Ethiopian TVET-System

# Irrigation & Drainage Construction

## Level II

**Based on, March 2017G.C. Occupational Standard**

**Module Title: Constructing and Install Irrigation Delivery and Drainage Water Assets**

**TTLM Code: EIS IDC2 TTLM 0919v1**

# This module includes the following Learning Guides

## LG73: Plan and Prepare for Work

LG Code: EIS IDC2 M17 LO1-73

## LG74: Construct and install drains, channels, pipes and associated fittings

LG Code: EIS IDC2 M17 LO2-74

## LG75: Finalize work

LG Code: EIS IDC2 M17 LO3-75

| Instruction Sheet-1 | Learning Guide – 73: Plan and Prepare for Work |
|---|---|

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

- Determining work requirements from specifications and instructions.
- Locating work site boundary, extent and scope of work
- Selecting, fitting and using personal protective equipments
- Identifying, checking and preventing work site hazards and damages
- Identifying legislative and organizational requirements.
- Providing appropriate drainage and diversion from work site
- Checking and using equipment and excavation methods

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Determine work requirements are from specifications and instructions.
- Select, fit and use personal protective equipment are
- Perform site check is to identify hazards and prevent damage to other utilities according to legislative and organizational requirements.
- Provide appropriate drainage and diversion from work site are without damage to environment.
- Check equipment and excavation methods are to meet safety requirements of task and site.

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6” in page 4, 12, 19, 22, 32 and 45 respectively
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3, Self-check 4, Self-
5. check 5 and Self- check 6” -” in page 11, 18, 21, 30, 43 and 52 respectively
6. If you accomplish the self-checks, do operation sheet in page 53
7. LAP Test in page 54

| Information Sheet-1 | Determining work requirements from specifications and instructions. |
|---|---|

## 1.1 Introduction to work requirements

Work requirements should be determining from maps or data's that are observed from simple inspection of storage tanks and water storage assets. This is the amount of work required by us in maintaining water storage assets.

Determining work requirement is a process of identifying and arranging all necessary things by reading and interpreting the given design plans, drawings, specifications and instructions that can be used to accomplish the specific construction works. The clearance boundary comprises the set of components and the corresponding configurations that are required to create a safe boundary for the performance of maintenance or operational activities. During clearance initiation and before clearance application, a virtual tag is defined on the clearance for each boundary component.

During clearance application, boundary components are moved into the required positions. Physical tags are printed and hung to make information about the clearance boundary accessible to workers in the field. The scope of protected work comprises the set of components that require maintenance, and the work order tasks that are planned. On the clearance, the following information defines the work boundary:

- Clearance description, primary component, site, unit, and plant system
- Associated work orders

On the associated work orders, the following information defines the scope of protected work:

- Work order description and primary component
- Work order tasks

## 1.2 Locating work site boundary, extent and scope of work

### 1.2.1 Site boundaries

Owners/operators of construction activity must complete several steps before beginning

construction. Identifying the construction site boundaries, the latitude and longitude for the centroid of the site, and the project's major phases.

It 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.

### 1.2.2 Extent of work

This shows that to the extent that the scope of work involves in the construction of irrigation and drainage works. Determining the extent of the work before starting of it and is useful for managing safe time and resources.

**Purpose of Understanding extent of work**:

- to choice technology for accomplishment of specific work,
- to define of work tasks,
- to estimate required resources for each task
- to estimate durations for individual tasks,
- to identify any interactions among the different work tasks.

## 1.3 Locating utilities

Safe work place and methods must be prepared by the persons conducting activities for any identified high risk construction work in relation to all construction works. A worker must eliminate or, where it is not reasonably practicable, control the risks associated with 'construction work' in line with the 'hierarchy of controls'. The one must monitor and, where required, review these risk control measures, especially when workplace specific circumstances change. Review risk controls regularly:

- before a change occurs to the work itself, the system of work or the work location
- if a new hazard associated with the work is identified
- when new or additional information about the hazard becomes available
- when a modifiable incident occurs in relation to the work
- when risk controls are inadequate or the SWMS is not being followed

In all of the above situations, stop the work, review the SWM adjust as required and re-brief the team and retain all versions of the SWMS in a readily available location for the

duration of the HRCW and for at least two years after modifiable incident occurs.

## 1.4 Risk assessment and prevention measures

Assessing the risk considers:

- Isolating the severity of any injury or illness that could occur, isolating small hazard that cause minor injury or significant hazards that cause severe affects.
- The likelihood or chance that someone will suffer an illness or injury, for example consider the number of people exposed to the hazard.

Assessing the risks help to:

- identify which workers are at risk of exposure determine what sources and processes are causing that risk identify if and what kind of control measures should be implemented
- Check the effectiveness of existing control measures.

### 1.4.1 Risk factors and potential hazards of construction processes

Construction work is a hazardous land-based job. Some construction site jobs include: building houses, roads, dams, weirs, channels, tree forts, workplaces and repair and maintain infrastructures. This work includes many hazardous task and conditions such as working with height, excavation, noise, dust, power tools and equipment. The most common fatalities are caused by the fatal four: falls, being struck by an object, electrocutions, and being caught in between two objects.

### 1.4.2 Eliminating Risks

Eliminating risk is the most effective control measure and must always be considered before anything else. If elimination of the risk is not reasonably practicable, you must consider using substitution, isolation or engineering controls, or a combination of these control measures, to minimize the risk.

## 1.5 Signage and traffic control

### 1.5.1 Public signage

- Signage refers to the design or use of signs and symbols to communicate a message to a specific group, usually for the purpose of marketing or a kind of advocacy. A signage also means signs collectively or being considered as a group.
- Signs are any kind of visual graphics created to display information to a particular audience. This is typically manifested in the form of finding information in places such as streets or on the inside and outside of buildings. Signs vary in form and size based on location and intent, from more expansive banners ,billboards, and murals, to smaller street, boards and lawn signs. Newer signs may also use digital or electronic displays.

The main purpose of signs is to communicate, to convey information such that the receiver may make cognitive decisions based on the information provided. In general, signs may be classified according to the following functions:

- **Information:** signs conveying information about services and facilities, such as maps, directories, or instructional signs.
- **Direction:** signs showing the location of services, facilities, functional spaces and key areas, such as sign posts or directional arrows.
- **Identification:** signs indicating services and facilities, such as room names and numbers, restroom signs, or floor designations.
- **Safety and** Regulatory**:** signs giving warning or safety instructions, such assigns, traffic, exit, or signs conveying rules and regulations


Figure 1: Different construction signage

**Sign shape:** The shape of a sign can help to convey its message. Shape can be brand- or design-based, or can be part of a set of signage conventions used to standardize sign meaning. Usage of particular shapes may vary by country and culture.

Some common signage shape conventions are:

- **Rectangular** signs are often used to portray general information to an audience.
- **Circular** signs often represent an instruction that must be followed, either mandatory or prohibitive.
- **Triangular** signs are often warning signs, used to convey danger or caution.

### 1.5.2 Site isolation & traffic control mechanisms

Where engineering works are carried out in or on the banks of rivers, burns, ditches, loch sand wetlands, it is often necessary to isolate and de-water the work area to create dry working conditions. Isolation of the works area reduces the risk of sediment entering the river or loch.

The first and most important consideration is whether it is possible to design out the need for such temporary works. This can be achieved by:

- considering alternative permanent works that do not encroach on the channel, loch or wet land (e.g. set back bridge abutments and single span bridges);
- using alternative construction methods (e.g. directional drilling or tunneling rather than open cut excavation for pipe and cable crossings).

If temporary works in or on the banks of rivers, burns, ditches, lochs or wetlands are unavoidable, choose the isolation method that causes the least disturbance to the water body but provides the highest level of pollution protection. As well as initially de-watering the isolated work area, most of the isolation methods are likely to require continual or intermittent de-watering due to ingress of surface water, seepage or ground water.

### 1.6 Specifications and organizational requirements

- **National standard construction specifications:** Is State the technical and workmanship requirements for the various operations required in the construction of the works, the methods of measurement, and the basis of payment.
- **National standard material specifications:** State the quality of materials to be incorporated in the permanent works.
- **Interim specifications:** Specifications prepared by States for use in contracts that include construction items or materials not covered by national standard specifications.
- **Standard specifications:** National standard and interim specifications.
- **Unique or one time use specifications:** Specifications for construction or material items that are unique to the contract and are not covered by national standard specifications or State interim specifications. The specifications are prepared within the State and intended for one time use only in a specific contract.
- **Construction details:** Prepared by the design office and state the special requirements peculiar to a specific work of construction.
- They may take the form of written addenda to the standard construction specifications or notes on the drawings.
- **Contract specifications:** The complete specifications prepared for a specific contract and consist of an assembly of appropriate standard and one-time-use

specifications supplemented by lists and descriptions of items of work and construction details.

**Objectives of specifications:** The national standard specifications are used to:

- ensure adherence to laws and regulations, prevent conflicts within the specifications and between the specifications and other contract requirements,
- prevent omission of essential elements and inclusion of extraneous materials,
- provide a uniform basis for interpretation, and ensure uniform quality of a project works.

| Self-Check 1 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. Determining work requirement is a process of identifying and arranging all necessary things by reading and interpreting the given:
   A. Design plans C. Drawings
   B. Specifications D. Instructions E. All
2. The complete specifications prepared for a specific contract and consist of an assembly of appropriate standard and one-time-use specifications supplemented by lists and descriptions of items of work and construction details is:
   A. Contract specifications C. Construction details
   B. Standard specifications D. Interim specifications
3. Isolating and dewatering the work area to create dry working conditions is needed when:
   A. Working in or on the banks of rivers C. Working on the burns,
   B. Working on ditches, loch sand wetlands D. All
4. Signage refers to:
   A. The design or use of signs and symbols to communicate a message to a specific group
   B. Any kind of visual graphics created to display information to a particular audience.
   C. Written addenda to the standard construction specifications or notes on the drawings.
   D. Signs giving warning or safety instructions, such as warning signs ,traffic signs

**Note: Satisfactory rating – 8 and above points Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

**Answer sheet**

1. _____ 3. _____
2. _____ 4. _____

| Information Sheet-2 | Selecting, fitting and using personal protective equipments |
|---|---|

## 2.1 Types and purposes of PPE

- Gloves – protect hands
- Gowns/aprons – protect skin and/or clothing
- Masks and respirators– protect mouth/nose
- Respirators – protect respiratory tract from airborne infectious agents
- Goggles – protect eyes
- Face shields – protect face, mouth, nose, and eyes

## 2.2 Selection and Use of PPE

- **A safety helmet must be worn where:**
  - ✓ there is a possibility that a person may be struck on the head by a falling object
  - ✓ a person may strike his/her head against a fixed object It should be noted that 'bump caps', commonly worn to protect against minimum sideways impact, do not provide protection against any of the hazards described above.
- A wide range of accessories can be fitted to helmets to make them more suitable for variable working conditions. Examples are as follows:
  - ✓ a retaining strap worn either under the chin or at the nape of the neck
  - ✓ a bracket and cable clip for the attachment of a lamp
  - ✓ an eye shield, face shield or welding shield
  - ✓ a wide brim for additional shade in hot climates
  - ✓ neck flaps for protection against weather, molten metal splash, hot substances, etc.
  - ✓ a lining for cold conditions
  - ✓ ear muffs Care should be taken to ensure that accessories and their attachment systems do not reduce the safety characteristics of the helmet, nor adversely affect the balance or comfort of the helmet.

- **Eye Protection must be worn where:**

A risk of eye injury exists such as flying particles, dust, splashing substances, harmful gases, vapours, aerosols, and high intensity radiation from welding operations, lasers and strong heat sources. Consideration must be given to the need for protecting persons who are working nearby or passing close to hazardous areas. It is essential that the maximum degree of eye protection is provided.

The following should be considered when selecting appropriate eye protection:

- Nature of risk to the eyes e.g. radiation, impact, dust/abrasive particles, liquid/chemical splash or spray etc.
- Conditions under which the person is working
- Visual requirements of the task
- Personal preference/comfort of wearer. This may include appearance, weight, ventilation and unrestricted vision.
- Condition of person's eyesight.

The need for eye protection to have appropriate impact rating and be fit for task The following general eye protectors are available:

- Goggles - An eye protector fitting the contour of the face and held in position by an adjustable headband.
- Wide Vision Goggles - An eye protector in which the lens or lenses extend over the full width of the face affording a large field of vision.
- Welding Helmet - A rigid eye protector which is worn by the operator to shield the eyes, face, forehead and front of the neck.
- Welding Hand shield - A rigid eye protector which is held in the hand to shield the eyes, face, forehead and front of the neck.
- Face shield - A device which includes a transparent visor, supported in front of the face to shield the eyes.

- Safety Spectacles - An eye protector with protective lenses mounted in spectacle-type frames, or integrally moulded into the frames with or without side shields, and held in position by the side arms.
- Tinted Safety Spectacles/Goggles - These may be provided to employees who require eye protection and who are generally required to work outdoors.

- **Hearing Protection must be worn where:**
  - ✓ A person is working in or near a noisy environment.

The following hearing protection devices are commonly available.

- **Disposable Hearing Protection Device –** A hearing protection device formed by packing a suitable material into or around the ear canal. Disposable hearing protection devices are discarded after a single wearing.
- Earplug **–** A hearing protection device, other than disposable hearing protection devices, that is inserted into the ear canal.
- **Ear Canal Cap –** A hearing protection device that covers the ear canal entrance and is held in place by a headband.
- **Earmuff –** A hearing protection device that covers the entire ear and is held in place by a suspension system.
- **Helmet –** A hearing protection device that covers the ears and an appreciable part of the head.
- **Suspension System –** A device that holds the hearing protection device in proper position on the wearer's head. A suspension system may be a headband, a neckband or a safety helmet.

The following factors must be considered when using ear protection PPE:

- **Respiratory protection must be worn where:** A person is working in an environment where there is :
  - ✓ deficiency of oxygen
  - ✓ particulate contaminants
  - ✓ gaseous or vapour contaminants Air Purifying Devices

- ✓ Dust Masks – used for protection against nuisance dusts such as sawdust, chalk, plant related and sanding dusts. These are generally not suitable for toxic substances.

- **Face protection must be worn where:** Employees are required to work outdoors and are exposed to the sun's rays. You should:
  - ✓ Attempt to schedule work that must be completed in full sun to before 10am and after 3pm.
  - ✓ Use shade wherever possible.
  - ✓ Wear loose and closely woven clothing (long sleeved, button up, collared shirt, gloves).
  - ✓ Wear a 10cm wide brimmed hat or hat with a neck flap.
  - ✓ Use a broad spectrum water resistant SPF30+ sunscreen at least 10–15 minutes before going out in the sun. Reapply every 2 hours while outdoors.
  - ✓ Drink plenty of water.
  - ✓ Wear close fitting sun glasses.
  - ✓ Where insect borne disease may be contracted (e.g Ross River Virus), use appropriate insect repellent.
- **Hand protection must be worn when:** The number of applications for which hand protection must be provided is very extensive. In general, protection is provided wherever there is a hazard and it is essential that the correct type is used for a specific task.
- **Foot protection must be worn when:** The type of duties performed require protective footwear. The footwear may also have special characteristics such as protective toecap, thickness and type of upper materials, thickness and type of sole, chemical resistant soles, penetration resistant mid soles and electrical conductive / antistatic properties.
- **Protection from falls :**A full body harnesses with lanyard attachment at the back should be used, to ensure a person cannot slip out of the harness. Systems must also be put in place to ensure that a person suspended this way can quickly be rescued if the need arises.

- **Other PPE :**This may include PPE for specific tasks such disposable clothing for working with chemicals, radiation hazards, welding, painting.

**Examples include:** lead aprons for x-ray protection; sleeve protectors, aprons, coveralls when using chemicals; leather jackets, trousers and spats for welding; thermal and cold protective clothing for work near furnaces and cool rooms

| Self-Check 2 | Written Test |
|---|---|

**Direction I:** Matching

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

| **"A"** | **"B"** |
|---|---|
| 1. Used to protect our head from falling object | A. Dust Masks |
| 2. Required when employees are to work outdoors and are exposed to the sun's rays | B. Ear Canal Cap |
| 3. Used for protection against nuisance dusts such as sawdust, chalk, plant related and sanding dusts | D. Ear plug |
| 4. A hearing protection device that covers the entire ear and is held in place by a suspension system. | E. Helmet |
| 5. A hearing protection device that covers the ear canal entrance and is held in place by a headband. | F. Earmuff |
| 6. protect skin and/or clothing | G. glove |
| | H. Face protection |
| | I. Gowns/aprons |

**Note: Satisfactory rating – 12 and above points Unsatisfactory - below 12 points**

You can ask you teacher for the copy of the correct answers.

Answer sheet

1._____

2. _____

3. _____

4. _____

5. _____

6. _____

| Information Sheet-3 | Identifying, checking and preventing work site hazards and damages |
|---|---|

## 2.1 Work place hazards

- A hazard is anything that may cause harm, such as chemicals, electricity, working from ladders, an open drawer etc.
- It is any condition associated with construction works that can cause harm to life, properties and environment.

Examples of hazards associated with construction are:

- the construction workplace itself, including its location, layout, condition and accessibility
- the use of ladders, incorrectly erected equipment, unguarded holes, penetrations and voids, unguarded excavations, trenches, unstable structures such as incomplete scaffolding or mobile platforms, fragile and brittle surfaces such as cement sheet roofs, fiberglass, roofs, skylights and unprotected formwork decks
    - ✓ falling objects, for example tools, debris and equipment
    - ✓ collapse of trenches
    - ✓ structural collapse
- the handling, use, storage, and transport or disposal of hazardous chemicals the presence of asbestos and asbestos-containing materials
    - ✓ welding fumes, gases and arcs
    - ✓ hazardous manual task
    - ✓ the interface with other works or trade activities

## 2.2 Risk assessment and identification of hazards

Risk assessment is the determination of quantitative or qualitative value of risk related to a concrete situation and a recognized threat(also called hazard).Quantitative risk assessment requires calculations of two components of risk(R): the magnitude of the potential loss(L), and the probability(p)that the loss will occur. Acceptable risk is a risk that is understood and tolerated usually because the cost or difficulty of implementing an effective countermeasure

for the associated vulnerability exceeds the expectation of loss. A risk assessment is simply a careful examination of what, in your work, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm. Identifying hazards is the process of examining each work area and work task for the purpose of identifying all the hazards which are “inherent in the job”.

### 2.3 Controlling risks and hazards

Some controls which could be put into place in your workplace are:

- **Slips and Trips**
  - ✓ Don’t leave things lying on the ground where someone could trip over them.
  - ✓ Have signage up if floor surface is wet to prevent slips.
  - ✓ Cover over cords etc. on floors so people don’t trip.
- **Lifting**
  - ✓ Never try to lift anything that is too heavy.
  - ✓ Always ask for assistance.
  - ✓ Plan your lift, particularly if item is large, awkward or possibly unstable.
  - ✓ Be shown the correct procedure for lifting anything. • Bend from the knees, not your back.
- **Electricity**
  - ✓ Never use faulty electrical equipment or cords etc.
  - ✓ If an item is damaged or faulty, tag it immediately and remove it from service.
  - ✓ Don’t mix electricity with water.
  - ✓ Always use electrical equipment in the manner for which it was made.
- **Machinery**
  - ✓ Never operate machinery under the influence of drugs or alcohol.
  - ✓ Never operate machinery unless you are trained to operate that machinery.
  - ✓ Keep clear of moving machinery at all times.
- **Fire**
  - ✓ Be aware of your workplaces fire procedure.
  - ✓ Know where fire extinguishers are located and how to use them.

- ✓ Be careful when in and around flammable substances.
- ✓ Read signage carefully in regards to flammable substances

### 3.3.1 Construction hazards and their prevention

The top four causes of construction fatalities are:

a) Falls,
b) Struck-by,
c) Caught-In/Between and
d) Electrocutions.

- **Prevention of fall**
  - ✓ Wear and use personal fall arrest equipment.
  - ✓ Install and maintain perimeter protection.
  - ✓ Cover and secure floor openings and label floor opening covers.
  - ✓ Use ladders and scaffolds safely.
- **Prevention of Struck-By**
  - ✓ Never position yourself between moving and fixed objects.
  - ✓ Wear high-visibility clothes near equipment/vehicles.
- **Prevention of caught-in/Between**
  - ✓ Never enter an unprotected trench or excavation 1.6 meter or deeper without an adequate protective system in place.
  - ✓ Make sure the trench or excavation is protected either by sloping, shoring, and benching or trench shield systems.

**Figure 2: Prevention of caught-in/Between**

| Self-Check 3 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. To prevent fall;
   A. Wear and use personal fall arrest equipment.
   B. Install and maintain perimeter protection.
   C. Cover and secure floor openings and label floor opening covers.
   D. Use ladders and scaffolds safely.
2. Risks and hazards at construction site may be:
   A. Slips and Trips C. Lifting
   B. Electricity D. Machinery E. All
3. A careful examination of what, in your work, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm is:
   A. Risk control C. Risk management
   B. Risk assessment D. Risk identification

**Note: Satisfactory rating – 6 and above points Unsatisfactory - below 6 points**

You can ask you teacher for the copy of the correct answers.

Answer sheet

1._____

2. _____

3. _____

| Information sheet - 4 | Identifying legislative and organizational requirements |
|---|---|

## 4.1 FDRE legislation and regulations

Legislative and organizational requirements are indicators of actual or potential risk of abuse, neglect or harm. You need to work within the parameters of accepted standards, such as:

- protocols defined in legislation
- Organizational procedures.

Legislative and organizational requirements may include:

- Relevant federal water legislation and regulations
- Local authority by-laws
- Organizational procedures
- Environmental
- Cultural heritage
- OHS procedures
- Dangerous goods and chemicals

### 4.1.1 Federal water legislation

Relevant federal water legislation and regulations is legislative framework created for the implementation of the water proclamation and the operational of the Ethiopian Water Resources Management policy.

Water policies including the issuance of water resources management proclamation and the 15-year Water Sector Development Programme (WSDP) beginning from 2002 are signs of effective governance by way of creating the ground for sustainable water resources development and management.

### 4.1.2 Water Resources Management Proclamation

The proclamation was issued with clear objectives and purpose to implement the, fundamental principles objectives, goal and the stipulated sectoral and cross cutting policy issues articulated in the water policy for Ethiopia.

- The proclamation has Nine Parts and 33 Articles and several sub- articles.

- The social, legal, environment, institutional and many more other related legislative provisions are treated here as appropriate and required.
- The proclamation declares, "All water resources of the country are the common property of the Ethiopian people and the state". (Federal Democratic Republic of Ethiopia (FDRE),197/2000 Article 5)
- Regarding water use priority, the proclamation states, "Domestic water use shall have priority over and above any other water uses". (FDRE, 197/2000 Article 7sub-article 1).

### 4.1.3 Federal water Regulations

Relevant federal water regulations are those covered in the proclamation, but detailing the procedures as to how the various legal materials contained in the proclamation are to be achieved on the ground. The Regulation has TEN parts and 44 relevant Chapters (Articles).

### 4.1.4 Local authority by-laws

Planning and implementing of water resources development and management, which are within the legal competence of the Regional States are further transferring down to the local administrative units at Woreda levels known as water desk. These desks are responsible for planning, budgeting, implementing and monitoring and follow-up of water projects and programmes, in their respective localities.

