until it meets resistance.
2. Turn the auger clockwise as you push and pull until the stoppage is cleared.
3. Remove the auger by turning it counterclockwise.
4. Throw a piece of toilet paper in the bowl and flush the water closet to assure that the stoppage is cleared.

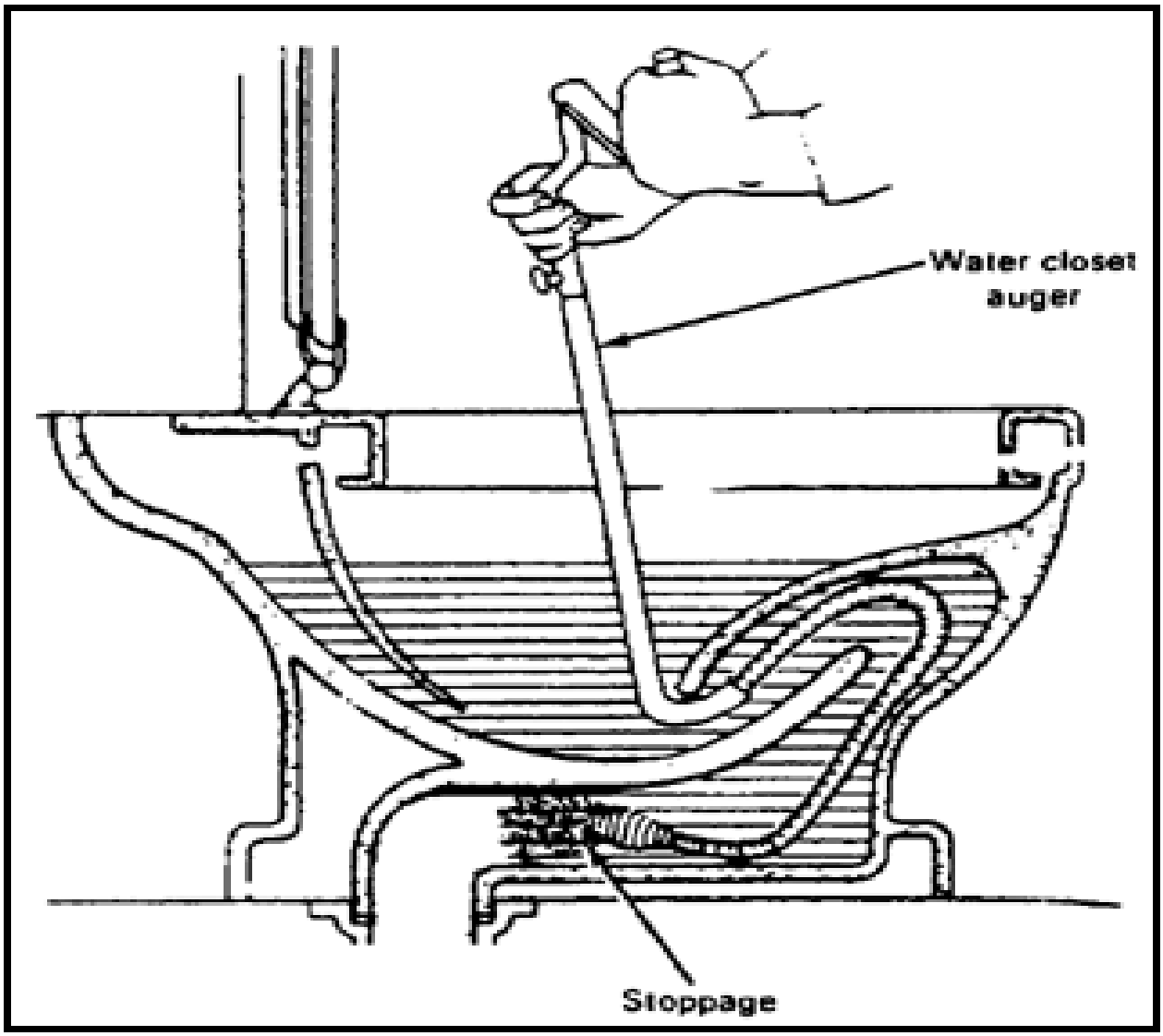


Fig 9.5 Auger Method

Clearing a urinal stoppage (P-trap)

A urinal with an exposed P-trap that has a stoppage is cleared in the same manner as a lavatory. Use a plain plunger first, then the drain snake.

