Horticultural Crops Production

Level III

Learning Guide-55

Unit of Competence: Implement erosion and sediment control measures

Module Title: Implementing erosion and sediment control measures

LG Code: AGR HCP3M013LO1-LG55

TTLM Code: AGRHCP3TTLM0120v1

LO1: prepare for implementation and construction

Instruction Sheet	Learning Guide #55

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

- Planning and scheduling erosion and sediment control
- Identifying survey pegs and site indicators
- Matching Equipment and tools
- Verifying selected equipment and tools

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**:

- Plan and schedule erosion and sediment control
- Identify survey pegs and site indicators
- Match Equipment and tools
- Verify selected equipment and tools

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 7.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1” in page 17, 21, 24 and 26 -.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio

Information Sheet-1	Planning and scheduling erosion and sediment control

A sediment control is a practice or device designed to keep eroded soil on a construction site, so that it does not wash off and cause water pollution to a nearby stream, river, lake, or sea. Sediment controls are usually employed together with erosion controls, which are designed to prevent or minimize erosion and thus reduce the need for sediment controls. Sediment controls are generally designed to be temporary measures, however, some can be used for storm water management purposes

1.1. Preparing erosion and sediment control plan

An erosion and sediment control plan is a document which describes the potential for erosion and sedimentation problems on a construction project and explains and illustrates the measures which are to be taken to control those problems. The plan has a written portion known as a narrative and an illustrative portion known as construction drawings.

The soil erosion and sediment control plan should be an integral part of the overall site plan. However, the soil erosion and sediment control plan needs to be consolidated, so it can be separated from the site pan for review.

The narrative is a written statement which explains the erosion and sediment control decisions made for a particular project and the justification for those decisions. The narrative is especially important to the plan reviewing authority because it contains concise information concerning existing site condition, construction schedules, and other pertinent items which are not contained in a typical site plan.

Since plan reviewers cannot always discuss the project at length with the site planner, it is important that they be provided with adequate information to make their review. The design calculations should be included as an appendix to the narrative.

The narrative also discusses where and when the various erosion and sediment control practices should be installed.

The operation and maintenance of the control measures should be included in the narrative.

The construction drawings visually illustrate the site features including existing conditions and proposed alterations. The construction drawings are important because they show the location, and dimensional details of the control measures. This information is needed by the reviewer to ensure that appropriate control measures are included. Construction super intendents and inspectors need the drawings to ensure that control measures are properly installed.

1.1.1. Purpose of the Plan

The purpose of an erosion and sedimentation control plan is to establish clearly which control measures are intended to prevent erosion and off-site sedimentation. The plan should serve as a blueprint for the location, installation, and maintenance of practices to control all anticipated erosion and prevent sediment from leaving the site.

The approved erosion and sedimentation control plan—showing the location, design, and construction schedule for all erosion and sedimentation control practices—should be a part of the general construction contract. State specifically the method of payment for implementing this plan in the contract, and consider erosion and sedimentation control an early pay item.

1.1.2. Elements of the Plan

An erosion and sedimentation control plan must contain sufficient information to describe the site development and the system intended to control erosion and prevent off-site damage from sedimentation. As a minimum, include in the plan:

- A site location or vicinity map,
- A site development drawing,
- A site erosion and sedimentation control drawing, drawings and specifications of practices designated with supporting calculations and assumptions, vegetation specifications for temporary and permanent stabilization,
- A construction schedule,
- A financial/ownership form, and brief narrative.

1.2. Data Collection and Preliminary Analysis

The base map for the erosion control plan is prepared from a detailed topographic map. If available, a soil map should be obtained from the local soil Conservation Service office. Transferring the soil survey information to the topographic map is helpful for site evaluation.

The design engineer responsible for the plan should inspect the site to verify the base map with respect to natural drainage patterns, drainage areas, general soil characteristics, and off-site factors.

The base map should reflect such characteristics as:

- soil type and land slopes,
- natural drainage patterns,
- unstable stream reaches and flood marks,
- watershed areas,
- existing vegetation (noting special vegetative associations),
- critical areas such as steep slopes, eroding areas, rock outcroppings, and seepage zones,
- unique or noteworthy landscape values to protect,
- adjacent land uses—especially areas sensitive to sedimentation or flooding, and
- Critical or highly erodible soils that should be left undisturbed.

In the analysis of these data, identify:

- Buffer zones,
- Suitable stream crossing areas,
- Access routes for construction and maintenance of sedimentation control devices,
- borrow and waste disposal areas, and
- The most practical sites for control practices.

The analysis of the topography, soils, vegetation, and hydrology should define the limitations of the site and identify locations suitable for development.

1.3. Principles of Site Development

The site evaluation data and the information shown on the field map serve as the basis for both the site development plan and the erosion and sedimentation control plan. Plan development to fit the proposed site, recognizing constraints determined in the site analysis.

To determine the best layout of the site, observe the following principles:

- **Fit the development to the site**—Follow natural contours as much as possible. Preserve and use natural drainage systems.
- **Limit clearing and grading**—clearly define work limit lines. Grade to minimize cut-and-fill slopes, preserve natural buffer areas, and limit the time that bare soil is exposed.
- **Minimize impervious areas**—Build in clusters to provide more open space, minimize parking areas, and reduce disturbance for utility line construction. Use porous paving materials when practical. Maintain existing vegetation where possible.
- **Avoid disturbing critical areas**—Identify and avoid areas vulnerable to concentrated runoff.
- **Maintain and enhance existing site values**—Retain significant trees and other plant groups. Avoid disturbing unique land forms, very steep slopes, and rock outcroppings.

1.4. Strategies in site Development

The erosion and sedimentation control plan should seek to protect the soil surface from erosion, control the amount and velocity of runoff, and capture all sediment on-site during each phase of the construction project. Strategies for controlling erosion and sedimentation should consider the following elements:

- **Schedule activities**—Coordinate the installation of erosion and sedimentation control practices to coincide with the construction activities as the most cost-effective control strategy. Many sedimentation control practices should precede grading activities.

- **Protect the soil surface**—Limit the extent of disturbance, and stabilize the soil surface immediately. Once the surface has been disturbed, it is subject to accelerated erosion, and should be protected with appropriate cover, such as mulch or vegetation, in an expedient manner.

- **Control surface runoff**—Divert water from undisturbed areas to avoid disturbed areas. Break up long slopes with temporary diversions to reduce the velocity of runoff. Divert sediment-laden water to sediment impoundments. Make all outlets and channels stable for the intended flow.

- **Capture sediment on-site**—Divert runoff that transports sediment to an adequate sediment-trapping device to capture sediment on the site.

1.5. Writing the plan

Development of the erosion and sedimentation control plan can be viewed as a series of phases that occur in approximate chronological order. The phases overlap considerably and so are not presented as steps.

Phase I: Runoff-Erosion Analysis

- **Landscape**—Evaluate proposed changes in the landscape to determine their effect on runoff and erosion. Note all physical barriers to surface runoff, such as roads, buildings, and berms. Check slope grades and lengths for potential erosion problems. Designate intended collection points for concentrated flow and specify controls to dissipate energy or stabilize the surface. Designate areas to be protected or used as buffer zones in this phase (Figure 4.2).

- **Runoff yield-** Evaluate surface runoff for the entire contributing drainage area—on-site and off-site. Delineate small sub watersheds on-site, and estimate peak runoff rates and volumes at selected collection points identified. Base runoff determinations on the peak discharge from the 10-year storm with site conditions during and after development—**not pre disturbance conditions**.

- **Sediment yield-** Estimate sediment yield by sub watersheds. This aids in identifying preferred locations for sediment traps and barriers, and can be used to estimate the expected cleanout frequency. An area that is subject to excessive erosion may call for extra storage capacity in traps or additional precautions during construction.

Phase II: Sediment Control

Erosion control practices reduce the amount of sediment generated, but they do not eliminate the need for sediment control devices such as barriers and traps. Sediment control practices operate by reducing flow velocity, and creating shallow pools that reduce the carrying capacity of runoff. Thus, sedimentation occurs on-site rather than off-site. Sediment is generally not controlled by filtering, but by deposition. The designer should locate all traps and barriers recognizing that they represent deposition points where access for maintenance will be necessary.

