NATURAL RESOURCES CONSERVATION AND DEVELOPMENT

NTQF Level -II

Learning Guide #40

Unit of Competence: - Participate in Indigenous Soil and Water Conservation Practices

Module Title: - Participating in Indigenous Soil and Water Conservation Practices

LG Code:- AGR NRC2 M09 LO3-LG#40

TTLM Code: AGR NRC2 TTLM 0919v1

LO 3: - Prepare for implementation of soil and water conservation measurement.

Instruction Sheet	Learning Guide #9

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

- Observing and following OHS procedures
- Matching indigenous soil and water conservation works
- Identifying survey pegs and site indicators.
- Matching equipment and tools
- Verifying work readiness of equipment and tools
- Selecting materials in line with construction 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 –**

- Observe and follow OHS procedures
- Match indigenous soil and water conservation works
- Identify survey pegs and site indicators.
- Match equipment and tools
- Verify work readiness of equipment and tools
- Select materials in line with construction schedule

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 20.
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 5.
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.

8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2” in page 7.
10. 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 2).
11. Read the information written in the “Information Sheets 3 . Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the “Self-check 3” in page 11.
13. 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 3).
14. If you earned a satisfactory evaluation proceed to “Operation Sheet 1” in page 12. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
15. Read the “Operation Sheet 1” and try to understand the procedures discussed.
16. If you earned a satisfactory evaluation proceed to “Operation Sheet 2” in page 13. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
17. Read the “Operation Sheet 2” and try to understand the procedures discussed.
18. If you earned a satisfactory evaluation proceed to “Operation Sheet 3” in page 14. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
19. Read the “Operation Sheet 3” and try to understand the procedures discussed.
20. Do the “LAP test” in page 15 (if you are ready). Request your teacher to evaluate your performance and outputs. Your teacher will give you feedback and the evaluation will be either satisfactory or unsatisfactory. If unsatisfactory, your teacher shall advice you on additional work.

Information Sheet-1	**Observing and following OHS procedures**

During construction of ISWC practices care has to be taken for workers (OHS) and property (tools and equipments). Observing and following OHS procedures may include, but not limited to:

- The use of Personal Protective Equipment (PPE) and clothing
- The use of safety and first aid equipment
- Forest pest and disease fighting measures
- Hazard and risk control
- Elimination of hazardous materials and substances
- Appropriate fitness for the task
- OHS hazard identification,
- Risk assessment and control procedures for dealing with hazardous events

Self-Check -1	Written Test

Name: _________________________ Date: _______________

Short Answer Questions

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are OHS procedures may include?(3points)

Note: **Satisfactory rating ->1.5 points Unsatisfactory - below 1.5 points**

Answer Sheet

Score = ___________

Rating: ____________

Information Sheet-2	Matching indigenous soil and water conservation plan to site conditions.

2.0. Matching indigenous soil and water conservation plan to site conditions.

Introduction to Soil and Water Conservation in Ethiopia

Prior to the 1974 revolution, soil degradation did not get policy attention it deserved. The famines of 1973 and 1985 provided an impetus for conservation work through large increase in food aid (imported grain and oil). Following these severe famines, the then government launched an ambitious program of soil and water conservation supported by donor and non-governmental organizations. The use of food aid as a payment for labor replaced voluntary labor for conservation campaigns.

A total of 50 million workdays were devoted to the conservation work between 1982 and 1985 through food-for-work. In Wollo a household head was providing on average 93 days per year and a women working approximately 69 days per year. Between 1976 and 1988, some 800,000 km of soil and stone bunds were constructed on 350,000 ha of cultivated land for terrace formation, and 600,000 ha of steep slopes were closed for regeneration. This environmental rehabilitation endeavor was described as "impressive"

However, this was not a long-term success and these structures had little long-term impact in preventing erosion. Almost all these sites, structures and practices were destroyed shortly after the construction. The monitoring made in one of the sites where conservation intervention was made by the support of the WFP indicated that 40% of the terracing was broken the year after construction. The project expected that the local people would bear all the costs of maintenance. Yet, farmers had few incentives to maintain structures or continue with practices. Seldom were structures Maintained and all often-impressive new structures and practices slowly disappeared leaving little evidence of intervention. Because of the failure of the local people to maintain the conservation measures, the introduced conservation measures that were originally designed as a protection against erosion rather exacerbated the problem.