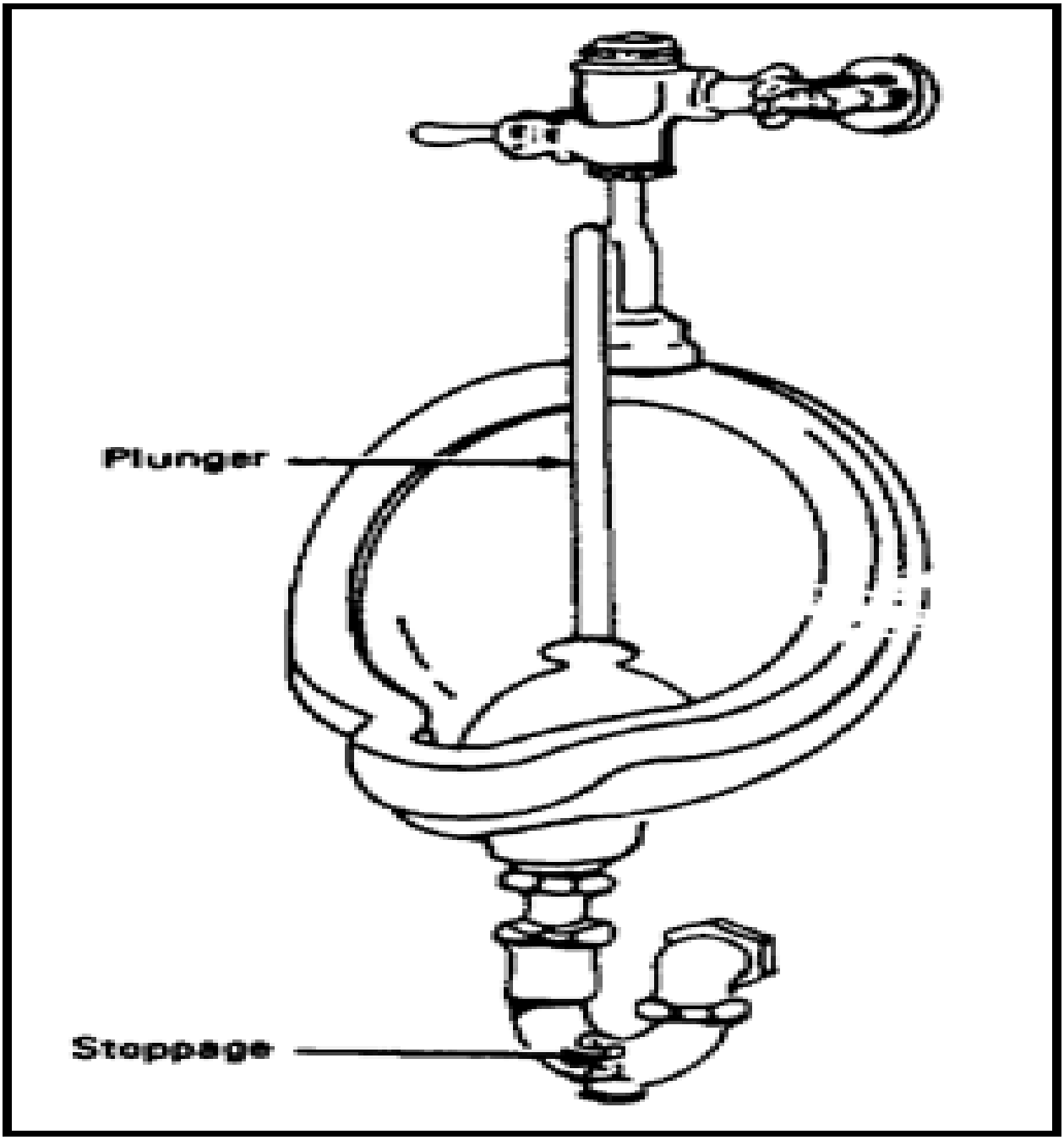


Fig 9.6 Clearing A P-Trap Urinal

Clearing a urinal stoppage (seal trap)

A urinal with a seal trap that has a stoppage is cleared by using a cone plunger first. Then use the drain snake that has a rounded end or the water closet auger.