- **Sediment basins and traps**— Select sites and install sediment basins and traps before other construction activities are started. Also consider locations for diversions, open channels, and storm drains at this time so that all sediment-laden runoff can be directed to an impoundment structure before leaving the construction site.

Divert sediment-free water away from sediment basins, and release it through stable outlets. This reduces construction costs, and improves basin efficiency.

This plan (sediment control plan) should show access points for cleanout of all traps and basins and indicate sediment disposal areas. Maintenance of storage capacity is essential throughout the construction period.

- Sediment fences— Sediment fences provide effective control of sediment carried in sheet flow. They are particularly useful where there is limited space to work such as near property lines, among trees, or near sidewalks or streets. Sediment fences should never be used across streams, ditches, channels, or gullies.

The sediment fence operates primarily by reducing flow velocity and causing a shallow pool to form. If filtering action is required, the designer should assume that the barrier will clog rapidly so that all runoff must be retained behind the fence or released through a designated outlet. Any outlet points must be reinforced and stabilized, and should be designated in the plan.

Place sediment fences on relatively flat ground with sufficient area for a pool to develop without putting unnecessary strain on the fence. If a level area is not available at the fence location, excavate a trench directly upslope from the fence.

Show sediment fences on the topographic map, and clearly indicate deposition areas and needed overflow or bypass outlet points. Also show access routes for maintenance.

- **Inlet protection**— Inlet protection devices for storm sewers, conduits, slope drains, or other structures make effective, low-cost deposition areas for trapping and holding sediment. A shallow excavation in conjunction with a sediment barrier can be effective at many locations. In the plan, show where these measures will be located, what type of device will be used, and how these devices will be constructed and maintained.

Phase III: Protection of Disturbed Areas

Once an area is disturbed, it is subject to accelerated erosion. In the plan, show how erosion will be controlled on these disturbed areas. Erosion control can be achieved by:

- limiting the size of clearing and time of exposure by proper scheduling,
- reducing the amount of runoff over the disturbed surface,
- limiting grades and lengths of slopes, and

• re-establishment protective cover immediately after land-disturbing activities are completed or when Construction activities are delayed for 30 or more working days.

- **Cut-and-fill slopes**— Steep cut or fill slopes are particularly vulnerable to erosion. Protect such slopes by temporary or permanent diversions just above the proposed slope before it is disturbed. Provide a stable channel, flume, or slope drain, where it is necessary to carry water down a slope. Flow conveyances may have vegetative, mechanical, or combined vegetative and mechanical liners, depending on slope and soil conditions.

Shorten long slopes by installing temporary diversions across the slope to reduce flow velocity and erosion potential. Install permanent diversions with slope drains and protected outlets on long steep slopes (over 20%) as the slopes are constructed.

Finish final slope grades without delay, and apply the appropriate surface stabilization measures as soon as possible. Roughen slope surfaces to improve the success of vegetative stabilization. Consider both the stabilization measures and how they will be maintained before planning the steepness of the finished slope. For example, if the finished slope is to have smooth grass cover, it should be constructed on a grade of 3:1 or flatter to allow mowing.

- **Surface covers**— Riprap, gravel, straw and other land covers can provide immediate surface protection to disturbed soil areas. Riprap is especially useful where concentrated runoff over steep slopes occurs. Riprap should be installed on a gravel or filter fabric bed.

- **Construction traffic**— Carefully plan stabilization of construction access areas, construction roads, and parking areas. Ensure that traffic patterns follow site contours, and limit the length of routes up steeper slopes. Generally, road grades should not exceed 12%. Controlling surface runoff is necessary to prevent serious roadside erosion. Proper grading of the road surface, stable channel design, the use of water bars, other diversions, and culverts help prevent erosive flows. Where water tables are high, subsurface drainage may be needed to stabilize the sub-grade. Storm drains should be considered for water disposal where channel grade exceeds 5%. Plans should show all stabilization measures needed to control surface runoff from all roads.

- **Borrow and waste disposal areas**— Clear borrow and waste disposal areas only as needed and protect them from surface runoff. Maintain berms as fill slopes are constructed to reduce slope length and control runoff. Slope all areas to provide positive drainage, and stabilize bare soil surfaces with permanent vegetation or mulch as soon as final grades are prepared. Direct all runoff that contains sediment to a sediment-trapping device. In large borrow and disposal sites, shape and deepen the lower end to form an in-place sediment trap, if site conditions warrant it. Off-site borrow areas may be governed by the N.C. Mining Act.

- **Utilities**—Use the spoil from utility trench excavations to divert flow from upslope areas, but use care in spoil placement to avoid blocking natural surface outlets. Diversions and water bars can reduce erosion when properly spaced across utility rights-of-way. When utilities are located near a stream, maintain an undisturbed buffer zone wherever possible. If site dewatering is necessary, pump or divert muddy water to sediment traps before discharging it to the stream. If streams must be crossed, make sure all necessary materials and equipment are on-site before construction begins, and complete work quickly. Finish all disturbed surfaces to design grade and immediately stabilize them with permanent vegetation or other suitable means. When utilities cross the stream, you must specify the plans to prevent sedimentation.

- **Perimeter protection**—Consider diversion dikes for perimeter protection for all proposed developments, and install them where appropriate before clearing the site. Exercise care not to create flooding or erosion by blocking the natural drainage pattern. Be sure to provide an adequate outlet.

- **Dust control**—Exposed soil surfaces that are nearly level have little potential for runoff erosion, but may be subject to severe wind erosion. Keeping the disturbed surface moist during windy periods is an effective control measure, especially for construction haul roads.

- **Preserving vegetation**—Preserve existing vegetation on the site as long

as possible as a cost-effective way to prevent on-site erosion and off-site sedimentation.

Phase IV: runoff conveyance

The safe conveyance of runoff water from a construction site is achieved by:

1. utilizing and supplementing existing stable watercourses,
2. designing and constructing stable open channels, or
3. Installing storm drains with stable outlets.

The plan should indicate locations and designs for these facilities. Complete and stabilize outlets for channels, diversions, slope drains, or other structures before installing the conveyance measure.

- **Existing watercourses**—When using existing watercourses, either show that flow velocities are acceptable for increased runoff conditions, or indicate how necessary stabilization will be achieved.

- **Excavated channels**— when channels are to be excavated, base a stability analysis on allowable velocity, or tractive force procedures. Include all calculations as part of the plan documentation.

Wide, shallow channels with established grass linings are usually stable on slopes up to 5%. These channels must be protected with temporary liners until grass is established. If channel gradients are too steep to use vegetation, riprap or concrete linings may be required, and in some instances grade stabilization structures may be needed.

- **Storm drains**— Where the site plan calls for a system of storm drains, the drains may be used effectively in the erosion and sedimentation control plan. Build junction boxes or inlets early in the construction sequence, and grade the adjacent area to drain toward the inlet. Install an inlet protection device at all

open pipe inlets, and excavate a shallow basin in the approach to the inlet for sediment storage. The storm drain flow from the protected inlets may be diverted to a sediment basin for additional sediment control. Restrict the drainage area for inlets to less than 1 acre, and frequently inspect inlet protections for needed maintenance.

Phase V: stream Protection

Stream banks, streambeds, and adjoining areas are susceptible to severe erosion if not protected. Include sufficient detail to show that streams are stable for the increased velocities expected from the development activity. At a minimum, all streams should be stable for flows from the peak runoff from the 10-year storm.

When stability analysis shows that the stream requires protection, vegetation is usually the preferred approach because it maintains the stream nearest to its natural state. When flow velocities approach 4-6 ft/sec, or if frequent periods of bankful flows are expected, structural measures such as riprap lining or grade stabilization structures are usually necessary. In the plan, show where stream protection is needed, and how it will be accomplished.