By most performance measures, soil and water conservation effort of the country ended up in remarkable failure. A large sum of money has been spent in the name of encouraging environmental protection, encouraging and coercing farmers to adopt conservation measures. Nevertheless, the implementation was very poor. Few structures persisted causing erosion rather than preventing it.

As pointed out earlier, to adopt the approach of integrated development, the SWC system is used as the detailed planning and subsequently the development unit. In order to execute the plan and to make as practically as possible the size of SWC area should not be too large. As a guide an area ranging from 1000-5000 ha is ideal. The SWC planning requires many factors to be considered or studied. E.g. climate, topography and slope, soil properties, availability of water, crop and livestock production (i.e. in depth analysis of socio-economic features, etc. To assess the general condition situations and standard-living conditions.

It is important to note that these factors should not only be studied as individual component but also their interactions. Analyses of these factors lead you to ask if there is a need for improvement of the SWC area.

It should be stressed that the involvement of the local population on the planning and implementation of SWC development is the key factor for the success. Past experience, shows that purely technical solution to the problem without adequate participation of the local farmers are bound to meet with failure.

Causes for the failure of past soil conservation efforts in Ethiopia

Studies conducted in different parts of the country came-up with different factors that explains the low level of success of conservation initiative. These studies attributed the low level of success of the initiative mainly to institutional and technological factors.

- **Institutional factors**

During planning soil and water conservation intervention, top-down approach was pursued where government officials tell peasant association (Kebeles) what to do to get the food aid. This approach gave local people little opportunity for discussion and participation on the initiative. The local people did not have a say on the design and their role was limited to provision of labor for the payment they get from the work. This made the local people see the initiative as imposition from the government and additional burden farmers are made to bear.

- **Technological factors**

Conservation initiatives that have been launched mainly focused on physical conservation measures. Other conservation measures such as biological and agronomic conservation practices that could have potential to provide incentive for adoption have been overlooked. In addition to this, these conservation measures have not been linked to indigenous conservation measures for which the local people are well acquainted. The return from these measures was in general negative at least in the short term. They take large proportion of area out of production. Introduction conservation measures through bund and terraces took up to 10% of the precious resource of farmers. The proportion these measures take increased rapidly with increasing slope of the field. Nevertheless, the benefit these structures increase from infiltration and reduced soil loss do not outweigh the loss of land to conservation works and the reduced yields caused by vermin living in terraces, water-logging and disturbance of the soil profile. These structures also require frequent maintenance, which is high labor demanding. These all resulted in negative attitude towards conservation.

➤ **Policies towards soil conservation in Ethiopia**

Polices related to land, the most important resource for the rural poor and of the national governments at different time played an important role in land management in Ethiopia.

2.1. Planning for conservation practices

The term "SWC" implies improved management of the two resources "soil" and "water", in order to maintain (support, increase) in a medium- to long-term perspective the production capacity of these resources, often measured in terms of crop yield.

Planning and implementing a technology is always a reaction to one or more (degradation) problems, which are identified through observations that are largely determined by the specific perception and knowledge of the observer.

The term "soil and water conservation" reflects a dual option, and it depends on the humidity of an area and the stakeholders' goals which option is more important.

- **In sub-humid areas**, the main focus lies normally on soil conservation with the opportunity to conserve moisture during times of low rainfall.
- **In semi-arid areas**, emphasis is given to water conservation with the option to pre-vent soil erosion during heavy rainstorms.
- In areas with **both long rainy seasons with extended dry spells**, the art of SWC is to combine both effects.

It is obvious that the farming practices and technologies described in what follows have different functions, the most important of which is food production.

Sequences in planning soil conservation

Soil conservation programs must be well designed if they are to reduce erosion effectively and not fail. The planning is important to identify major areas of erosion and to select suitable conservation measures so that the farmers are willing to implement it.

Brief sequences in planning soil conservation:

- Beginning with through assessment of erosion risk using techniques of erosion hazard assessment such as, rainfall agressivness, erodibility, topography or practices.
- Followed by land use plan by adopting land classification methods, so that the land is used in accordance with its capability. This enables to identify which area is suitable or not for particular purpose under present or proposed economic, social and production technology. At this stage you could be able to identify where erosion is likely to occur etc.
- Once the appropriate land use has been determined, the conservation measures proposed must be relevant to the farming system, and the nature of the erosion problem.
- The final stage is to quantify the impacts of the proposed land use and associated conservation strategy on the crop production and environment. Ideally economic evaluation can be made, but the benefits related to minimizing adverse environmental impacts are difficult to quantify.