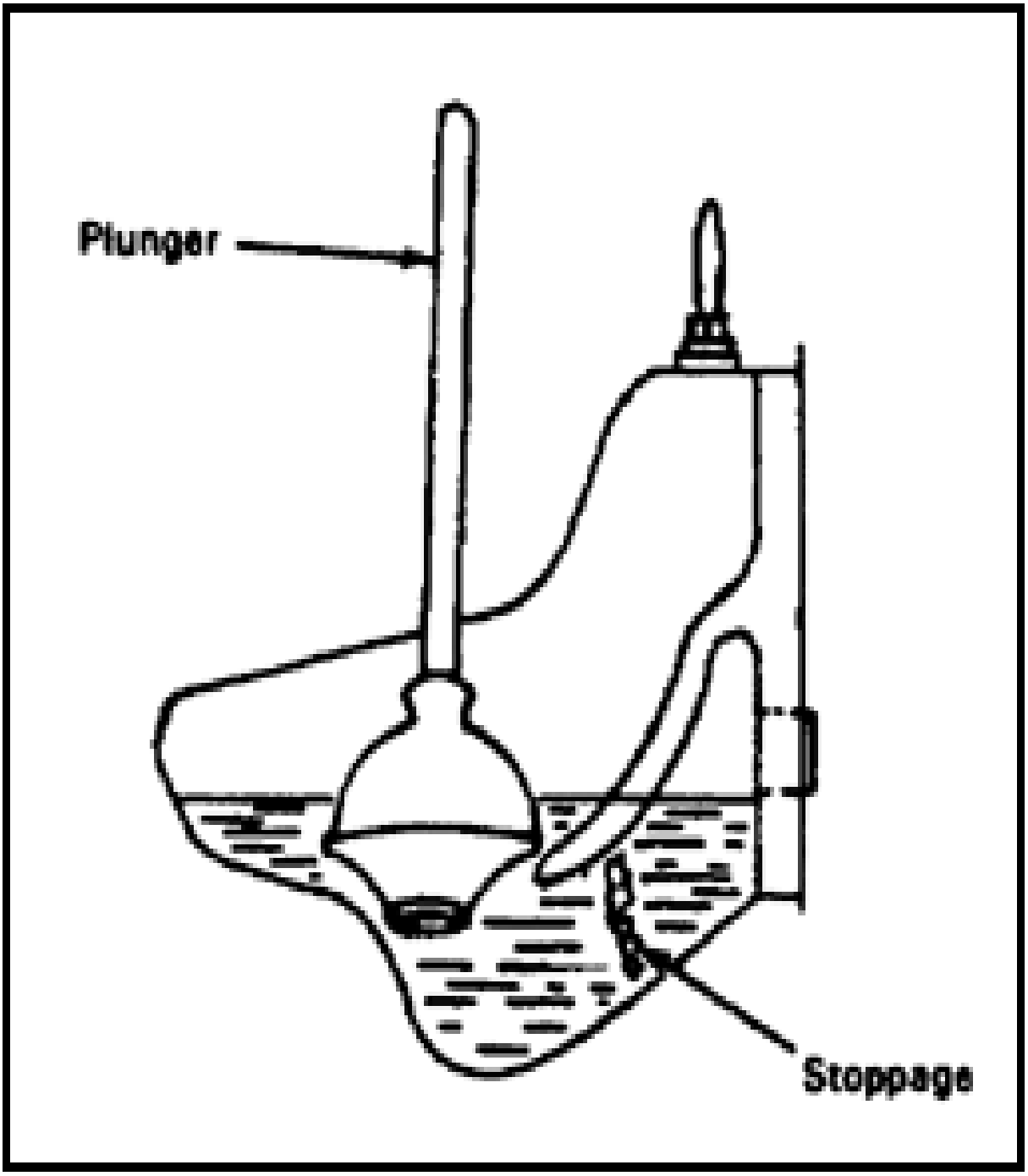


Fig 9.7 clearing a seal trap urinal

Clearing a bathtub stoppage (P-trap)

1. Remove the pop-up stopper with its linkage.
2. Unscrew the overflow cover and pull it out with its linkage.
3. Push the snake down into the overflow opening until it meets resistance.
4. Turn the snake handle clockwise pushing the snake until it turns freely. The stoppage is cleared. Remove the snake from overflow opening.
5. Turn on the water to check that the stoppage has been cleared.
6. Replace the overflow cover.
7. Replace the pop-up stopper.
8. Make sure the pop-up stopper works properly after replacement

