Small Scale Irrigation Development

Level I

Model TTLM

Learning Guide#06

Unit of competency: Support Basic Irrigation Structure Works

Module Title: Supporting Basic Irrigation Structure Works

LG Code: AGR SSI1 M06 LO1-LO3

TTLM Code: AGR SSI1 TTLM 1218V2

Nominal Duration: 25 Hours

Instruction sheet	Learning guide #06

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

- ✓ Identify and prepare material for irrigation structure works
- ✓ Support Surface irrigation structures
- ✓ Maintain, clean up and store worksite and equipment

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:

Identify and prepare material for irrigation structure works

- Select appropriate tools and equipment for male and female.
- Select and check equipment and tools.
- Techniques for load and unload materials by encouraging females and males.
- Select and check Suitable Personal Protective Equipment for male and female**.**
- Provide Irrigation structure works.

Support Surface irrigation structures

- Undertake identification of diversion structures works.
- Identify Conveyance, distribution and management (control) structures**.**
- Undertake identification of field distribution systems.

Maintain, clean up and store worksite and equipment

- Check, maintain and store Equipment, tools and materials.
- Restore work site and environmental improvements or controls to complete work.

Learning Activities

1. Read the specific objectives of this Learning Guide.

2. Read the information written in the "Information Sheets"

3. Accomplish the "Self-checks"

4. If you earned a **satisfactory** evaluation proceed to "the next information sheet However, if your rating is **unsatisfactory**, see your teacher for further instructions or go back to Learning Activity

5. Submit your accomplished Self-check. This will form part of your training portfolio (if necessary)

6. Read the "Operation Sheet" and try to understand the procedures discussed.

7. Request access to the materials required for that particular practical session. Practice the steps or procedures as illustrated in your learning guide. Go to your teacher if you need clarification or you want answers to your questions or you need assistance in understanding a particular step or procedure

8. Do the "LAP test" (if you are ready) and show your output to your teacher. Your teacher will evaluate your output either satisfactory or unsatisfactory. If **unsatisfactory**, your teacher shall advice you on additional work. But if **satisfactory** you can proceed to the next Learning guide**.**

Information Sheet-1	Identify And Prepare Materials For Irrigation Structure Work

1.1 Selecting appropriate tools and equipment

May include but not limited to:

1. Water mains, Services, Valves, Meters
2. Pipes including:
    - Polyvinyl chloride (PVC),
    - Polyethylene,
    - Cast iron
    - Steel
3. Fittings including:
    - Jointing systems for pipe types, e.g. J-bolt, Bolted flanges, T-connectors
4. Others construction materials (cement, sand, aggregate, reinforcement bar, timber, eucalyptus poles, nails, black wire, bitumen, construction joints, water stops…)

1.2 Selecting and checking equipment and tools

It is essential to check irrigation structure work, tools and equipments for damage or malfunction and shall report damage or malfunction to the authorized representative in writing. If failed to maintain the broken or malfunctioning irrigation structure components within few days of the breakage or malfunction, there will be a loss due to damages resulting from the broken irrigation structure component.

Hence, it is necessary to check the system, materials and equipments. In addition, maintenance of the system has to be carried out regularly.

1.3 Techniques for loading and unloading materials by encouraging females and males

The techniques used when loading and unloading materials should demonstrate correct manual handling and minimize damage to the load and the vehicle while transporting irrigation equipments.

The most common techniques of loading and unloading materials use the following guidelines:

- Develop an operations plan that describes procedures for loading and/or unloading.
- Conduct loading and unloading in dry weather if possible.
- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- Consider placing a seal or door skirt between delivery vehicles and building to prevent exposure to rain.
- Design loading/unloading area to prevent storm water run-on, which would include grading or berming the area, and position roof downspouts so they direct storm water away from the loading/unloading areas.
- Have employees load and unload all materials and equipment in covered areas such as building overhangs at loading docks if feasible.
- Load/unload only at designated loading areas.
- Pave loading areas with asphalt instead of concrete.
- Avoid placing storm drains in the area.
- Grade and/or berm the loading/unloading area to a drain that is connected to a dead end.

1.4 Selecting and checking Suitable Personal Protective Equipment for male and female

Personal protective equipment (PPE) is used to protect an individual from hazards associated with their work tasks or environment. Specific types of personal protective equipment include protective clothing, eyewear, ear muff, mouth clamp, gloves, hard hat and safety shoe.

Some of the commonly used PPE include the following:

Eye protection

It is required to use eye protection equipments like goggle, eye shield, to protect our eye from dusts, chemicals, etc by all workers engaged in hazardous activities or are exposed to identify eye hazards.

Hand Protection

It is required to use appropriate hand protection when hands are exposed to hazards, such as:

• Skin absorption from harmful substances;

• Cuts, lacerations or abrasions;

• Chemical exposure;

• Thermal burns and/or temperature extremes
• Potentially infectious material.