The sequence of events to be considered in planning a soil conservation strategy, suggested by **perrens and trustrum (1984)** is given as under;

A. land and water resource inventory

i. land resource inventory

- ✓ erosion and present land use
- ✓ Physical factors; soils, geology, rainfall, slope, vegetation, micro relief, drainage pattern.

ii. water resource inventory

- ✓ existing development and use
- ✓ Physical factors; stream flow, floods, water quality, sedimentation.

B. land capability assessment and erosion sedimentation index

i. land capability assessment

- ✓ assessment of capability and suitability of landscape units;
    - mountain
    - steep lands
    - hill lands
    - flat lands

ii. erosion/ sedimentation index

- ✓ identification of sources of erosion hazard and fate of sediment
- ✓ rank of landscape unit and elements based on erosion and sedimentation sources and sinks.

C. potential land use and suitability and conservation needs

i. potential land use suitability

- ✓ based on resource capacities and constraints
    - forestry, agro-forestry, grazing, extensive cropping & grazing and intensive cropping

ii. conservation needs

- ✓ Consider socio economic factors and integrate soil conservation with land use.

D. conservation needs with land use potential

- protection forestry
- production forestry
- gully controlling works
- contour cultivation and strip cropping
- zero or minimum tillage

E. options and priorities

- ✓ use economic analysis (benefit cost analysis) to judge the alternatives

e.g.

- reserve A and E for forestry
- develop farming system for D
- improve productivity of B
- develop cropping and tillage system for C

F. management actions

- ✓ Sheet erosion, wind erosion, sedimentation, flooding, landslides, gullies, stream banks

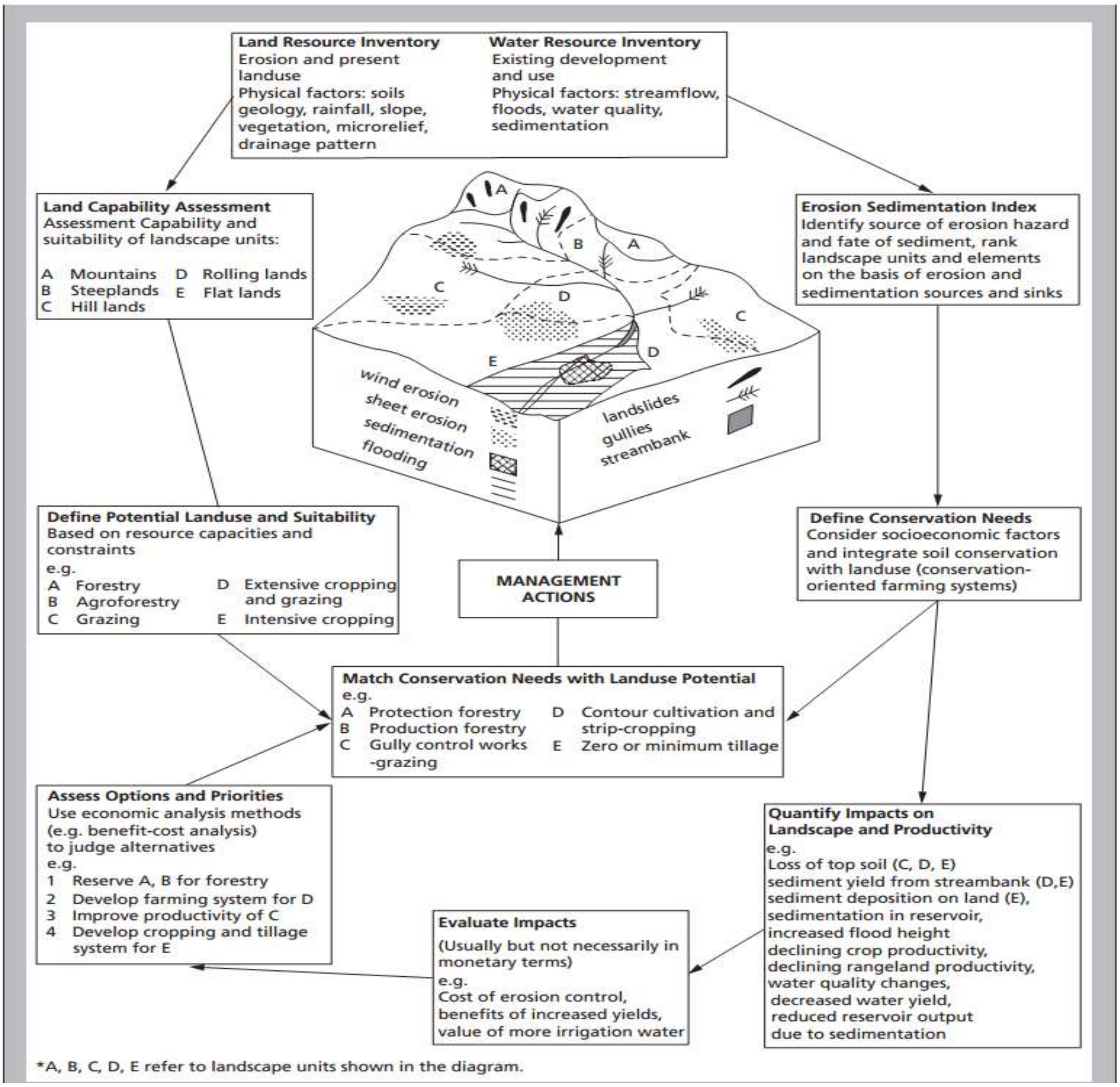
G. quantify impacts on landscape and productivity