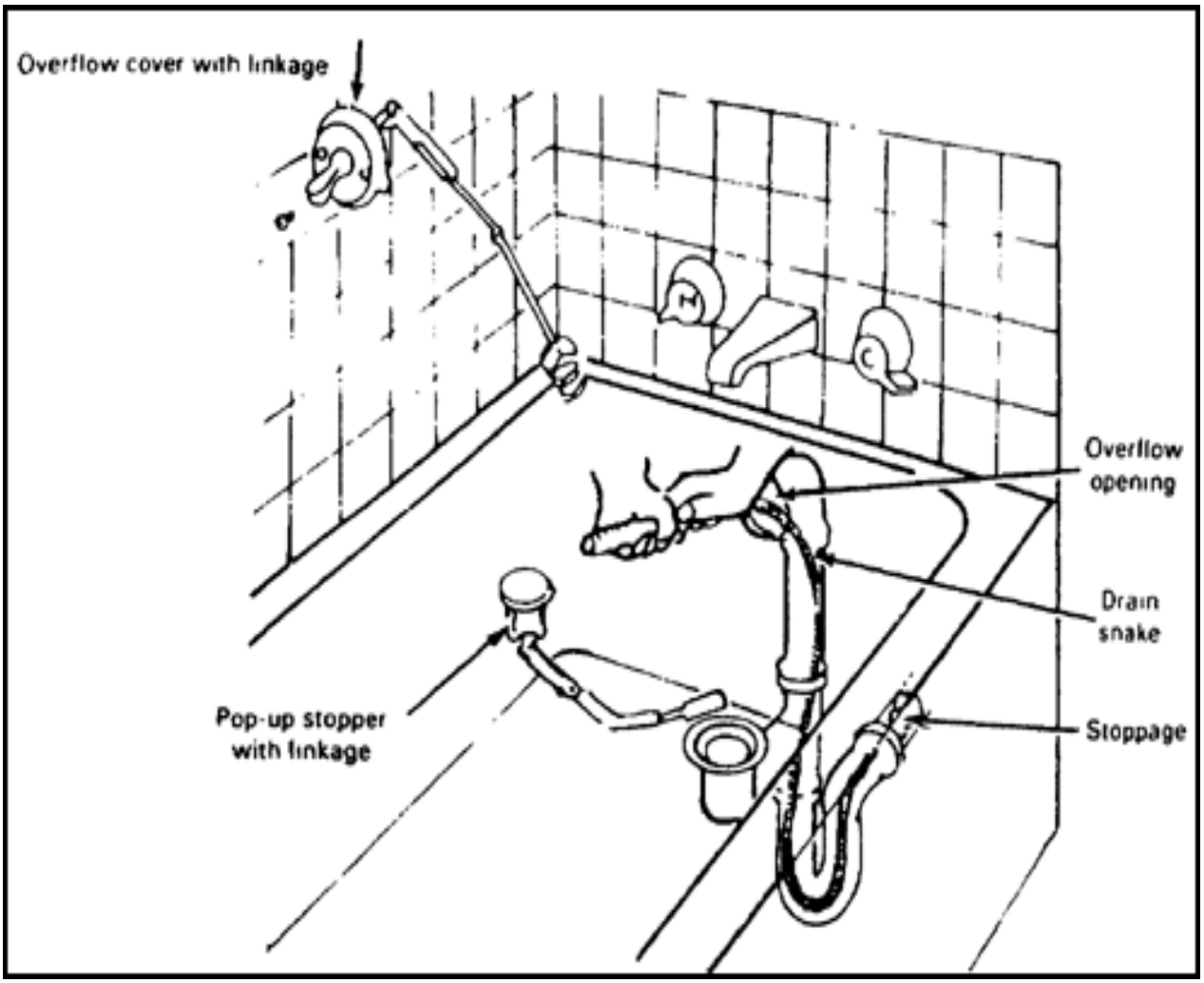


Fig 9.8 Bathtubs with P-Trap

Clearing a bathtub stoppage (drum trap)

1. Remove the drum trap cover with a wrench.
2. Remove the gasket from the trap.
3. Push a snake into the trap's lower pipe to search for the stoppage. If a stoppage exists, clear the stoppage.
4. If there is no stoppage in the lower pipe, remove the snake.
5. Push the snake into the trap's upper pipe and operate the snake to remove the stoppage.
6. Replace the gasket if the gasket is worn or damaged.
7. Screw the cover on hand tight and tighten it with a wrench.
8. Turn on the water to check that the stoppage has been cleared.