Body Protection

- Chemical Resistant Clothing: Protective apparel designed to provide a barrier against a variety of chemical hazards. Chemical resistive clothing may be required for tasks where chemical splashing is anticipated or large volume transfers are conducted. Prior to selection of chemical resistant clothing, EH&S should be consulted;
- Laboratory Apparel and Scrub Suits: A wide variety of styles and materials are available to protect employees during laboratory operations. The selected type of lab coat or other apparel is designed to protect the wearer against accidental splashes or day-to-day handling of chemicals;
- Overalls

Body protection(PPE)		Purpose
Ear muff		▪ It is required to protect the ear from dangerous sound and dust.
Overalls		▪ It retains heat radiated from the body and keeps the wearer warm in the cold weather
Mouth guard		▪ It is required to protect the mouth from the entering of dust and different chemicals.
Hard hat		▪ It is required to protect the head from sun, accident and dust.
Safety shoe		▪ It is required to protect the foot from different hazards.

1.5 Providing Irrigation structure works

The aim of irrigation facilities is to divert water from a source, convey it to appropriate locations in the system and distribute it within the field so that water reaches the roots of the crops in an optimal manner to ensure improvement of agricultural production.

Irrigation networks are man-made facilities put in place to achieve the above mentioned objective. Irrigation networks also include drainage networks which are responsible for the removal of excess water from the field and road networks which are required for access to the various parts of the irrigation system. Drainage is usually a complementary component of irrigation and irrigation schemes without a drainage facility is seldom successful particularly in poorly drained heavy soils.

Self-Check 1	Written Test

Name: _____ **Date:** _____

Directions: **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.**

1. Write some of the tools and equipments used in irrigation structure work? (5 pts)
2. List irrigation structure PPEs? (5pts)
3. Discuss the techniques used to load and unload irrigation structure equipment? (5pts)

Note: **Satisfactory rating - 15 points and above** **Unsatisfactory - below 15 points**

You can ask your teacher for the copy of the correct answer

Operation sheet-1	Identify and prepare materials for irrigation structure work

Objectives: Identify and prepare materials, tools and equipment using for irrigation structure work.

Water mains, Services, Valves, Meters

Pipes including:

- Polyvinyl chloride (PVC),
- Polyethylene,
- Cast iron
- Steel

Fittings including:

- Jointing systems for pipe types, e.g. J-bolt, Bolted flanges

Others construction materials (cement, sand, aggregate, reinforcement bar, timber, eucalyptus poles, nails, black wire, bitumen, construction joints, water stops…)

Lap Test	Practical Demonstration

Name: _____ Date: _____

Time started:_____ Time finished:_____

Instructions:

You are required to perform the following activity:

Task1: Identify tools and equipments used in irrigation structure work.

Task2: Identify techniques used to load and unload irrigation structure materials.

Task: Selecting and checking suitable personal protective equipment.

Information Sheet -2	Support Surface Irrigation Structures

2.1 Undertaking identification of diversion structures works.

Diversion head works are structures constructed across a river (head of a canal) to facilitate a regulated and continuous diversion of water into the off-taking canal. Whenever the source of water for irrigation is a river, it is hardly possible to divert a regulated and continuous flow into

the main canal without a headwork. This is due to the fact that the flow in the river is never uniform and varies from season to season.

Thus, there is a need to regulate the flow into the canal system in order to ensure a continuous diversion of water. There is practically no storage provided by a diversion structure. The purpose is to raise and keep the water level more or less constant (reduce the fluctuation of water levels) at the head of the canal.

Types of diversion structures

Diversion head works can be classified as weirs and barrages based on the structures provided at the crest.

A) Weir*:* A weir is a barrier (structure) constructed across a river to raise the water level in the river behind it so as to enable regulated diversion of water. A weir has a raised crest behind which a small ponding of water will take place. Weirs can be constructed with or without shutters on the crest of the weir.
There are the following common types of weirs:

- Masonry weirs with vertical or slightly sloping u/s and d/s face
- Rock fill weirs
- Concrete weirs with sloping glacis
- Ogee crest weirs

Masonry vertical drop weirs

These weirs have a horizontal floor constructed of masonry and a crest wall with vertical or slightly sloping downstream face. The height of the crest depends on the actual site conditions and head required behind the weir. Sheet pipe walls are driven at the upstream and downstream of the floor. These weirs are suitable whenever the drop in water levels is small.