- **Runoff into stream**—Only sediment-free runoff may be discharged from construction sites directly into streams. Ensure that all other flows enter from desilting pools formed by sediment traps or barriers.
- **Velocity control**—Keep the velocity of flow discharged into a stream within acceptable limits for site conditions. Control velocity by installing an appropriate outlet structure. Standards for two types of outlet protection devices are given in *Chapter 6* (Practices 6.40 and 6.41). Design procedures for riprap outlet structures are contained in *Appendix 8.06*.
- **Buffer zone**—Areas adjoining streams should be left undisturbed as buffers (Figure 4.3). Existing vegetation, if dense and vigorous, will reduce flow velocities and trap sediment from sheet flow. However, the principal benefit of leaving natural buffer zones along streams is that they prevent excessive erosion in

these sensitive areas. Maintaining stream canopies also protects fish and wildlife habitats; provides shade, wind breaks and noise barriers; protects the bank from out-of-bank flood flows; and generally preserves natural site aesthetics.

Indicate stream buffer zones in plans that involve natural streams. The width is determined by site conditions, but generally should not be less than 25 feet on each side of the stream. Where natural buffers are not available, provide artificial buffers.

Where work is required along a stream, you must provide a mechanical or artificial buffer.

- **Off-site stream protection**—Increased rate and volume of runoff from development activities may cause serious erosion at points some distance downstream. The developer should work with downstream property owners to stabilize sensitive downstream channel areas.
- **Stream crossing**—Minimize the number of stream crossings. Construct crossings during dry periods; if necessary, divert water during construction. The plan should show the type of crossing to be used and the associated control measures to minimize erosion from surface runoff such as diversions, outlet structures, riprap stabilization, etc.

Phase VI: Construction Scheduling

Appropriate sequencing of construction activities can be the most effective means for controlling erosion and sedimentation. Consequently, present the construction activity schedule of the general contract as part of the erosion and sedimentation control plan. Put into place the primary erosion and sedimentation control practices for the site, i.e., sediment basins and traps, and a water conveyance system before undertaking major land-disturbing activities.

Install sediment basins and primary sedimentation control practices as the first structural measures. Next install the overall water disposal outlet system for the site.

Stabilize all construction access routes, including the construction entrance/exit and the associated drainage system, as the roads are constructed. Install storm drains early in the construction sequence, and incorporate them in the sedimentation control plan. Then install low-cost inlet protection devices for efficient sedimentation control in the area around the inlets. This allows early use of the inlets and the drain system.

Install diversions above areas to be disturbed and, where appropriate, locate diversion dikes along boundaries of areas to be graded before grading takes place.

After all principal erosion and sedimentation control measures are in place, perform the land clearing and rough grading. Clear areas only as needed.

Complete final grading and surface stabilization in an expedient manner and within the construction schedule. Minimize the time of exposure, and select temporary ground cover according to the location and season. Temporary surfaces should be stabilized as soon as active grading is suspended, and graded slopes and fills must be stabilized within 21 calendar days, regardless of the time of year.

Phase VII: Maintenance

In the erosion and sedimentation control plan, indicate who is responsible for maintenance and when it will be provided. The maintenance schedule should be based on site conditions, design safeguards, construction sequence, and anticipated weather conditions. Specify the amount of allowable sediment accumulation, design cross-section, and required freeboard for each practice and what will be done with the sediment removed. The plans should also state when temporary practices will be removed and how these areas and waste disposal areas will be stabilized.

Phase VIII: Performance Requirement

Even though the developer may have an approved plan that is properly installed and maintained, he/she is not relieved of responsibility for off-site sediment damage resulting from his/her construction activities. Therefore, frequently inspect the property boundary for evidence of sedimentation. If off-site damage occurs, the developer may be

responsible for immediate corrective measures. Modification of the plan and re-approval may also be necessary.

The erosion and sedimentation control plan should be flexible enough to allow for modification to correct problems. It is common for unanticipated events or construction changes to occur during project development that may require major alterations in the plan. Resubmit significant changes for approval before they are implemented.

Phase IX: Preconstruction Conference

A preconstruction conference with the owner, contractor, and erosion control personnel at the site is recommended as a means of assuring proper implementation of the erosion and sedimentation control plan. This conference is required by some local ordinances. A preconstruction conference allows all parties to meet, review the plans and construction schedule, and agree on responsibility and degree of control expected. Discuss maintenance requirements, phasing of operations, and plan revisions at this time.

Self-Check -1	Written Test

Name: _____ Date: _____

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

1. What is an erosion and sediment control plan? (5 points)
2. What are the components of erosion and sediment control plan? (5 points)
3. Mention the phases of erosion and sediment control plan. (5 points)
4. Write site development principles (2 points)
5. Write elements of erosion and sediment control plan. (3 points)

Answer Sheet

Score = _____

Rating: _____

Note: Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information Sheet-2	Identifying survey pegs and site indicators

Before applying the technologies every implementer should be identified select the site with its indicators and set or conduct survey.

The indicators may be;

- Soil erosion indicators
- Loss of land productivity

Surveying may include; select site where to apply the practices and conduct surveying and set pegs to identify the site for implementation of erosion and sediment control activities.

Knowing the type of soil found on the project site will help the designer decide upon the degree of erosion protection required. This will ensure that the ESCP is adequate to control soil movement without being overly conservative. Each county has a published survey of soils and that information is found in the Natural Resource Conservation Service Soil Survey, a mapped inventory by county with physical properties and characteristics described for each soil type. Of prime importance are the predictions of soil behavior for selected land uses. Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock.

Operational procedures of survey pegs and site indicators

i. **Main staking out**

This is used to define

- for works of engineering construction: the axes;
- for earthworks: the axis of the route, the longitudinal profile, the curves, the location of the cross-sections.

Staking out is carried out using hard-wood, square or circular cross-section stakes, 50 cm in length. In loose soil, the stakes should be driven home with a sledge hammer; on rocky land, they should be cemented into holes made with a jumper bar.

The stake heads should be painted to ensure that they are clearly visible, and each stake should be numbered and referred in plan and altitude to the fixed reference points. The stake head should be set at the exact measurement of the future ground level if this is not more than 30 cm higher or lower, or an exact number of decimals above or below.

ii. **Additional or secondary staking**

This is carried out from the main stakes and indicates the boundaries of the works, such as the edges of trenches or banks. These stakes are not leveled and they should be painted in a different colour to that of the main stakes.

iii. Displaced stakes

Before the work is started, the main stakes which are located within the area covered by the works should be displaced at a constant distance outside the boundary of the structure. This displaced staking should also be levelled in relation to the axis stakes as shown in fig below:

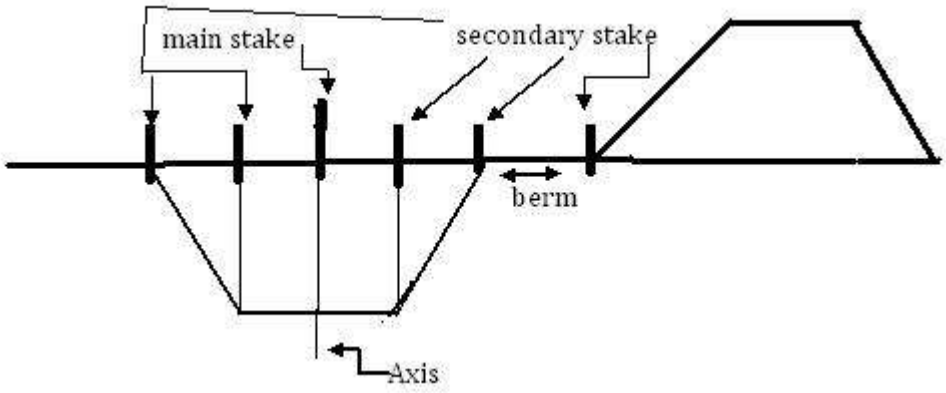


Fig.1. ground plan depicted on paper

For the trapezoidal earth ditch volume of earthwork can be calculated as follow:

$$\textit{volume of earthwork} = \frac{\textit{top width} + \textit{bottom width}}{2} \times \textit{depth of the ditch} \times \textit{length of the ditch}$$