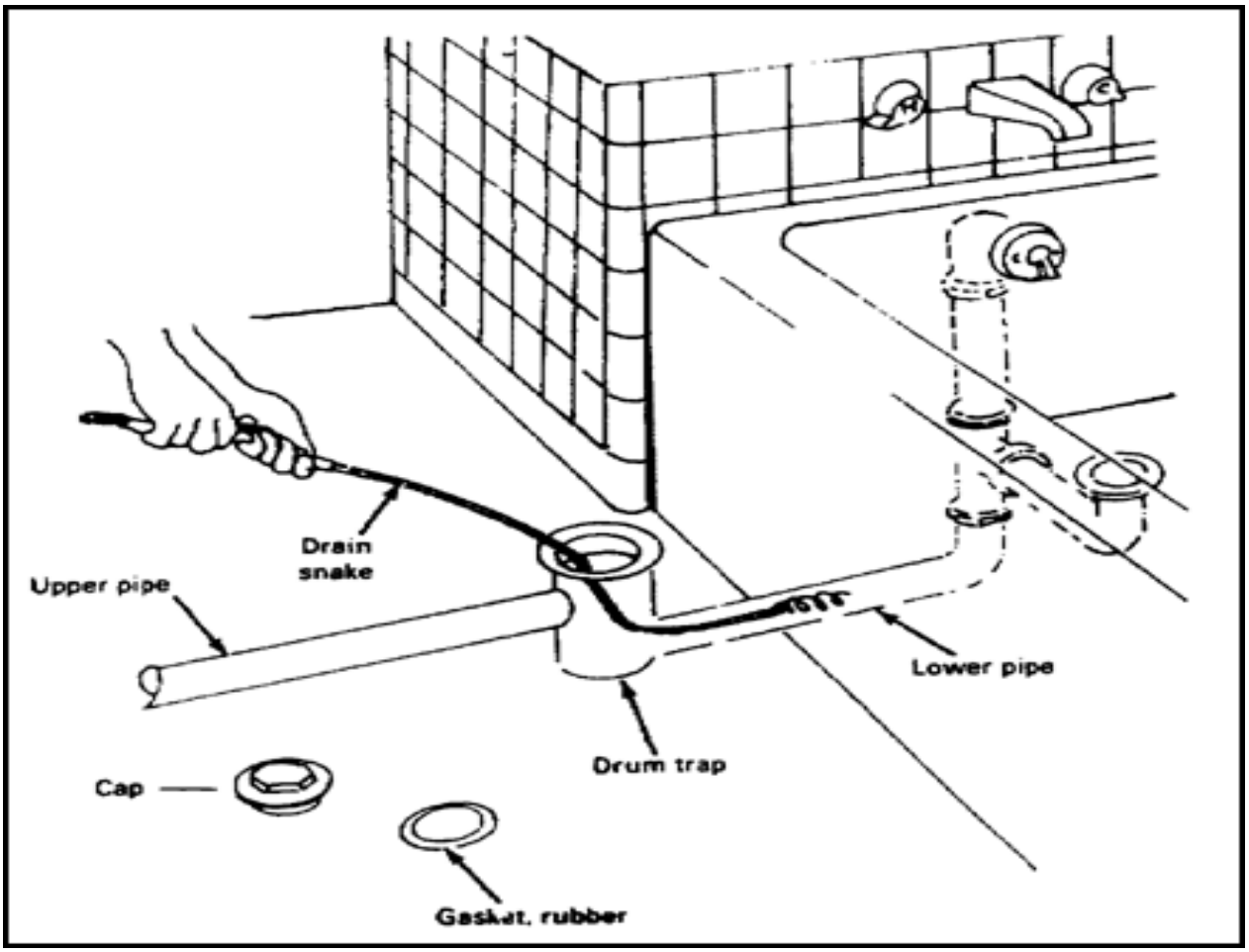


Fig 9.9 bathtubs with drum trap

Clearing a shower floor drain stoppage with a hose.

1. Remove the strainer.
2. Hook up a hose for a water source where possible.
3. Place the other end of the hose into the shower drain.
4. Stuff large rags around the hose to form a tight seal.
5. Turn water on full force, off and on again. The surge of water will clear the stoppage.
6. Remove the rags and run water down the drain to make sure the stoppage is cleared.
7. Replace the strainer.

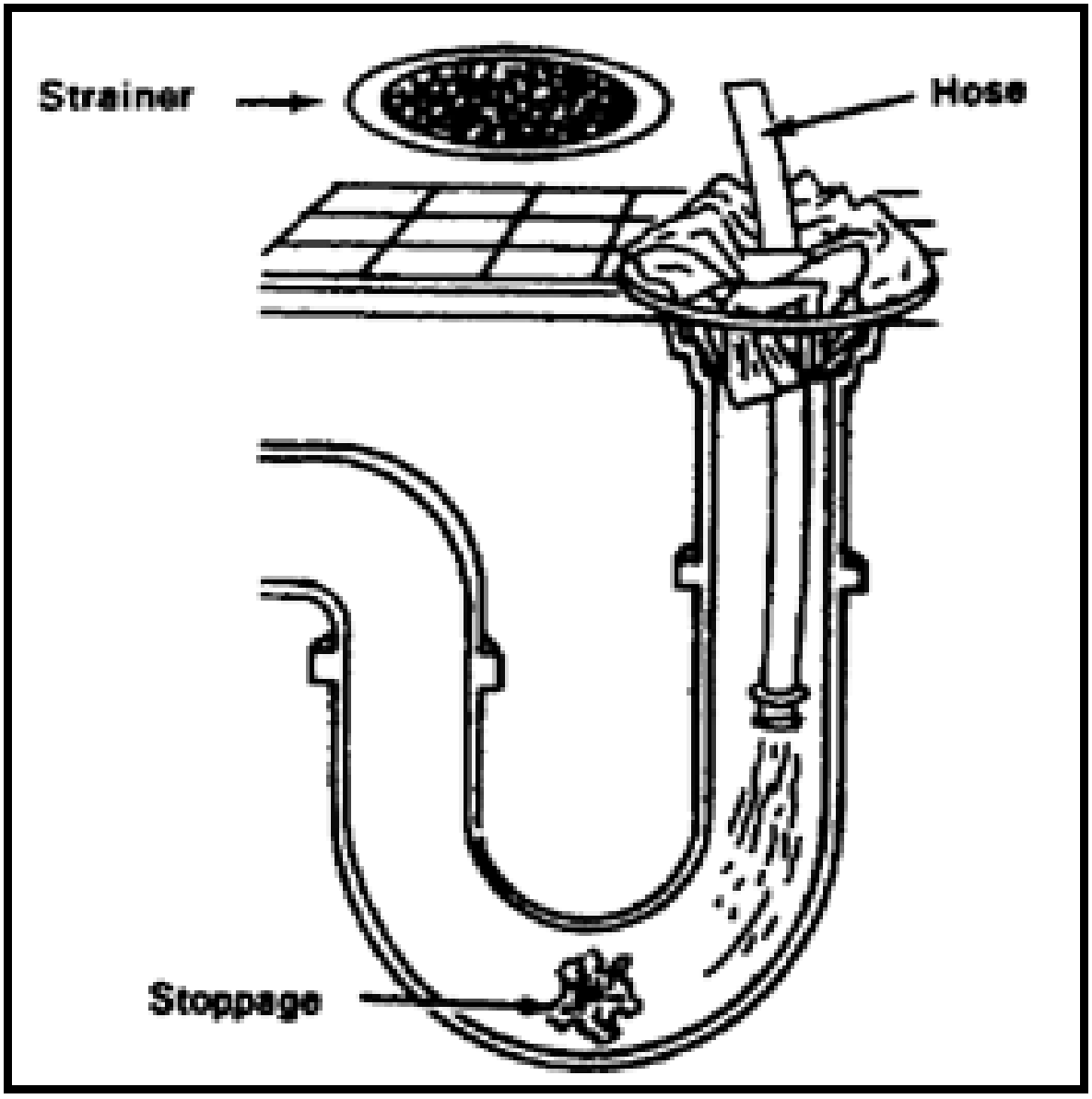


Fig 9.10 Hose and Water Method

Clearing a shower floor drain stoppage with a drain snake.