### 4.1.5 Organizational procedures

Procedure is the fundamentals of the policy, outlining what has to be done to implement the policy. A policy is a course of action or guidelines to be followed whereas a procedure, outlines what has to be done to implement the policy. For example, a staff recruitment policy could involve the following procedures:

- All vacant paid positions will be advertised in local and state-wide papers.
- The advertisements will have details of duties, salary range, closing date and contact details.
- All interested people will be mailed job descriptions and information about the organization

### 4.1.6 Environmental requirements

Depending on the regulation, a violation can result in both civil and criminal penalties. Ethiopia has established 16 the fundamental general policy principles that guide the equitable, sustainable and efficient development, utilization, conservation and protection of water resources in Ethiopia as it is stated in the document of Ethiopian Water Resources Management Policy.

The policy's stated goal is to "improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole". This is done through several sectoral policies as well as some cross-sectoral policies. One sectoral policy specifically addresses climate change and atmospheric pollution, through:

- promoting a climate monitoring programme
- acknowledging a commitment to mitigate emissions, even at low or even insignificant levels of contribution to global emissions
- actively participating in protecting the ozone layer, as a means to reduce vulnerability of the highlands of Ethiopia
- encouraging re-vegetation, monitoring grazing and rehabilitating degraded land to compensate for high biomass-fuel consumption

Other sectoral policies include:

- soil husbandry and sustainable agriculture
- forest, woodland and tree resources
- genetic, species and ecosystem biodiversity
- energy resource
- water resources
- mineral resources
- human settlement, urban environment and environmental health
- control of hazardous materials and pollution from industrial waste
- cultural and natural heritage

Thus, any water resources development construction should obey federal water legislation and regulations.

### 4.1.7 Cultural heritage

Cultural heritage is the legacy of tangible and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestow for the benefit of future generations.

Ethiopia is rich in linguistic and cultural diversity. This diversity includes tangible and intangible heritage with both traditional and modern cultural expressions, languages, and centuries old know how in handicraft production. The intangible heritage of Ethiopia is also rich with an exceptional variety including ceremonies, festivals, celebrations, rituals, and other living expressions.

**Tangible culture:-**Tangible cultures are those of features such as buildings, monuments, landscapes, books, works of art, and artifacts.

**Intangible culture: -** Intangible cultures are those of attributes such as folklore, traditions, language, and knowledge, and natural heritage (including culturally significant landscapes, and biodiversity.

### 4.1.8 OHS procedures

- Some kinds of accidents commonly caused by lack of Observing OH& S policies and procedures are:
- Poor Interpretation of work instructions according to job requirements
- Well organized and selected tools are not available
- Substandard and unsafe installation
- Control devices remain unchecked

### 4.1.9 Dangerous goods and chemicals

Dangerous goods or hazardous goods are solids, liquids, or gases that can harm people, other living organisms, property, or the environment. Dangerous goods are substances, mixtures or articles that, because of their physical, chemical (physicochemical) or acute toxicity properties, present an immediate hazard to people, property or the environment.

Hazardous chemicals are any substance, mixture or article that satisfies the criteria for a hazard class in the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) that are used in the workplace. These can be classified according to their health and physicochemical hazards.

### 4.2 Codes of practice and standards

The term standard refers specifically to a specification that has been approved by a standards setting organization. The standards most frequently encountered in construction work will now be described under two headings; 'general-purpose standards' and 'nuclear standards'. Both standards specify systems which will maintain and assure quality; the difference is that whereas the first category is oriented to the requirements of the market place, the second is aimed more at satisfying the statutory requirements imposed by regulatory authorities particularly in respect of safety.

Federal democratic republic of Ethiopia, ministry of water resources formulates and adopt national standards and criteria for the design, installation, construction, operation, maintenance, inspection and other activities in all water resources management undertakings.

Any water work activities should be agreed with the standards and full fill with the following conditions.

- Adopt the water sector as the responsible authority for issuance of the necessary professional certification, professional permits and licenses for consultancy, contracting, as well as manufacturing and importing related to water resources development.
- Provide the necessary legal framework for penalties commensurate with the violation of legal provisions relating to water resources.

### 4.3 Organisational policies, manuals and induction programs

Ethiopia has established 16 the fundamental general policy principles that guide the equitable, sustainable and efficient development, utilization, conservation and protection of water resources in Ethiopia as it is stated in the document of Ethiopian Water Resources Management Policy.

The policy's stated goal is to "improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole. This is done through several sectoral policies as well as some cross-sectoral policies. One sectoral policy specifically addresses climate change and atmospheric pollution, through:

- promoting a climate monitoring programme
- acknowledging a commitment to mitigate emissions, even at low or even insignificant levels of contribution to global emissions
- actively participating in protecting the ozone layer, as a means to reduce vulnerability of the highlands of Ethiopia
- encouraging re-vegetation, monitoring grazing and rehabilitating degraded land to compensate for high biomass-fuel consumption

Other sectoral policies include:

- soil husbandry and sustainable agriculture
- forest, woodland and tree resources
- genetic, species and ecosystem biodiversity
- energy resource
- water resources
- mineral resources
- human settlement, urban environment and environmental health
- control of hazardous materials and pollution from industrial waste
- cultural and natural heritage

Thus, any water resources development construction should obey federal water legislation and regulations.

### 4.4 Community land care agreements

Land care is a unique community-based approach to managing and restoring natural environment and improving the sustainability of agricultural activities.

Land carries the name for a type of community nitrogenization which involves local

groups of volunteers repairing the natural environment. Originally projects focused on agricultural farmland. The idea was that farmers, conservationists and scientists could work together to improve both farm quality and natural ecosystems.

The concept of "land care" brings people together who share a common problem and usually live in the same drainage or "catchment", an area that collects and directs water to a common point. By working together in a catchment, land problems can be tackled successfully.

A Land care group usually starts when community members with common objectives come together over their shared community priorities or concerns for management of natural assets. For example, erosion of sand dunes due to mismanaged beach access or weeds affecting agricultural productivity. Groups normally set their own agenda and manage the number and types of sites or projects and level of work required.

| Self-Check- 4 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. Which of the following is not true with respect to Community land care agreements?
   A. Land care is a unique community based approach to managing and restoring natural environment
   B. It starts when community members with common objectives come together over their shared community priorities or concerns for management of natural assets.
   C. Land care is the name for a type of community not organisation which involves local groups of volunteers repairing the natural environment
   D. None
2. Climate change and atmospheric pollution could be addressed through policies like:
   A. Promoting a climate monitoring programme
   B. C. Soil husbandry
   C. Forest, woodland and tree resources
   D. D. Ecosystem biodiversity
   E. E. All
3. _____refers to a specification that has been approved by a standards setting organization.
   A. Standard
   B. C. Code of practice
   C. Policy
   D. D. Procedure
4. _____are solids, liquids, or gases that can harm people, other living organisms, property, or the environment.
   A. Hazardous goods
   B. Non-hazardous goods
   C. Chemicals
   D. D. Acids
5. Which of the following is true based on EFDRE water resources management proclamation

A. The proclamation has Nine Parts and 33 Articles and several sub- articles.

B. The social, legal, environment, institutional and many more other related legislative provisions are treated here as appropriate and required.

C. The proclamation declares, "All water resources of the country are the common property of the Ethiopian people and the state". (Federal Democratic Republic of Ethiopia (FDRE),197/2000 Article 5)

D. Regarding water use priority, the proclamation states, "Domestic water use shall have priority over and above any other water uses". (FDRE, 197/2000 Article 7sub-article 1).

E. All

**Note: Satisfactory rating – 10and above points  Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

1. _____
2. _____
3. _____
4. _____
5. _____

| Information Sheet - 5 | Providing appropriate drainage and diversion from work site |
|---|---|

## 5.1 Introduction to drainage system

Drainage refers to the removal of excess water from the ground surface as well as from the subsurface soil to facilitate the proper growth of plants and to avoid the hazards due to water logging. It can be done by using taleranol mole drains (in clay soil). Drainage system(agriculture) An agricultural drainage systems assembly which water is drained on or in the soil to enhance agricultural production of crops. It may involve any combination of storm water control, erosion control, and water table control. A ditch is a small to moderate depression created to channel water. A ditch can be used for drainage, to rainwater from low-lying areas, alongside roadways or fields, or to channel water from a more distant source for plant irrigation.

There are two types of drainage:

- **Surface drainage:** Collect water from road surface and adjacent areas
- **Subsurface drainage:** Transport water through pores as subsurface flow Collect water from road surface, shoulders, side slopes and adjacent areas.

## 5.2 Purposes of drainage systems

- To cause water to leave the road as shallow, non-erosive sheet flow, and enable
- harvesting of run-off water.
- In a direction and pattern to suit combinations of road material, slope and terrain.

In any project involving land drainage, it is advisable to work from the downstream part of the system in an upstream direction. It is necessary to provide a suitable outlet for the drainage water, either by gravity or by pumping.

If the outlet alone is insufficient, a main system of open drainage channels and ditches must be constructed to convey the drained water to the outlet and the main system cannot provide adequate control of groundwater levels in the fields, a system of field drains is needed, forming a detailed drainage system, consisting largely of subsurface pipe drains. Open trenches are sometimes used for groundwater control instead, e.g. in

drainage of heavy land and in the humid tropics. However, the use of open trenches for subsurface drainage is not generally recommended, as they hamper agricultural operations, reduce the cultivable area and increase the maintenance burden.

If these field drains are still not able to cope with water stagnating on the surface, additional measures should be taken. Where any element of the main drainage system is not functioning properly, all upstream facilities cannot fulfill their purpose. Thus, a good outlet and a well-designed and well-maintained main drainage system are prerequisites for adequate field drainage.

### 5.3 Dewatering construction site

- Dewatering is the removal of water from solid material or soil by wet classification, centrifugation, filtration, or similar solid-liquid separation, such as removal of residual liquid from a cake by a filter as part of various industrial processes.
- Construction dewatering, un watering, or water control are common terms used to describe removal or draining groundwater or surface water from a river bed, construction site, caisson, or mine shaft, by pumping or evaporation. On a construction site, this dewatering may be implemented before subsurface excavation for foundations, shoring, or cellar space to lower the water.
- Construction dewatering is used to portray the act of removing groundwater or surface water from a construction site. Usually the dewatering process is done by pumping or evaporation and is generally done prior to excavation for footings or to lower water table that might be causing troubles during excavations.
- Construction dewatering, un watering, or water control are common terms used to describe removal or draining groundwater or surface water from a riverbed, construction site, caisson, or mine shaft, by pumping or evaporation.
- There are four important dewatering methods one should be aware of:
  - ✓ Well point method of dewatering
  - ✓ Educator well
  - ✓ Open sump pumping
  - ✓ Deep well point method
- Pumps and dewatering equipment are used to remove water from volume liquid, solid material or soil. Pumps simply remove liquid from a volume of liquid, whereas

dewatering equipment separates water from another material such as soil or sludge.

- They can be used for a number of different operations, including:
  - ✓ Keeping water rout of foundations, pits, tunnels, and other excavations.
  - ✓ Lowering the water table below excavation level.
  - ✓ Pumping water out of coffer dams.
  - ✓ Supplying water for jetting, sluicing and other general purposes.
  - ✓ Foundation grouting.
  - ✓ Drying solids.
- The choice of equipment depends on various factors, such as:
  - ✓ The project complexity.
  - ✓ The amount of liquid to be moved.
  - ✓ Thera teat which the liquid needs to be moved.
  - ✓ The height of the suction lift– distance from the water to the pump.
  - ✓ The loss incurred due to friction.
  - ✓ The size of the pump.
  - ✓ The type of liquid.

### 5.2.1. Types of Pumps

#### 5.2.1.1. Centrifugal pumps

Centrifugal pumps contain a rotating impeller which creates a vortex that sucks air out of the hose. Water rises to the pump as a result of atmospheric pressure.

Priming involves filling the pump casing with liquid before the pump is started. This is done to prevent the casing becoming filled with vapours or gases that inhibit pumping. Self-priming pumps have a reserve supply of water in the impeller chamber.

Air-operated centrifugal pumps, often known as ‘sump pumps’, consist of a small centrifugal pump fixed to an air motor. These are often used in tunnels and foundation pits to handle sewage oil or sludge.

Figure3: Horizontal centrifugal pump

#### 5.2.1.2. Displacement pumps

Displacement pumps can be either reciprocating or diaphragm pumps. Reciprocating pumps work by the action of a piston or ram moving in a cylinder. Larger pumps may have two or three cylinders. Water is drawn into the cylinder when the piston moves in one direction, and pushed out at the rear. These have high efficiency and reliability, and are able to pump against varying heads at a uniform rate. However, they are better for low-flow conditions.

Figure4: Displacement pump

Diaphragm pumps work by drawing water in to a cylinder in which a flexible diaphragm is raised and lowered. The downward motion of the diaphragm pushes the water out

through the delivery pipe. They can pump liquids containing 10-15% solids, and are suitable for work where the flow watercarriers greatly.

#### 5.2.1.3. Submersible pumps

- Submersible pumps can be used for lowering ground water or removing water from a deep slump.
- The pump unit is suspended from the rising main or, if a flexible hose is used, from a wire cable.
- The pump consists of a centrifugal unit and motor mounted in a single cylindrical unit with a space between pump and casing which allows the water to move upwards to the rising main.
- They are intended for heavy duty work that involves lifting gritty water.

Figure 5: Different sizes submersible pumps

#### 5.2.1.4. **Air**lift pumps

Airlift pumps consist, not of moving parts, but of a long vertical pipe connected to as upply of compressed air. The air carries the water up the pipe to the discharge area. Airlift pumps are often used for moving silt from the base of a cofferdam.

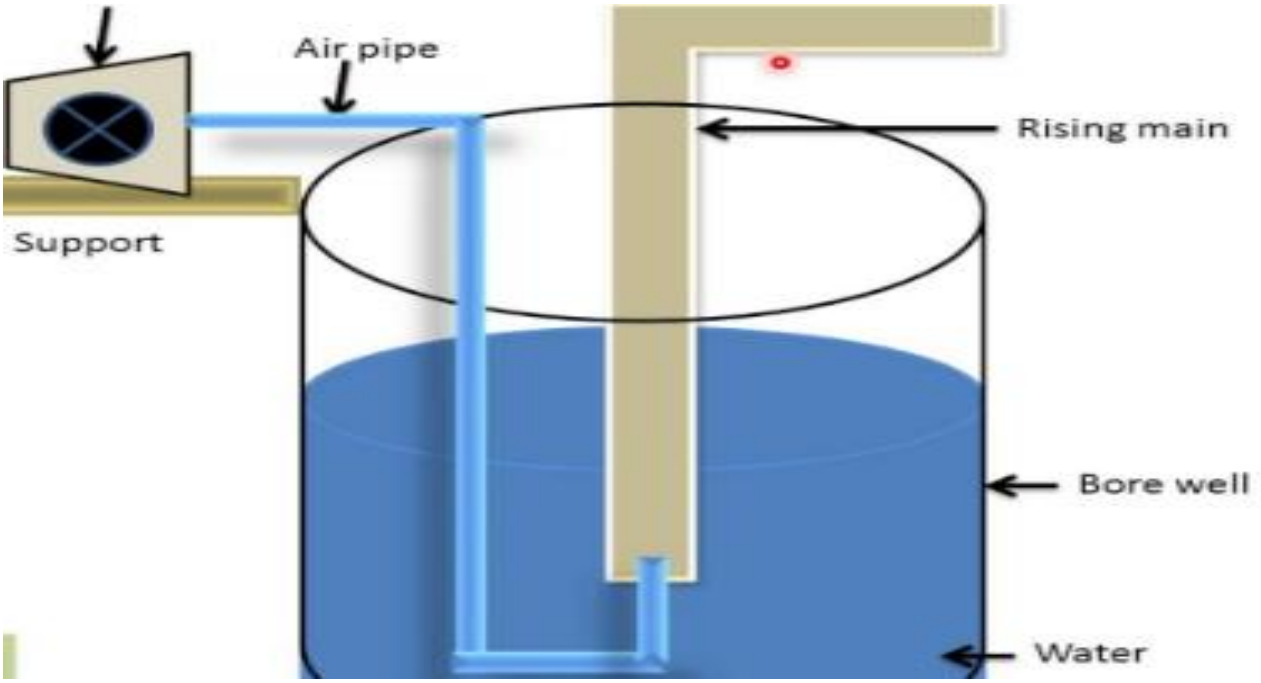



Figure 6: Air lift pump

### 5.2.2. Dewatering Equipments

The type of dewatering equipment to be used will depend on the corrosion potential of the material, such as sludge, to be pumped, hazardous contaminants, and so on. Equipment may need to be constructed with durable materials.

#### 5.2.2.1. Centrifuges

Centrifuges separate solids from liquids through sedimentation and centrifugal force. A bowl, spinning at high speed, separates the water from the solids which are compacted against the bowl walls.

#### 5.2.2.2. Vacuum filters

Vacuum filters involve creating a vacuum to draw out water from solids. They can dry solids enough to eliminate the need for subsequent steps such as digestion or heat treatment before disposal, incineration, or usage.

#### 5.2.1.3. Filter presses

Filter presses use a porous press to separate solids from liquids. Solids are captured in pores between two or more porous plates, and built up on the surface. Water is forced

through the pores either from plate pressure by pushing the plates together or from a build-up of solids pressure by continuously pushing solids into the cavities.

#### 5.2.1.4. Drying beds

Drying beds consist of perforated or open joint drainage pipes laid within a gravel base. Sludge is placed on top of a sand layer and allowed to dry. Water is removed through natural evaporation and by gravity draining from the sludge mass through the supporting sand to the drainage piping. Cracks develop as the sludge dries, allowing evaporation to occur from the lower layers which accelerates the drying process.

## 5.1 Methods of diverting water from construction site

A water diversion is the removal or transfer of water from one watershed to another. The term “consumptive use” is used to define diversions and exports, because the water is being “consumed” without then returning to its source.

Diversion structures route runoff in excess of base flow to storage facilities during wet periods, for later use during dry periods. Flood diversion structures, such as dikes, are also useful methods for mitigating the adverse effect of torrential rains and at the same time capturing the excess water for later use.

Diversion channels or floodways are man-made channel built to offer a different route for excess water to flow further mitigating the effects of flooding and restoring rivers to their natural water level.

## 5.2 Diverting Water for Construction Projects

Often, construction projects require work done across streams, rivers, or similar small bodies of water. Since these bodies of water cannot be fully blocked, water must be diverted to maintain a healthy flow. Some typical projects requiring water diversion are:

- dredging
- fish habitat protection
- environmental remediation
- pipeline crossings
- levee repair

- wetland management
- irrigation canal work

### 5.4.1.Water Diversion

Sometimes a diversion is necessary for construction to ensure an isolated, dry project area. In some cases, water is temporarily rerouted in order to prevent or minimize contamination of clean surface waters. Water diversion also provides an effective method of sediment control. With water diversion, work zone sediment is prevented from entering the body of water, which is especially crucial when dewatering storm water areas.

### 5.4.2. Best Method for Water Diversion

Working in water is one of the most complex construction scenarios imaginable, and an Cofferdam should be an essential component of your water diversion project. Easily deployed and completely portable, Aqua-Barrier® can be used in a variety of configurations to divert water, creating a dry work environment.

### 5.4.3. Construction Projects & Water Diversion

Inflatable bladder dams, like the Aqua-Barrier, have quickly become the leading method for water diversion and dewatering in construction. They are easy to deploy, effective, and environmentally friendly. Consider investing in a water inflated bladder dam for your future dewatering and diversion projects.

Figure 7: Water Diversion

## 5.3 Construction area isolation methods

### 5.5.1 Partial isolation/‘cofferdam’

Partial area of the channel is isolated and kept dry with the use of barriers (often referred to as a cofferdam) and flow is allowed to continue in the remainder of the channel. Barriers used to isolate part of the channel can be made of a number of different materials.

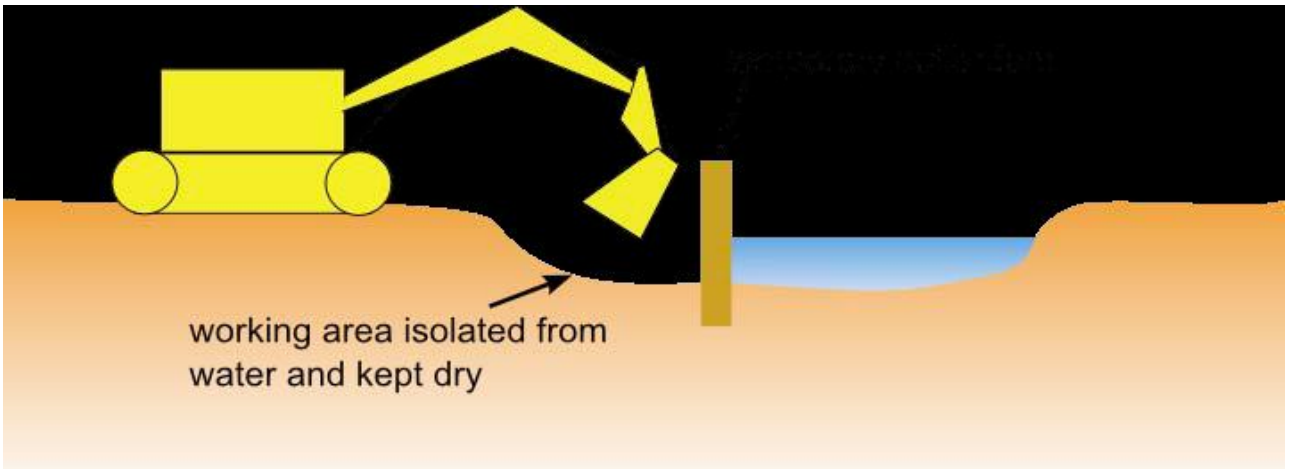



Figure 8: Partial isolation by coffer dam

### 5.5.2. Partial isolation using a caisson

This provides isolation of the channel similar to cofferdams. They are essentially large boxes or cylinders (usually pre-cast concrete and steel) which are open at the top and bottom and are lowered into the water to isolate an area of bed.

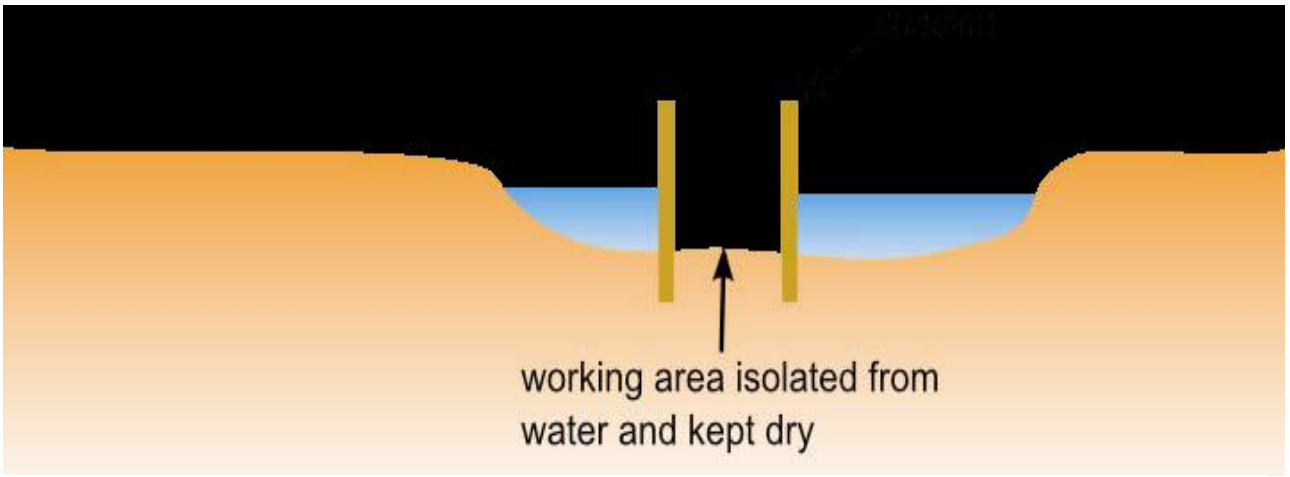



Figure 9: Partial isolation using a Caisson

### 5.5.3. Full isolation temporary diversion channel

A whole section of the channel is isolated and kept dry, and the water is transferred downstream of the works area by excavating a temporary open channel.