Work output or work norms vary depending on the type of soil or land, climate, ease of tools and equipment. To decide the labor required, it is important to calculate the volume of earth work. For example, if work norm for trenching of silting basin is $2.5m^3$/PD, labor required to trench silting basin of $10m^3$ is $10m^3/2.5m^3$/PD=4person per day. Labor required for a trapezoidal cross-section graded bund with 50 and 30 top and bottom width and length of 1km, depth 0.5m can be calculated as follow:

Let say work norm for this cut- off drain is $0.8m^3$/PD, then

Volume of earthwork (v), $v = \frac{0.5 + 0.3}{2} \times 0.5 \times 1000 = 200m^3$

Persons required to accomplish the work in one day are $200m^3/0.8m^3 = 250$

Self-Check -2	Written Test

Name: _____ Date: _____

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

1. Write the Operational procedures of survey pegs and site indicators? (5 points)
2. Write the difference secondary staking and Displaced stakes (5 points)

Answer Sheet

Score = _____
Rating: _____

Note: Satisfactory rating - 10 points Unsatisfactory - below 10 points

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

Information Sheet-3	Matching Equipment and tools

Matching equipment and tools to program works and terrain on site for successful implementation of erosion and sediment control is necessary. Equipment and tools may include, but not limited to: Knives, trowels, spades, forks, hammer, rakes, hoes, pegs, shovels, buckets, brooms, wheelbarrows, sand bags, stationery, measuring tapes, spades, GPS, Gabion wire, Stationery, digital cameras, internet, telephone.

In order to match equipment and tools to program works and terrain on site for erosion and sediment control works, identifying constraints that may enhance or hinder the program works has to be assessed.

A. Identify constraints

Before opening a site, the site manager should make survey of local conditions and site reconnaissance for the following information:

- **Major natural constraints** eg. Information on climatic conditions such as time of rainy season, excessive heat or frost, etc. time of problems of sanitary conditions, risk of any epidemic, peak flow should be collected and analyzed.
- **Technical constraints and economic constraints**: **Site access** - existing roads and tracks, their distance from the construction, need for the construction of new access routes. Supplies of materials - examining the potential of existing quarries quality of the materials they supply, delivery capabilities and prices. Supplies of equipment- It is necessary to assess the number of tools and machines required on the site: conditions for the purchase of new equipment, local resources and the condition of available second-hand material.

B. Tools and equipment for execution of earthworks

The type of land will determine the choice of equipment to be used; output and, consequently, the cost of earthworks. The tools used for manual earth moving are either hand tools or portable mechanical tools.

- **Trenching tools -**The main manual tools are: Pneumatic picks, pneumatic spades, the crowbar, the wedge, the pick, the pickaxe.
- **Tools for loading earth-** For loading excavated earth, use is made of: the shovel and the fork.

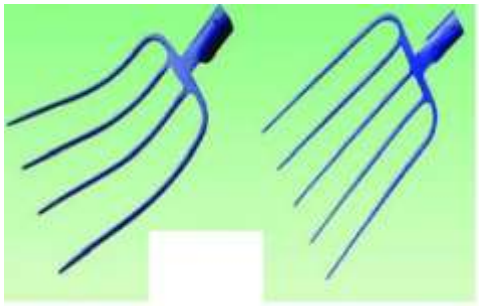
- **Tools for soil haulage-** Depending on the country, local resources and haulage distances, the following means are employed:
  - wicker baskets;
  - hoppers carried on the back;
  - 2-man bamboo stretchers;
  - 40-60-litre wheelbarrows
  - For larger capacities and haulage distances (greater than 100 m), animal-drawn equipment is used, such as: pack saddle, single-axle cart, etc. or use of light mechanical haulage equipment: motor barrows, dumpers, etc. are possible.

- **Tools for soil compacting-** The simplest soil compacting tools are hand tampers manipulated by a single worker and pneumatic tampers also operated by a single worker and supplied with compressed air by a small motor compressor.

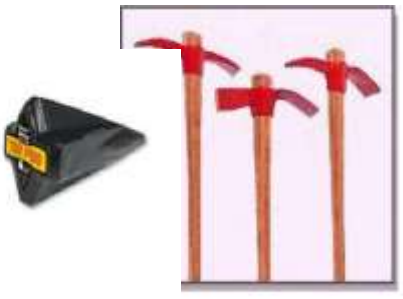
Rake

Shovel

Spade



Fork



wedge

Pickaxes

Wheelbarrow

Self-Check -3	Written Test

Name: _____ Date: _____

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

1. Mention some of tools and equipment used for erosion and sediment control? (5points)

Answer Sheet

Score = _____
Rating: _____

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

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

Information Sheet-4	Verifying selected equipment and tools

Work readiness of selected equipment and tools are verified as directed by supervisors. Verifying work readiness of selected equipment and tools if they are maintained and ready for work needed (*Clean tools, apply oil to prevent rust, remove rust with a wire brush, sharpen tools for peak efficiency grind battered tools into shape*); checking sufficiency through inventory if new or additional purchase needed, security clearance for transport,etc.

Self-Check -4	Written Test

Name: _____ Date: _____

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

1. Why we need to verify equipment and tools for the selected activities of erosion and sediment control? (5 points)

Answer Sheet

Score = _____
Rating: _____

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

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

Horticultural Crops Production

Level III

Learning Guide-56

Unit of Competence: Implement erosion and sediment control measures

Module Title: Implementing erosion and sediment control measures

LG Code: AGR HCP3M013LO2-LG56

TTLM Code: AGRHCP3TTLM0120v1

LO2: carry out implementation and construction

Instruction Sheet	Learning Guide #56

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

- Constructing earthworks
- Installing erosion and sediment control products and materials
- Identifying of sediment control measures
- Applying site works maintenance inspection schedule

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**:

- Construct earthworks
- Install erosion and sediment control products and materials
- Identify of sediment control measures
- Apply site works maintenance inspection schedule

Learning Instructions

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 7.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1” in page 31, 53 and 55 -.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio

Information Sheet-1	Constructing earthworks

1.1 **Goals of Constructing earthworks**

- Protect the land surface from erosion;
- Intercept, divert, and safely dispose of “clean” run-on water from undisturbed areas, clear of any disturbed areas, or to pass “clean” water through the site without mixing with “dirty” (sediment contaminated) site run-off;
- Progressively re-vegetate or stabilize disturbed areas; and
- Prevent sediment-contaminated water leaving the site.

1.2. Principles of constructions

The following principles should be utilized as much a possible on all construction projects.

1) Minimize the amount of disturbed soil and limit the time the disturbed area is exposed.

- Adjust the activity to natural site features (topography, soils, waterways, and natural vegetation).
- When possible, minimize the grade change on the site, which will decrease the amount of disturbed soil and the amount of erosion that can occur.
- Only clear and grub the portions of the site where it is necessary for construction and retain existing vegetation wherever feasible.
- Consider staging the project so that only a small portion of the site will be disturbed at any one time.
- If there are disturbed areas of the site that will not be re-disturbed for a long period, then these areas should be stabilized with temporary seeding, mulching or matting.

2) Prevent offsite runoff from flowing across disturbed areas.

- Divert surface runoff from the construction site and exposed areas using dikes, berms, drainage swales or ditches. The method of choice depends on the size of the drainage area and the steepness of the slope (further

discussed in the Drainage and Sediment Control section).

3) Reduce the velocity of the runoff traveling across the site.

- Steeper slopes result in faster moving runoff, which results in greater erosion.

  Grade change should be as gradual as possible.
- Cover erodible soils and sloped areas with mulch, vegetation, matting or riprap. Vegetative covers increase the surface roughness, which reduces the velocity of the surface runoff.
- Runoff concentrated into swales or channels can be slowed by reducing the slope, increasing the channel width, constructing check dams and by establishing a vegetative cover.

4) Remove the sediment from onsite runoff before it leaves the site.

- Since it may take several weeks to establish a grass cover to control erosion, it is important that measures which can remove sediment from runoff before it flows off of the construction site be installed.
- Sediment control devices include check dams, gravel filter berms, sediment control fences, straw bale filter barriers, sediment traps and sediment control ponds. The selection of the best measure depends on a number of criteria including the size of the disturbed area, the type of runoff (concentrated or sheet- flow) and the volume of runoff.
- The sediment control devices must remain in place until permanent vegetation has been established or the site is otherwise stabilized

5) Develop and implement a thorough monitoring and maintenance program.