- ✓ loss of top soil (B, C, D)

- ✓ Sediment yield from stream bank (C, and D)
- ✓ Sediment deposition on land (C)
- ✓ Increased flood height
- ✓ Declining crop productivity
- ✓ Declining range land productivity
- ✓ Water quality changes
- ✓ Decreased water yield
- ✓ Reduced reservoir output due to sedimentation

H. Evaluate impacts

- ✓ Cost of erosion control
- ✓ Benefits of increased yield
- ✓ Value of more irrigation water.



Preparation for SWC System development planning

Having identified the SWC System for development, the next stage is collecting the above mentioned basic information of the SWC area. Some of the required information may be obtained from maps and aerial photographs if available. However, much of the information will have to be collected from the map, report, interview and field reconnaissance.SWC development planning should refer to **multi-disciplinary approaches**. It is not only conservationist interest but also other sectors of economic development. Mainly agronomist, extension promotes, forester, soil scientist, range land manager, sociologist may be required. But in many situations all these disciplines may not be available. So that the core disciplines can be sufficient.

Information required about SWC area include:

- **Assessment of bio-physical** particularly climatic conditions
  - Knowledge of **climatic conditions** likely to occur in SWS area is basic requirement. The amount distribution and intensity of rainfall is a particular importance. This is useful for the design of many soil and water conservation structures. In addition the knowledge of rainfall and temperature is essential for selected a suited vegetation erosion control species. This information may be obtained from metrology stations, National Atlas of Ethiopia supplemented by local people information.
  - Information about **topography, slope and vegetation condition** of the area are also required.
- **Socio-economic survey**
  - The socio-economic survey must reflect the conditions and important characteristics of SWC area. Socio-economic survey of the SWC area is a fundamental requirement and are useful to identify farmers problems, requirements priorities and also helps to identify where development potentials exist to improve living standard of the farmers.

TIP

What type of information can I expect to find on a topographic map?

A topographic map identifies numerous cultural and natural ground features, which can be divided into the following categories:

- culture: roads, buildings, urban development, boundaries, railways, power;
- transmission lines;
- water: lakes, rivers, streams, swamps, rapids;
- relief: mountains, valleys, slopes, depressions;
- vegetation: wooded and cleared areas, vineyards and orchards;
- toponymy: place names, water feature names, highway names.

Refer to the legend on the back of a national topographic map for a complete listing of all features and their corresponding symbols. Information along the map borders and on the back of the map provides valuable details to help you understand and use a topographic map; for example, the map scale and scale conversion, the legend and the currency of the map information.

Table; Sample Plan and program format

Activity	Location of activities	Required budget	Required materials	Time frame	Responsible personnel	Remark

2.2. Preparing schedule of works

Activity	Work schedule (In months)											
	Jan.	Feb.	Mar.	Apri	May	Jun.	July	Aug.	Sept.	Oct.	Nov	Dec.