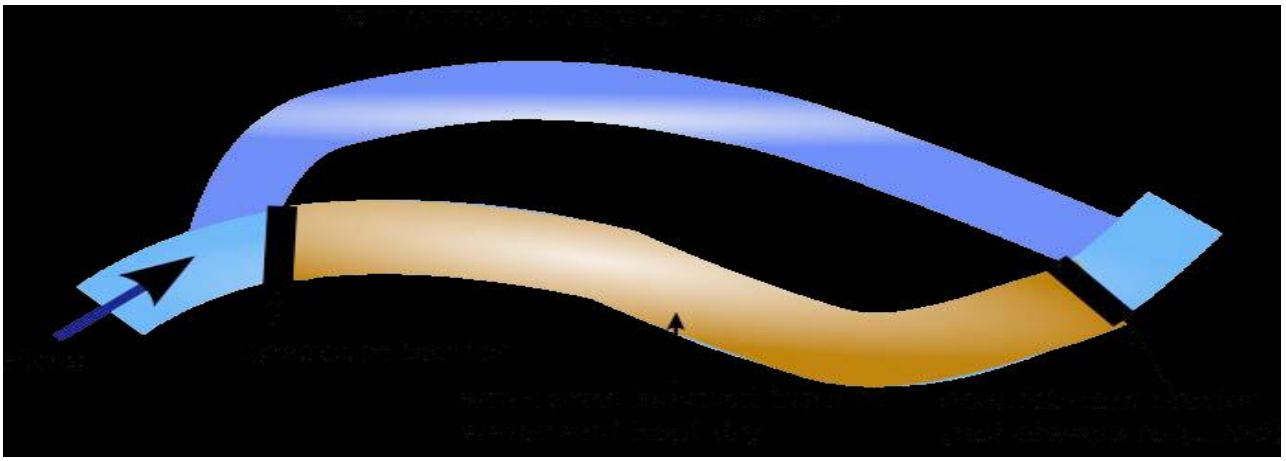


Figure 10: Full isolation with temporary diversion channel

### 5.5.4. Full isolation gravity/flume pipe

A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area through gravity fed flumes/pipes. The flume(s) is normally placed on the bed of the watercourse through the works area and outfalls at the downstream barrier, if present, or far enough downstream to prevent the water backing up into the work area.

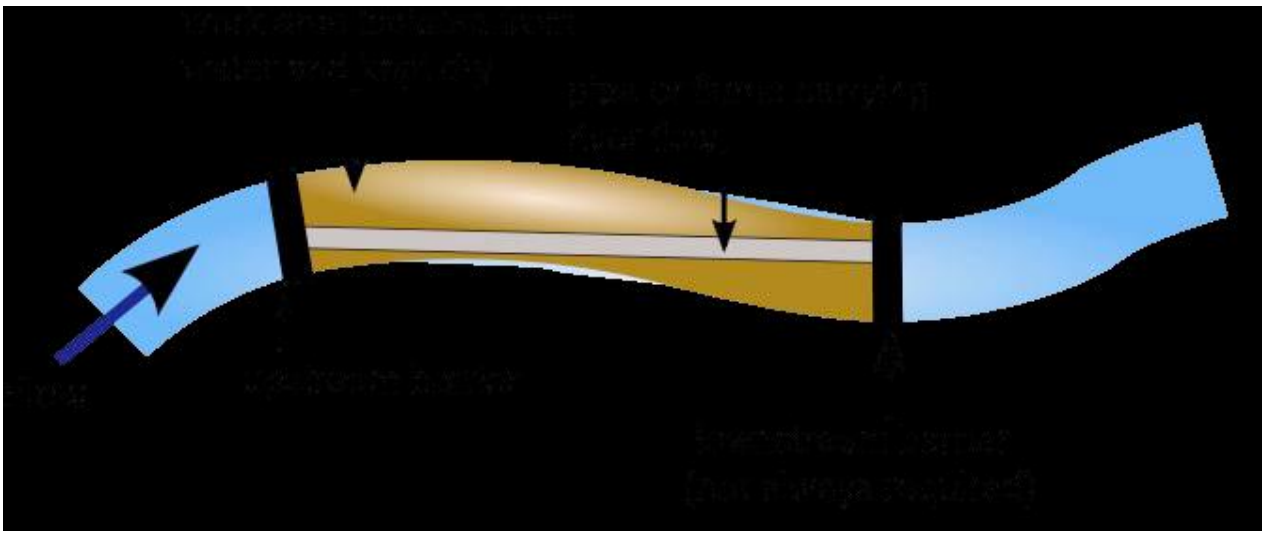


Figure 11: Full isolation gravity/flume pipe

### 5.5.5. Full isolation over pumping / siphon

A whole section of the channel is isolated using barriers that span the full width of the river. This seep a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipe work need not be located in the isolated area.

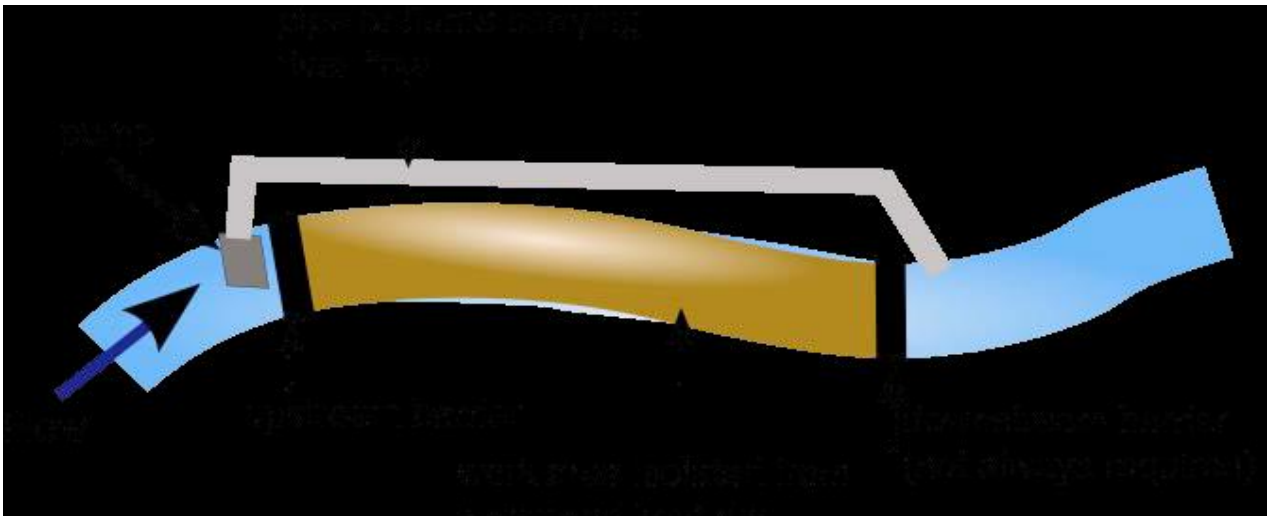


Figure 12: Full isolation over pumping/siphon

### 5.5.6. Isolation with silt curtain

In this case the works area still remains wet and a silt curtain is placed around the works area to minimize sediment being transferred downstream.

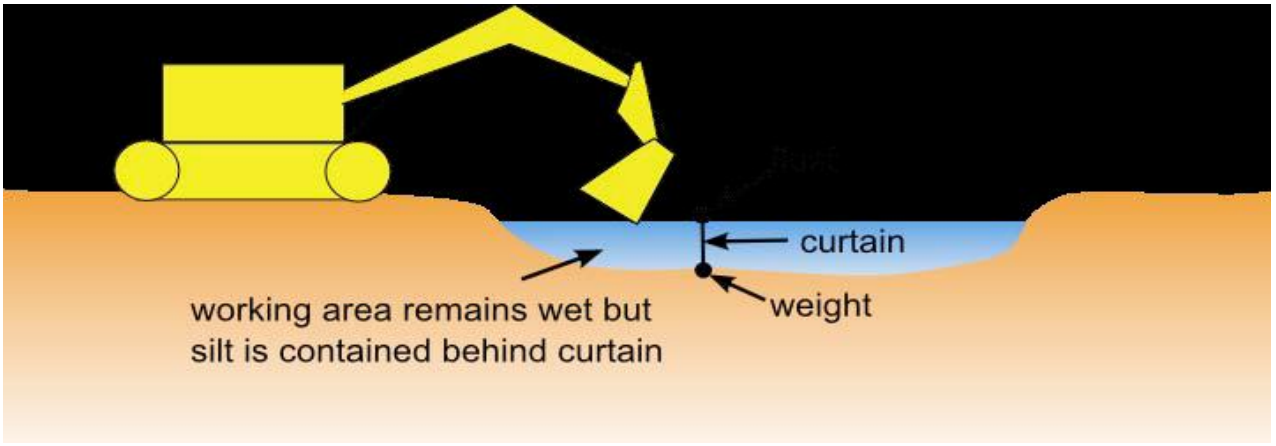



Figure 13: Isolation with silt curtain

| Self-Check 4 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer. **(4 points each)**

1. _____is the removal of excess water from the ground surface as well as from the subsurface soil to facilitate the proper growth of plants and to avoid the hazards due to water logging.
   A. Irrigation
   B. Conveyance
   C. Drainage
   D. Infiltration
2. **Purposes of drainage systems**
   A. To cause water to leave the road as shallow, non-erosive sheet flow, and enable
   B. harvesting of run-off water.
   C. In a direction and pattern to suit combinations of road material, slope and terrain.
   D. All

**Direction I:** Matching

**Instruction:** Match the items under the column "A" with items under column "B" and write the letter of your answer on the answer sheet provided in the next page. Use bold letter**.(4 points each)**

| "A" | "B" |
|---|---|
| 1. A whole section of the channel is isolated using barriers that span the full width of the river. | A. The type of liquid |
| 2. Common terms used to describe removal or draining groundwater or surface water from a riverbed, construction site | B. Submersible pumps |
| 3. Choice of pump type | D. Dewatering |
| 4. Air-operated centrifugal pumps | E. Full isolation over pumping / siphon |
| 5. Work by the action of a piston or ram moving in a cylinder | |
| 6. A whole section of the channel is isolated using barriers that span the full width of the river. | G. Reciprocating pumps |

H. Full isolation gravity

I. Horizontal centrifugal pump

**Note: Satisfactory rating – 16 and above points  Unsatisfactory - below 16points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

| Information Sheet -6 | Checking equipment and excavation methods |
|---|---|

## 6.1 Excavation equipments

**These include:**

- Backhoe loader: These have an adjustable shovel in the front and a bucket in the back.
- Bulldozer: You can think of this piece of machinery as the monster of the excavation industry
- Crawler loader
- Excavator
- Skid-steer loader
- Trencher

Table 1: Summary of hand and power excavation tools and equipments

| **Hand tools** | |
|---|---|
|  **Spade** |  **shovel** |
|  **Trowel** |  **Pick axe** |

| | |
|---|---|
|  **Mattock** |  **Hoe** |
| **Machinery Tools used for Soil Excavation** | |
|  **Tracked Excavator** |  **Wheeled Excavator** |
|  **Back hoe Excavator** |  **bulld ozer** |
|  **Roller** |  **Trencher** |

### 6.1.1 Rules for using excavation equipments

- Always follow equipment and workshop instructions, including the use of recommended personal protection equipment.

- At the end of each working day clean the tools and equipment you used and check them for any damage. If you note any damage, tag the tool as faulty and organize a repair or replacement.
- Equipment and tools used are checked after use for damage, splits or cracks in accordance with organizational requirements.
- Lockout/tag out describes a set of safety practices and procedures that are intended to prevent workers from using equipment or materials determined to be unsafe or potentially unsafe.
- Equipment and tools are cleared and cleaned after use in accordance with organizational requirements
- Equipment and tools are lubricated after use in accordance with organizational requirements.

Any damaged equipment and tools are repaired and/or replaced after use in accordance with organizational requirements.

### 6.1.2 Types of excavation

- Channel. Channel excavation comprises removing materials from drainage ditches and channels, usually to alter water flow or to increase capacity
- Bridge
- Drainage/Structure
- Borrow
- Earth
- Dredging
- Muck
- Footing

## 6.2 Communication equipments

Communication Equipment are devices that aid in the communication process between individuals. They have escalated in the recent decades to the extent that society is spoilt with choices in the way they send and receive information.

These days, communications are mainly run by software. However, the hardware still remains relatively important. Communication exist in various forms, each with their own operational way and usage. The following are the different types of Communication equipment:

Figure 14: Different types of communication equipments

### A. Automated Voice Answering Systems

They are basically answering machine that receives messages and provides the requested information. They are largely used by large companies receiving large volumes of customer calls regarding their service. Answering systems also help to prevent human error and decreases the workload of call center employees. This way, the employees can also utilize the time used to answer calls more and perform more important tasks.

### B. Intercom

Intercom is a type of communication equipment. It has fixed microphone units that are connected to a centrally located control device. The device provides the aid for an individual to communicate their message to a large audience in a large area. For

example, a supervisor making an organizational wide announcement, he can use the intercom to do so for convenience and transmission of the message to his subordinates. It can either be wireless or hand-wired; some even uses transmission via radio frequency. Some examples of intercom users are television stations, communication facilities and power plants.

**C. Telephone**

A telephone is a machine that converts sound signals into a type that other telephone devices can convert into perceptible sound. This permits two individuals to converse with one another from a protracted distance away. Similar to intercoms, telephones can be wireless or wired, digital or analog. There are varieties of accessories like the answering machine and headsets. They are to augment the capabilities of the telephone.

**D. Pager**

A pager is a device that receives signals from another party. It then alerts the user for the received signal. The pager beeps, flashes or vibrates as a form of signaling. It also displays the text with a call back number the user should call to. However, the usage of pager has decreased significantly with the rise of mobile technology such as mobile phone and tablets. Despite the fall in usage, pagers are still being in use in places like restaurants, hospitals and factories in some cases.

**E. Radio**

Radios are the transmission and reception of electromagnetic waves of frequency. Walkie talkies and citizen's band radios are examples of radios people use to communicate with one another. They usually have a receiver, transmitter receiver and an antenna. They usually have a base or mobile configuration. They normally have an advantage over telephones in terms of communication as these devices are usually free of charge.

**F. Fax Machines**

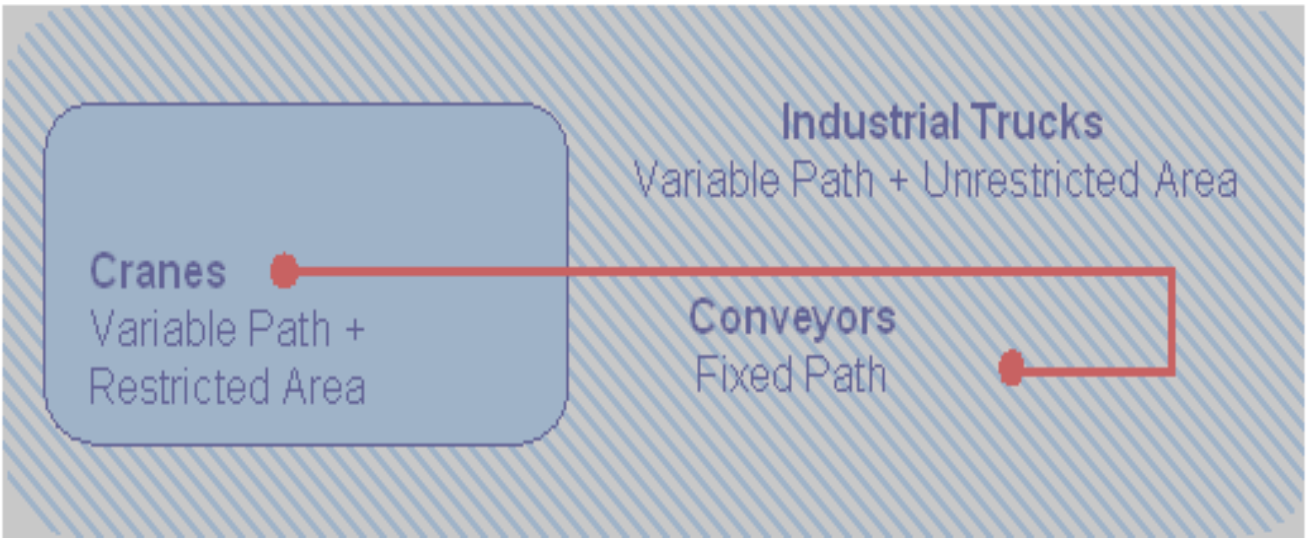
Fax also known as facsimile is commonly known as tele fax or tele copying. It is the transmission of scanned printed materials in visuals. They are sent through a telephone number connected to an output device normally a printer. The original document is scanned with the fax machine, followed by the processing of contents as a single fixed

image. It is then converted into a bitmap and transmitted through the telephone system. The fax machine receiving the image converts the code and prints it on a paper copy.

Figure15: Two-way radio communication equipment and systems

### 6.3 Transportation equipments

Transport equipment is used to move material from one location to another (e.g., between workplaces, between a loading dock and a storage area, etc.) within a facility or at a site.




The major subcategories of transport equipment are:

- **Conveyors**: Equipment used to move materials over a fixed path between specific points.
- Cranes: Equipment used to move materials over variable paths within a restricted area.

- Trucks: Equipment used to move materials over variable paths, with no restrictions on the area covered by the movement (i.e., unrestricted area).
- Equipment: Material can also be transported manually using no equipment.

### 6.4 Selecting personal protective equipments

This is used to ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment. Employers are responsible for:

- Performing a “hazard assessment” of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate PPE for employees.
- Training employees in the use and care of the PPE.
- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program. In general, employees should:
- Properly wear PPE,
- Attend training sessions on PPE,
- Care for, clean and maintain PPE, and n Inform a supervisor of the need to repair or replace PPE

All PPE clothing and equipment should be of safe design and construction, and should be maintained in a clean and reliable fashion. Employers should take the fit and comfort of PPE into consideration when selecting appropriate items for their workplace. PPE that fits well and is comfortable to wear will encourage employee use of PPE. Most protective devices are available in multiple sizes and care should be taken to select the proper size for each employee. If several different types of PPE are worn together, make sure they are compatible. If PPE does not fit properly, it can make the difference between being safely covered or dangerously exposed.

When conducting equipment safety checks, ensure that there are no cracks or deformities on the lenses, ensure the strap is in good working order and is firmly sealed to the cheek and forehead.

| Self-Check 6 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. Select machinery tools used for soil excavation

   A. Pick axe C. Trowel

   B. Trencher D. Shovel

2. A type of excavation comprising removing of materials from drainage ditches and channels, usually to alter water flow or to increase capacity is:

   A. Channel C. Dredging

   B. Borrow D. Drainage/Structure

3. A type of communication equipment with fixed microphone units that are connected to a centrally located control device is:

   A. Intercom C. Pager

   B. Telephone D. Automated Voice Answering Systems

4. Transport equipment is used to move material from one location to another within a facility or at a site including:

   A. Between workplaces C. Between a loading dock and a storage area

   B. From site to home D. All

5. With respect to selection and use of PPE, employers are responsible for:

   A. Properly wear PPE

   B. Attend training sessions on PPE

   C. Identifying and providing appropriate PPE for employees.

   D. Care for, clean and maintain PPE

   E. All

**Note: Satisfactory rating – 10 and above points Unsatisfactory - below 10points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

1. _____ 3. _____ 5. _____

2. _____ 4. _____

| Operation Sheet- 1 | Identifying, checking and preventing work site hazards and damages |
|---|---|

**Activity 1: - Identifying hazards**

**Steps:**

**Step1:** Identify hazards, i.e. anything that may cause harm.

**Step2:** Decide who may be harmed, and how.

**Step3:** Assess the risks and take action.

**Step4:** Make a record of the findings.

**Activity 2:** - **Preventing hazards**

**Steps:**

**Step 1:** Identify the hazard by carrying out a work place risk assessment;

**Step 2:** Determine how employees might be at risk;

**Step 3:** Evaluate the risks;

**Step 4:** Record and review hazards at least annually, or earlier if something changes.

| Operation Sheet- 2 | Techniques of providing appropriate drainage and water diversion structures for work site |
|---|---|

**Follow these steps to construct diversion coffer dam.**

**Step 1:** Wear appropriate PPE and select and use appropriate tools and equipments

**Step 2:** Clear the site

**Step 3:** Set out the site

**Step 4:** Excavate the site

**Step 5:** Compact the site

**Step 6:** Divert the water to the dam

**Step 7:** Check, maintain and store tools and equipments appropriately

| LAP Test | Practical Demonstration |
|---|---|

Name: _____

Date: _____

Time started: _____ Time finished: _____

**Instruction I:** Given necessary templates, tools and materials you are required to perform the following tasks within **8 hours.**

Task 1: Identify work place hazards

Task 2: Prevent work place hazards

Task 3: Construct diversion coffer dam

| Instruction Sheet | Learning Guide – 74: Construct and install drains, channels, pipes and associated fittings |
|---|---|

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

- Providing bedding and foundations for structures
- Selecting, loading and installing pipes and fittings
- Selecting, placing and joining prefabricated components
- Checking installed pipes, fittings and prefabricated components
- Perform work-related calculations
- Constructing cast in situ components

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Provide bedding and foundations according to structure type, location and specification.
- Select, lay and install and join pipes and fittings are according to manufacturer and organizational requirements.
- Select, place and join prefabricated components are according to manufacturer and organizational requirements.
- Check, installed pipes, fittings and prefabricated components to ensure that test specifications are met.
- Construct cast in situ components according to specifications and organizational requirements

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1-7” in page 56, 65, 77, 83, 94, 97 and 103 respectively
4. Accomplish the “Self-check 1-7” -” in page 64, 76, 82, 93, 96, 102 and 112 respectively
5. If you accomplish the self-checks, do operation sheet in page 114,116 and 117
6. LAP Test in page 119

| Information Sheet-1 | Providing bedding and foundations for structures |
|---|---|

## 1.1. Introduction to bedding and foundation

- Bedding is the material placed in the bottom of the trench on which the structure is laid.
- Foundation is the in place material beneath the structure. If the foundation is unsuitable, it must be removed and replaced with a suitable material.
- All types of rock can be bedding: solid rock(bed rock bedding) and loose rock(soilbedding).Beddingformedbyrockunderitsnatural,nativeconditions which is natural bedding; if the rock is compacted or reinforced, the bedding called artificially reinforced bedding.
- The proper choice of the type of bedding and foundation not only ensures durability and normal service conditions for a structure but also is of great nonimportance.
- Inbuilding hydraulic engineering structures it becomes necessary to prevent water from seeping into the bedding.