- Conduct a routine check, including after each rain event, to ensure that all control measures are working properly.
- Additional preparation may be required if heavy rain is predicted.
- Keep an inventory of erosion and sediment control materials throughout construction.

Self-Check -1	Written Test

Name: _____ Date: _____

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

1. What are the Goals of Constructing earthworks for erosion and sediment control? (5points)
2. Write principles of construction (5points)

Answer Sheet

Score = _____

Rating: _____

Note: Satisfactory rating - 10 points Unsatisfactory - below 10 points

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

Information Sheet-2	Installing erosion and sediment control products and materials

2.1. Selection Of Erosion And Sediment Control Measures

Both stabilization and drainage control measures can be used to control erosion and sedimentation. Stabilization measures are used to stabilize the soil to prevent erosion. Structural drainage and sediment control measures are implemented to trap sediment-laden runoff before it leaves the site. A combination of both erosion and sediment control measures should be implemented for the plan to be effective. The selection of the best combination of measures is site specific and a site investigation should be conducted before selecting appropriate measures.

1) surface stabilization and erosion control

Surface stabilization measures will help prevent erosion of soils and should therefore be given primary attention. The following are some common accepted surface stabilization and erosion control measures:

- **Surface Roughening**
  - Surface roughening is a temporary measure and it can help reduce runoff velocity, increase infiltration and trap sediment. It helps protect exposed soil until a vegetative cover is established and should be done as soon as possible after existing vegetation has been removed.
  - The soil surface can be roughened by the creation of horizontal grooves or depressions that run parallel to the contour of the land (can be created by dozer treads or other heavy equipment).
  - Can be used in combination with other stabilization measures such as seeding and mulching.

➢ Re-vegetation

○ Seeding

- Seeding can be a temporary or long-term erosion control measure. An immediate plant cover will not be established, unless hydro seeding is conducted.
- Seeding is most appropriate in flat areas and on slopes less than 3H:1V. It should take place as soon as possible after the land has been disturbed.
- The surface soil must be loosened for water to infiltrate and roots to penetrate.

  Seedbed preparation may require the application of a fertilizer.
- The selection of vegetation mixture is dependant upon site conditions. Grasses and legumes are commonly used in seed mixtures.
- Mulch should be used as it helps conserve moisture and increases the odds of successful re-vegetation.

○ Hydroseeding

- Hydroseeding, where a slurry of seed, fertilizer, mulch, binder and water is sprayed on a prepared surface, is an acceptable process.

- Hydroseeding should not be applied to compacted soils, eroded surfaces or areas

  where ponding has occurred. The soil should be loosened and free of roots, branches, weeds, rocks, ruts and ridges.
- Hydroseeding should not be neglected until the end of a project. It should be completed in stages as construction progresses. It should not be conducted during periods of heavy rain or strong winds.

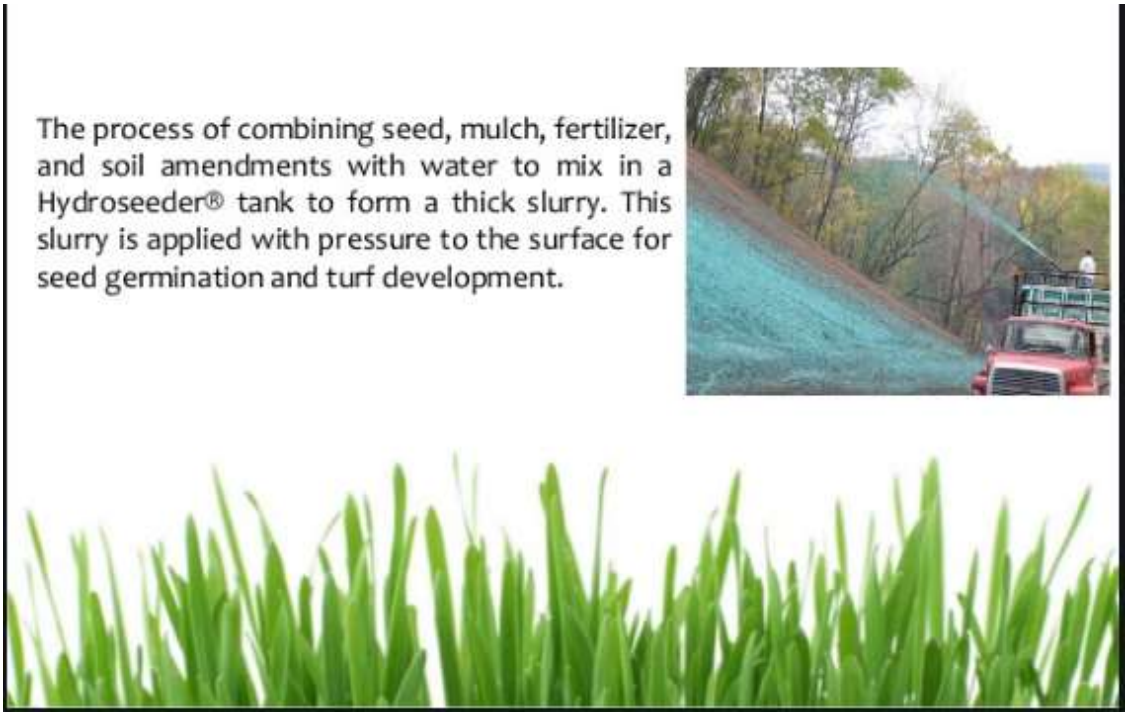


Fig.1. hydro seeding

- **Sodding**
  - Sodding is appropriate for graded areas where a permanent cover is required.
  - Will provide immediate cover and erosion control.
  - Sodding should be done as soon as possible after the area has been cleared and should include a prepared topsoil bed.
  - The sod should be rolled out horizontally across the slope with joints staggered.
  - Sod should not be installed during very hot or wet weather or frozen ground.

Fig.2. sodding erosion control

➢ Mulching

- Mulch, commonly consisting of hay or straw is applied to the ground surface as a temporary erosion prevention measure. It also aids in plant growth and re-vegetation as it helps conserve moisture.
- Mulching can provide immediate, effective, and inexpensive erosion control.
- Mulching can be used together with seeding or planting. Straw is the mulch most commonly used in conjunction with seeding.
- Mulch can be applied by hand or with a mulch blower.
- A tackifier, which is a bonding agent that helps secure the mulch to the soil, may be applied with the mulch. The supplier should be consulted for the application rate and ratio.
- On steep slopes and critical areas such as waterways, mulch matting should be used with netting or anchoring to hold it in place.

➢ Matting

- Matting or erosion control blankets are used to protect slope surfaces, channels or newly seeded soil from eroding. Erosion control blankets are commonly made of mulch, wood fibre or synthetics. The selection of the mat is dependent upon the availability and the length of time protection is

required.

- Most applicable for steep slopes, generally greater than 3H:1V, and where high velocity runoff or severe erosion problems are anticipated.
- The effectiveness of matting increases when used in conjunction with hydroseeding or mulching. It provides protection against surface runoff, allowing vegetation to properly establish and preventing washing away of seeds.
- The ground surface should be prepared, graded and large rocks or debris removed.

  It is important that the mat be in continuous contact with the underlying soil.
- The following are some important installation guidelines:
  - ✓ Fertilize and seed the area as required.
  - ✓ Lay out the mats starting from the up-slope end of the site. The adjacent edges of adjoining mats shall be overlapped by a minimum of 10 cm (4 in.).
  - ✓ Using U-shaped wire staples, staple the upper upslope edge of the mat into a 15 cm (6 in.) deep trench. Then backfill and firmly pack the trench.
  - ✓ If two mat lengths are used end-to-end, the down-slope mat should be overlapped a minimum of 10 cm (4 in.) by the up-slope length. The down-slope mat should be stapled into a trench.
  - ✓ Staples should be placed 45 cm (1.5 ft) apart along overlaps and 60 cm (2 ft) apart along outer edges, making sure the mat is in contact with the soil.
  - ✓ Erosion check slots shall be made in highly erodible areas or where slope exceed 4H:1V to prevent water from accumulating underneath the mat. On slopes more than 15.2 m (50 ft) long, there should be an erosion check slot at the midpoint. On slopes and ditches more than 30.5 m (100 ft) long, there should be a check slot at 15.2 m (50 ft) intervals. The check slots are trenches about 100 mm (4 in.) deep

and 100 mm (4 in.) wide dug across the slope or ditch.