***Note**: Weekly and daily activity plan template is also prepared as shown in table above*.

2.3. Matching site conditions with the plan and schedule of works

Matching indigenous and introduced soil and water conservation plan and schedule of works with site conditions helps us for successful implementation of the plan. Here is the development plan format as described below.

The format of the development plan consists:

a) **The development map**: The location of the development measures are shown on this map. The extension worker therefore can easily locate on the ground where various soil and water conservation measures to be built. In addition any development work that has been previously implemented (which has been indicated on the present land use map) should be also recorded on this map

b) **A table of inputs**: After completing the development map the next step is preparing the table of inputs to determine the appropriate inputs required for implementing the plan. The volume of inputs required can be estimated from the extent of the work, specification, availability of tools, materials, labor and others.

c) **The time table**: A time table for the development measure should be prepared. The time table is used when to implement the various development measure and quantity of labor and other material required.

Self-Check -2	Written Test

Name: ___________________________ Date: ________________

Short Answer Questions

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention a brief sequences in planning soil conservation works. (10points)
2. SWC development planning should refer to **multi-disciplinary approaches**. What does a multi-disciplinary approach mean? (5points)
3. What are the two Information required about SWC area? (5points)

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

Answer Sheet

Score = ___________

Rating: ____________

Information Sheet-3	Identifying survey pegs and site indicators.

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.

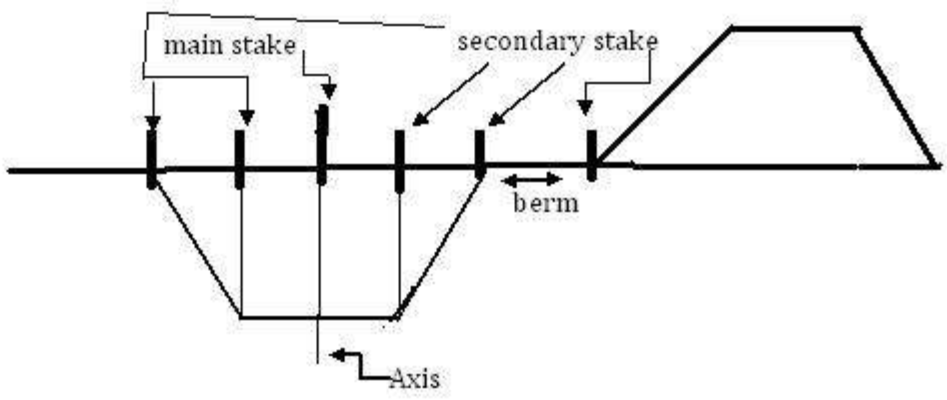
ii. **Additional or secondary staking**

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. ground plan depicted on paper



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

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

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 3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. If the top and bottom width of a trapezoidal diversion ditch is 60cm and 40cm and has a depth of 0.6m, what is the volume of earthwork of 900m long diversion ditch? (5 points)
2. If work norm of question two above is $0.7m^3$/PD, how many persons are required to accomplish the work in one day? (4 points)

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

Answer Sheet

Score = ____________
Rating: _____________

Information Sheet-4	Matching equipment and tools

Matching **equipment and tools** to program works and terrain on site for successful implementation of indigenous SWC work 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 ISWC 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 equipments 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 4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the constraints that may enhance or hinder the ISWC program works? (5points)
2. List equipments and tools needed for ISWC works.(5points)

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

Answer Sheet

Score = ____________
Rating: _____________

Information Sheet-5	**Verifying work readiness of 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 5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

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

Answer Sheet

Score = ____________

Rating: ____________

Information Sheet-6	Selecting materials in line with construction schedule

Materials are selected to complete proposed works in line with construction schedule. Out of the verified tools and equipment select materials to complete proposed works in line with construction schedule.

Self-Check 6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

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

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Operation Sheet 1	I. Marking contour lines

Contour lines are horizontal lines across a slope, linking up points at the same elevation. It is important to mark contour lines as preciously as possible when building barriers such as level bunds and bench terraces that protect the soil from erosion. A simple way of marking contour is line level.

The line level

A line level consists of two wooden poles of the same height (usually 2 m) with a string 10 m long joining them. The poles have marks every 10 cm. a sprit level is tied exactly in the middle of the string.

You will also need sticks or pegs to mark the contour on the ground (about 20 pegs per 100 m), and a stone or hammer to drive the pegs in to the ground. Three or four people are needed to mark contours using a line level.