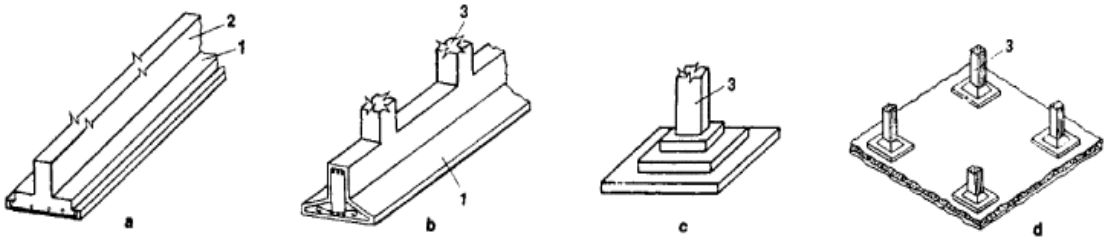



Figure16: Cast shallow foundations:(a) continuous under a wall, (b)continuous under columns, (c)isolated under a column, (d)combination under columns;(1) lower continuous footing of reinforced concrete, (2) foundation walls (3) column size.

## 1.2. Foundation and bedding for irrigation and drainage structures

Foundation and bedding are needed for every irrigation and drainage irrigation structures based on the type of location and types of soil they are laid.

### 1.2.1. Drop structures

It is necessary that the flow of irrigation water in the water conveyance system is always under control. Water control structures are therefore required for water conveyance system to control the flow of water and dispose at safer velocity.

Drop structure is used for conveying water in the channel from higher elevation to lower elevation while controlling the energy and velocity of the water as it passes over. These structures are needed in canals and ditches to convey water down steep slopes at non erosive velocities.

Drop structure is constructed at end of each reach to lower water head abruptly in to the next reach by subdividing the slope in to several reaches with relatively flat slopes. Water is conveyed down the slope in the stepwise manner. The components of drop structure include an inlet section, a vertical or inclined drop, a stilling pool or other means of dissipating energy, and an outlet section for discharging water into the next reach.

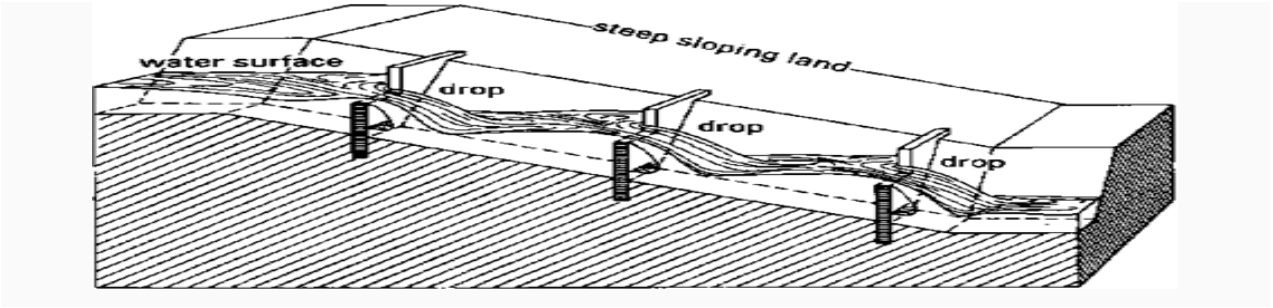



Figure 17: A view of drop structures in a canal on steep sloping land.

### 1.2.2. Pipe drop spillways

Pipe drop structure is used where a channel has to cross an embankment. In such cases water can be safely discharged from a higher to a lower one by providing a pipe drop. This type of structure allows the discharge of water through a pipeline, without disturbing the existing bunds or embankment. The components of structures are gated pipe, stilling basin with end sill. Stilling basin is provided for dissipation of energy of water flow. A stilling basin is made up of brick or stone masonry, or concrete.

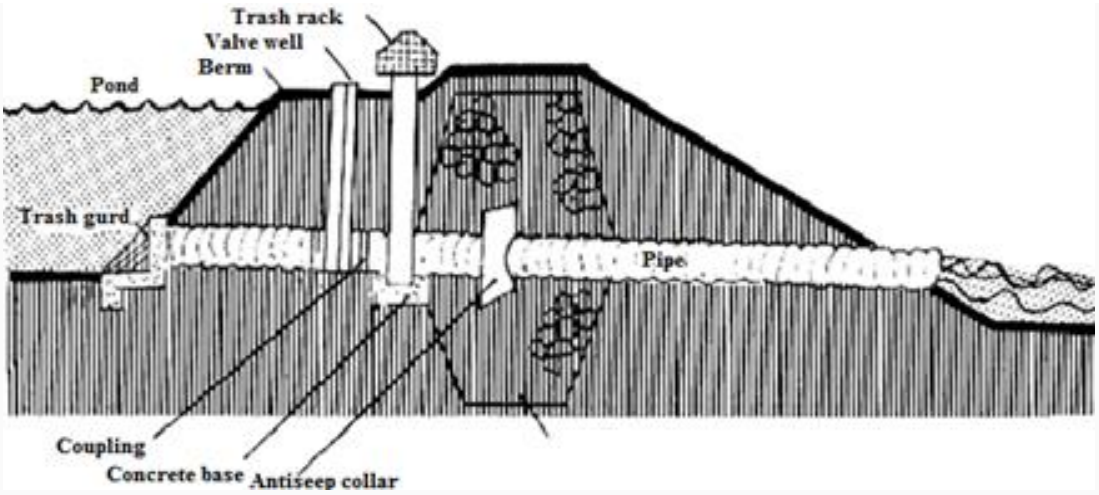



Figure: 18: A drop-inlet pipe spillway with drain pipe.

### 1.3. Canal head regulators

A canal head regulator is required to serve the following function:

- To regulate the discharge into the off taking canal, functions:
- To control the entry of sediment into the canal


Figure19: Canal head regulator

#### 1.3.1. Types of head regulators in canals

(i) Still pond regulation:

(ii) Open flow regulation

(iii) Silt control devices

1. Still pond regulation

- Canal draws water from still pond
- Water in excess of canal requirements is not allowed to escape under the sluice gates.
- Velocity of water in the pocket is very much reduced; silt is deposited in the pocket.
- Occurs when the silt has a level about 1/2 to 1m below the crest level of head silt.

2. Open flow regulation

- Sluice gates are opened and allow excess of the canal requirement
- Top water passes into the canal
- Bottom water maintain certain velocity in the pocket to keep the silt to remain in suspension
- Canal is not closed for scouring the silt.

3. Silt control devices **:**

Entry of silt to canal can be controlled by:

- Providing a divide wall to:
  - ✓ Create a trap or pocket
  - ✓ Create scouring capacity of under sluices
  - ✓ By concentrating the currents towards them
  - ✓ Paving the bottom the approach channel to reduce disturbance because due to disturbance sediment remains in suspension**.**

## 1.4. Erosion barriers

Erosion control is one of the biggest concerns for many large construction. Multiple factors can cause erosion, and every situation calls for specific solutions based on the site and the severity of the problem. Controlling erosion is important not just for preserving the construction site and protecting the new structure but also for minimizing the environmental impact that the project has on the surrounding area. Erosion control measures can add significantly to the project cost, and manufacturers are continually developing innovative products to minimize cost as well as environmental impact.

### 1.4.1. Geo textiles

Geo textiles are commonly used to control erosion and improve soils over which roads, embankments, pipelines, and earth-retaining structures are built. Depending on the

application, geo textiles may have an open mesh weave, a warp-knitted structure, or a closed fabric or nonwoven surface.

Figure 20: Geo textiles

### 1.4.2. Retaining Walls

Reinforced soil retaining walls represent an innovative method of resolving familiar, as well as unfamiliar and challenging problems of soil stabilization. Instead of regarding soil as a mass to be contained.

**Figure 21: Retaining wall**

### 1.4.3. Gabion Baskets

Gabion baskets act as retaining walls and erosion control in civil works. These baskets are filled with stone to present flexible, monolithic structures. The double-twisted-wire-mesh has built-in, non-raveling effect that prevent accidental damage from spreading.

Figure 22: Gabion baskets

### 1.4.4. Reno mattress

Reno mattresses are used for river bank and scour protection, channel linings for erosion and sediment control and embankment stability. The base section of the Reno Mattress is divided into compartments and filled with rock at the project site.

### 1.4.5. French Drains

A French drain is a system of underground piping—called drain tile—that channels surface and groundwater to an exit point. The drain tile may also be perforated to allow water to seep into the soil below the tile, while excess water travels to the exit point. French drains are installed with a slope of about 1 inch of drop per 10 feet of horizontal run.

Figure23: French drains

### 1.4.6. Soil Nails

Soil nailing provides a resisting force against slope failures and offers relatively quick installation.

Figure 24: Soil nails

### 1.4.7. Riprap

Riprap is a commonly used method to protect soil from erosion in areas of concentrated runoff. Riprap is a layer of very large stones interlocked together to act as a barrier on slopes that are unstable because of seepage problems or areas that are receiving a large, concentrated flow.

Figure 25: Rip rap

### 1.5. Head walls

Headwalls and wing walls are produced to finish and secure the ends of pipe, box culverts and bridge sections. They are designed to function together with the conduit to provide a sound, functional and permanent structure.

**Applications:** Head- and Wing walls are used where:

- The conduit enters or exits finished grade
- Flow must be channeled into or out of a conduit
- The earth embankment surrounding the pipe must be retained
- The exposed pipe ends pose a danger to traffic
- Appearance of the pipe end is important

**Types:** Headwall and wing wall systems can include:

- Parapets
- Free-standing wing walls
- Free-standing headwalls
- Precast aprons

**Sizes:** Every conduit size and shape has a corresponding Head- and Wing wall system available.

**Joints:** Headwall and Wing wall systems are usually connected structurally to the adjacent conduit.

### 1.6. Concrete drainage channel

It is a channel made of concrete and foundation and bedding materials should be provided during construction and installation to prevent channel seepage. The bedding material depends on: soil type, location and gradient of the channel

| Self-Check 1 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer sheet provided in the next page. Use bold letter**.(4 points each)**

1. The material placed in the bottom of the trench on which the structure is laid is:
   A. Bedding C. Sand
   B. Foundation D. Concrete
2. _____are produced to finish and secure the ends of pipe, box culverts and bridge sections.
   A. Headwalls and wing walls C. Head regulators
   B. Pipe Drop Spillways D. Drop structures
3. Which irrigation structure is used to control the flow of water in conveyance system?
   A. Drop structure C. Spill ways
   B. Head regulators D. Erosion barriers
4. A canal head regulator is required to serve the following function:
   A. To regulate the discharge into the off taking canal, functions:
   B. To control erosion and improve soils over which roads, embankments, pipelines
   C. To create a trap or pocket
   D. to create scouring capacity of under sluice

**Note: Satisfactory rating – 8 and above points** **Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

1. _____
2. _____
3. _____
4. _____

| Information Sheet 2 | Selecting, loading and installing pipes and fittings |
|---|---|

## 2.1 Selecting irrigation and drainage pipes and their fitting

- Clay, concrete and plastic pipes give satisfactory results if they meet quality standards and are properly installed.
- Collector pipes are made of concrete or plastic.
- Perforated corrugated plastic collectors, wrapped with a sheet envelope, may be installed comparatively easily if the surrounding soil consists of quicksand or has other quick properties.

In practice, selection is mostly based on cost comparison and on local availability. In addition, the following observations may be relevant:

- If all types of pipe are available, the use of corrugated plastic pipes has distinct advantages
- If pipes are not locally available, local manufacture of concrete pipes is the most straightforward and the easiest to implement. It requires less skill than manufacturing other types of pipe, and is already economical on a small scale. Plastic pipes occupy an intermediate position: local manufacturing from imported raw material is indeed possible for reasonably large quantities.
- Plastic pipes are particularly suited for machine installation. They have the advantage that their performance is the least affected by poor installation practice.
- The manufacturing cost of small diameter pipe (i.e. < 100 mm) is usually of the same order for clay tiles, concrete tiles and plastic.

## 2.1 Types of irrigation and drainage pipes

### 2.1.1 Clay tiles

Clay tile may be either porous or glazed. Pipe sections are abutted against each other and water enters through the joints. The porous type usually has butt joints, but it may also have flanges. Standard drainpipe sizes are 50, 65, 75, 80, 100, 130, 160, and 200

mm inside diameter. Good quality pipes are adequately baked and are free from cracks and blisters. Clay tile with cracks or other visible shortcomings and badly formed pipes should not be used.

- Clay tile is very durable and highly resistant to weathering and deterioration in aggressive soil conditions e.g. in soils containing sulphates and corrosive chemicals.
- It can be used in almost all circumstances.
- Clay tile is lighter than concrete and has excellent bearing strength. It is however fragile and must be handled with care. Clay tiles require a good deal of manual handling.

Clay tiles may be laid manually in a hand dug or mechanically excavated trench. These pipes may be covered with bulky materials or with 'envelopes' in strip form. Clay tiles should be installed in such a way that a perfect alignment between individual pipes is obtained. The maximum gap between individual pipes may not exceed 3 mm, except for sand where it should be not more than 2d85, i.e. the particle size for which 85 percent of the soil particles on dry weight basis have a smaller diameter.

### 2.1.2 Concrete Tiles

- It is used if clay tile is not available, or if greater diameters must be applied. Concrete pipes are used mostly in medium to large sizes, with inside diameters of 100, 150 and 200 mm and up, and section lengths of 0.60, 0.91, 1.22 and 2.40 m. Tile over 300 mm inside diameter is usually reinforced. Butt joints are common. The manufacture of concrete tiles is much simpler than that of clay tiles.
- Pipes should be well formed, finished, free from cracks and chips, and properly cured. Concrete pipes should be used only when soil and groundwater analyses have established that conditions are suitable for their use.
- Concrete pipes should not be used at locations where industrial waste or house refuse has been collected. Special high sulphate resistant cements and high density concrete should be used to resist chemical attack. Concrete pipes may disintegrate slowly from weathering, and are subject to erosion from fast flowing water carrying abrasive material**.**

### 2.1.3 Plastic pipes

Smooth plastic pipes were made of rigid polyvinyl chloride (PVC) and were provided with longitudinal slits to permit water entry. Smooth plastic pipes have never found a widespread use because they were rapidly superseded by corrugated pipes. Advantages of plastic pipes includes:

- Light weight makes handling easier, even for great lengths.
- Long, continuous length eases handling, gives less alignment problems, and reduces stagnation of pipe supply resulting in a high installation rate for drainage machines.
- Flexibility and coil ability facilitate handling, transportation and installation.
- Greater and more uniformly distributed perforation area, facilitating access of water.
- Easy wrapping with envelope materials.
- Safer implementation without too wide joints or misalignment.
- Less labour intensive and consequently lower labour cost for manufacture, handling, transportation and installation.
- Vulnerability to deterioration from UV-radiation when exposed to sunlight for long periods, especially if made of PVC
- Increased brittleness at low temperatures.
- Increased deflection risk at high temperatures and excessive stretch during installation.
- Lower deflection resistance under permanent load.
- Risk of collapse under sudden load, e.g. by trench wall caving or stones.
- Smaller transport capacity for the same inner diameter because of corrugation roughness.
- Not fire resistant.
- Not easy to relocate in the field with a tile probe without damaging the pipe.
- Corrugated plastic drains are made of PVC, high-density polyethylene (PE) and polypropylene (PP).

### 2.1.4 Corrugated pipes

Standard outside diameters are 40, 50, 65,80, 100, 125, 160- and 200-mm. Larger diameters are available as well. The inside diameter is normally 0.9 times the outside

diameter. Corrugated plastic pipes of not too large a diameter (up to 250 mm) are delivered in coils. Larger diameter pipes are supplied in lengths of 6 m.

Water enters corrugated pipes through perforations, which are located in the valleys of the corrugations. Elongated openings or 'slots' are common, yet circular openings may be found as well. The perforations may have a diameter or slot width usually ranging between 0.6 to 2 mm. The length of the slots is approximately 5 mm, but sawn slits of larger diameter pipes may be longer. The perforations should be evenly distributed over the pipe wall, usually in at least four rows with a minimum of two perforations per 100 rom of each single row.

Regular quality control of corrugated plastic pipes is very important. The impact of sudden loads, simulating trench wall caving on the pipe at temperatures corresponding to the ambient installation temperature should be part of a testing programme.

## 2.2 Pipe accessories/fittings

Subsurface drainage systems require accessories and special structures such as pipe fittings (couplers, reducers, junctions, end caps), gravity or pumped outlets, junction boxes, inspection chambers (manholes), drain bridges, non-perforated rigid pipes, blind inlets, surface inlets, controlled drainage or sub irrigation facilities, and cleaning provisions. Some fittings are made by pipe manufacturers, others are manufactured by specialized companies, and others are fabricated on the spot.

A wide range of pipe fittings, made of various raw materials, is commercially available for all kinds of pipes. Fittings for clay, concrete and corrugated plastic pipes are generally made by the various pipe manufacturers and therefore they are mostly not interchangeable. Cross, T and Y-pieces connect laterals or collectors with collectors. Many fittings are fabricated with multiple sizes at the ends facilitating the connection of various sizes of collectors and laterals. The end sides of the fittings are cut off, or adapted by removing some parts in the field to attach to the appropriate diameter. Simple connections with elbows and T-pieces on top of the collector are nowadays used to connect laterals with collectors.

### 2.2.1 End caps

End caps prevent the entrance of soil at the upstream drain end opening. They can be made of the corresponding pipe material but any other durable flat material can be used for this purpose as well.

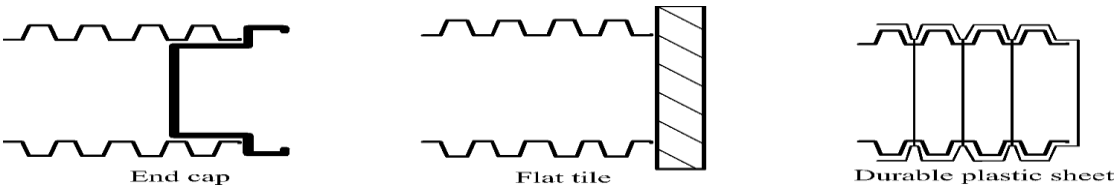



Figure 26: End caps

### 2.2.2 Couplers

Corrugated pipes generally have external 'Snap-On' couplers to connect pipes of the same diameter. Alternatively, a piece of pipe of the same diameter that is split for easy placing around both pipe ends, and firmly wrapped with tape or wire to keep it in place during installation, can be used instead.

Internal couplers can be used with the trenchless technique to prevent separation of connected pipes when passing through the pipe feeder device.

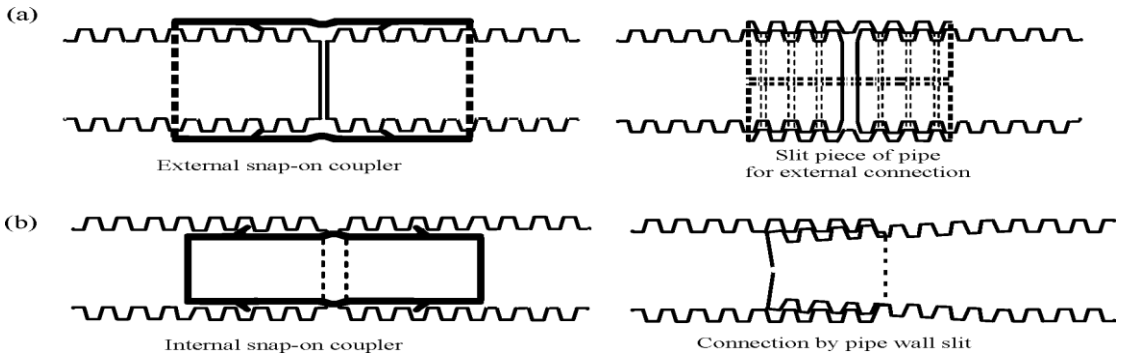



Figure 27: Couplers

Pipes can also be connected internally by making a slit in the end of the upstream pipe and forming a cone that is pushed into the end of the downstream pipe. Such connections are not very reliable and do impede the discharge of water and suspended solids.

Reducers connect two pipe ends of different diameters.

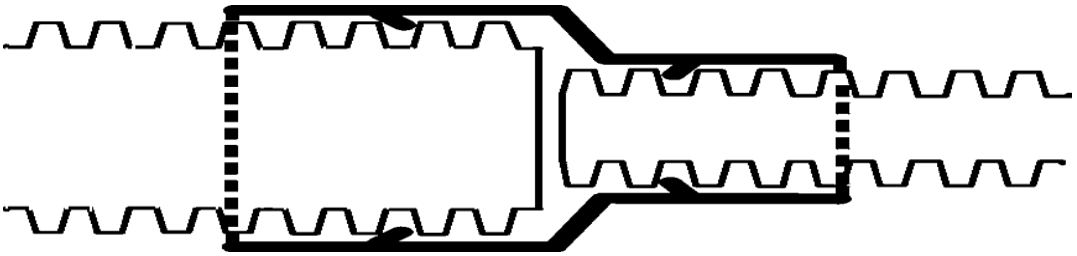


Figure 28: Reducers

## 2.3 Connection structures

Junction Boxes: Junction boxes are used where two or more drains (laterals and/or collectors) come together or where the diameter or the slope of the collector changes. They can be pre casted or made of masonry or cast in place concrete, but also rigid plastic or concrete pipes can be used for this purpose.

Junction boxes can be combined with a silt trap and extended to the soil surface. The bottom of the silt trap should be at least 0.30 m below the bottom of the inlet of the downstream pipe. The invert of the entering laterals should be positioned at least 0.10 m above the top of the leaving collector to further sedimentation in the silt trap.

Blind junction boxes will not hinder field works. The lid should therefore be situated at a minimum depth of 0.40 m below soil surface. They can be exposed if inspection and occasional cleaning is required. With the lid at the soil surface, the junction box is not so very much different from an inspection chamber, yet it hampers field works. The position of blind boxes and covered manholes should be well documented. Nevertheless, finding them is often difficult. If they do not contain steel components, a lid with steel bars should be installed on top of the structure in order to facilitate easy location with a metal detector.

Manholes: Inspection chambers or manholes differ from junction boxes with a silt trap in that they provide for ready access if drains require inspection and cleaning. The material can be concrete or masonry, but also redwood has been used successfully. Deep inspection chambers are constructed with a number of reinforced concrete rings. They should be sufficiently large and must be provided with metal rungs fixed in the wall to allow a man to descend to the drain lines. Since the lid of manholes is usually above the

soil surface, they are objectionable because of their interference with farming operations. To meet this objection a capped manhole, with the top at least 0.40 m under the soil surface, can be installed with the inconvenience that the top of the manhole has to be dug out for each inspection.

Drainpipes can he connected to or slid into a rigid, reinforced concrete, plastic or coated steel pipe where they have to cross a road, a waterway, a gutter, unstable soil, a row of trees to prevent roots from growing into the pipes, or other obstacles.

Drain Bridges: The undisturbed natural soil in which the pipes are laid normally has enough strength to support the pipe. However, when the drain crosses a soft spot where the soil has not yet settled, e.g. a filled-in former ditch, drain bridges should be used to maintain the level of the drain during settlement of the soil. Drain bridges can be made of timber blocks on which the drain is laid or of a continuous length of solid, rigid pipe surrounding the drain.