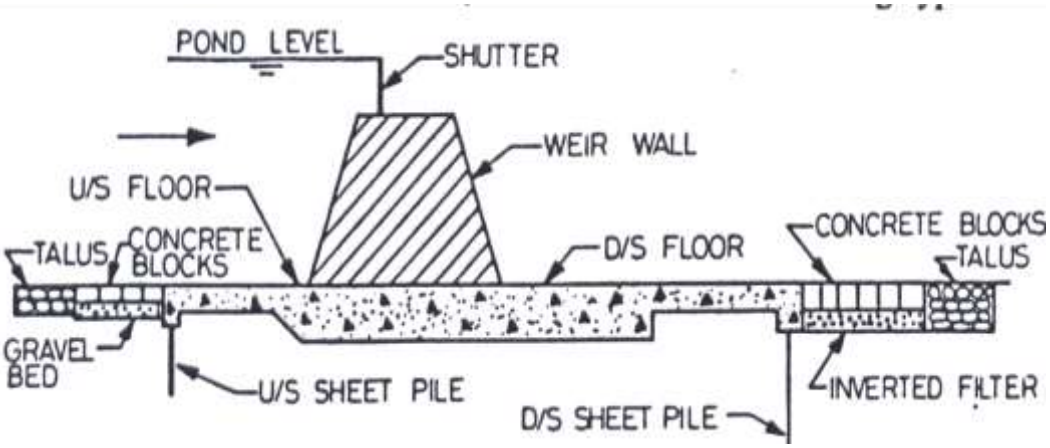


Fig: Vertical drop weir

Rock fills weirs

These weirs are constructed of rocks with extremely sloping downstream face. Such weirs are suitable whenever there is excess stone available for construction.

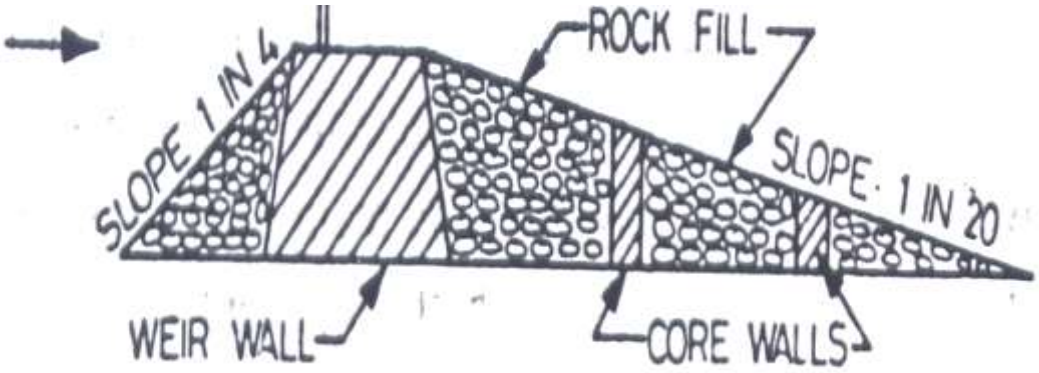


Fig: Rock fill weir

Concrete sloping weir

The crest of this weir has sloping glacis both on the upstream and downstream. Cutoff sheets are provided at the upstream, intermediate and downstream of the floor to the depth equal to the scour depth. Hydraulic jump is formed on the downstream slope for energy dissipation. These weirs are suitable whenever the drop in water level is large.

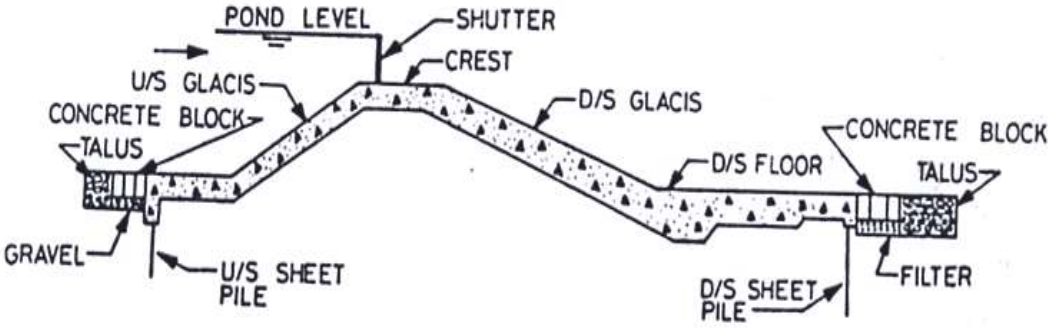


Fig: Concrete glacis weir

Ogee crest weirs

Ogee crest weir is a weir whose crest wall is rounded to increase the discharge coefficient. It consists of a concrete weir wall with vertical upstream face and rounded top and downstream. It is designed as gravity section similar to vertical drop weir.

Fig: Ogee crest weir

Gravity and non-gravity weirs

There is uplift force on the floor of the weir from water seeping under the foundation of the weir. Whenever weir is designed so that the weight of the weir is sufficient to balance the uplift pressure caused by seeping water, it is called gravity weir. On the other hand, when the concrete slab (floor) is designed continuously with the weir body to keep the structure safe against uplift, it is called as non-gravity weir.