Using a line level to mark contours

1. Always starts laying out contours at the top of the slope (not the middle or bottom), or immediately below the cutoff drain (if you have dug one). Drive a peg in to the ground where you want the first contour to begin.
2. One person holds the first pole upright at this first peg. The other person walks roughly level with the other pole until the string is tight. The third person checks the sprit level in the middle of the string, and directs the second person to move the pole up or down the slop until the bubble is in the middle of its run. Drive a peg in to the ground next to the second pole.
3. The two people holding the poles then both move forward until the first pole is at the second peg. Keeping the string tight, the second person again moves his or her pole up or down the slope until the line is again level. Drive a third peg in to the ground here. Repeat the process until the whole contour line is marked out.
4. To start a second contour line further down the slope, find a starting point by measuring the vertical interval you want. Then repeat the process for the new contour line.

In difficult topography, it might be inconvenient to measure 10 m at a time. Try to use half of the string (5 m).

Operation Sheet 2	Method of Marking graded lines

Graded are lines of constant gradient (usually 1% or 2%), going across a slope. They are used to plan conservation structures, such as cut-off drains and graded terraces that need to slope gently so they allow water to drain away.

Line level to mark graded lines

You can use the same line level as for marking contours, only you have to fix the string differently. The string on a standard line level is 10 m long.

First, decide the gradient you want to mark. For a 1% gradient, the height difference over 10 m equals 10 cm. tie the string on one pole at a height of 110cm. on the other pole, tie it at 100 cm. when the bubble is at the centre of the sprit level, the string will be level, but the bottom of the second pole will be 10 cm higher than the bottom of the first pole.

For a 2% gradient, tie the string at 120 cm on the first pole, and the other end at 100 cm.

For a 0.5% gradient, tie the string at 105 cm on the first pole.

Using a line level to mark graded lines

procedures

1. Start marking graded lines at their lower end, for example, where you want a graded drainage line to meet a natural stream. Mark this place with a peg, and stand the pole with the string tied higher up (e.g., at 110cm) here.
2. Move the other pole (tied at 100 cm height) roughly level and slightly upslope until the string is tight (10 m away).
3. Check whether the bubble is in the center of the sprit level. Move the second pole up or down the slope until the bubble shows the string is exactly level. Mark this point with another peg.
4. Move both poles forward until the first pole is at the second peg (this pole must always be lower down, nearer the start of the line). Move the second pole until the string is tight, then move it up and down the slope until the string is level. Mark this point with a third peg. Repeat this process until you have marked out the whole graded line.
5. To start a second graded line, find a starting point by measuring the vertical interval you want. Then repeat the process for the new line.

Operation Sheet 3	Measuring vertical intervals and slope gradients

Measuring vertical intervals and slope gradients

A' vertical interval' is the distance in height between two objects, such as two terraces contour bunds. Conservation structures should be built at a small enough vertical intervals to prevent erosion.

Measuring vertical intervals with a line level

Procedures

1. To measure a vertical interval of 1 m, fix the string on one pole of the line level at 100 cm. you can unite the string from the other pole; you will not need it.
2. Have the person with the free end of the string hold it on the ground at the top of the slope.
3. A second person with the pole and string attached moves straight down the slope. The first person pays out enough string to keep the string taut. The third person watches the bubble in the sprit level.
4. When the bubble is in the center of its run, the string is level. The pole is exactly 1 m below the free end of the string. Mark these two places with pegs or stones.
   On gentle slopes, the string may be too short. Try measuring the vertical interval in two steps of 50 cm each.

To mark a larger vertical interval of, say, 1.5 m, you can measure a 1 m vertical interval, then one of 0.5 m.

A rule of thumb for spacing structures such as check dams and bench terraces:

- On slopes less than 15%, use a vertical interval of 1 m.
- On slopes steeper than 15%, use a vertical interval 2.5 times the depth of the soil. For example, if the soil is 50 cm deep, space check dams at a vertical interval of 125 cm.