### 2.4 Importance of inlets

Blind Inlets: Blind inlets are intended to drain stagnant pools, while sediments are intercepted. They consist of a trench above a drain that is filled with porous material. Durable material, such as stones, gravel and coarse sand is preferred as trench backfill. The gradation may vary from finer material at the surface to coarser with depth, although the trench can also be filled with one suitable porous material. The advantage of blind inlets is the initial low costs and the lack of interference with tillage operations. However, in general the use of blind inlets has been unsatisfactory because they tend to clog at the surface with fine soil particles and other sediments.

Surface Inlets: Surface water inlets are incidentally used to evacuate surface water from localized areas through the drainage system when the construction of ditches is not feasible or impractical. A proper silt trap is essential to prevent or reduce drain siltation. The open inlet can be in the collector line although it is better located next to the collector and connected to it with a siphon as a safeguard against poor maintenance.

Surface inlets are usually made of masonry or cast in place concrete, but concrete and rigid plastic pipes can also be used. A metal grating is usually installed to restrict the entry of trash and waste.

## 2.5 Installing Irrigation pipes/drains and fittings

Manual installation of drains and installation with backhoe machines are a valid option for small drainage projects. Backhoes make wider trenches than drainage machines commonly used in large projects. They are also used for wide and deep excavations for large collectors. Drainage machines either make narrow trenches in which the drains are laid or they put the drain directly into the ground.

Trenching machines are either wheel or chain trenchers. They are appropriate for a wide range of working depths and widths. Trenchless machines can be classified in either vertical or V-ploughs. The trenchless installation method, however, has some practical limitations with respect to drain types, drain sizes, gravel application and installation depth.

### 2.5.1 Installation procedures

#### 1. Blinding

Since the risk of sedimentation is largest during installation and in the immediate subsequent period as long as the backfill has not settled and stabilized, drains are normally covered with friable topsoil to create a stable and highly permeable soil surround, and to preserve the alignment. Therefore trenching machines are equipped with cutters to bring a layer of topsoil or soil from another suitable layer from the sides of the trench on top of the drain. Its thickness should be at least 100 to 250 mm, depending on the drain diameter. Granular envelope material can also be used to achieve a highly permeable drain surround and to prevent vertical and horizontal displacement once the pipe is installed.

Blinding, the initial covering of the drain with topsoil, is not recommended when organic envelopes are used, because topsoil with organic matter and intensive microbiological

activity enhances the risk of microbiological decomposition of these envelopes. In such cases, soil from another suitable layer, with low organic matter, can be used for blinding.

Further backfilling of the trench should be done as soon as possible and, at the latest, at the end of each day if there is a risk of surface water entering the trench.

### 2. Soil Cohesion

- Since soil cohesion is strongly correlated with its water content, installation of the drainage system should preferably be done in unsaturated soil conditions with the water table below installation depth and outside periods of general wetness.
- The backfill should have settled before heavy rain or irrigation.
- Drainage installation in wet conditions is discouraged, yet it is not always possible to drain under favorable or ideal circumstances.
- When cohesion less soils are drained in saturated conditions, an envelope must be wrapped immediately around the drain and the drain covered with backfill material before the liquid sand flows into the trench.
- Caving of the trench wall, which often occurs in cohesion less or low cohesive soils, may damage and/or displace the drain. In every case, the drain and the envelope should be in place before the trench box has passed. Possibly, a longer trench shield may be used to protect a greater length of the trench. The drain should be blinded immediately. Simultaneous and instantaneous backfilling will help to prevent trench wall failure.
- In cohesion less soils, drainage machines should be kept moving at all times. If not, fluid sand is likely to enter the trench box and cause problems with sedimentation as well as with alignment and grade of drains. Many problems, encountered with trenchers or backhoe excavators in saturated cohesion less soils, can be avoided by trenchless drainage installation. Drainage of physically stable, well structured soils under general wetness may destroy the soil structure during excavation and create a less permeable trench backfill.
- The machine should move fast enough to preserve the structure of the soil and not turn the excavated soil into slurry. Structural deterioration of an originally stable, well-structured soil can be avoided with trenchless drainage installation. The

functioning of drains installed with the trenchless technique depends very much on the changes in soil structure brought about by the passing of the blade.

- Drainage of clay soils in wet conditions will unavoidably result in smearing and reduction of the hydraulic conductivity where the machine has physical contact with the soil.
- Drainage of cohesive soils in wet conditions must be avoided, regardless of the available drainage machine.
- The installation conditions for laterals of a composite drainage system in saturated soil are improved if the time span between the installation of "permeable" collectors and installation of the laterals is long enough. In severe cases, where the construction of collectors is difficult because of quicksand, a temporary drain may be helpful.

### 3. Backfilling and finishing of trenches

Backfilling and finishing of trenches should ensure a minimum of later land subsidence and preclude the occurrence of piping. The piping phenomenon may occur as a result of internal erosion of trench backfill by water flowing from the soil surface directly to the drains through the loose backfill material.

- Soil piping may cause soil material to be carried by the flowing water into the drain, creating sinkholes at the soil surface and/or mineral clogging of drains and envelopes, if present.
- Neither heavy loads, nor significant flooding should be imposed on newly installed drains until the soil in the trench is stabilized. The loose backfill material will settle naturally with time.
- Since backfilling is usually done with a tractor equipped with a dozer blade, passage of the tractor wheel over the backfilled trench, filling it up, and running over it again will speed up the process, yet care must be taken to avoid crushing the pipe.

A common procedure is that one track of the drainage machine runs over the drain line on its way back to the outlet drain to begin installing the next lateral. In dry soil, the rate of compaction following this procedure may not be sufficient.

Trenching machines can install clay, concrete, or plastic pipes. Clay and concrete pipes are manually placed on a chute that conveys the tiles down into the trench shield where they automatically move into the right position on the bottom of the trench.

- The tiles should be installed in the trench in such a way that a perfect junction between drains is obtained.
- For drains of larger sizes, an inspector, standing or sitting in the shield, checks for correct laying.
- The maximum gap between drains may not be more than 3 mm except for sandy soils or soils with a sandy layer on drain depth where it should be not more than 2d85. Clay and concrete tiles without gravel or appropriate synthetic envelopes are not recommended in cohesion less fine sand.

Larger diameter pipes are usually laid out on the field beforehand, and then guided through the trenching machine.

- Excessive pulling can result in connections becoming loose or pipes breaking off.
- During the uncoiling of the pipe, pipe breakage can be easily overlooked, yet the missing piece of drain will cause local wetness. Therefore, trenchless drainage machines must be equipped with guides to facilitate smooth entrance of the drainpipe into the feeder tube.
- PVC pipes should not be installed at temperatures below 3°C because of their brittleness at low temperatures.
- Storage at temperatures exceeding 40°C for PE and 80°C for PVC pipes, as well as installation at temperatures above 40°C should be avoided in order to prevent pipe deformation as a result of load and longitudinal stress.

| Self-Check 2 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer sheet provided in the next page. Use bold letter**.(4 points each)**

1. The common irrigation pipe are made of:
   A. Concrete C. Clay
   B. Plastic D. All
2. Selection of irrigation and drainage pipe based on:
   A. Cost comparison C. Ease of installation and maintenance
   B. Local availability D. Durability E. All
3. Which of the following is in correct about the installation of irrigation drainage pipe?
   A. The backfill should have settled before heavy rain or irrigation.
   B. Drainage installation in wet conditions is discouraged
   C. Drainage of cohesive soils in wet conditions must be avoided, regardless of the available drainage machine.
   D. Drainage pipes could only be installed manually
4. The main advantage of plastic pipes over clay and concrete pipes is their:
   A. Low cost C. Low weight
   B. Low durability D. Availability
5. _____prevent the entrance of soil at the upstream drain end opening.
   A. Couplers C. End caps
   B. Reducers D. Spigots

Note: Satisfactory rating–10 and above pts Unsatisfactory - below 10pts

You can ask you teacher for the copy of the correct answers.

**Answer Sheet**

1. _____
2. _____
3. _____
4. _____
5. _____

| Information Sheet - 3 | Checking organizational requirements |
|---|---|

### 3.1 Organisational requirements

Policies and procedures are an essential part of any organization. Together, policies and procedures provide a roadmap for day-to-day operations. They ensure compliance with laws and regulations, give guidance for decision-making, and streamline internal processes. Organizational requirements are:

- The organization's vision, goals, objectives and priorities.
- business and performance plans.
- systems, processes and requirements for quality assurance.
- specific change initiatives.
- Legal requirements, for example, occupational health and safety and anti-discrimination legislation.
- are those which come out of a system being placed in a social context.
- will have their source not only in organizational structures and the activities of individuals and groups but also in power structures, obligations and responsibilities, control and autonomy, values and ethics.
- Its main purpose is to develop a methodology that will enable systems designers to reason about organizational goals, policies and structures, and the work roles of intended end users.
- can be derived by using the soft systems approach of Check land and the socio-technical approach of Mumford in as much as both methods consider the operation of the proposed system within the broad context of the organisation and the people within the organisation.

Some examples of organizational requirements are:

- the organization's vision, goals, objectives and priorities
- business and performance plans
- systems, processes and requirements for quality assurance
- specific change initiatives
- legal requirements, for example, occupational health and safety and anti-discrimination legislation
- standards (such as for ethical behaviour) and protocols
- confidentiality and security requirements
- defined resource parameters.

## 3.2 Specifications and organisational requirements

- Requirements a statement of one thing a product must do or a quality it must have.
- A specification often refers to a set of documented requirements to be satisfied by a material, design, product, or service.
- A specification is often a type of technical standard. Specifications are a type of technical standard that may be developed by any of various kinds of organizations, both public and private.

### 3.2.1 Types of specification

- **A requirement specification:** is a documented requirement, or set of documented requirements, to be satisfied by a given material, design, product, service, etc. It is a common early part of engineering and development processes, in many fields.
- **Afunctional specification:** is a kind of requirement specification, and may show functional block diagrams.
- **A design or product specification:** describes the features of the solutions for the Requirement Specification, referring to either a designed solution or final produced solution. It is often used to guide fabrication/production. Sometimes the term specification is here used in connection with a data sheet(or spec sheet),

which may be confusing. A data sheet describes the technical characteristics of an item or product, often published by a manufacturer to help people choose or use the products. A data sheet is not a technical specification in the sense of informing how to produce.

- **An in-service specification:** specifies the conditions of a system or object after years of operation, including the effects of wear and maintenance (configuration changes).

Requirements and specifications are very important components in the development of any embedded system. There is a distinct difference between requirements and specifications.

- A requirement is a condition needed by a user to solve a problem or achieve an objective.
- A specification is a document that specifies, in a complete, precise, verifiable manner, the requirements, design, behavior, or other characteristics of a system, and often, the procedures for determining whether these provisions have been satisfied.

### 3.3 Environmental requirements

Environmental Requirement is:

- all laws and requirements relating to human, health, safety or protection of the environment or to emissions, discharges, releases or threatened releases of pollutants, contaminants, or Hazardous Materials in the environment (including, without limitation, ambient air, surface water, ground water, land surface or subsurface strata), or otherwise relating to the treatment, storage, disposal, transport or handling of any Hazardous Materials.
- all applicable present and future statutes, regulations, rules, ordinances, codes, licenses, permits, orders, approvals, plans, authorizations, concessions, franchises, and similar items, of all governmental agencies, departments, commissions, boards, bureaus, or instrumentalities of the countries, states and political subdivisions thereof and all applicable judicial, administrative, and regulatory decrees, judgments, and orders relating to hazardous materials.

- all orders, contracts and laws concerning or relating to or imposing liability for pollution or protection of the environment, including those relating to the presence, use, manufacturing, refining, production, generation, handling, transportation, treatment, transfer, storage, disposal, distribution, importing, labeling, testing, processing, discharge, release, threatened release, control or other action or failure to act involving any Hazardous Substances, each as amended and as now in effect and in effect at Closing.

### 3.3.1 Environmental standards

- Are administrative regulations or civil law rules implemented for the treatment and maintenance of the environment.
- Are set by a government and can include prohibition of specific activities, mandating the frequency and methods of monitoring, and requiring permits for the use of land or water. Standards differ depending on the type of environmental activity.
- Produce quantifiable and enforceable laws that promote environmental protection. The basis for the standards is determined by scientific opinions from varying disciplines, the views of the general population, and social context. As a result, the process of determining and implementing the standards is complex and is usually set within legal, administrative or private contexts.

## 3.4 Legislative requirements

All people and organizations are required to comply with relevant legislation to which they are subject. This includes prescribed laws, regulations and bylaws. Organizations need to determine their legislative obligations.

It is a requirement of an act of parliament or subordinate legislation that applies in relation to the supply of the works or in relation to the contractor. A number of stakeholders will have requirements in place that must be taken into account in any risk management process.

Laws have been put in place to ensure that organizations and individuals meet a minimum standard of care to ensure their activities do not result in harm or loss to others. Breaches of these laws can result in fines, jail or both. Local government will also have a range of requirements that must be met.

Examples of legislative and regulatory requirements may include:

- legislation dealing with
    - ✓ disasters, emergencies
    - ✓ occupational health and safety
    - ✓ the environment
    - ✓ equal employment opportunity
    - ✓ privacy.

- local government requirements dealing with
    - ✓ land use planning
    - ✓ building and planning permits
    - ✓ business permits
    - ✓ community interaction
    - ✓ noise limits
    - ✓ traffic management
    - ✓ use of community facilities and event permits.
- Safety standards
- Operating procedures
- Emergency procedures
- Management procedures.

Requirements for the organisation will be defined during the establishment of the emergency risk management context. This stage may also highlight the requirements of stakeholder organizations. Clarification of stakeholder organizations' requirements will be refined through ongoing consultation.

All employees, contractors, suppliers, clients, etc will be required to know what the legal, regulatory and organizational requirements are and to work within them. Breaches of organizational policies and procedures can result in injury or death, legal action being taken by an affected stakeholder or a stakeholder organisation withdrawing their support.

| Self-Check 3 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer sheet provided in the next page. Use bold letter**.(4 points each)**

1. Legislative and regulatory requirements may not include:
   A. The environment C. Land use planning
   B. Traffic management D. Operating procedures E. All
2. All laws and requirements relating to human, health, safety or protection of the environment or to emissions, discharges, releases or threatened releases of pollutants, contaminants, etc., is:
   A. Environmental requirements C. Statuary requirements
   B. Safety requirements D. Legislative requirements
3. A documented requirement, or set of documented requirements, to be satisfied by a given material, design, product, service, etc., is:

A. A requirement specification C. Afunctional specification

B. A design or product specification D. An in-service specification

4. _____ Are administrative regulations or civil law rules implemented for the treatment and maintenance of the environment.
   A. Environmental standards C. Environmental requirements
   B. Environmental assessment D. Environmental protection
5. Organizational requirements are:

A. Specific change initiatives. C. Business and performance plans

B. Organization's vision and goals D. Standards and protocols E. All

**Note: Satisfactory rating – 8 and above pts Unsatisfactory - below 8 pts**

You can ask you teacher for the copy of the correct answers.

**Answer Sheet**

1. _____
2. _____
3. _____
4. _____
5. _____

| Information Sheet- 4 | Selecting, placing and joining prefabricated drainage components |
|---|---|

## 4.1 Types of pre-fabricated vertical drainage components

### 4.1.1 Geo textiles

Prefabricated drainage systems often incorporate a geotextile fabric covering to separate soil from a flat, flexible polymeric core. The core channels water to drains that are easily connected to standard piping.

Prefabricated vertical drains(PVDs) are composed of a plastic core encased by a geotextile for the purpose of expediting consolidation of slow draining soils. These prefabricated wick drains are used to shorten pore water travel distance, reducing the preloading time.

Vertical drainage is the system of boreholes for lands drainage, from which water is pumped out by pumps with submerged electric motors. Depending on the location of wells over a drained area, they distinguish systematic drainage(wells are equally spaced over the area) and linear drainage.

Figure 29: Geo textile vertical drains

### 4.1.2 Prefabricated concrete drainage structures

Prefabricated drainage structures are made of precast concrete and assembled on site. These are used to construct open irrigation and drainage channels.

Figure 30: Concrete Prefabricated drainage component

Figure 31: Prefabricated concrete drainage components in place

### 4.1.3 Benefits of prefabricated vertical drains

Here are just a few of the benefits that come with choosing a prefabricated drainage system as well as a great option to consider.

### I. Easier installation

Figure 32: Installation of geo textiles

- One significant benefit of a prefabricated drainage system is the easier installation process.
- Because these systems come pre-assembled, there is less hassle when it comes to putting it in place.

### II. Saves you money

- Another great benefit to choosing prefabricated drainage systems is the cost saving aspect.
- Non-prefabricated drainage systems can end up costing you a lot of money, from the assembly to the installation and maintenance. It all begins to add up rather quickly, and you can spend hundreds of dollars to get a drainage system in place.
- With a prefabricated system, there is no need to worry about hiring large teams to assemble the drain body or redo the flooring, allowing you to save a lot of money.

### III. Fewer parts

- When you choose a prefabricated drainage system, there are fewer parts that you have to concern yourself with.
- Instead, the body that is made from a single sheet of material, which all you have to do is put it in place as per the instructions.

### IV. Saves time

- A prefabricated system comes ready to install automatically saves you time.
- Once it has had that time to set and harden, you can go back to using the space as usual. With less downtime required, you can get this done without sacrificing any work time.

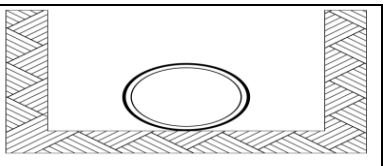
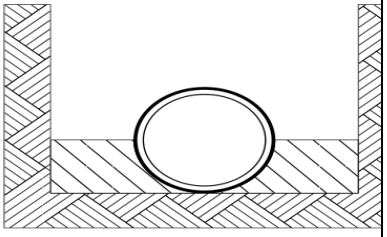
## 4.2 Principles of placing and joining prefabricated components

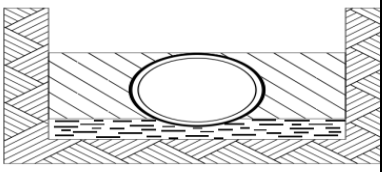
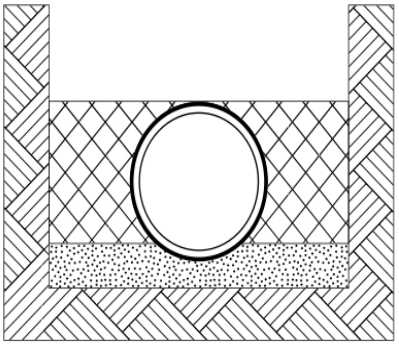
- If trench soil quality and applicable safety regulations permit, it is best to use shields that are placed with no portion of their sides extending lower than one quarter of a pipe diameter below the pipe crown.
- This minimizes the amount of lifting required and precludes the possibility for disturbing embedment materials.
- If the sides of the trench box or shield do project below this point, then the box should be lifted vertically as described above, before moving along the trench.
- The minimum inside clear width of the box, or shield, should allow for the minimum trench width requirements for the pipe to be satisfied plus an additional 12 to 24inches depending on the pipe diameter.

## 4.3 Ways of joining pipes and fittings

Distribution pipe can be joined in either of the following ways. The type of joint used is mostly determined by the pipe material used, but also by other requirements such as the ability to handle tension forces, toleration of small deflections and ease of use in the field.

Table 2: Laying conditions

| | |
|---|---|
| **Type 1**<br>• Flat-bottom trench<br>• Loose backfill |  |
| **Type 2**<br>• Flat-bottom trench.<br>• Backfill lightly consolidated to centerline of pipe.<br>• “Flat-bottom” is defined as undisturbed |  |

| | |
|---|---|
| earth. | |
| **Type 3**<br>• Pipe bedded in 4-inch minimum loose soil<br>• Backfill lightly consolidated to top of pipe |  |
| **Type 4**<br>• Pipe bedded in sand, gravel, or crushed stone to depth of 1/8 pipe diameter, 4-inchminimum. Backfill compacted to top of pipe.<br>• Loose soil or select material is defined as “native soil excaved from the trench, free of rocks, foreign materials, and frozen earth.” |  |

The type of joints are:

- In spigot and socket (or bell and spigot) joints, one end of a pipe section(the bell) is enlarged and provided with a rubber seal, while the other end (the spigot) is left unchanged. To join two pipes, the spigot of one pipe is pushed in to the bell of the other pipe to create a watertight seal.
- Butt fusion jointing is used to connect HDPE pipes: the ends of both pipes are heated and then pressed together at a prescribed pressure to create a bond.
- Electro fusion is an alternative jointing method for HDPE pipes that employs special collars with built in heating coils. The ends of the pipes are cleaned and their outer layers removed using a special scraping tool to expose virgin material. The electro fusion collar is then placed over the pipe ends and an electrical current applied to the heating coil. The heat melts the material of the collar and pipe together.

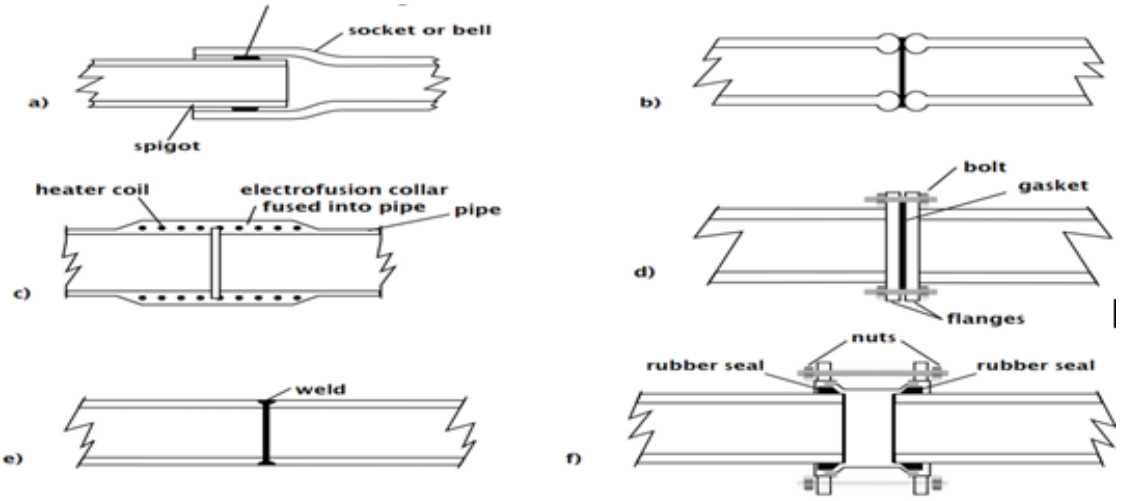



Figure 33: Common types of pipe joints: a) spigot and socket; b) butt welded; c) electro fusion; d) flanged; e) welded; f) mechanical coupling.

### 4.4 Backfilling and compacting pipe zone

Backfilling should follow pipe placement and assembly as closely as possible to prevent the pipe from being shifted out of line by cave ins, protect the pipe from external damage, eliminate pipe lifting due to flooding of open trench and lessen the possibility of backfill material becoming frozen in cold weather.

### 4.4.1 Types of Backfill

**Initial Backfill** - This is the critical zone of embedment soil surrounding the pipe from the foundation to at least 6 inches over the pipe.