B) Barrage*:* A barrage is also an obstruction constructed across a river for raising the water level and regulates the diversion of water to canals. However, the crest wall of a barrage is low and pounding of water takes place by gates. The gates are fitted on the top of the crest wall and can be closed and opened as required based on the flow in the river.

Advantages and disadvantages of weirs and barrages

The main advantage of weirs over barrages is that its initial cost is usually low. The disadvantages include: High afflux (increase in water level) during floods, siltation or sedimentation problem due to relatively high crest and effective control during floods is not possible. The advantage of barrages is that effective control of flow is possible, afflux and thus flooding is small during floods and Silt inflow into the off-taking canal can be controlled. It has a disadvantage that its initial cost is high.

Fig: A barrage across a river

Components and Layout of Diversion Headwork's

Diversion head works generally consist of the following components:

- Weir wall/Barrage
- Under sluices
- Divide wall
- Canal head regulator
- Silt excluder
- Guide banks
- Wing walls (Marginal bunds)

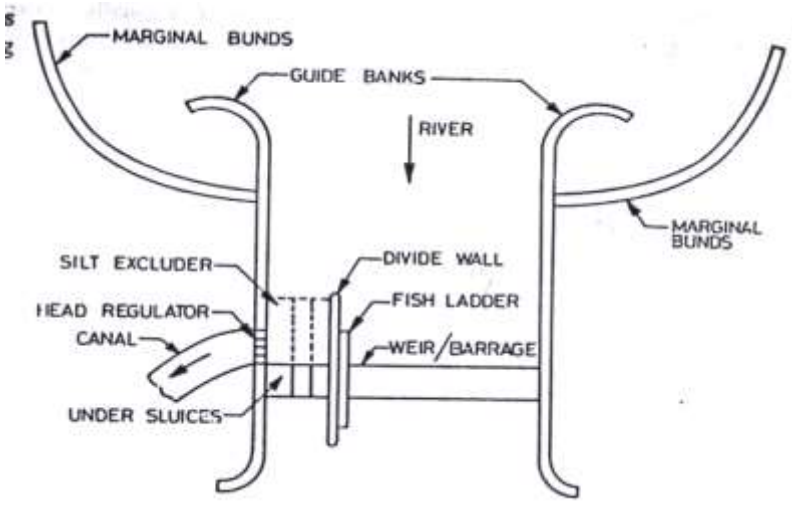


Fig: Typical layout of diversion headwork

Under sluices

The main weir body is constructed in the middle portion of the diversion head works. Adjacent to the canal head regulators, under sluice section is provided. When canal intake is only in one direction, the under sluice is provided on that side only. The profile of under sluice section is similar to a sloping weir section, but its crest is at lower level than that of the crest of the weir (usually at river bed.)

Functions of under sluice

- ✓ Maintains well defined river channel near the canal head regulator;
- ✓ To scour (remove) away the silt deposited in front of the head regulator;
- ✓ To pass small floods of 10% to 20% of design flood during rainy season to the downstream;
- ✓ To quickly lower the u/s high flood level because the discharge intensity over the sluice portion is greater than that in the weir portion;
- ✓ To minimize the effect of Main River water current on the head regulator.

Divide wall

This is a wall placed parallel to the flow direction in the river to separate the weir section from the under sluice section of the headwork. On the upstream, it extends to little upstream of the head regulator and on the downstream it usually extends to the end of loose protection.

Functions of divide wall

- ✓ Separates the floor of the under sluices and weir (floor of under sluice at a lower level);

- ✓ It helps to provide a clear pocket near the canal head regulator where silt can accumulate;
- ✓ It isolates the silt accumulation pocket to ensure scouring;
- ✓ Helps to avoid cross currents which might cause deep scour of the river bed;
- ✓ Helps to concentrate the scour action of the under sluices on only the silt accumulation pocket;
- ✓ Helps to minimize the effect of the river current on the head regulator.

Canal head regulator

A head regulator is a structure provided at the head of the off-taking canal to regulate and control the inflow into the canal. It is usually provided at one or both banks of the river with its axis making an angle 60^0 to 90^0 to the weir axis. It will be sized in such a way that it can pass the required design discharge of the main canal when the water level on the upstream is at the pond level.