- ✓ Consider installing a diversion ditch at the top of the slope to further control the amount of storm water that may flow over an area.

Fig.3. matting erosion control

➢ Geotextiles

- A geotextile, another form of erosion protection blanket, is a porous filter fabric, usually made from synthetic materials.
- Geotextiles can be used to stabilize channel floors or to protect seeding on planted slopes until they become established. It can also be used to separate soil and riprap to prevent the soil from being eroded from beneath the riprap.

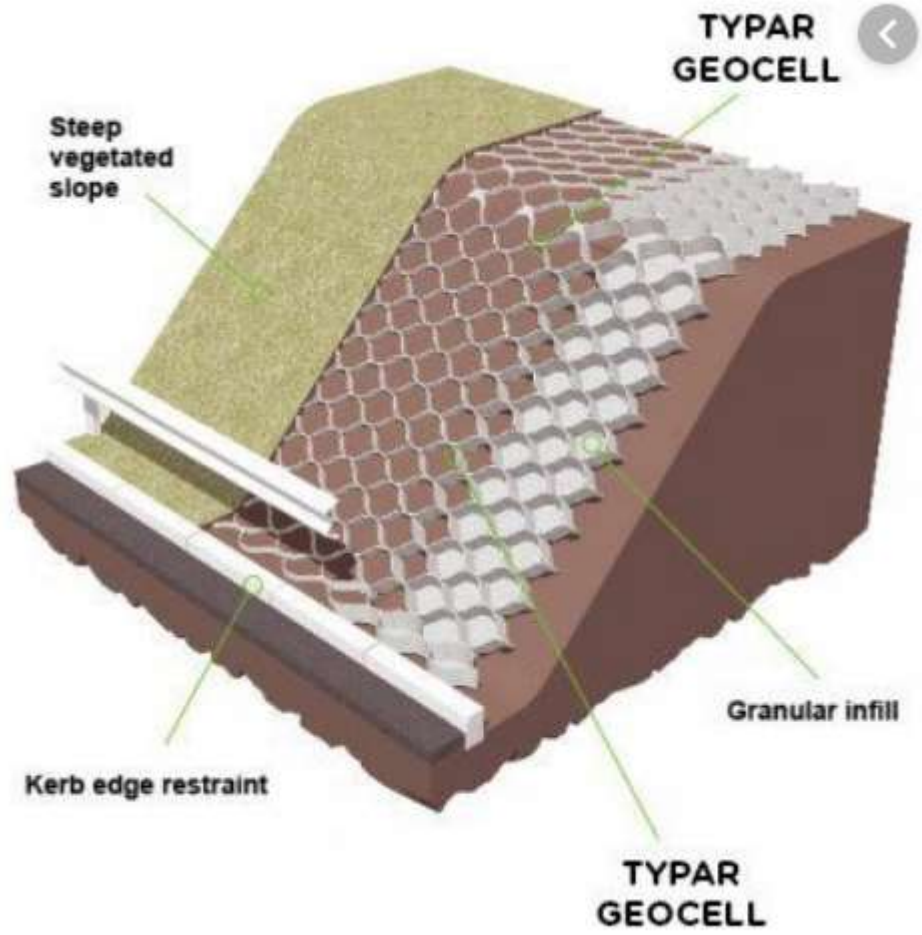


Fig. 4.geotextiles erosion control

➢ Rock Riprap

- Riprap is typically used on long steep slopes where it is difficult to establish vegetation due to high flow and surface runoff velocities. It can also be used to provide stream bank protection where vegetation alone is insufficient to prevent erosion.
- The stone size should be of a mixed gradation so that voids between large stones are filled with smaller ones.
- Filter fabric (geotextile) should be used to prevent fines from being washed out from underlying soil. To protect the fabric a layer of coarse gravel can be placed on top of the fabric, below the riprap.
- Riprap should be applied at a thickness of at least 1.5 times the maximum stone size and not less than 30 cm (1 ft) thick.

Fig.5. riprap erosion control

➢ Buffer Zones

- A buffer zone is a strip of dense vegetation that is used to minimize the erosion potential. They are often used to delineate disturbed areas, sensitive areas and property boundaries and to protect stream banks. It is usually used as a temporary measure where the area has not been finally graded.
- The buffer zone can be an area of natural vegetation that is left undisturbed during construction or it can be newly planted or seeded.
- The buffer strip should be wider for steeper slopes or areas exhibiting excessive runoff.
- Vegetation strips should be oriented perpendicular to the flow direction.
- The selection of vegetation depends on the site conditions and the intended use of the buffer strip. May consist of grasses, legumes, shrubs and trees.

Fig.6. buffer strip

2.2. Drainage And Sediment Control Structures

Runoff, which passes over disturbed soil, should pass through sediment controls before it flows off of the construction site. To remove sediments from sheet-flow run-off, a filtration device such as a sediment control fence should be installed on the perimeter of the disturbed area. For concentrated flow, a diversion device such as a drainage swale or dike should be constructed and carry the runoff to a sediment basin or sediment trap. Inlet protection for catch basins and curb inlets, which receive flow from a disturbed area, Should be constructed to remove the sediments from the runoff before it flows into the Inlet. The following are some common sediment control measures:

- **Earth Dike**
  - An earth dike or interceptor dike is a ridge or ridge and channel combination used to divert upslope runoff from construction areas towards sediment basins or sediment traps. They can also be constructed near the perimeter of the construction area to prevent sediment-laden runoff from leaving the site.
  - The dike can be constructed with compacted soil and stone, riprap, or vegetation.
- **Drainage Swale**
  - Often referred to as interceptor swale, interceptor ditch, diversion channel or

diversion ditch. The swale can be parabolic, V-shaped or trapezoidal.

- They are used to reduce slope lengths and to intercept and divert water away form

  construction sites or other erodible areas to a suitable outlet point such as a sediment trap or sediment control pond. They are usually built around the perimeter of the site or along the upslope perimeter of a disturbed area.
- They should be built before any major soil disturbing activity takes place on site.
- Depending on the soil type and the velocity and volume of the anticipated runoff, it may be necessary to line the swale with a geotextile and/or stabilize the bottom and sides of the channel with vegetation, rock or other type of stabilization. If the soil is silt, sand, sand and gravel or organic, it is recommended to line the swale with polyethylene or other geotextile and construct a number of check dams within it. Bedrock or hard glacial till subgrade can remain unlined. Steep gradient and/or swales carrying a large volume of water may require full rock armouring to design water levels to prevent bank erosion.
- Grassed swales are broad, shallow, gently-sloping channels stabilized by suitable vegetation, which can increase infiltration of runoff and sediment removal. Until turf becomes established it will be necessary either to (i) divert runoff via an alternative route (ii) line the channel with a temporary protective lining, and mulch the shoulders thoroughly, or (iii) lay sod over the channel.
- There should be no dips or low points in the swale where storm water can collect.

