

ROAD CIVIL WORK

Level II

NTQF

Learning guide 38

**Unit of Competence: Conduct Gravel Pavement
Works (Labor Based)**

**Module Title: Conducting Gravel Pavement Works
(Labor Based)**

LG Code: CON RCW2 M10 LO1-38

TTLM Code: CON RCW2 TTLM 1019 v1

**LO 1: Prepare and perform pre-
condition activities**



Instruction Sheet

Learning Guide 38

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

- Safety requirements of equipment, OHS regulation requirements and application
- Types, Sources and use of codes and standards
- Type and function of plant, tools and equipment
- Work place traffic management
- Work activity planning and management
- Time and resource management
- Duties and responsibility of employ and employer
- Environmental protection requirements

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 –

- Apply Types & Sources of Information are obtained, confirm the allotted task.
- Obtain and implement Occupational Health & Safety requirements as per organizational policies and procedures.
- Identify signage requirements are obtained and implemented.
- Check and Select Plant, tools and equipment to carry out tasks are for serviceability and any faults are rectified or reported.
- Identify Material appropriate the work application, safely handled and located ready for use.
- Responsibilities and obligations civil construction employment conditions are communicated.
- Identify Environmental protection requirements of the project environmental management plan or appropriate regulatory specifications



Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks”. in each information sheets.
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-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next information sheet



Introduction to module

- **Introduction to labor based Conduct Gravel Pavement Work Labor Based**

Gravelling work is the most expensive part of district & feeder road rehabilitation. Typically it comprises 30 % – 50 % of the total contract cost, depending on the haulage distance from gravel sources to the road.

Unless proper funding is available, it will be difficult to plan for full gravelling on district & feeder roads and careful prioritization and planning of works is required.

In the planning of gravelling work, it is essential and a golden rule, to keep haulage distances short, therefore, to identify as many gravel sources as possible along the road under construction.

In this guide, gravel and literate means 'naturally occurring gravel' and a quarry is the source, where the gravel or literate is found. The whole of gravelling work can be divided in a number of distinct operations, which are separated by different bills in the

- Quarry preparation
- Excavation, stock piling, loading and spreading of gravel
- Haulage, and compaction of gravel

As mentioned before, gravelling work is expensive. This is mainly because of the equipment input required. Therefore, it is important to make proper work planning and minimize interruptions for the equipment.

The organization of the labor force is very important, and several options are possible. The contractor may employ a large gang of laborers working on individual daily tasks. This requires much organization, setting out of tasks and supervision by the contractor.



Information Sheet-1	Safety requirements of equipment, OHS regulation requirements and application
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1.1 requirements

Health and safety of workers

The health and safety aspects of the workers are largely governed by the Health and Safety rules and regulation in Compliance with the requirements for the accommodation of traffic, which is not only intended for the wellbeing of the public but also to protect the workers involved on the road.

The following minimum practical requirements are, however, drawn to the contractor's attention:

The issue of protective clothing, boots, gloves, overall clothes, etc. to the workers is essential.



Use of diesoline by workers to clean hand arms and tools, when working with bitumen, must be discouraged – the use of paraffin is preferable.

A properly equipped first aid kit must be available at all times.


Transportation of workers on open trucks/trailers must be controlled e.g. all passengers must be seated with no legs hanging over the side of the truck/trailer.

1.2 Personal Safety equipment's:

- **Objectives:**-After completing the learning element the trainee will be able to wear safety working clothes, shoes and etc. in the working place.

Safety equipment	Uses	Images
Head protection (hard hat)	Hard hat is used to protect head of the worker from any falling objects dropping from high level during construction.	
Over all cloths	Protects the normal clothes from dust, grease and other spilling materials.	



Safety shoe (boot)	Protects the worker from nail, sharp objects and heavy falling objects by hard-rolled leather shoes with metal toe caps	
Rubber boot	Protects the workers feet from colds, chemical, and mud in the working area.	
Mask	Protects eyes of the worker from other endangering object and dust during construction.	
Goggle	Protects eyes of the workers during welding of metal works and when placing reinforcement in the form work.	
Glove	Protects the workers from oils, chemicals, and dust and other dangerous material that affect the skin.	
Hand Guard	Protect hands of the worker while chiseling and hammering. It is available in different standard sizes of the chisel handle and designed for slipping over chisel handles	
Safety Belt	Secures laborers working in a plane where the construction is done at high level.	
Hearing protection	The noise levels in some areas on construction sites are often above the level which causes sensory hearing loss to workers in the vicinity.	