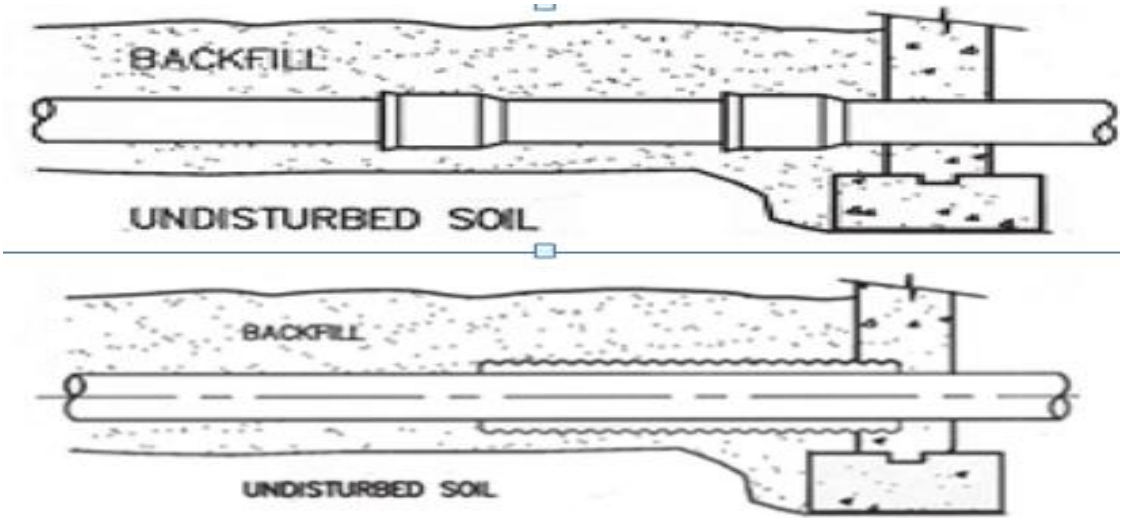



Figure34: Initial backfill

The pipe's ability to support loads and resist deflection is determined by the quality of the embedment material and the quality of its placement. Within the initial backfill zone are bedding, haunching, primary, and secondary zones.

- **Primary Initial Backfill -** This zone of backfill provides the primary support against lateral pipe deformation. To ensure such support is available, this zone should extend from trench grade up to at least 75 percent of the pipe diameter. Under some conditions, such as when the pipe will be permanently below the ground water table, the primary initial backfill should extend to at least 6 inches over the pipe.
- **Secondary Initial Backfill -** The basic function of the material in this zone is to distribute overhead loads and to isolate the pipe from any adverse effects of the placement of the final backfill.
- **Final Backfill -** As the final backfill is not an embedment material, its nature and quality of compaction has a lesser effect on the flexible pipe. However, arching and thus a load reduction on the pipe is promoted by a stiff backfill. To preclude the possibility of impact or concentrated loadings on the pipe, both during and after backfilling, the final backfill should be free of large rocks, organic material, and debris.

Figure 35: Final Backfilling and compaction

The material and compaction requirements for the final backfill should reflect sound construction practices and satisfy local ordinances and sidewalk, road building, or other applicable regulations.

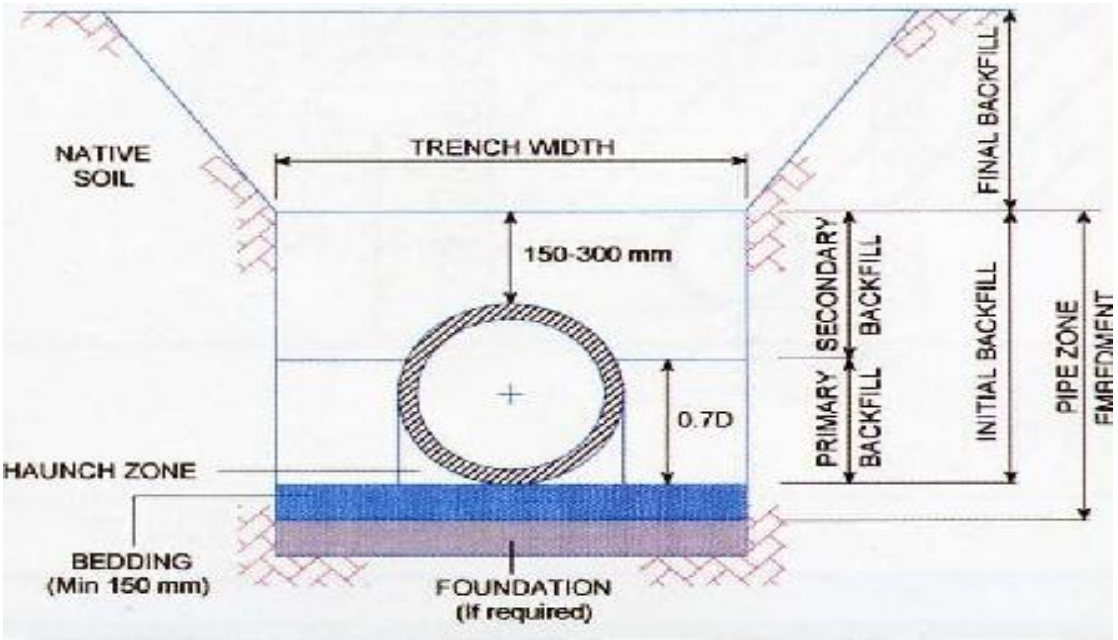



Figure 36: Bedding, backfilling and compacting pipe zone

### 4.4.2 Principles of backfilling

- Any selected or granular fill must be carefully hand-compacted in layers not exceeding 150mm to complete the pipeline surround. Place and compact this fill equally on both sides of the pipeline to prevent displacement.
- Slice with a spade around the barrels to form a cradle for the pipes. This work is important, as the pipeline derives some of its strength from a properly constructed bedding.
- The trench must be backfilled to at least 300mm above the crown of the pipes before any power-ramming takes place. Backfill should then be well-compacted in layers not exceeding 300mm.
- As backfilling proceeds withdraw timber and trench sheeting in stages to avoid disturbing the pipeline or the creation of voids within the bedding and surround.
- Backfill material shall be evenly graded and not include constituents exceeding 50mm or any clay or organic material. In the case of structures, the maximum size of constituents shall not exceed 30 mm. All backfill material shall be approved by the Engineer.
- Backfilling shall be done in layers not exceeding 200mm thick if done manually or 300mm if done by machinery. The value of moisture content of the soil shall be checked carefully.
- The compaction shall be done by rollers, compactors, vibrators or other manual means as approved by the engineer.
- The Contractor shall monitor the backfill and shall ensure that at all times during, and at the end of the period of maintenance all finished levels are in accordance with those established in the Contract.
- Costs shall be included in the unit prices for installation.

## 4.5. Installation of reinforced concrete pipe (RCP)

Reinforced concrete pipe, or RCP, is one of the standard materials used in storm sewer systems, sanitation systems, and large irrigation projects. One benefit of concrete is its inherent strength, which simplifies installation and backfilling. On the other hand, RCP is very heavy and must be handled carefully during transportation and installation.

## Installation Tips

- Reinforced concrete pipes must be handled and moved carefully to prevent damaging the bell (the wide or flared end of the pipe sections) and thespigot (the narrow end that is inserted into the bell of an adjoining pipe).
- RCP should never be dragged to the site.
- It is best if the pipes are unloaded with the use of a nylon sling or other certified material that can support the weight of the pipe. The pipe must be balanced precisely in the sling for safety and to prevent damage.
- Trenches for RCP should be wide enough to accommodate at least two pipes. The grade (pipe slope) is established during trenching, followed by laying down a bedding material.
- The bedding should be free of debris and must provide a uniformly level surface. When setting RCP into the trench prior to installation, the pipes should not be supported on their bells, as this can damage them.
- Just before installation, each RCP section is cleaned to remove all dirt from the pipe's bell.
- The backfill material is placed evenly in lifts on both sides of the pipe until the trench is filled about one foot above the top of the pipe.
- It is important that the material is not be bulldozed into the trench or dropped directly onto the pipe. The backfill material must not contain large boulders, which do not compact and could damage the pipe. The material also should be free of roots and other organic material.
- Once the pipe is adequately backfilled and compacted, the trench can be filled up to grade, per the project specifications. At any stage during the backfilling process, heavy construction equipment should not drive over the pipe until adequate backfill is in place or the pipe is deep enough that it will not be damaged.

| Self-Check 4 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer sheet provided in the next page. Use bold letter**.(4 points each)**

1. Reinforced concrete pipe, or RCP, is one of the standard materials used in:

A. storm sewer systems C. sanitation systems

B. large irrigation projects D. road drainage E. All

2. is used to distribute materials overhead loads and to isolate the pipe from any adverse effects of other loads.

A. Secondary initial backfill C. Final backfill

B. Initial backfill D. Primary initial backfill

3. Joints in which one end of a pipe section is enlarged and provided with a rubber seal, while the other end is left unchanged are:

A. Spigot and socket (or bell and spigot) C. Butt fusion jointing

B. Electro fusion D. Flexible joints

4. Types of laying conditions on flat-bottom trench requiring loose backfill is:

A. Type 1 C. Type 2

B. Type 3 D. Type 4

5. The most common form of drainage system is:

A. Parallel drainage system.

B. Radial drainage system.

C. Rectangular drainage system.

D. Dendritic drainage system

Note: Satisfactory rating – 10and above pts Unsatisfactory - below 10pts

You can ask you teacher for the copy of the correct answers.

Answer Sheet

1. _____ 4. _____

2. _____ 5. _____

3. _____

| Information Sheet 5 | Checking installed pipes, fittings and prefabricated components |
|---|---|

## 3.1 Problems with drainage materials

Installing drains in the traditional way, which is by manual labour, cannot be easily done under adverse conditions such as shallow groundwater tables or general wetness. This restriction usually prevents drainage performance and a long service life for manually installed systems. The quality of drainage material also affects the durability of installed drainage system. So, installed drainage assets should be checked and tested to meet the standard requirement and the required specification must be met.

## 3.2 Quality control of installed drainage assets

- Drainage assets are every component in drainage system including: pipes, fittings and prefabricated components.
- Quality in construction is defined as 'meeting or exceeding the requirement of client/owners.
- Quality control in installation is making sure that things are done according to the plans, specifications and permit requirements.
- Controlling quality is monitoring if the installation work practices are going as planned or not, examining the quality of the current installation tasks, and provide reports daily for any unsatisfactory work output.
- The common way of controlling quality of construction works/installation works is the inspection of installed drainage assets.
- Its main purpose is to minimize the chance of defects before the project delivery to the owner.

## 3.3 Testing installed drainage pipes

Installed irrigation drainage pipes should be tested before using. In this case, the alignment/laying slope, leakage and other aspects are tested using different techniques by appropriate personnel.

Tools and equipments used for testing drainage pipe include: Hydro static pump, tape meter, water level and others.

Figure 37: Checking the alignment of installed drainage pipe

| Self-Check 5 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer sheet provided in the next page. Use bold letter.**(4 points each)**

1. Problems with installing drains in the traditional way is:
   A. Use of manual labour
   B. Cannot be easily done under adverse conditions such as shallow groundwater tables or general wetness.
   C. Cost
   D. Use of cheaper materials
2. What aspect do you test in drainage pipe?
   A. The alignment C. Leakage
   B. Length D. Flow E. All
3. Equipment used for testing installed pipe may be:
   A. Hydrostatic pumps C. Tape meters
   B. Water levels D. Shovel

**Note: Satisfactory rating – 6 and above pts Unsatisfactory - below 6 pts**

You can ask you teacher for the copy of the correct answers.

**Answer Sheet**

1. _____
2. _____
3. _____

| Information Sheet 6 | Perform work-related calculations |
|---|---|

## 3.1 Tools and materials needed

- A map of the catchment area with gradient lines, or a study of the catchment area from which it is possible to calculate its gradients and boundaries
- Ruler
- Paper with gridlines
- A calculator with the option 'y to the power x' ($y^x$)
- Preferably the IDF-curves (intensity-duration-frequency curves) of the zone studied.

## 3.2 Analysis of the catchment area

First the catchment area with its boundaries will have to be identified on the map. A catchment area is the entire surface that will discharge its storm water to one point (the discharge point).

- As water always flows from high to low, it is possible to identify the catchment area on a map with the aid of the gradient lines.
- Once the catchment area is identified, its surface must be estimated.
- This can be done by transferring the contours of a catchment area on paper with gridlines, and counting the grids.
- Now the average gradient in the catchment area has to be identified.
- This can be done on the map with the aid of the gradient lines and the horizontal distances. Usually the average gradient of the terrain can be taken.

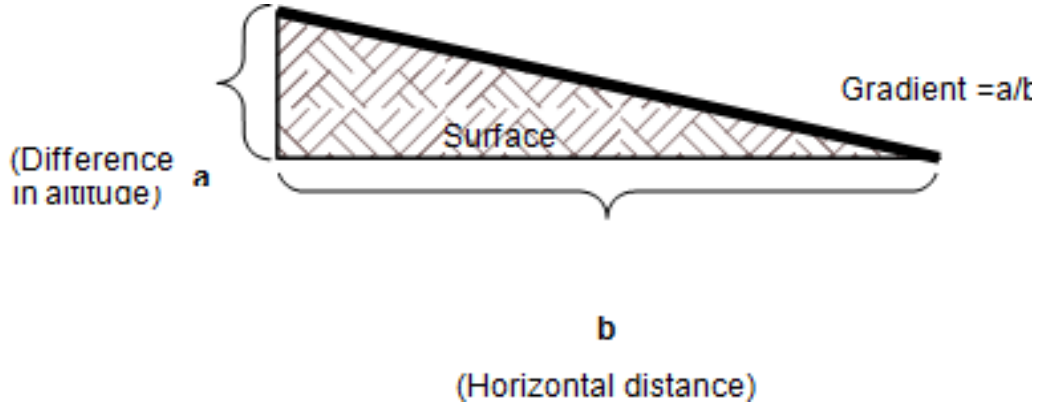



Figure38: The gradient of a terrain

The next step is to assess the surface of the terrain. This information is needed to determine the runoff coefficient of the area. The runoff coefficient is that part of the rainwater which becomes storm water; a runoff coefficient of 0.8 means that 80% of the rainfall will turn into storm water. The runoff coefficient depends on the type of terrain, and its slope. Future changes in the terrain must be anticipated in the design of the drainage system to avoid problems at a later date. If no other values are available, the values from table A6.1 can be used.

**Table 3:** Runoff coefficients of different types of terrain (these values are approximate figures assuming a low soil permeability)

| ***Terrain type*** | ***Runoff coefficient*** | |
|---|---|---|
| | ***Gradient < 0.05 (flat terrain)*** | ***Gradient > 0.05 (steep terrain)*** |
| | | |
| | | |
| Residential areas and light industry | 0.7 | 0.8 |
| Dense construction and heavy industry | 1.0 | 1.0 |

### 3.3 Determining the rainfall intensity

If no local IDF-curves (intensity-duration-frequency curve) are available, a rain- fall intensity of 100 mm per hour can be assumed (this value is for tropical countries, with

catchment areas smaller than 150 ha). If no IDF curves can be found, the reader can skip directly to the section Calculating the amount of water the catchment area will produce.

If the IDF curves of the area can be obtained, these should be used. IDF curves show the rainfall intensity (in mm per hour) against the duration of the rains (in minutes) for specific return periods. Several curves from different return periods may be presented in one graph. A curve with a return period of 1 year will show the worst storm that will on average occur every year, a curve with a return period of 2 years is the worst storm that can be expected in a 2-year period, and so on.

To know which value to take from the IDF curve, the time of concentration has to be calculated. The time of concentration is the time the water needs to flow from the furthest point in the catchment area to the point where it will leave the area (the discharge point). The time of concentration is determined with the formula:

$T_{con} = 0.02 \times (0.77^{x} (Sav_{)} - 0.383 L_{max}$ $T_{con}$: the time of concentration (in minutes)

$L_{max}$: the maximum length of flow in the catchment (in meters)

$S_{av}$ the average gradient of the catchment area

**Example 6.3**

If the furthest point of our catchment area is at a distance of 500 meters from the discharge point, and the difference in altitude between this point and the discharge point is 10 meters, then the time of concentration would be around (0.02 x (500)0.77 x (10/

500)-0.383 =) 11 minutes.

### 3.4 Calculating the amount of water, the catchment area will produce

The amount of storm water the catchment will produce can be determined with the formula:

$$Q_{des} = 2.8 \times C \times I \times A$$

$Q_{des}$ : the design peak runoff rate, or the maximum flow of storm water the system will be designed for (in liters per second). C : the runoff coefficient (obtained from

table)

i: the rainfall intensity at the time of concentration read from the chosen IDF curve; if no IDF curves are available, a value of 100 mm/h can be taken (in mm/h)

A: the surface area of the catchment area (in ha (10,000 m2))

**Example 6.4**

If our catchment area would be a residential area, with a surface of 12 ha, a gradient of 0.02, and a rainfall intensity of 100 mm/h, than the design peak runoff rate would be around (2.8 x 0.7 x 100 x 12 =) 2350 liters per second.

It should be remembered that this figure is not a fixed value. Every once in a while, storms will occur which produce more water than the drainage system can deal with (normally, on average, periods just above the return period). The larger the capacity of the system (the longer the return period the system is designed for) the less often it will overflow, and the higher its costs.

The size of the drain can be calculated with the formula:

$$Q = 1000 \times \left( \frac{A \times (R)^{0.67} \times (S)^{0.5}}{N} \right)$$

Q: the capacity of discharge of the drain (in l/s)

A: the cross section of the flow (in $m^2$)

R: the hydraulic radius of the drain

S: the gradient of the drain

N: Manning's roughness coefficient: for earth drains, 0.025; brick drains

### 3.5 Sizing a drain to cope with the design peak runoff rate

With the design peak runoff rate known, plan where the drains will be installed is designed. A drainage system must be planned together with other structures like roads and buildings to assure they are all adapted to one another.

Unlined drains are at risk of erosion, and should therefore have a relatively low gradient to control the velocity of the storm water. Gradients in unlined drains should probably not exceed 0.005 (1-meter drop in 200 meters horizontal distance). In less stable soil unlined

drains should be made with a slope less steep than 1/2, in more cohesive material a steeper slope could be used.

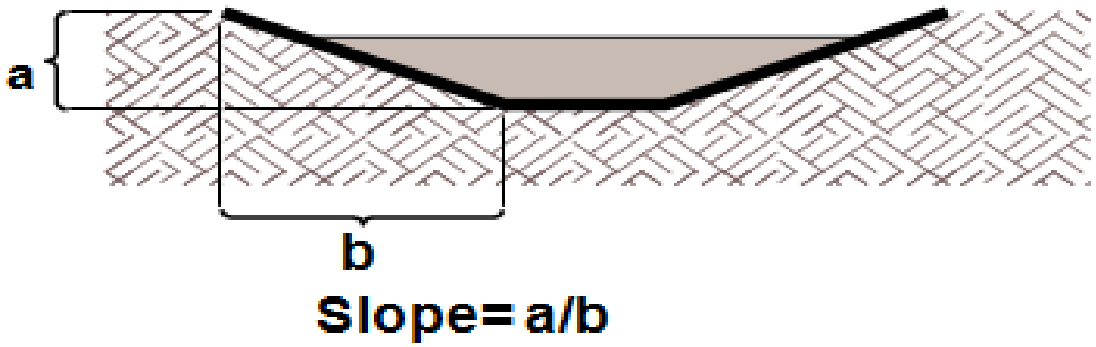



Figure 6.5(a). Section of an unlined drain in less stable soil

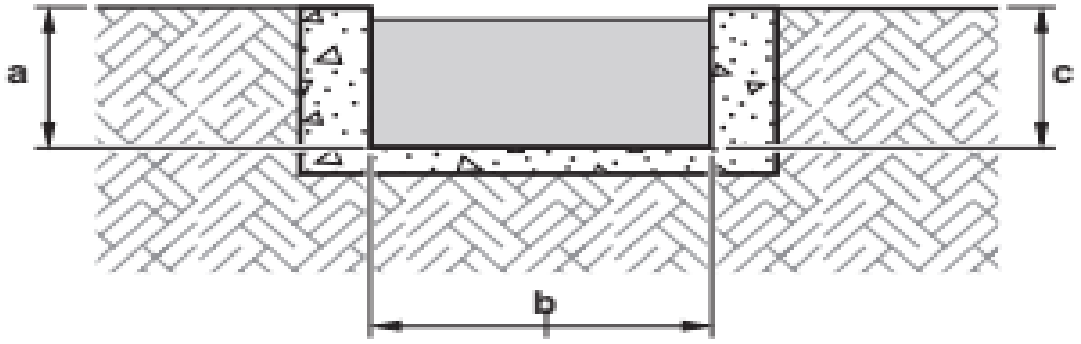



Figure 39: Hydraulic radius for rectangular drain

The hydraulic radius is the surface area of the cross section of the flow/the total length of the contact between water and drain;

Hydraulic radius = (a x b) / (a + b + c).

**Example 6.5**

A completely filled, rectangular, smooth concrete drain of 1.5 m by 0.7 m, with a gradient of 0.005, canal in ideal circumstances discharge around (1000 x ((1.5 x 0.7) x ((1.5 x 0.7/(1.5 + 0.7 + 0.7))0.67 x (0.005)0.5 ) / 0.015) = 2500 litres per second.

| Self-Check 6 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer sheet provided in the next page. Use bold letter**.(4 points each)**

1. Tools and materials needed for calculations in drainage construction are:
   A. A map of the catchment area
   B. Paper with gridlines
   C. Ruler
   D. A calculator
2. If our catchment area would be a residential area, with a surface of 24 ha, a gradient of 0.02, and a rainfall intensity of 100 mm/h, than the design peak runoff rate would be around:
   A. 2350 liters per second
   B. 2300 liters per second
   C. 4700 liters per second
   D. 4750 liters per second
3. A completely filled, rectangular, smooth concrete drain of 1.5 m by 0.7 m, with a gradient of 0.005, canal in ideal circumstances discharge around :(take N=0.030).
   A. 1250 liters per second
   A. 2500 liters per second.
   C. 1200 liters per second
   D. 1260 liters per second
4. All are correct **EXCEPT:**
   A. A catchment area is the entire surface that will discharge its storm water to one point .
   B. Catchment area on a map can be identified with the aid of gradient
   C. The runoff coefficient depends on the type of terrain, and its slope.
   D. The runoff coefficient is that part of the rainwater which is evaporate

Note: Satisfactory rating – 8 and above pts Unsatisfactory - below 8 pts

You can ask you teacher for the copy of the correct answers.

Answer Sheet

1. _____
2. _____
3. _____
4. _____

| Information Sheet 7 | Constructing cast in situ components |
|---|---|

## 7.1 Definitions of cast in situ concrete

- In situ is manual concrete poured in a form of liquid and become rigid concrete for the time given in the site. If you see some reinforcement were installed first with some of the concrete mold, it is probably an in-situ cast concrete building.
- Cast in place concrete, also known as poured-in-place, is a concreting technique which is undertaken in suitor in the concrete component's finished position.
- Cast in sit refers to a construction material, a beam or a pile, that is to be assembled or cast on site rather than prefabricated in a factory.
- Cast in place concrete is the preferred choice for concrete slabs and foundations, as well as components such as beams, columns, walls, roofs, and so on.
- Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as casting, which is ejected or broken out of the mold to complete the process.
-

## 7.2 Difference between precast & cast in situ concrete

Precast concrete is the new construction technique that makes construction speedy and economical on the large construction projects. It has many advantages over the cast in situ concrete method for construction. Cast insitu concrete is the easy and conventional method.

The cast in situ concrete is a standard concrete which is poured into the specific formwork on the site and cured to get the strength of RCC elements.