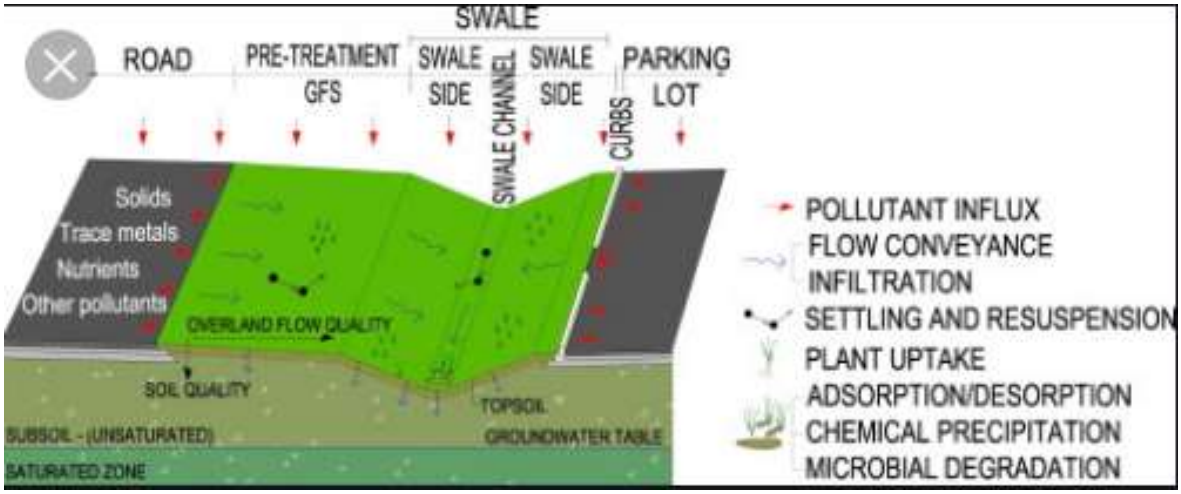


Fig.7. grass swale

➢ Gravel or Stone Filter Berm

- A filter berm is a temporary ridge constructed of loose gravel, stone, or crushed rock. It slows and filters flow, diverting it from an exposed traffic area to a stabilized outlet.
- This method is appropriate where roads and other right-of-ways under construction should accommodate vehicular traffic.
- Berms should only be used in gently sloping areas. The spacing of the berms will depend on the steepness of the slope. They should be placed closer together as the slope increases.
- Berm material should be well-graded gravel or crushed rock.

➢ Sediment Control Fences

- A sediment control fence, commonly referred to as silt fence or filter fabric barrier, is used to remove sediment from overland sheet flow runoff. It is not intended to handle concentrated channel flow or high velocities.
- Sediment fences are installed perpendicular to the flow to intercept runoff, trapping the sediment. A sediment fence should be used in the following locations:
  - i. To delineate buffer zones;
  - ii. Along the contours of exposed slopes;
  - iii. At the downslope perimeter of cut or fill slopes or disturbed areas;
  - iv. Adjacent to streams and along the bank of a watercourse;

v. At the outer boundary of the work area.

- The fence should be erected before there is any soil disturbed on the site.
- Should be used where the size of the drainage area is not more than 0.1 ha/30 m of silt fence length or in small swales where 1 ha is the maximum contributing drainage area.
- Prefabricated sediment control fences shall be installed as per the manufacturer's instructions.
- The following are some sediment control fence installation guidelines:
  - ✓ The geotextile fabric shall be erected to a height of approximately 0.75 m above the ground surface (so that at least 0.15 m is left as a bottom flap for burying) and secured to wood or steel posts.
  - ✓ Reinforcement of the fabric, using a wire fence, may be necessary.
  - ✓ Support posts should not be over 2.5 m apart. Extra strength filter fabric may be used without wire fence backing if posts are not over 2.0 m apart.
  - ✓ Fabric joints should be lapped at least 0.15 m and stapled. The filter fabric should be stapled to the upstream side of the wooden stakes.
  - ✓ The lower edge of the fence should be buried in a trench at least 0.15 m to 0.30 m deep and covered with backfill to prevent flow under the fence.
  - ✓ The sediment control fence should be inspected frequently. Sediment should be removed when they reach about half of the height of the fence, and shall be disposed of at a location at least 30 m from any watercourse and such that it cannot wash into a watercourse.

➢ Straw Bale Filter Barriers

- Straw bale barriers can be placed around the downslope perimeter of a disturbed area or along the bank of a watercourse in order to intercept runoff, trapping the sediment before it reaches a watercourse.
- They are a short-term measure and only effective to treat runoff from small drainage areas.

- They should be bound with wire or string, placed lengthwise in a trench, staked, and backfilled. There should be at least 2 stakes per bale. The first stake in each bale should be driven toward the previously laid bale to force the bales together.
- Straw bale barriers should be checked regularly and immediately after each rainfall. Straw bales can deteriorate in 30 to 60 days. Sediment control fences are stronger and have a higher filtering capacity than straw bale barriers.

2.2.1. Check Dams

- A check dam is a small dam constructed across a drainage ditch, swale or channel. It is used to trap sediments by reducing the flow velocity and allowing sediments to settle out before discharge to a watercourse, to minimize channel scour and to hold moisture in underlying soil, thereby facilitating the establishment of vegetation.
- The drainage area of the ditch or swale should not be greater than 4 hectares (10 acres). The check dams should be installed before drainage is allowed to flow through the ditch.
- Several check dams, not over 40 cm (1.3 ft) high, are preferable to a few larger dams. Check dams should be placed between 15 to 200 metres apart depending on the slope of the ditch and erodibility of the soil. The top of the check dam should be as high as the base of the one upstream.
- The center of the dam should be at least 15 cm lower than the ends of the dam. This can be accomplished with a notch at the center of the dam.
- Each end of the dam should be risen by 45 cm (1.5 ft) or more to protect the bank.
- A protective apron should be placed at the foot of the dam, extending 1 m (3.3 ft) beyond the main spillway and on both banks of the ditch.
- A small area should be excavated just upstream of the check dam to provide some capacity for trapping sediment.
- Regular inspections are necessary to ensure that sediment does not

accumulate to an elevation of more than half of the height of the dam at which point the accumulated sediment should be removed.

- The type of check dam used will depend on the volume and velocity of the runoff, the required life expectancy of the dam and on whether the check dam is to be temporary or permanent.

i. Stone Check Dams

- Used in ditches of low to moderate slope (1-8o), having a small drainage area.
- The size of stone should be selected base on the anticipated velocity of runoff.
- They are usually constructed with stone having a minimum size of 50 mm. If available, a gradation of stone size of at least 100-150 mm (4-6 in.) should be used. If 25-50 mm (1-2 in.) rock is used, the centre and backside of the dam should be protected with 100 mm (4 in.) rock.

  A geotextile filter should be placed under the stones to provide a stable
- foundation, to facilitate the removal of the stones and to prevent the finer soil particles from washing away.

  The side slopes should be approximately 2H:1V.
- Stone check dams vary in height up to 1.0 metre depending on the size and
- drainage area of the ditch and should be placed such that the elevation of the toe of the upstream dam is the same elevation as the top of the downstream dam.

Fig.8. stone check dams

ii. Log Check Dams

- Should be constructed with logs of 10 cm to 15 cm diameter salvaged from clearing operations if possible.
- The logs should be embedded at least 45 cm into the soil.
- The center of the check dam should be approximately 15 cm lower than the outer edges.

iii. Gabion Basket Check dam

- Gabion baskets are fabricated from wire mesh and filled with rock.
  May be used in channels or ditches of moderate slope, having a small to medium size drainage area, and where a source of rock is available.
- The bottom of the wire baskets should be set approximately 300 mm (12 in.) below the bottom of the ditch.
- Placing a layer of straw at the bottom of the gabion can improve the sediment trapping efficiency.
- A rock apron should be placed down-stream of the baskets and extend 1 m (3.3 ft) from the gabion.
- The channel sides should be stabilized by sodding, seeding, mulching or gravelling immediately after construction.

iv. Plank Dam

- Plank dams can be used in channels with small to medium drainage areas and when a durable check dam is required.
- Posts are set at a depth of approximately 1 m (3.3 ft) in a straight line across the channel (on each side of the spillway).
- A 30 cm deep (1 ft.) trench should be dug along the upstream side to permit placing the bottom plank and a thin layer of straw or grass as a seal. The trench should be backfilled and well compacted with earth.
- Planks are nailed to the posts with the ends of the planks set well into the banks.
- A spillway notch shall be cut in the center of the dam and a rock apron installed.