- ✓ **Note:** -Keep the working clothes in safe place so that you can change it easily. A locker should be used so that you can store your personal material safely while you are performing your works.



- ✓ **Body protection:** -Skin is extremely vulnerable to all types of hazards in works like painting, welding, sewer works, demolition works, etc. leading to different types of skin diseases. Full sleeved shirts and trousers provide good protection against many of the hazards. In case of ionizing radiation use of shielding layers inside the cloths is necessary

Self-Check 1	Written Test
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Directions: Choose & write the letter of correct answer on the space provided under the blanket (8 pts)

1. .Which one of the following safety equipment Protects the workers feet from colds, chemical, and mud in the working area .(3 points)

A, Rubber boot

C. Goggle

B, spade

D. Glove

2. _____ Is not list of personal safety equipments.(5 points)

A, Mask

C. Goggle

B, rake

D. Glove

Note: Satisfactory rating – 4 & above points Unsatisfactory - below 4 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____

Answer the Questions





Information Sheet 2

Types, Sources and use of codes and standards

2.1 Types, Sources and use of codes and standards

Specification and code of standards

The specification will call for the construction of a 150 mm-thick un stabilized pavement layer, constructed in accordance with the relevant specifications referred to in the scope of work in the contract documents.

- **Types and Source of codes and standards**

GENERAL STANDARDS AND APPLICATION

This guideline lists the current design standards that are applicable to Main Roads works. It refers to AASHTO, Austrians, SAI Global, Ethiopian Standards documents as well as Main Roads documents that are available in hardcopy form only. Where Main Roads hardcopy documents have been superseded by online documents, this is noted in the tables.

This list will be revised on a regular basis so that any new publications that are released by others can be added.

This list consists of four sections. The first section details Road, Traffic, Survey and Mapping related Design and Construction Standards, Codes and Guidelines. The second section details Bridge Design Codes and Manuals. The third section details Environment Standards and Guidelines and the fourth section details current Codes, Design Guides and Reference Material relating to Materials and Pavement Technology.

For each document the following information is given:

- Title
- Author
- Edition
- Latest edition and/or reprinted year
- Superseded by Available Format and Location

Where a document has been superseded by another document the details of the new document are provided, including the latest edition and available format. Where applicable the reprinted year is also provided.

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Where a document is labeled as being available online, it can be found at under the relevant area.

The Main Roads website has a search engine which can be used to quickly find documents.

The Road and Traffic Engineering guidelines can be found under the Standards area of the website.

For each different responsibility area, contact details of the person responsible for maintaining that portion of the list is given.

Road and traffic design and construction standards and guidelines

Road design standards and guidelines

The information needs to be provided with the sample to the testing laboratory. During sampling standards i.e. ERA, AASHTO, IS, ASTM, etc will instruct you on A bad sample is worse than no sample at all

ERA (ETHIOPIAN ROAD AUTHORITY) manual have a technical specification for road construction rehabilitation for gravelling pavement...

ILO (INTERNATIONAL LABOR ORGANIZATION)

AASHTO (AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS) The American Association of State Highway and Transportation Officials is a standards setting body which publishes specifications, test protocols and guidelines which are used in highway design and construction throughout the United States

ASTM International, formerly known as American Society for Testing and Materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

- **Use of codes and standards**

Mostly to select material that meet the specifications the following parameters need to be evaluated

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- Grading
- Shrinkage
- Aggregate hardness
- Material strength.

- **Grading**

The grading requirements for the characterization of material for unpaved roads are based on only five sieve sizes, that is 37.5 mm, 26.5 mm, 4.75 mm, 2 mm, and 0.425 mm. For the testing, the material needs first to be dried, the mass determined, and then the material sieved (manual shaking) through the recommended sieves above with a soft brush being used where necessary. The mass of each portion is determined. The oversize index, grading coefficient and percentage passing the 0.425 mm sieve can then be determined. It should be noted that the influence of the hygroscopic moisture content on the parameters determined is negligible. The fraction passing the 0.425 mm sieve should be retained for shrinkage testing.

- **Shrinkage**

The bar linear shrinkage test is carried out on the fraction passing the 0.425 mm sieve. The material should be moistened until it is at or very near the liquid limit, placed in the mould, and oven-dried at 105°C until all shrinkage has stopped. The length of the sample is then measured and the percentage shrinkage calculated. It is recommended that the sample is dried for at least 12 hours (overnight if not done in a solar oven), but experience has shown that this can take as little as four or five hours, depending on the soil.