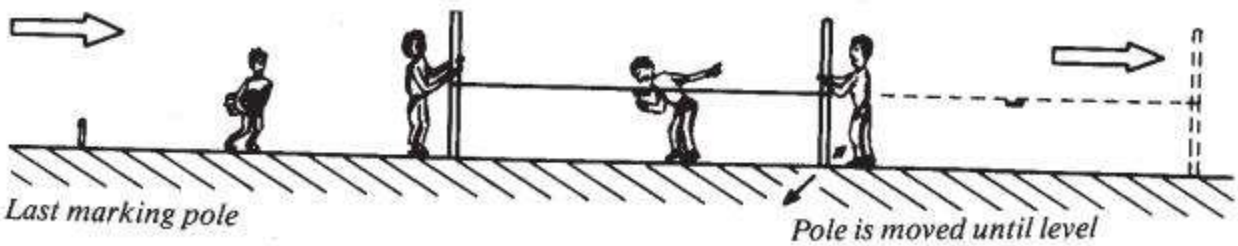
Operation Sheet 4	Measuring vertical intervals and slope gradients

Measuring slope gradients with a line level

Procedures

1. Measure a convenient vertical interval (cm) of any distance
2. Measure the horizontal interval (length of the string) in meters.
3. Divide the vertical interval by the horizontal interval.
   Slope in % = $\frac{\text{Vertical interval in centimeters}}{\text{Horizontal interval in centimeters}} \times 100$

Proceed across the slope as shown in the drawing below. Survey 10 m at a time, in difficult topography only 5 m (half the rope).



a) Definition:

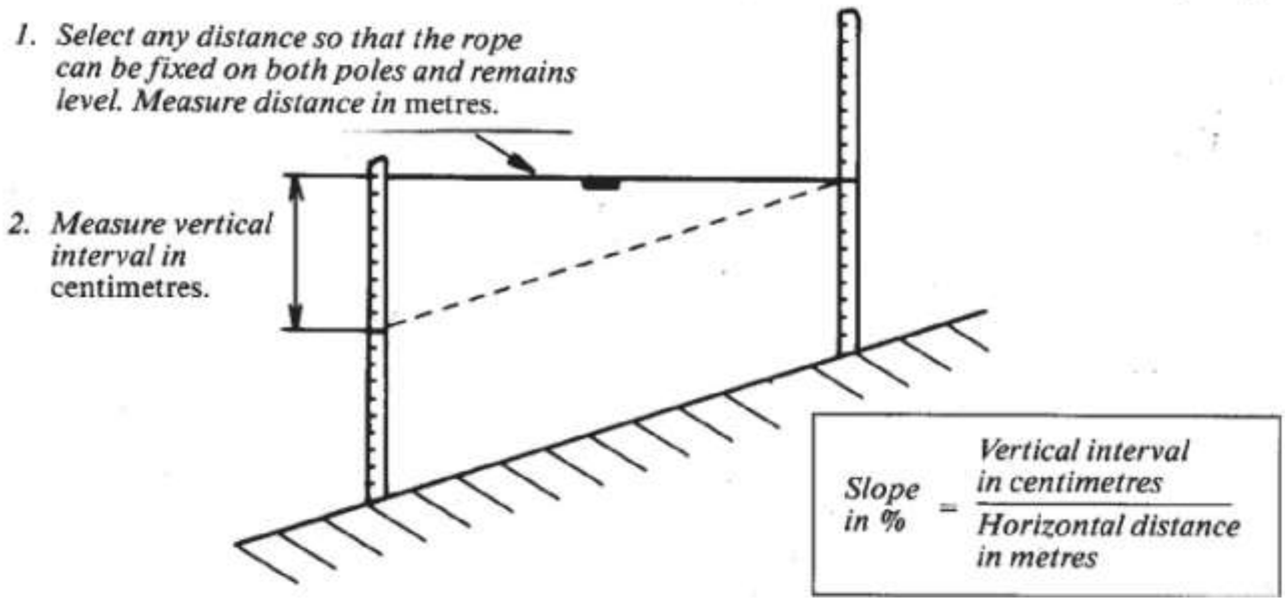
Slope gradient is the steepness of a slope. It is given as height in percentage of length (%) or in degree.

b) Materials:

The following items are needed:
- Waterlevel or this page of the book (see c) below)
- Thin plastic rope, 11 m long, meter band or meter stick
- 2 wooden poles, 2 m long, marked every 10 cm
- Small poles for marking on the ground

d) Measuring slope gradients with the line level:

Follow the steps given below and use the formula to calculate the slope percer tage. Take care that you use the correct units (1 metre = 100 centimetres, cm)



LAP Test	Practical Demonstration

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

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

Task 1.

Task 2.

Task N.

List of Reference Materials

1- **BOOKS**

2- **WEB ADDRESSES (PUTTING LINKS)**