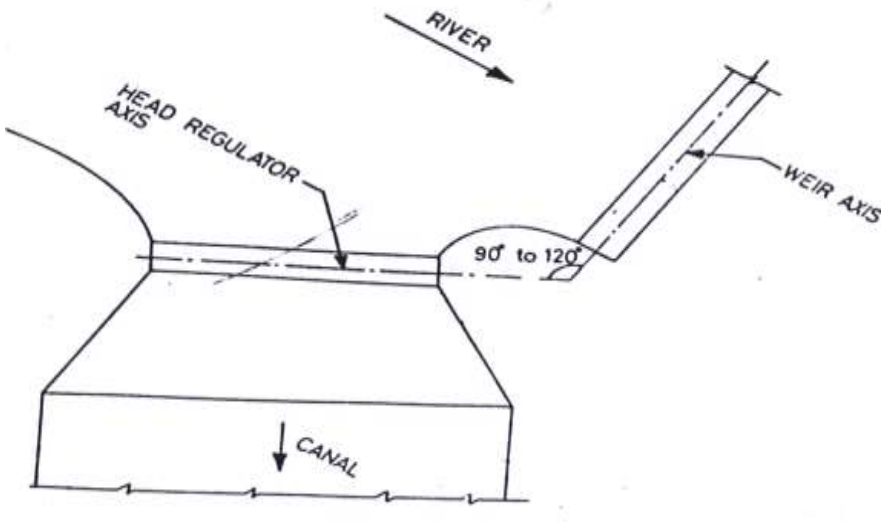


Fig: Alignment of head regulator

Functions of head regulator

- ✓ It regulates the supply of water into the off-taking canal;
- ✓ Controls silt entrance into the canal;
- ✓ Prevents flood water from entering the canal;
- ✓ Used to stop the water supply into the canal for maintenance and when highly silt-laden water flows in the river.

Silt excluder

Silt excluder is provided in the under sluices portion of the headwork to pass highly silt-laden water through the under sluices. It enables only relatively clear water to enter the canal. It is aligned at right angle to the axis of the canal. They are small lined tunnels through which the bottom silt-laden water will be passed down to the scouring sluices.

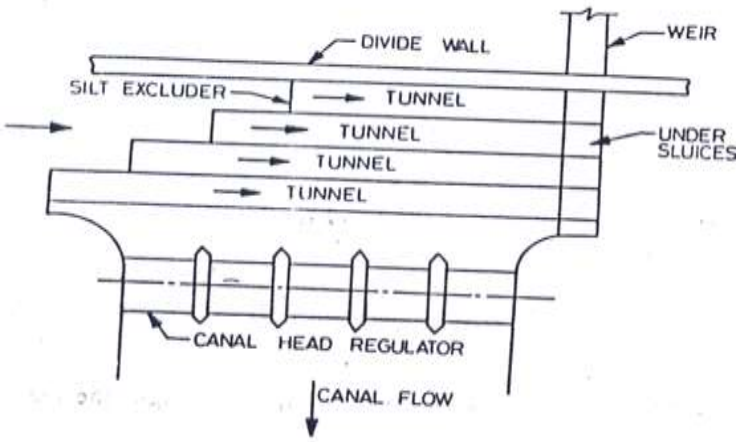


Fig: Alignment of silt excluder

Guide banks

Guide banks are rigid structures provided on either side of the headwork to guide the river flow directly to the headwork and to avoid scouring and meandering of the river near the work. Guide banks are particularly important when the headwork is located near alluvial banks of the river where bank scouring and meandering are evident.

2.2 Identifying Conveyance, distribution and management (control) structures

Conveyance structures are structures used to divert irrigation water (simply water) from source to the irrigation field (command area) through canals.

Conveyance structures includes: Canal, pipes, siphons, etc.
Canals: are structures used to carry water through it.

Based on the alignment, irrigation canals can be classified into three:

- **Contour canal:** is a canal aligned nearly parallel to the contour lines. However, the canal should have sufficient slope along the flow in order to produce the required velocity of flow.

Such a canal irrigates only on one side of the canal (lower side). Such canals would cross maximum number on natural drainages.

- **Watershed canal (ridge canal):** is a canal aligned along the watershed of the area to be irrigated. Watershed in this case is the line dividing the total area into two small sub-catchments within the area. Irrigation from a watershed canal is possible by gravity on both sides. Cross drainage works will be avoided by this alignment as no natural drainage can cross the natural watershed.
- **Side slope canal:** is a canal running roughly at right angles to the contour lines. Such canals are aligned parallel to natural drainages and will not cross them.

Based on the sizes and importance, irrigation canals can be classified as:

Main (Primary canal): is a canal at the head of which water inters to it for irrigation. As a rule no direct irrigation takes place from main canals. Generally whenever possible, main canals are aligned as contour canals till it reaches a watershed.

Branch canal: This is a canal which branches from the main. Direct irrigation does not take place from these canals as well.

Secondary canals: These are canals branching either from the primary canals or branch canals. Secondary canals convey water for the secondary units in the command area. These canals are generally aligned as side slope canal (across contours). Direct irrigation seldom occurs from these canals.