1. Remove the strainer.
2. Push a snake into the drain opening until it meets resistance.
3. Turn the handle in a clockwise direction, pushing and pulling the snake until it moves freely in the drain. Remove the snake.
4. Run water into the drain to make sure the stoppage is cleared.
5. Replace the strainer.

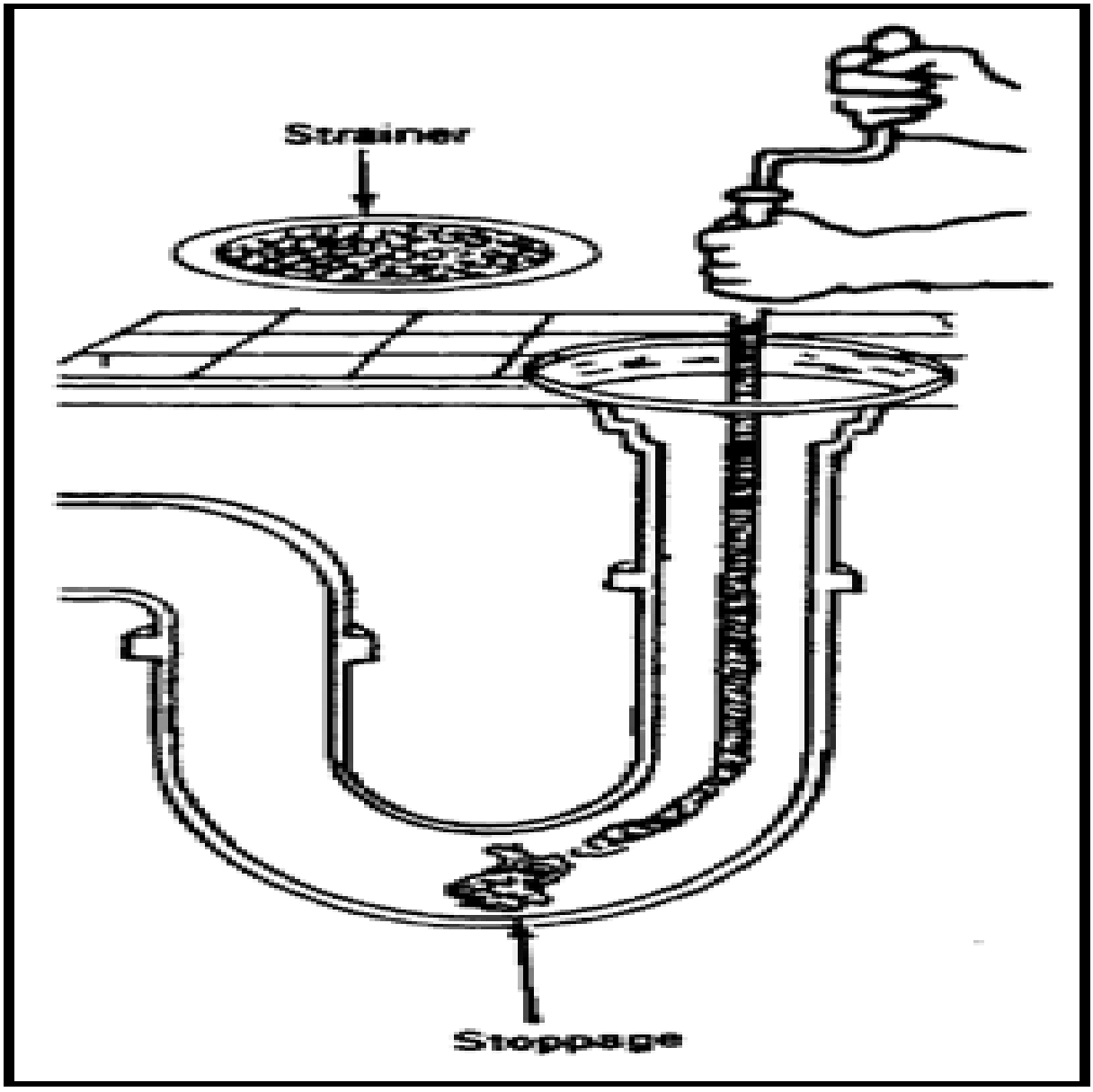


Fig 9.11 Drain snake method

NOTE: A floor drain stoppage is cleared in the same manner

9.5 Testing pipe work

Refer Lo 3 and 7 (under sub content 3.4 and 7.5)

9.6 Repairing of pipe work

Most **piping systems** used today are manufactured using PVC, a hard plastic that is known to be durable. However, when pressure is put on the pipe, it is bound to break. When a pipe breaks at one point, it makes no sense replacing the entire system. PVC couplings are often used to repair that section of the pipe by cutting out the broken part and installing a new piece.

Here is how the repair process is conducted:

Step 1: Locate the Damaged Area

You will need to find out where the fluid is leaking in order to determine the section of the pipe that needs repair. Look out for damp patches or odors in case the piping system transports waste water.

Step 2: Mark the Area

Once you identify the point of damage, the next step is to mark the section that is going to be repaired; mark the cutting 6 inches away from the point of breakage/fracture on each side. You can use a felt pen to mark the cutting point.