The differences in between cast in situ and precast concrete are:

- In situ is concrete that is cast in its final place. examples of this are:
  - ✓ Traditional strip foundations.
  - ✓ Traditional concrete floors.
- Precast concrete is buildings elements cast in a location that is not the final placement Examples are:
  - ✓ Precast walls
  - ✓ precast stairs

- ✓ Gravity retaining blocks
- ✓ Concrete Masonry Units


Figure 40: Differences between cast in situ and precast components.

### 7.2.1. Precast concrete

- Elements can be cast in advance and held until the hour you need them, thereby saves time.
- In the precast concrete, elements are manufactured in a controlled casting environment and hence it is easier to control mix, placement and curing.
- Less labors are required.
- Maintenance cost of precast concrete structure is higher.
- Precast concrete is cheaper form of construction if large structures are to be constructed.
- Skilled labours are required at construction site.
- Weather condition has no effect on casting work.
- Precast concrete requires heavy machinery and cranes for handling i.e. lifting and installation of heavy elements
- Precast concrete construction is quick as it can be installed immediately and there is no waiting for it to gain strength.
- Increase in strength can be achieved by accelerated curing.
- On site strength test is not required.
- High strength concrete can be used because it is in controlled condition.
- Total construction time is less as compared to cast-in-situ.

- Speedy construction is possible.

Figure 41: Precast Concrete elements


Figure 42: Precast Concrete Elements

### 7.2.2. Cast in situ components

- Cast in place concrete is the preferred choice for concrete and foundations, as well as components such as beams, columns, walls, roofs, and so on.

- In the cast-in-situ concrete, column, slab etc. elements are casted on site in the open environment and hence it is difficult to control mix, placement and curing.
- Elements cannot be casted in advance.
- Weather condition can delay the casting work.
- It offers unlimited possibilities to the designer for any shape formation with a limitless selection of surface textures.
- In situ concrete is cheaper form of construction for small structures.
- Maintenance cost of cast-in-situ concrete structure is less compared to the precast concrete structure.
- More labors are required.
- Skilled labors are required at construction site.
- Local contractors can also build the structure.
- Cast in situ concrete does not require such handling equipment.
- In situ concrete construction is slow as gaining of strength requires time.
- Increase in strength at situ by accelerated curing is a difficult task.
- On site strength test is required.
- It will difficult to use high strength concrete as it depends on site condition and resources available.
- Total construction time is more as compared to precast.

## 7.3 Constructing cast in situ drainage structures

- Cast in place concrete, also known as poured in place, is a concreting technique which is undertaken in or in the concrete component's finished position.
- While cast in place concrete can allow for greater flexibility and adaptability, it can be difficult to control the mix particularly if weather conditions are not favorable.
- Cast in place concrete will also require a strength test and time for curing, which makes it slower to construct than precast concrete. However, there are fewer joints in the structural system not as much handling equipment is required.

### 7.3.1. Advantages of cast in situ construction methods

- Does not require any heavy lifting equipment or transporting equipment
- The super structure is safe from transportation and lifting damages.

- The best method to construct a bridge in Inaccessible areas.
- Used for cost effective construction of solid, voided or ribbed reinforced concrete slab bridges.

### 7.3.2. Disadvantages of Cast-in-Situ Construction Methods

- It is time consuming as compared to precast construction methods.
- If the bridge is constructing over water bodies, severe damage may occur to the unset concrete during flood conditions.
- This method requires large number of workers and requires skilled supervision.

## 7.4 Methods of Placing of Concrete for Various Situations & Locations

Concrete is a vital material and plays a major role in the quality of buildings or structures. One may say that the making is easy but it's not enough. It is important that a concrete mix is correctly designed, batched, mixed and transported, but it is also important to place concrete correctly. The placing of concrete is an essential operation because it largely determines the success of a structure and its durability. Hence concrete placement must be done in systematic and efficient way to give the best results desired.

### 7.4.1. Placing of concrete within small earth mould

- In this kind of placing, concrete is placed in a small surface area on the earth such as foundation bed below the walls or columns.
- If the surface of the bed is dry then it must be made damp, so the earth doesn't soak the water from concrete.
- If the foundation bed is too wet than the water and mud must be removed completely to expose the firm bed before placing of concrete.
- Clear all the obstruction such as any root of trees passing through the foundation, some charred or tarred elements because its further growth piercing the concrete at a later time can lead to deterioration of concrete.

### 7.4.2. Placing of concrete within large earth mould

- In this type of placing, concrete is placed in a large surface area on the earth such as road slab and airfield slab or timber plank form work.

- In such concrete placement, before the concreting, the ground surface on which the concrete is placed must be free from loose earth and other organic matters such as grass, roots, leaves etc.
- The earth must be appropriately compacted and made sufficiently damp to prevent the absorption of water from concrete because it makes concrete week.
- Concrete is placed in alternative bays for the construction of road slabs, airfield slabs and ground floor slabs in buildings.
- In these bays, there are contraction joints and dummy joints which are given for shrinkage. Concrete should be properly dumped and concrete pouring and dragging from one place should be avoided.
- Joints gap are filled with the wooden husk or bitumen to prevent deterioration.

### 7.4.3. Placing of concrete within formwork

- Formwork is the temporary mould into which concrete is poured and formed. It can be said that concrete formwork is the supporting part of the structure. It is generally used for the beam and columns.
- Concrete formwork should be rigid so that it does not get deformed under the pressure of placement of fresh concrete and should be watertight so that the slurry does not leak out because it makes water insufficient
- The surfaces of form have to clean and brushed for every new use of formwork.
- Mould releasing agents such oil or grease should be applied inside of the formwork for easy stripping.
- The joints between planks, plywood or sheets must be properly and effectively plugged so that concrete/slurry will not leak during compaction or any vibration.
- If reinforcement is provided than it should be correctly tied and placed having appropriate cover and reinforcement should be clean and free form dirt and oil.
- Generally, difficulties arise when the concrete is to be poured from a greater height like placing of concrete in the column. It is likely to segregate or block the space to prevent further entry of concrete. To avoid this kind of difficulties concrete is placed by tremie or chute.

Figure 43: Placing of concrete within formwork

## 7.5 Constructing Concrete lined V-drain

### 7.5.1. Materials

Materials required for the construction of lined concrete drains include:

- Cement, aggregate and sand for concrete
- Mesh reinforcing to specification, if required.
- Joint material to specification, if required.

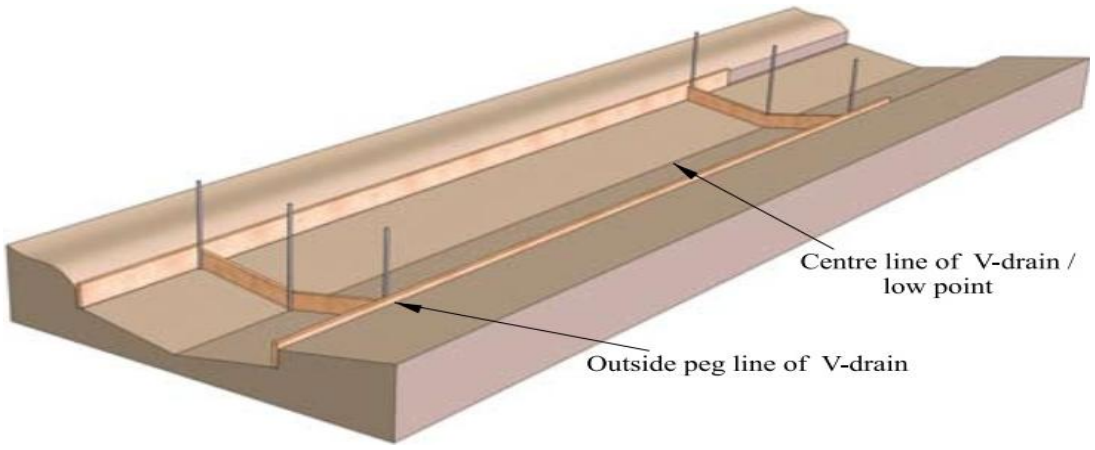



Figure 44: Setting out of V-drain

- If the local soil cannot be used to contain the concrete that will form the drain, side-formers must be used. Align these, using the building line pulled between the outside pegs. If the drain needs a clean, definite edge, side formers may also be

required.

- The side formers may be suitable standard steel formwork or timber such as scaffold boards on edge. Both are capable of providing a neat finish. Care must always be taken to keep the forms true to line and given levels.
- Curing of the concrete shall commence as soon as the concrete has hardened sufficiently to ensure that the surface will not be marked or stained in any way. Curing may be done by covering the exposed surface with sand or fabric mats.

### 7.5.2. Backfilling sides

After the pitching or concrete work has been completed and the initial curing has taken place, you may be required to backfill the channel, i.e. build up the surrounding area to the upper levels of the channel. Such backfill shall be placed in layers not exceeding 150 mm and each layer should be watered and thoroughly compacted. The backfill should be sloped towards the channel encouraging water to enter it.

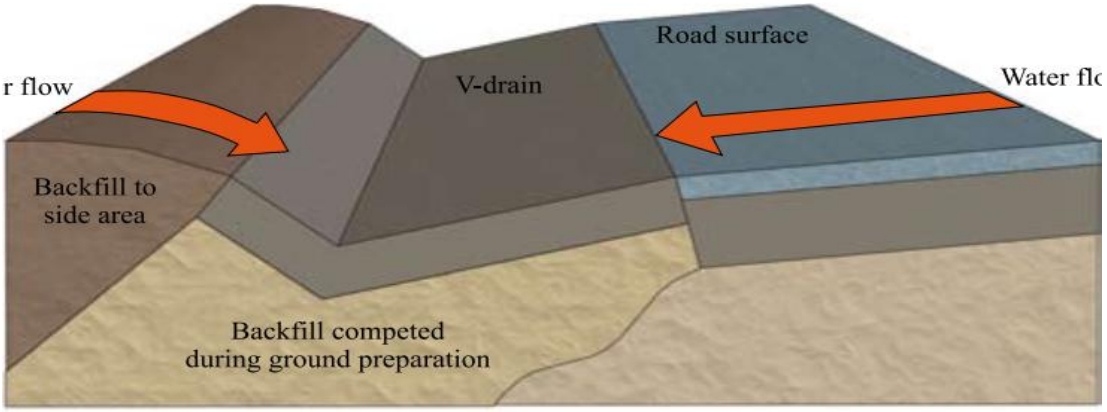



Figure 45: Backfilling V-drains

## 7.6. General guidelines in construction of open channels of V-drain

- Approach the final excavation level with caution.
- Attention must be given to the surface finish of linings in order to fulfil the design requirements.
- Careful backfilling of spaces along and behind structures is essential for the drain to function correctly. Adequate quality control measures must be in place.
- Commence work at the lower end so that any water flowing into the channel will drain away immediately and not accumulate to saturate the soil.
- Concrete work must be properly cured for at least four days. Poorly cured concrete will not have the abrasion resistance needed to withstand high velocity, debris laden

flows.

- Considerable effort is required to ensure good preparation before lining, as uneven settlement may destroy the lining and negate its purpose.
- Drainage of the space behind the lining may be crucial and attention must be focused on getting the details to work. Filter layers and the installation of flap-valves to relieve groundwater pressures may require the input of a specialist.
- Grouting of stone pitching should be undertaken as the job progresses. If grouting is delayed, storm flows carrying sediments can fill the voids in the pitching. Should this happen, the pitching will have to be taken up, the sediments cleaned out and the stone re-laid.
- Poor soils exposed during excavations should be removed and replaced with better quality gravel soils.
- Stone pitching and block-laying is always started at the low end and worked upstream.
- The completed project must be able to do the job intended i.e. collect and carry surface water away from the road structure and surrounding area.
- The final product must comply with the shape of the pre made drain formers. The final surface must be uniform and true to shape.
- The project must be left clean and tidy and pleasing to look at.
- The units should be tightly packed.
- The use of templates is encouraged, as unskilled labour will quickly learn how to use them to ensure correct shape and side-slope of the channel excavation.

| Self-Check 7 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer sheet provided in the next page. Use bold letter**.(4 points each)**

1. All are true about cast in situ concrete, **EXCEPT:**
   A. It is the easy and conventional method.
   B. It refers to a construction material, a beam or a pile, that is to be assembled or cas ton site rather than prefabricated in a factory.
   C. Is the product produced by casting concrete in a mould or formwork cured to get the strength of RCC elements.
   D. Is common in traditional strip foundations.
2. When using p**recast Concrete:**
   A. Less labors are required.
   B. Weather condition has no effect on casting work.
   C. Precast concrete requires heavy machinery and cranes for handling
   D. Speedy construction is possible.
   E. All

**3.** Which of the following is the disadvantages of cast in situ construction methods?
   A. The superstructure is safe from transportation and lifting damages.
   B. It is the best method to construct a bridge in Inaccessible areas.
   C. This method is used for Cost effective construction of solid, voided or ribbed reinforced concrete slab bridges.
   D. It is time consuming as compared to precast construction methods.

4. Materials required for the construction of lined concrete drains include:
   A. Cement, aggregate and sand for concrete
   B. Mesh reinforcing to specification
   C. Joint material to specification
   D. All

**Note: Satisfactory rating – 8 and above pts  Unsatisfactory-below 8 pts**

You can ask you teacher for the copy of the correct answers.

**Answer Sheet**

1. _____
2. _____
3. _____
4. _____

| Operation 1 | Techniques of providing foundation and bedding for concrete drainage channel |
|---|---|

**Steps**

**Step 1:** Wear appropriate PPE and select and use appropriate tools, equipments and materials

**Step 2:** Excavate a trench for the trench

**Step 3:** Prepare foundation for the channel

**Step 3:** Select appropriate foundation and bedding material for the structure

**Step 4:** Place the bedding material at the bed the trench

**Step 5:** Compact and level the bedding material as standard

**Step 6:** Check, clean, maintain and store tools and equipments

| Operation 2 | Techniques of installing drainage pipe |
|---|---|

**Use the following steps to install irrigation drainage pipes**

**Step 1:** Wear appropriate PPE and the prepare necessary tools and equipments

**Step 2:** Mark installation area

**Step 3:** Dig a trench

**Step 4:** Place pipe bedding material to required thickness (min.4”), and shape bed true to line and grade, free from depressions and high points.

**Note:** Provide uniform bedding for the pipe and any protrusions such as joints.

**Step 5:** Compact full width of bed to 95% Standard Proctor Density.

**Step 6:** Shape bedding to a cylindrical surface conforming to the pipe radius.

**Step 7:** Ensure that the pipe is lifted into place using rope or web slings. Do not use chains or cables.

**Step 8:** Lay pipes on prepared bed, true to specified line and grade.

**Step 9:** Attach pipe

***Note***: Leave adequate clearance at each joint position to prevent possibility of sand and gravel contaminating joining surface (especially O-ring joint surface) See fig 1 below.

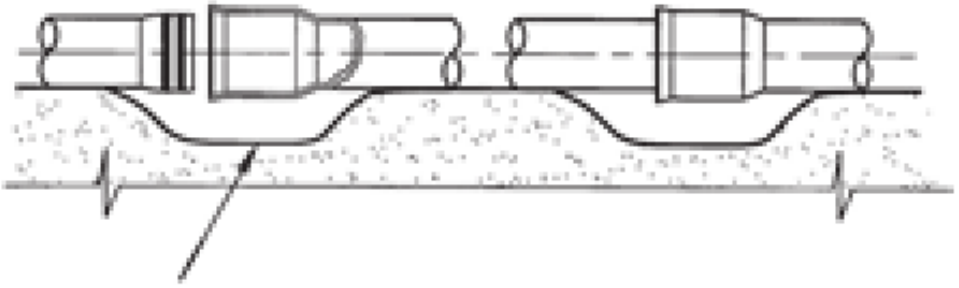


Fig 1

**Step 10:** Provide access to the joint to apply butt & strap materials.

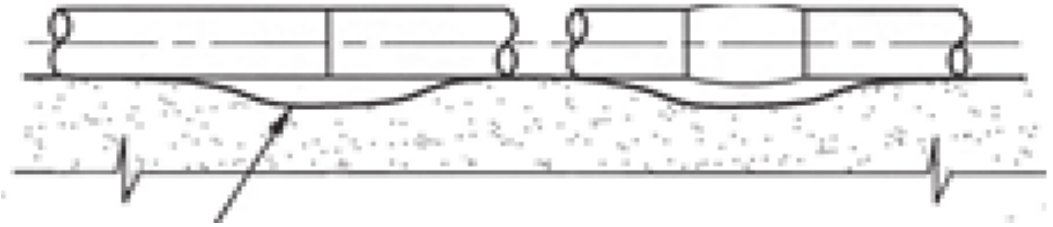


**Fig 2**

**Step 11:** Provide access to the joint to install bolts, etc.

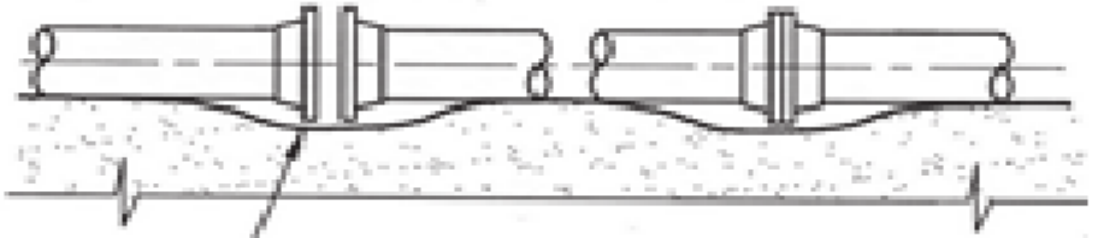


**Fig 3**

**Step 12:** Place embedment materials by methods which will not disturb or damage the pipe. Work in and compact the haunching material in the area between the bedding and the underside of the pipe before placing and compacting the remainder of the pipe-zone embedment.

**Step 13:** Place pipe-zone embedment material in uniform lifts not in excess of 6" (150mm). Compact material to 95% Standard Proctor Density. Minimum cover over top of the pipe is 6" (150mm).

**Step 14:** Fill the trench (backfill the trench)

**Step 15:** Test the installed pipe

**Step 16**: Clean, maintain and store tools, equipments and materials appropriately

| Operation 3 | Procedures of placing and joining prefabricated drainage components |
|---|---|

**Activity 1: Place and join heavy concrete drainage pipe**

**Step1:** Wear appropriate PPE and the prepare necessary tools and equipments

**Step 2:** Excavate and lower shield to pipe crown

**Step 3:** Excavate below pipe crown from within shield

**Step 4:** Place embedment

**Step 5:** Lift shield in steps as embedment is placed

**Step 6**: Clean, maintain and store tools, equipments and materials

**Activity 2: Joining DI pipes with flanged joints**

**Step1:** Wear appropriate PPE and the prepare necessary tools and equipments

**Step 2:** Align the pipes.

**Step 3:** Clean flange faces.

**Step 4:** Position gasket.

**Step 5:** Lubricate bolt threads, mating surface and flange with automotive grade oil/grease.

**Step 6:** Insert nut bolts one by one and tighten opposite bolts one by one.

**Step 7**: Clean, maintain and store tools, equipments and materials

**Activity 3: Joining PVC drainage pipe**

**Step 1:** Wear appropriate PPE and the prepare necessary tools and equipments

**Step 2:** Gather your PVC pipe and fittings.

**Step 3:** Assemble your structure as you designed it. Press the pipes firmly all the way into the fittings as far as they will go until they hit the detent in the fitting.

**Step 4:** Using a 1/8” Drill Bit mounted on a drill, drill a hole into the fitting where it meets the pipe.

**Step 5:** Using a screwdriver bit mounted on a drill; drive the wood screw into both the fitting and the pipe.

**Step 6:** Repeat on other sides of the pipe/fitting until you reach the level of comfort for durability.

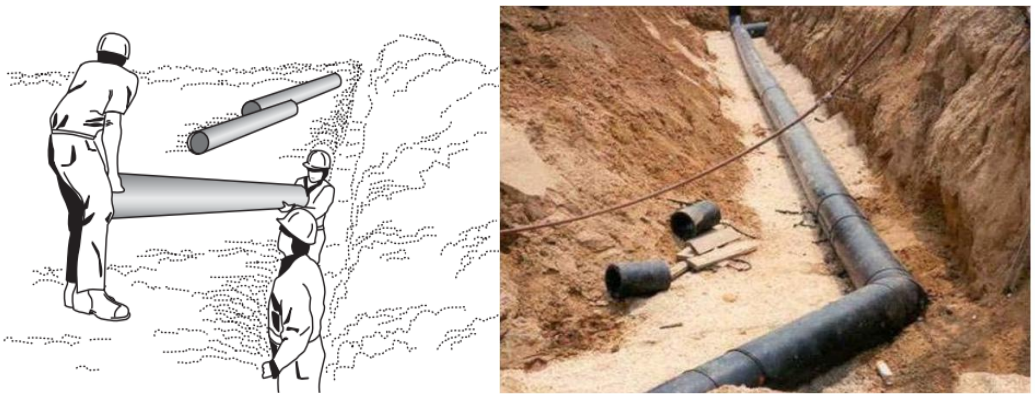


Figure 1: Pipe Placement in Open Trench

**Step 7**: Clean, maintain and store tools, equipments and materials

| **Operation-4** | **Procedures of constructing concrete cast in situ drainage components** |
|---|---|

**Use these steps to construct concrete cast in situ irrigation V-drain[4]**

**Steps to follow:**

**Step 1:** Wear appropriate PPE and prepare tools and equipments

**Step 2:** Clear the site

**Step 3:** Set out the site

**Step 4:** Excavate the soil and prepare the foundation. Excavate all unwanted material to the depth required between the building lines.

***Notes:***

- Use the straight edge as a guide between the formers. At this stage the excavation should take on the shape of the required V-drain, as you will be using the drain formers as a profile. Trim sides neatly.
- At this stage, remove all unwanted material such as rocks, timber and clay, and form the excavation into a well-compacted V-shaped shallow trench to the bottom depth of the drain. This will now act as a mould to receive the concrete that forms the channel of the drain.

**Step 5:** Measure, cut and fix form works

**Step 6:** Position the form work at the site

**Step 7:** Mix the concrete using the given ratio

**Step 8:** Pour the mixed concrete to the form work

**Step 9:** cure the concrete appropriately

**Step 10:** Backfill the sides with appropriate backfill materials

**Step 11:**Compact the ground using the tamper or punner. Adjust the excavation levels of cut and fill to a uniform depth of drain thickness.