Tertiary canals: These are canals within the tertiary units. At the head of such canals is the tertiary off-take structure. Water can directly be taken from these canals for irrigation.

Field canals: These are small canals located at the head of each farm plot or field. Field canals supply directly the irrigated fields (furrows, basins and borders).

Siphon is a tube that is used to move liquids between locations without any mechanical pumping. This device uses pressure to keep the liquid flowing without exerting external force. Siphons operate using atmospheric pressure**.**

Pipes are the most widely used conveyance device
Pipes for irrigation structure works are made from the following materials:

- Cast iron,
- Steel,
- Pre-stressed Concrete,
- Asbestos Cement

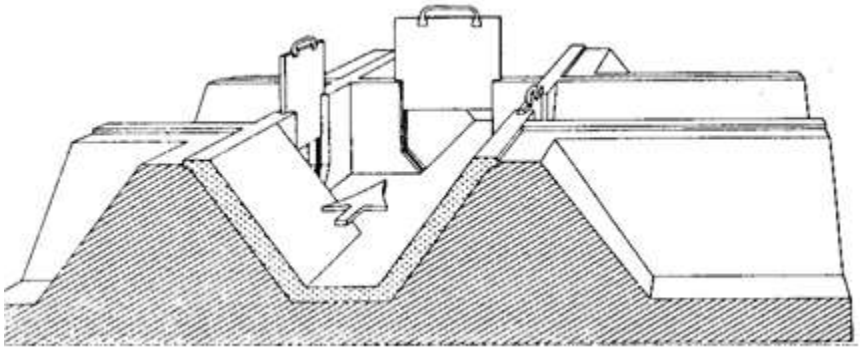
- Reinforced Concrete, and
- Polyethylene, low or medium density.
- Other types (e.g. Aluminium and copper materials).

Distribution structures are structures used to distribute water though canal and in the command area.

These distribution structures include:

Division boxes:- Division boxes are used to divide or direct the flow of water between two or more canals or ditches.

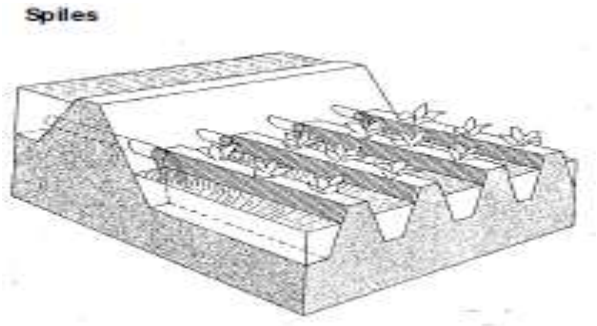
Water enters the box through an opening on one side and flows out through openings on the other sides. These openings are equipped with gates.



Turnouts:- Turnouts are constructed in the bank of a canal. They divert part of the water from the canal to a smaller one. Turnouts can be concrete structures or pipe structures.

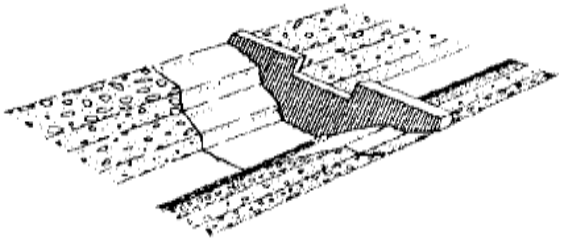
Fig: Turnouts

Spile. It is a small short pipe buried in the canal embankment for letting water from field channel to the field. Spiles are made of bamboo, concrete or baked clay pipes. Good water intake control can be obtained either by adjusting the water level in the field channel or by closing individual spiles with a plug or lid. However, spiles can become blocked with mid or plant debris, and thus needs to be regularly inspected.

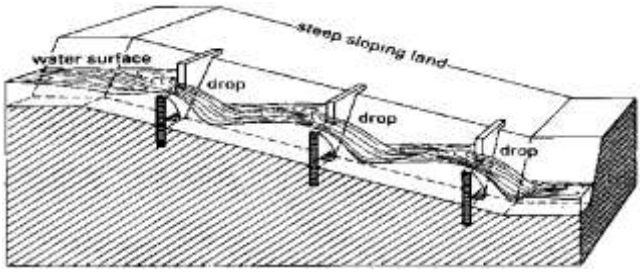


Stop logs: Stop logs are frequently used to temporarily block flow through a spillway or canal during routine maintenance. At other times stoplogs can be used over longer periods of times, such as when a field is flooded and stoplogs are being used in smaller gates in order to control the depth of water in fields.

Checks:- To divert water from the field ditch to the field, it is often necessary to raise the water level in the ditch.
Checks are structures placed across the ditch to block it temporarily and to raise the upstream water level. Checks can be permanent structures.