Step 3: Cut Out the Piece

With two marks now, you can cut the two sections of the pipe using a hacksaw. Try and make straight cuts on both sides. With the two cut pipe ends, measure the distance between them and use this to determine the length of the new piece of PVC that will be installed in that section. Make sure the new pipe that you will fit in this section has a similar diameter to the existing pipe.

Step 4: Apply Primer

Don't use PVC glue before applying a primer. The primer needs to be applied on one end of the new pipe and also on one end of the existing pipe both on the outside sections. Apply primer on the interior of the coupling as well. Give the primer time to dry.

Step 5: Fit the Coupling

Push the one end of the coupling onto the end of the pipe that doesn't have any primer. Next, apply the PVC glue onto all the areas that have primer and then push the other end of the coupling onto the new pipe. Wait until the area is stuck. This should take less than a minute and

then let go. Make sure that half of the coupling is pushed inside the new pipe and the other half is in the existing pipe.

9.7 Work completion authorities

The drainage connection works may be taken up by lot owners / developers or by the Drainage Services Department (DSD).

Execution of Works

DSD shall commence work:-

- upon -

Completion of the drainage works within the lot; and a clear site being available to the DSD contractor; and

- After completion of all the necessary preparatory procedures with the utilities and departments concerned on matters relating to excavation.