**Step 12**: Clean, maintain and store tools, equipments and materials

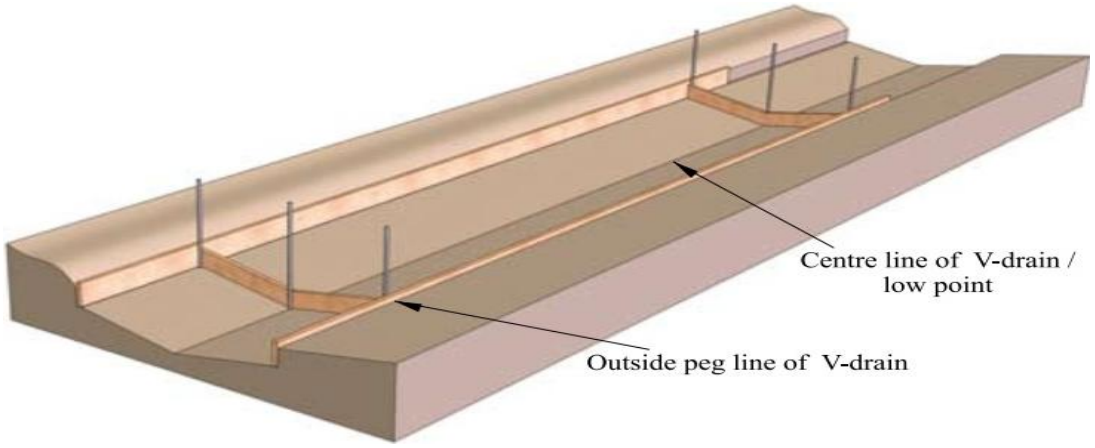



Fig: Setting out of V-drain

| LAP Test | Practical Demonstration |
|---|---|

Name: _____

Date: _____

Time started: _____

Time finished: _____

**Instruction I:** Given necessary templates, tools and materials you are required to perform the following tasks within **18 hours.**

**Task 1:** Place and join heavy concrete drainage pipe

**Task 2:** Join DI pipes with flanged joints

**Task 3:** Join PVC drainage pipe

**Task 4:** Install drainage pipe

**Task 5:** Construct cast in situ V-drain4

**Task 6:** Check installed pipes, fittings and prefabricated components

| Instruction Sheet | Learning Guide- 75: Finalize work |
|---|---|

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

- Checking constructions and installations
- Checking, maintaining and storing equipment, tools and materials
- Backfilling, compacting and restoring work site
- Maintaining workplace records

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

- Check constructions and installations to ensure that specifications are met.
- Check, maintain and store equipment, tools and materials according to manufacturer guidelines and organizational procedures.
- Backfill, compact and restore work site to meet environmental and organizational requirements.
- Maintain workplace records as required.

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1-4” in page 121, 124, 128 and 132 respectively
4. Accomplish the “Self-check 1-4” -” in page 123, 127, 131 and 135 respectively
5. If you accomplish the self-checks, do operation sheet in page 136,137 and 138
6. LAP Test in page 139

| Information Sheet 1 | Checking constructions works and installations |
|---|---|

## 1. 1 Introduction

The common way of controlling quality/checking constructed works is the inspection of finished parts of a product. The quality control engineers' main purpose is to minimize the chance of defects before the project delivery to the owner or his consultancy.

Controlling quality means monitoring if the work practices are going as planned or not, examining the quality of the current construction tasks, and provide reports daily for any unsatisfactory work output. Moreover, an important part of quality management is quality communication, because effective communication plays a vital role in your project. You should provide a common contact list and arrange a scheduled meeting to maintain a healthy working environment.

Finishing work is the concluding stage of construction; in many cases, the overall quality of a building or structure being put into service depends on the quality of its execution. The main types of finishing work include facing, plastering, flooring (and parquetry), painting, wallpapering, and glazing.

## 1.2. Specification of constructed works

Construction specifications, also called specs, are the details for the work that needs to be completed in a construction project. These details include information such as materials, the scope of work, installation process, and quality of work. According to the Dictionary Architecture & Construction a specification is, "a written document describing in detail the scope of work, materials to be used, methods of installation, and quality of workmanship for a parcel of work to be placed under contract; usually utilized in conjunction with working (contract).

Purpose of specification is to highlight the necessary information which cannot be obtained from drawing. Further main purposes of writing specifications are; To show the strength of construction material or construction work.

## 1.3. Quality control of construction works

Quality control is branched from the quality management sector as the responsible party to ensure that products and facilities comply with requirements and established standards. The common way of controlling quality is the inspection of finished parts of a product.

Quality control in construction means making sure that things are done according to the plans, specifications and permit requirements. The quality assurance process checks the quality plan and quality control process to confirm that quality standards are implemented on the project site.

## 1.4. Construction inspection checklist

Checklists are used to aid inspectors in reviewing and inspecting the construction work. The checklists could be generic or prepared for the specific construction project. The checklists will help the inspectors plan their inspections and serve as a reminder in review of work plans and inspection of installed work. The checklists are prepared to indicate types of items to be covered and format and are not intended to be complete for the categories discussed. Depending on the type of construction, checklists for other categories, such as, mechanical, electrical and welding, should be included.

### 1.4.1. Sample inspection checklists in concrete placement

The following characteristics of concrete placement should be reviewed:

- Placing equipment is clean and free of loose concrete, mud, and other debris that could jeopardize the quality of the structure.
- Reinforcing steel and embeds are clean and free of loose rust, grease or other matter that may adversely affect concrete bond.
- Embedded piping has been tested as specified.
- Joints and surfaces to receive concrete are free of deleterious materials.
- Forms are clean and free of foreign material.
- Provisions for hot or cold weather concrete protection are provided.
- Concrete is placed in a manner to prevent segregation.
- Placement of concrete is made in lift thickness as specified and within time restrictions between lifts for high lift placements.
- Concrete is properly vibrated.
- Placement is made to avoid excessive drying of fresh concrete before next lift is placed.
- Concrete is sampled and tested at specified frequency for strength, slump, temperature and unit weight.
- Concrete is brought to final grade and finished as specified.

| Self-Check 1 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. Who is responsible to check the quality of construction works and installations?
   A. Quality control engineer
   B. Surveyor
   C. Irrigation engineer
   D. Site foreman

2. _____is the responsible party to ensure that products and facilities comply with requirements and established standards.
   A. Quality control
   B. quality assurance
   C. Quality management
   D. Quality inspection

3. A tool used to check the quality of constructed or installed works is:
   A. Inspection checklists
   B. Drawings
   C. Specifications
   D. All

4. All are tested concerning placement of concrete **except:**
   A. Embedded piping has been tested as specified.
   B. Forms are clean and free of foreign material.
   C. Concrete is properly vibrated.
   D. Concrete is brought to final grade and finished as specified.
   E. None

**Note: Satisfactory rating – 8 and above points  Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

1. _____  3. _____
2. _____  4. _____

| Information Sheet 2 | Checking, maintaining and storing equipment, tools and materials |
|---|---|

## 2.1. Selection of tools and equipment

All tools and equipment necessary and required for proper maintenance activity shall be on the project in first class working condition and shall have been approved by the authority before maintenance is permitted to begin.

Selection of materials, pipe, and equipment should be consistent with system operating and reliability considerations, energy conservation, and the expected useful life of the project. To avoid delivery delays, standard equipment that can be supplied by several manufacturers should be specified. Delivery schedules must be investigated prior to purchase commitments for mechanical equipment. As a general rule, patented equipment, furnished by a single manufacturer, should be placed in competition with functionally similar equipment available from other suppliers. Equipment of an experimental nature or equipment unproved by actual, full scale use should not be used.

## 2.2. Checking and maintaining equipments, tools and materials

Tools and equipment used at drainage system construction undergo rigorous handling. These tools are exposed to large amounts of dirt and abuse. Proper maintenance of tools and equipment is critical to preserving them for future maintenance jobs. Failure to maintain the tools properly results in unnecessary expense.

From initial foundation development, to the final construction of the exterior trim, these tools are exposed to large amounts of dirt and abuse. Proper maintenance of construction tools and equipment is critical to preserving them for future construction jobs.

## 2.3. Instructions for checking and maintaining tools and equipments

- Use the right tool for the right job.
- Clean the tools and equipment after each day's work.
- Inspect and repair all equipment and tools at the completion of each job. Make all repairs to the equipment that is necessary for future work.

- Clean the maintenance tools and equipment after each day's work. While a thorough cleaning is not required each day, a general wipe-down and removal of the heaviest construction dirt is key to extending the life of the tools.
- Lubricate some tools which have movable part before each day's use.
- Inspect and repair all maintenance equipment and tools at the completion of each job. Make all repairs to the equipment that is necessary for future work. This will prevent time being wasted repairing faulty equipment at future jobs.

### 2.4. Storing equipments, tools and materials

Depending on your needs, a simple toolbox will suffice. Tools should always be organized and sorted and put back in their designated area after each use. This way, they're always there when you need them. Ideally, tools won't touch each other while they're stored.

- Keep all of your instruments in a dry area free of moisture, dust and direct sunlight.
- Tools should never be left on the ground or a working area as they can pose a serious hazard. Try to group your tools together in a way that makes sense to you.
- To ensure that tools and equipment remain in good condition and last for a long time, store them properly.
- Properly stored tools and equipment will be easy to find when needed and are less likely to be lost.

Figure 45: Storing tools

### 2.4.1. Benefits of storing tools and materials

- Tools and parts are kept in good condition and are easy to find.
- Costs are reduced.
- Productivity is increased because time is not lost looking for tools, parts and equipment.
- Workshop staffs develop a sense of responsibility and pride in their work.

### 2.4.2. Instructions for storing tools and equipments

- Delegate a portion of your shape, shed or basement closet as a place to store tools. Clean out the junk and clutter and make a space only for tools. Figure out how much space is needed for the amount of tools you have. Sweep away cobwebs, dirt and other foreign matter. Get a shelving unit and store chemicals, liquids and paint substances out of the reach of children and pets.
- Find the parts. Locate cords, bits, nails and screws and organize them. Allocate plastic bins to store smaller household tools. If you have a large tool collection, organize by type for easy location. Keep the parts for each specific tool close by.
- Clean out dirt and debris from tools. Oil power tools to lubricate moving parts. Repair loose handles and clean out oil or other fluids used to power the tool. Sharpen blades and replace worn out parts.
- Set up racks. Mount commercially available racks along the wall of your shop or storage area to hang tools, cords and other equipment. Screw racks into the wall with screws recommended by the manufacturer and a power drill. Wind long cords in a loop and hang from rack. Place tools on racks by the handle. Draw the outline of the tool with a permanent marker to identify its place, or use labels to mark the location.
- Create a library. For tools and appliances that have various functions, designate a library area or bin within the storage space for user manuals and warranty sheets. Store the booklets alphabetically and in a dry area. Type up a sheet listing all of the books to create simple table of contents.
- Store tools

| Self-Check 2 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. Which of the following activities come first in storing tools and equipments?
   A. Create a library.
   B. Set up racks.
   C. Clean out dirt and debris from tools.
   D. Delegate a portion of your shape, shed or basement closet as a place to store tools.
2. All are the benefits of storing tools and materials, **EXCEPT:**
   A. Tools and parts are kept in good condition and are easy to find.
   B. Costs are increased.
   C. Productivity is increased because time is not lost looking for tools, parts and equipment.
   D. Workshop staffs develop a sense of responsibility and pride in their work.
3. Selection of materials, pipe, and equipment should be consistent with:
   A. System operating and reliability considerations
   B. Energy conservation
   C. The expected useful life of the project
   D. All
4. One of the following tool is **NOT** used for construction of drainage structures:
   A. Excavator C. Spade
   B. Hoe D. Shovel
5. Why we maintain construction tools and equipments?
   A. To elongate the life of the tools and equipments
   B. To make the tools and equipments functional
   C. For safety purposes D. All

**Note: Satisfactory rating –10 and above points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

**Answer Sheet**

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

| Information Sheet 3 | Backfilling, compacting and restoring Work site |
|---|---|

## 3.1. Backfilling

On completion of backfill operations and other work, the entire site shall be cleared of all debris, and ground surface shall be finished to a neat workman like appearance. All damages done to the environment during the course of the drainage system maintenance should be restored as its original position.

Figure 46**:** Backfilling

## 3.2. Compacting

One of the ways to control water seepage for irrigation canals is to reduce soil permeability; this can be made by compacting the soil. Soil compaction is carried out by means of special compactors, rammers and vibration machines. Compaction allows reducing seepage by 70-75%, but it can be implemented only on cohesive soils. Seepage losses are also reduced considerably with changing seepage characteristics of canal bed soil by soil compaction and mud fill. Canal bed soil can be compacted by different methods: rolling; impact, and shooting.

- Rolling is carried out by special compactors: tamping/sheeps foot; sectional/harrow; and smooth-wheeled rollers.

- Use of tamping rollers gives the highest efficiency; these machines allow compacting soil down to a layer of 60-70 cm.
- Impact compaction is carried out by impact compactors (rammers) or excavator plates; in this case, the maximal layer of compacted soil comes to 1 m.
- Effect of the compaction lasts for several years, after which the compaction needs to be renovated. When compacting the soil, its optimum water content should be provided.
- Mud filling implies washing out of soil silt particles that come along with irrigation water to the upper layer of the canal bed soil.

Figure 47: Compacting

### 3.3. Restoring Working Site

At the completion of any construction and installation of drainage system work site should be restored and environmental management should be practiced. All things which disturb the environment as the result of drainage system maintenance should be cleared off site.

Restoration of work site is very important after because the work may have a certain effect on the environment directly or indirectly so after the dams or the water storage reservoirs been maintained be careful to look for any damage to the environment and restore it as it was before.

### 3.3.1 Re-vegetation processes

Revegetation is the process of replanting and rebuilding the soil of disturbed land. This may be a natural process produced by plant colonization and succession, manmade re wilding projects, accelerated process designed to repair damage to a landscape due to wildfire, mining, flood, or other cause.

- Re-vegetation helps prevent soil erosion, enhances the ability of the soil to absorb more water in significant rain events, and in conjunction reduces turbidity dramatically in adjoining bodies of water. Re-vegetation also aids protection of engineered grades and other earthworks.
- Originally the process was simply one of applying seed and fertilizer to disturbed lands, usually grasses or clover.
- The fibrous root network of grasses is useful for short term erosion control, particularly on sloping ground.
- Establishing long term plant communities requires forethought as to appropriate species for the climate, size of stock required, and impact of replanted vegetation on local fauna.
- The motivations behind re-vegetation is usually erosion prevention.

Figure 48: Revegetation process

| Self-Check 3 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. _____is the process of replanting and rebuilding the soil of disturbed land.
   A. Revegetation
   B. Backfilling
   C. Compacting

Irrigating2. What should be done at the completion of any construction and installation of drainage system works?
   A. Site should be restored
   B. Environmental management should be practiced.
   C. Site should be backfilled
   D. All

3. Canal bed soil can be compacted by:
   A. Rolling
   B. Impact compacting
   C. Shooting
   D. None

4. Equipment used for compacting backfilled soil is:
   A. Compactor
   B. Roller
   C. Tamping rollers
   D. Tamping/sheeps foot
   E. All

**Note: Satisfactory rating – 8 and above points  Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

**Answer Sheet**

1. ----------
2. ---------
3. ---------
4. ---------

| Information Sheet 4 | Maintaining workplace records |
|---|---|

## 4.1. Definitions of a Record

- Document that memorializes and provides objective evidence of activities performed, events occurred, results achieved, or statements made. Records are created/ received by an organization in routine transaction of its business or in pursuance of its legal obligations. A record may consist of two or more documents.
- All documented information, regardless of its characteristics, media, physical form, and the manner it is recorded or stored. Records include accounts, agreements, books, drawings, letters, magnetic/optical disks, memos, micrographics, etc. Generally speaking, records function as evidence of activities, whereas documents function as evidence of intentions.

## 4.2. Purposes keeping of records

Reasons for record keeping include in construction:

- Legal requirements
- Contractual requirements
- To control work
- To proliferator future work

Good records will help you do the following:

- Monitor the progress of your business
- Prepare your financial statements
- Identify sources of your income
- Keep track of your deductible expenses
- Keep track of your basis in property
- Prepare your tax returns
- Support items reported on your tax returns

The extent of the record keeping required will depend on the type of project. A balance must be maintained between keeping adequate records in preparation for a dispute arising, and attempting to record everything, which is can be difficult, time consuming and costly.

Some record keeping requirements, such as recording the minutes of meetings for example, may be carried out at the discretion of the individual organization, with different

frequency rates, levels of detail, and time for which records must be kept, appropriate for different situations. Other records may be a legal or contractual requirement, following prescribed rules.

Records are kept in the workplace to document what was done and why. If someone wants to sue the business for something, then the business has records that show what was done, by whom, and when. Workplace records also document when maintenance or repairs were done, to help people remember when they may be needed next. And all of these records can help when the person who did the work moves to another town and someone else has to figure out what needs doing and how it used to be done.

Construction and installation records are written notes that provide documentation about the upkeep of a certain piece of work. These records are particularly useful in maintenance management because they help businesses ensure their work is kept in good condition. In addition, they provide businesses with a way to manage and track repair and preventative upkeep expenses.

### 4.3. Maintaining workplace records

A standard form called the Daily Work Sheet has been prepared for recording this information. At the end of each day you should fill out the Daily Work Sheet and file it in a folder or other safe place.

At the end of each week, you need to prepare a weekly report outlining the work you have done. This report is known as the Take-off Sheet and is a summary of the information contained in the Daily Work Sheets.

It is a need to show the Take-off Sheets to the Contract Supervisor before you can receive any payment. Finally, when you have completed the installation and construction works, you will need to fill out a Completion Report. This is a summary of the work you have done throughout the construction process, as recorded in the Daily Work Sheets and the Take-off Sheets.

During construction, the following types of document ought to be maintained:

- Accidents
- Amounts of money paid
- Change Orders
- Cost Accounting Records
- Daily reports or diaries
- Deliveries to site
- Drawings
- Equipment Records
- Inspection Reports
- Labor used
- Materials used
- Meeting Minutes
- Observations
- Photographs and Video recordings
- Problems encountered and their solutions
- Project Correspondence Files
- Schedules
- Technical details of the work done (ground formation, depth of excavation etc)
- The Estimate/Bid File


Figure 49: Records

| Self-Check 4 | Written Test |
|---|---|

**Direction I:** Multiple choice item

**Instruction:** Choose the best answer for the following questions and write the letter of your answer on the answer.**(4 points each)**

1. Reasons for record keeping include in construction include all **but not:**
   A. To increase cost
   B. Contractual requirements
   C. To control work
   D. To provide data for future work
2. During construction, types of document ought to be maintained are:
   A. Cost accounting records
   B. Drawings
   C. Meeting minutes
   D. Schedules
   E. All
3. Select the incorrect statement.
   A. A record is a document that memorializes and provides objective evidence of activities performed, events occurred, results achieved, or statements made.
   B. Records are created/received by an organization in routine transaction of its business or in pursuance of its legal obligations.
   C. A record may consist of two or more documents.
   D. Every documents are records

**Note: Satisfactory rating – 6 and above points Unsatisfactory - below 6 points**

You can ask you teacher for the copy of the correct answers.

**Answer Sheet**

1. ----------
2. ---------
3. ---------

| Operation Sheet -1 | Techniques of checking constructions and installations |
|---|---|

**Procedures:**

**Step 1:** Prepare checklist for inspection

**Step 2:** Wear appropriate personal protective equipments and prepare appropriate measuring and testing tools and equipments

**Step 3:** Conduct visual inspection and take measurements

**Step 4:** Take corrective action to the defects

**Step 5:** Report the result

**Step 6:** Document your findings

| Operation Sheet -2 | Procedure of maintaining and storing tools and equipments |
|---|---|

**Activity 1: Maintaining tools and equipments**

**Step 1:** Select and wear appropriate PPE

**Step 2:** Select appropriate tools and equipment

**Step 3:** Clean your tools. Cleaning the tools regularly is essential to their proper functioning

**Step 4:** Protect electrical cords. Airlines and electrical cords are prone to heavy damage since they are generally in the way of construction vehicles, and foot traffic

**Step 5:** Lubricate tools

**Step 6:** Inspect tools regularly

**Step 7:** Store tools with care

**Activity 2: Storing tools and equipments**

**Step 1:** identify and handle records in accordance with enterprise procedures.

**Step 1:** track location of records.

**Step 1:** apply security controls to ensure the integrity of records is not compromised.

**Step 1:** maintain workplace records systems.

**Step 1:** identify problems and take appropriate action.

| Operation Sheet -3 | Procedures of backfilling, compacting and restoring work site |
|---|---|

**Activity 1: Backfilling prefabricated open concrete drain**

**Steps:**

**Step 1.** Select and wear appropriate PPE

**Step 2.** Select appropriate tools and equipment fitting for the purpose

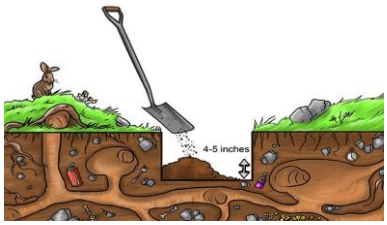
**Step 3.** Select the types of material you will use for the back-fill e material and make sure that the fill material is free from organic materials

**Step 5.** Back fill the entire section surrounding the structure

**Note:** Be sure that the foundation cures for at least five to seven days.

**Activity 2: Compacting construction work site using tamper**

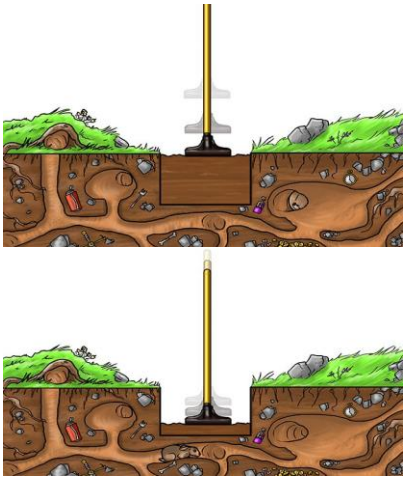
**Steps**




**Step 1 - Refill trench**

- Begin by moving the soil you removed from your trench back into it. If you do not have the soil you removed, use a soil that is native to your area.

- Use a shovel to refill your trench and spread it in an even layer until it's about 10-12cm (4-5")high.



**Step 2 - Use trench tamper**

- Use your trench tamper to compact the soil in the trench. Use a firm pressure to pack down the soil, but be more careful when directly tamping over pipes or cables so as not to damage them.
- This is why a manual trench tamper is preferable over a mechanical one when backfilling a trench.

**Step 3 - Repeat the above steps**

- Repeat the process, adding more soil and compacting until the trench is completely filled to ground level.
- A mechanical tamper can be useful for larger trenching projects to finish off the leveling, once

the trench has been filled.

**Step 4: Clean, check, maintain tools**

| **Operation Sheet -4** | **Techniques of maintaining work place records** |
|---|---|

**Activity 1: Procedures of creating a simple record keeping system in a work place**

**Step 1:** Select and appropriate tools and equipments

**Step 2:** Capture the information.

**Step 3:** Check to make sure the information is complete and correct.

**Step 4:** Record the information to save it.

**Step 5:** Consolidate and review the information.

**Step 6:** Act based on what you know.

**Activity 2: Procedures of managing and maintaining construction records in a work place**

**Step 1:** Identify the functions and activities for which each program is responsible

**Step 2:** Determine what records are needed to document those activities and functions

**Step 3:** Create sufficient records to document those activities and functions.

**Step 4:** Maintain those records in a way that allows all persons who need access to find and retrieve what they need.

**Step 5:** Remove or destroy records only with authorization; don't retain records authorized for destruction.

**Step 6:** Keep official records separate from non-record materials.

**Step 7:** Make someone responsible for the records program.

**Step 8:** Transfer records identified as permanent to the National Archives as required.

**Step 9:** Protect vital records appropriate to their value.

**Step 10:** Protect records that contain security classified, confidential business, or other types of sensitive information with appropriate safeguards.

**Step 11:** Do all of this in a manner that is as cost effective as possible.

| LAP Test -1 | Practical Demonstration |
|---|---|

Name: _____ Date: _____

Time started: _____ Time finished: _____

**Instruction I:** Given necessary templates, tools and materials you are required to perform the following tasks within 4 ***hours.***

**Task 1:** Check constructions and installations

**Task 2:** Maintain and store tools and equipments

**Task 3:** Backfill, compact and restore work site

**Task 4:** Maintain work place records

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