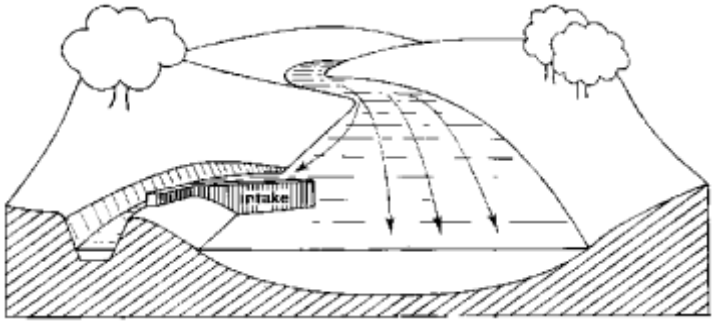


Drop Structures:- are structures placed to pass water to a lower elevation while controlling the energy and velocity of the water as it passes over.



Management (control) structures:- are structures used to manage or control the amount of water in the canal by using different water control gates. This mainly includes the main intake structures and water control structures;

Main intake structure:- The intake structure is built at the entry to the irrigation system. Its purpose is to direct water from the original source of supply (lake, river, reservoir etc.) into the irrigation system.



Water control gates: Water control gates control the flow of water from point to point in open channel situations. We offer a variety of flap gates, sluice gates, slide gates, overshot gates, radial gates and roller gates to meet specific needs.

Gate systems include manual or power operating systems, stems, accessories and, in some cases, automation packages for operating the gates.

Flap gate

Sluice gate

Slide gate

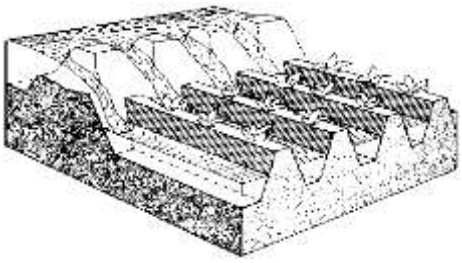
Radial gate

2.3 Undertaking identification of field distribution systems

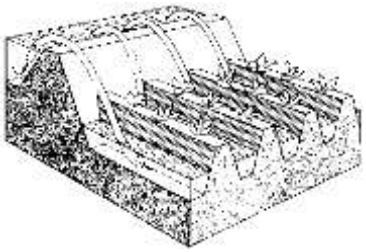
Field distribution systems are systems used to distribute irrigation water in the field. In surface irrigation water is applied to the fields at ground level. Either the entire field is flooded or the water is directed into furrows or borders.

1. **Furrow irrigation:-** Furrows are narrow ditches dug on the field between the rows of crops. The water runs along them as it moves down the slope of the field.

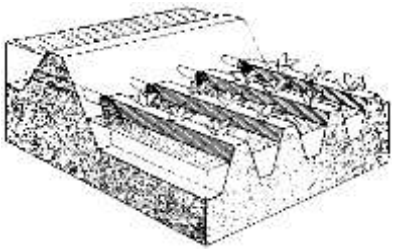
The water flows from the field ditch into the furrows by opening up the bank or dyke of the ditch or by means of syphons or spiles. Siphons are small curved pipes that deliver water over the ditch bank. Spiles are small pipes buried in the ditch bank.



a. Flows to the furrows through openings in the bank

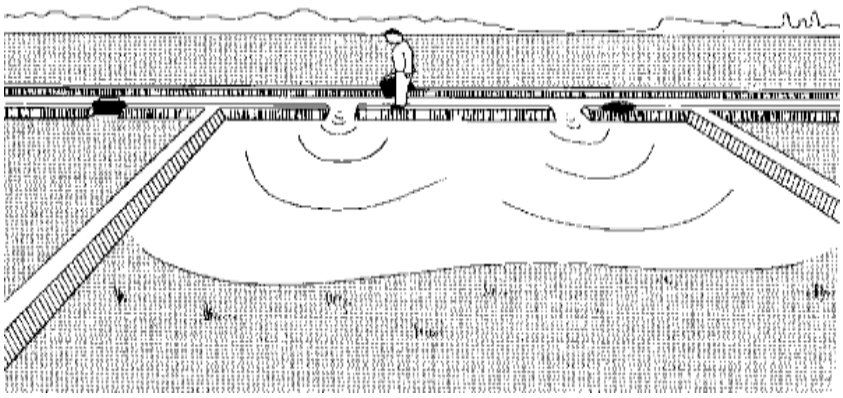


b. The use of siphons



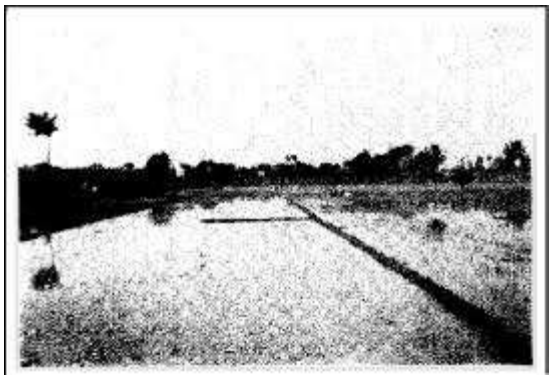
c. The use of spiles

2. **Border irrigation:-** In border irrigation, the field to be irrigated is divided into strips (also called borders or border strips) by parallel dykes or border ridges.
   The water is released from the field ditch onto the border through gate structures called outlets. The water can also be released by means of siphons or spiles. The sheet of flowing water moves down the slope of the border, guided by the border ridges.