Procedural Flowchart

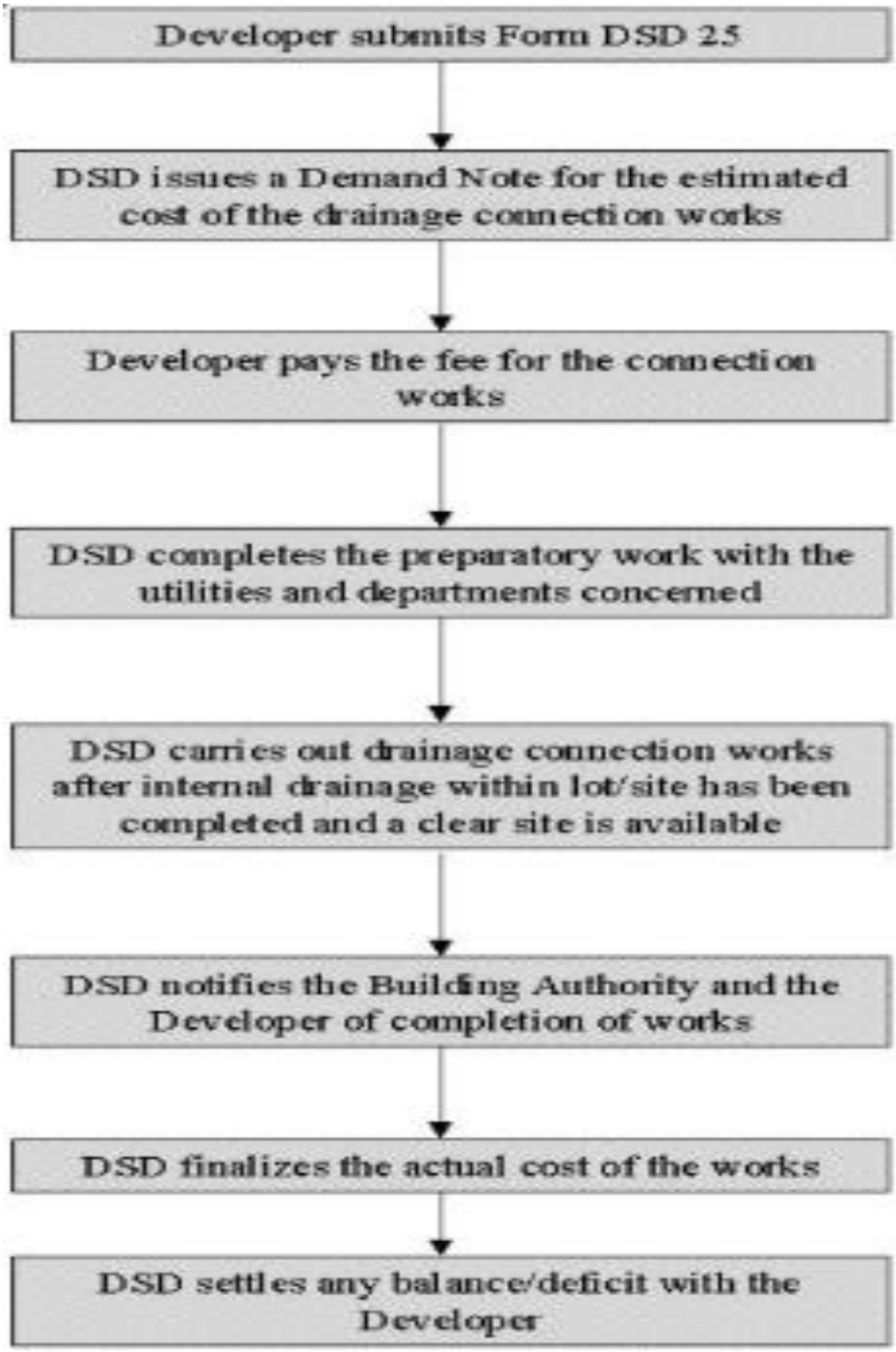


Fig9.12 Procedural Flowchart

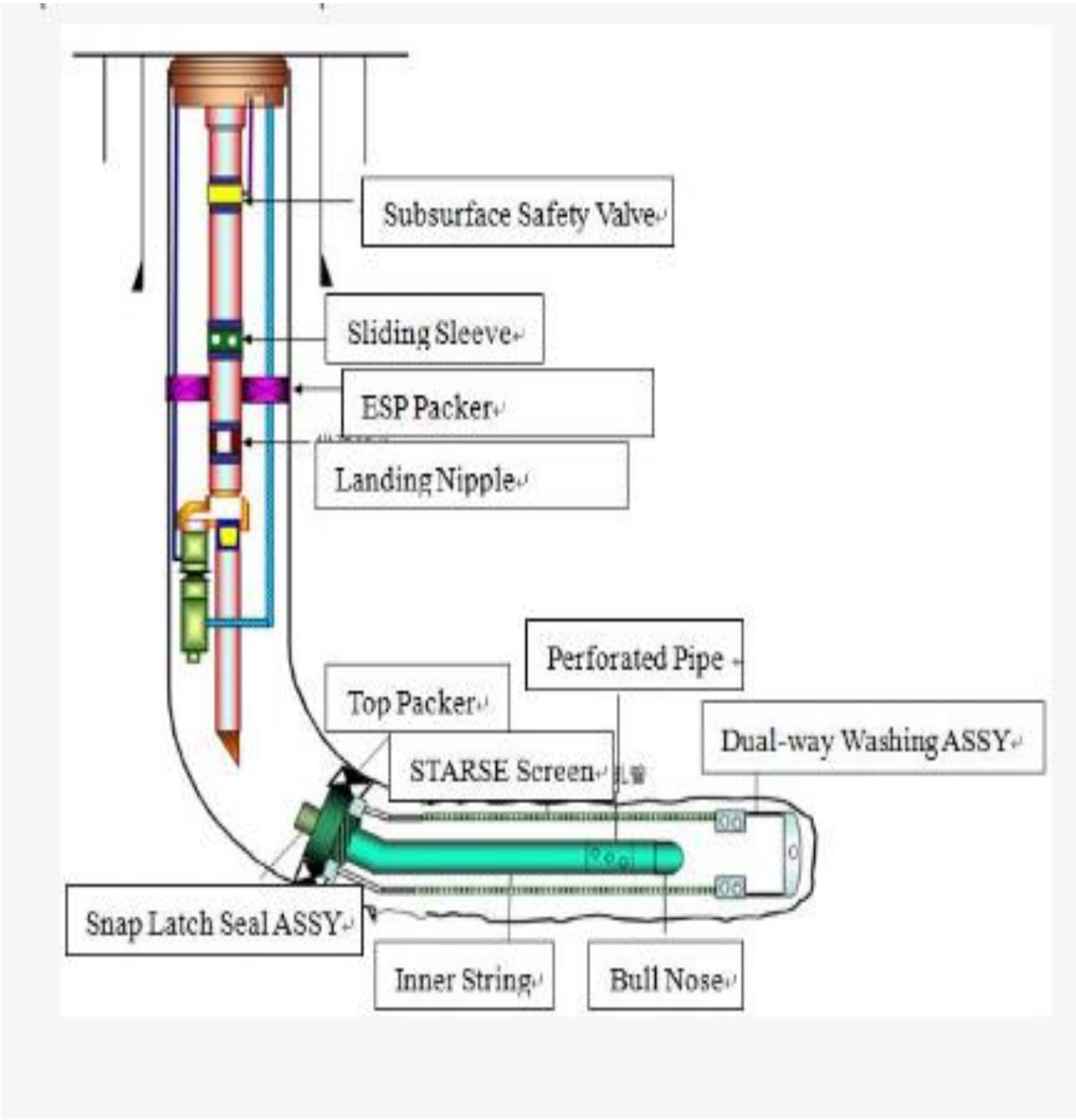


Fig 9.13 Schematics of completion

Self-check-9

I. Write True or False

1. The problem of blocked drains occurs when foreign materials such as soap, hair, food, and fats build up between the drain-pipe and other pipes that flow at the bottom.
2. Sectioned Sewer rods are used for cleaning large sewers.
3. Completion of the drainage works within the lot; and a clear site being available to the DSD contractor

II. Mach Column "A" with Column "B"

Column "A"	Column "B
_____1. Blockage	A. DSD
_____2. Operator Error	B. Used to improve pipe hydraulics
3. Drainage Services Department	C. Stoppage
	D. Is setting up the pumping system improperly

III. Choose the best answer from the following alternatives

1. One of the following is the main causes of pump line blockages
   a) a deficiency in the mix design
   b) the human factor
   c) problems with the pipeline itself
   d) All
   e) None
2. Which of the following is stoppage clearing tool and equipment?
   a) Augers
   b) Hand Spinners
   c) Water Jetting Machines
   d) Cables and Tools
   e) All

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