- **Aggregate hardness**

Aggregate hardness measurements are necessary to identify those materials which will disintegrate under rolling or traffic, as well as those which are excessively hard and will result in a rough road if too much of this type of material is included.

- **Material strength**

Material strength is an indication of the capacity of the material to support the wheel loads of the traffic using the road. The traditional method for determining this property is the soaked California Bearing Ratio (CBR) test. This test is routinely carried out in a central or typical site laboratory but is expensive to set up, requires a large amount of equipment, and is relatively time consuming.



Self-Check 2	Written Test
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Instructions: Directions: write the letter of correct answer on the space provided under the blanket (10 pts)

1. _____ Is an indication of the capacity of the material to support the wheel loads of the traffic using the road?
 - A. Grading
 - B. Shrinkage
 - C. Aggregate hardness
 - D. Material strength.
- 1 _____ Is measurements are necessary to identify those materials which will disintegrate under rolling or traffic?
 - A. Grading
 - B. Shrinkage
 - C. Aggregate hardness
 - D. Material strength.

Note: Satisfactory rating – 5 & above points Unsatisfactory - below 5 points

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

Answer Sheet

Name: _____

Date: _____

Score = _____

Rating: _____






Information Sheet 3

Type and function of plant, tools and equipment






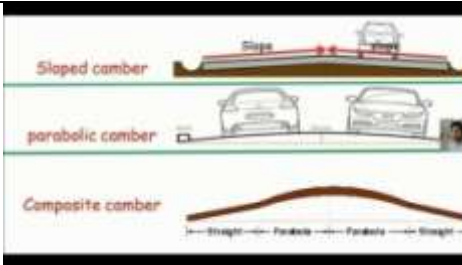

3.1 Type and function of plant, tools and equipment

The surveying and setting out requirements for labor-based road construction vary with the type of work to be executed. The construction of new roads requires a complete by the survey Engineer to establish the alignment. The engineer provides the contractor with the relevant reference points and levels.

- Gravel pavement necessary plant, tools and equipment**

Hauling equipment	Definition	Picture
Dump truck	Dump trucks are the most common type of equipment used for hauling large quantities of materials from quarries and borrow pits to the work sites.	
Wheelbarrows	The wheelbarrow is a useful piece of transport equipment for short distances (up to 200 meters). Wheelbarrows are used for earth and concrete works, transporting construction materials such as soil, gravel, sand, aggregate, stone, concrete, etc.	
Tractor and Trailer	Tractors are employed in labour-based works mainly to haul various implements. Trailers are commonly used in several labour-based works projects. They are mainly used for hauling gravel, but are also used for camp support activities.	



Animal carts	A cart is a vehicle designed for transport, using two wheels and normally pulled by one or a pair of draught animals.	
tractor towed water trailer with water browser	The term browser is used by water companies in the United Kingdom to refer to mobile water tanks deployed to distribute fresh water in emergency situations where the normal system of piped distribution has broken down or is insufficient.	
Roller	Several types of tools and equipment can be used for compaction. These include hand rammers, rollers and plate compactors.	
Rakes or Spreaders	Rakes are used in road works for raking out vegetation from loose soil. Commercially produced rakes have 10 to 16 teeth, each about 75 - 100mm long, with an overall length about 400 - 450mm.	
Sledge Hammer	A sledgehammer is a tool with a large, flat, often metal head, attached to a long handle. The long handle combined with a heavy head allows the sledgehammer	
Camber Board	Camber is a slight upward curve in the middle of a ski or board , with the contact points - where a un weighted ski or board contacts the road surface	
Spirit Level	Spirit levels are available in all different sizes. For construction work robust and long spirit levels are ideal.	



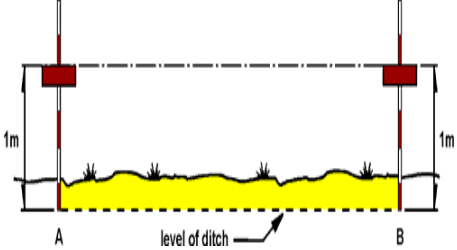






Profile board	A profile board is designed in such a way that it can be attached to a ranging rod.	
Hoes	The hoe, in addition to being very useful in agriculture, is also a commonly used tool when using labour-based work methods for rural road works.	
Shovels and spade	Shovels are used for scooping up material and loading it on to a trailer, truck or wheelbarrow, or throwing it directly to where the material is needed.	
Strings	Alignment string /mason line/, sometimes called, Fish line, is a rope used to transfer horizontal & vertical alignments or lines, i.e.,	
ranging rods,	Ranging rods are round sticks usually 2 m long with a diameter of approximately 2.5 cm. They are made of various materials (metal, hard plastic, wood) and are usually provided with a pointed metal end.	
Crowbar	The crowbar, like the pickaxe, is mostly used for penetrating or breaking up stony or hard soils.	
Tape Measure	A great variety of tape measures exist. The most common length of tape measure used for setting out is 30 meters.	