Border irrigation

3. **Basin irrigation:-** Basins are horizontal, flat plots of land, surrounded by small dykes or bunds. The banks prevent the water from flowing to the surrounding fields. Basin irrigation is commonly used for rice grown on flat lands or in terraces on hillsides. Trees can also be grown in basins, where one tree usually is located in the centre of a small basin.



Basin irrigation

Self-Check 2	**Written Test**

Name: _____ **Date:** _____

Directions: **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.**

1. What does mean diversion structure, weir and barrage? (5 pts)
2. Write component of diversion structures and their functions? (5pts)
3. What does mean conveyance, distribution and management structures? (5pts)

Note: **Satisfactory rating - 15 points and above** **Unsatisfactory - below 15 points**

You can ask your teacher for the copy of the correct answers

Operation Sheet 2	Support Surface Irrigation Structures

Objectives: The aim of irrigation facilities is to divert water from a source, convey it to appropriate locations in the system and distribute it within the field so that water reaches the roots of the crops in an optimal manner to ensure improvement of agricultural production.

Procedure:

Identify diversion structure and types of diversion structures.

Identify conveyance, distribution and management structures.

Lap Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished:_____

Instructions:

You are required to perform the following activity:

Task 1: Identify diversion structure and types of diversion structures such as weir and barrage

Task2: Identify component of diversion structures

Task: Identify conveyance, distribution and management structures

Information Sheet 3	Maintain, clean up and store worksite and equipment

3.1 Checking, maintaining and storing equipment, tools and materials

The equipments, tools and materials used in irrigation structure work require checking, cleaning, maintaining and storing properly after use.
Cleaning is one of the most essential elements in maintaining a safe tool and equipment. Some of the materials, tools and equipments commonly used for cleaning purpose are listed below.

- Air freshener dispenser
- Sealer applicators, rubbish bins, waste bins, large industrial bins, tidy bins,
- Brooms and wire brush
- Rubbish picking up tools, wall washers, warning sign, safety signs
- Detergents and oils
- Grease and other lubricants

Maintaining equipments, tools and materials after the use for work and finally must be store in the stock pile.

3.2 Restoring work site and environmental improvements or controls to complete work.

Irrigation structure work sites are expected to be clean, tidy, comfortable and good to create conducive environment for work.

Cleanliness is the most essential elements in maintaining a healthy and safe work environment. Not only does a clean workplace reflect the professionalism of a business or facility and help motivate employees, it also promotes a healthy workforce as a clean environment prevents accidents and the spread of germs.
Like Health & Safety, maintaining a clean work environment is the responsibility of everyone.
Working together we can all contribute to creating a safe and healthy workplace and a professional looking facility for employees, visitors and customers.

Irrigation structure and site maintenance

i. The job site shall be kept in a neat, clean, and orderly condition at all times during the installation process.
ii. All scrap and excess materials are to be regularly removed from the site and not buried in trenches.

iii. Trenching, laying pipe and backfilling shall be continuous so that the amount of open trench at the end of each work day is minimized. Any open trench or other excavations shall be barricaded and marked with high visibility flagging tape.

Self-Check 3	**Written Test**

Name: _____ **Date:** _____

Directions: **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.**

1. List some of the equipments commonly used for cleaning purpose (3pts)
2. Why do you need to make good working site? (5pts)

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

You can ask your teacher for the copy of the correct answers

Operation sheet-3	Maintain, clean up and store worksite and equipment

Purpose: to provide the trains with the skill of cleaning, maintaining and storing equipments, tools and materials.

Conditions or situations for the operation: provided the needed equipment, tools and materials the trains will perform the task within 2:00hr

Procedure

- Use PPE
- Inspect equipments, tools and materials
- Separate damage equipments. tools and materials
- Repair damaged equipments, tools and materials correctly
- Clean equipments tools and materials properly
- Store equipments, tools and materials properly in the right place

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions:

1. You are required to perform the following activity:
    - Request your teacher to arrange equipments, tools and materials used in irrigation structure work, in order to cleanup, maintain and store on completion of irrigation structure activities.
2. Request your teacher for evaluation and feedback.