v. Straw Bale Check Dams

- Straw bales are often used as check dams in channels or ditches. They should not be used in channels with drainage areas greater than 0.8 hectares.
- Straw bales must be secured into the channel and staked with two stakes angled towards the adjacent bal

vi. Sandbag dams

- Sandbag dams can be used in channels with small drainage areas and a low runoff velocity.
- A trench is excavated to a depth of 25 cm (10 in.) across the channel or ditch.
- Sandbags are laid in a row across the channel at least two bags high. The bags should be overlapped.
- Sandbags can be used to create an apron below the spillway. Sandbags should extend a minimum of 1 m (3.3 ft) downstream.
- The sides of the channel should be stabilized by sodding, seeding, mulching or gravelling immediately after construction.

vii. Spillway Structure for Sediment Pond Dykes

- They are used in conjunction with sediment ponds to retain water and allow suspended particles to settle out. The discharge from the ponding area is filtered by riprap, which lines the outlet. They are built to pond runoff from ditches or from grubbed areas, or at the end of a cut where runoff leaves the ditch to flow down a natural slope.
- Sediment should be removed when it accumulates to a level equal to half of the design depth of the trap or prior to the level of sedimentation reaching a point within 300 mm of the crest of the spillway.

viii. Riprap Erosion Control Structure for Ditches

- Typically installed in rock ditches where stakes required for Type C and D structures cannot be driven.
- A small ponding area is excavated behind the dam where the runoff is detained before discharging.
- They are usually used in channels having grades steeper than 8% with heavy flows or in rock ditches where stakes cannot be driven.
- They should be constructed of geotextile fabric and random riprap “R-5”. The outlet consists of rock with an impermeable membrane sandwiched between the rocks.
- Sediment deposits shall be removed when the level of sedimentation is within 100 mm of the top of the structure, or as directed by the Engineer.

ix. Straw Bale Erosion Control Structure for Ditches

- Consists of a small dam made of geotextile fabric, straw bales and riprap constructed across a ditch. A small ponding area is excavated behind the dam where the runoff is detained before discharging.
- They can be used in channels or ditches and along side of waterways or property boundaries. They are most effective for treating small drainage areas (less than 0.6 to 0.8 hectares) for a short period of time.
- Generally used in ditches having grades up to 8 % with low to medium

flows.

- A trench the width of a straw bale and the length of the proposed barrier should be excavated to a minimum depth of 100-150 mm (4-6 in.) below the surface.
- The bales are placed on their sides tightly together in the trench.
- Two wooden or steel stakes need to be driven through each bale. The first stake in each bale should be driven toward the previously laid bale to force the bales together.
- Loose straw should be wedged between any cracks to seal openings.
- The excavated soil should be backfilled and lightly compacted up to a depth of 100 mm (4 in.) against the upslope side of the barrier and to ground level on the down-slope side.
- A sediment trap should be excavated on the upslope side of the barrier.

Sediment deposits shall be removed when the level of sediment is about halfway to the top of the structure or prior to the level of sedimentation reaching a point within 100 mm of the crest of the notch.

- Straw bales must be checked on a regular basis and rafter each rainstorm. Straw bales can deteriorate in 30 to 60 days.

2.2.2. Sediment Control Ponds

- Runoff from a disturbed area can be intercepted and directed to a sediment control pond, also referred to as sediment basin or siltation pond, where runoff is detained long enough to allow most of the sediments to settle out.
- A sediment pond differs from a sediment trap with respect to the contributing drainage area it services. Ponds are generally constructed for larger disturbed areas or where the volume of water to be treated is expected to be high. They are usually designed for disturbed areas larger than 2 hectares (5 acres).
- The pond should be located at the lowest practical point in the catchment area, below construction activities, and should be large enough to handle the maximum expected amount of runoff. It should be constructed before

any land disturbing activity occurs on the site. Multiple ponds may be designed for a large development.

- The pond design should include an outlet riser pipe and a spillway or gravel outlet to prevent scour. It may be necessary to use filter fabric on the spillway.
- The sediment pond should be inspected periodically and after each rain event.

  The pond should be cleaned out when sediment have filled about half of the volume. The accumulated sediments shall not be disposed within 30 m of a wetland or waterway or where it could re-enter the basin.
- The pond should remain in operation until the site is permanently stabilized by vegetation and/or permanent measures are in place.
- The sediment pond should be designed by a qualified engineer.

Fig. 9.sediment capture ponds

The following are some design guidelines for sediment control ponds:

- ✓ Identify the contributing drainage area, the anticipated runoff volume and the soil type. Larger ponds may be required if soil is clay or silt as they

take more time to settle.

- ✓ In general, the pond should be sized for a minimum storage volume of 250 m3/ha.
- ✓ The average pond depth should be at least 1.2 m (4 ft) to lessen the clean out frequency.
- ✓ Average hydraulic retention time: Minimum of 40 minutes.
- ✓ Length to width ratio should be a minimum of 2:1, preferably 4:1, in order to increase the amount of time in which settling may occur.
- ✓ Minimum sediment storage depth: 0.5 meters
- ✓ Minimum freeboard: 0.6 meters
- ✓ Interior side slopes should not exceed: 2H:1V
- ✓ Exterior side slopes should not exceed: 3H:1V

➢ Sediment Traps

- Overland flow runoff from a disturbed area can be directed to a sediment trap,which operates like a small sediment control pond. The trap retains the runoff long enough to allow most of the sediments to settle out.
- The sediment trap is formed by excavating a pond or by placing an earthen embankment across a low area or drainage swale.
- Sediment traps are suitable for small drainage areas, usually less than 2 hectares (5 acres). The trap should be large enough to allow the sediments to settle and should have the capacity to store the sediments until removed.
- In general, sediment traps should be sized for a minimum storage volume of 150 m3/ha over the contributing drainage area.
- Side slopes should not exceed 2H:1V.
- Traps should be inspected periodically and after each rainfall. The trap should be cleaned out when sediment have filled about half of the design volume. The trap should remain in operation until the site area is permanently stabilized by vegetation and/or other permanent measures.

➢ Storm Drain Inlet Protection

- Drain inlet protection will prevent sediment from entering the underground storm pipe system prior to stabilization of the disturbed area. Drain or curb

inlet protection should be used where storm inlets are operational prior to permanent stabilization of the disturbed area.

- Storm drain inlet protection is a filtering measure placed around any inlet or drain to trap sediment. Inlet protection can be formed using gravel or stone, sod, straw bales or filter fabric, which trap the sediment before it enters the system. Filter fabric is used when storm water flows are relatively small with low velocities.
- Gravel filters can be used where velocities are higher.
- This type of protection is appropriate for small drainage areas, generally not exceeding 0.4 hectares (1 acre) and where storm drain inlets will be operational prior to permanent stabilization.

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 is an erosion control measures? (5points)
2. What are the components of erosion and sediment control measures (5points)
3. Mention different type of check dam. (5points)
4. Write difference between mulching and matting (5points)

Answer Sheet

Score = _____
Rating: _____

Note: Satisfactory rating - 20 points Unsatisfactory - below 20 points

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

Information Sheet-3	Applying site works maintenance inspection schedule

3.1. Maintenance and inspection

Erosion and sediment control measures must be inspected and maintained regularly, particularly after rain that causes runoff, to ensure they function correctly and that any failures or inadequacies are corrected as soon as possible. Damaged or poorly constructed measures can actually create more erosion than they prevent.
When no longer should require, temporary measures be removed and the area should stabilized and establish vegetation.

A maintenance program should be implemented throughout construction activities. The maintenance program should include daily routine checks, repairs, replacements and an inventory of control materials. All control measures shall be inspected periodically and after each rainfall event.

Ensuring that erosion and sediment control structures are properly maintained will also prevent or limit mosquito breeding. Some maintenance principles include cleaning out the temporary sediment traps and basins, maintaining ditches to ensure positive drainage and removing grass cutting and other debris.

The sediment and erosion control devices must remain in place and be maintained in functional condition until permanent vegetation has been established or the site is otherwise stabilized.

Self-Check 3	Written Test

Name: _____ Date: _____

Directions: Answer all the questions listed below.

1. Mention the importance of maintaining erosion and sediment control structures (5 points)

Answer Sheet

Score = _____

Rating: _____

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

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

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2. Taffa Tulu, 1983. Manual on soil and water conservation
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5. http://www.or.nrcs.usda.gov/contact/countydir.html
6. https://en.wikipedia.org/wiki/Sediment_control

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