Table 3.1:gravel pavement tools and equipment



Self-Check 3	Written Test
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Instructions: Directions: Choose & write the letter of correct answer on the space provided under the blanket (6 pts)

1. _____ Is not Hauling equipment
 - A. Wheelbarrows
 - B. Rakes
 - C. Tractors and trailers
 - D. Trucks
2. _____ Is not Compaction tools and equipment
 - A. Tear roller
 - B. Static vibrator
 - C. Animal carts
 - D. Roller
3. _____ Is the Spreading and surfacing tools and equipment
 - A. Static vibrator
 - B. Animal carts
 - C. Tear roller
 - D. Rakes

Note: Satisfactory rating – 3 & above points Unsatisfactory - below 3 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____



Information Sheet 4

Work place traffic management

4.1 What is a traffic management plan?

A traffic management plan (TMP) is a site-specific plan that covers the design, implementation, maintenance and removal of temporary traffic management (TTM) measures while work or activity is carried out in the road corridor (road, footpath or beam).

The traffic management plan deals with traffic moving through the site. That is traffic on public roads and members of the public.

In most states of Australia, traffic management, including the erection of signs is covered under socialized traffic control training.

If you are undertaking traffic management activities such as erecting signs, you will need to have the appropriate training and certification.

You're WorkCover or Road and Traffic Authority office will be able to advise if you need this specialized training and who you can get the training from.

4.2 What is the traffic control?

Traffic Control are markers, signs and signal devices used to inform, guide and control traffic, including pedestrians, motor vehicle drivers and bicyclists.

These devices are usually placed adjacent, over or along the highways, roads, traffic facilities and other public areas that require traffic control.



Figure 4.1 Traffic management plan

4.3 What are the traffic rules?

Traffic laws are the **laws** which govern **traffic** and regulate vehicles, while **rules** of the road are both the **laws** and the informal **rules** that may have developed over time to facilitate the orderly and timely flow of **traffic**.

4.4 What are the traffic regulations?

Traffic regulation, control of the movement of vehicles and pedestrians, chiefly on city streets.

4.5 Vehicle management plan

The vehicle management plan deals with on site vehicle movements, haul circuits and dump runs, and material routes.



With vehicle management plans, larger or loaded vehicles will have right of way unless site plans say otherwise.

Road rules still apply and directional signs need to be obeyed under vehicle movement plans.



Figure 4.2: Vehicle management plan



Self-Check 4	Written Test
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Instructions: Directions: Choose & write the letter of correct answer on the space provided under the blanket (6 pts)

1. Traffic laws **are the laws which govern traffic and regulate vehicles, while rules of the road are both the laws?**
 - A. True
 - B. false
2. Traffic regulation is not control of the movement of vehicles and pedestrians, chiefly on city streets
 - True
 - false
3. *Vehicle management plan*-----
 - A. plan deals with on site
 - B. Traffic regulation
 - C. movement of vehicles
 - D. pedestrians
 - E. all

Note: Satisfactory rating – 3 & above points Unsatisfactory - below 3 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____



Information Sheet 5

Work activity planning and management

5.1 Work activity planning and management

- **Concept on project planning**

Planning consists of setting specific targets and goals and specifying in detail the necessary resource and actions to reach those targets. Similarly every work site needs to be organized in a structured manner in order to ensure that the outputs of all staff and workers are properly coordinated. In order to be able to prepare a plan one needs to have available essential data and background information, like:

- Site inspection report
- List of available equipment
- Contract document with specifications and work drawings
- List of available personnel, especially skilled labor
- List of available tools
- List of material required

- **Project Plans**

In order to be able to measure progress and to what degree the project is successful in moving towards its ultimate goals, the project implementation plans will include a time schedule during which specific targets or milestones are to be reached. As part of this exercise, the project manager or supervisor may establish the project special development programmers to increase the speed at which the goals can be reached.

Project implementation and maintenance plans commonly relate to specific development projects, normally involving the construction or improvement of one particular road project or road project section. Detailed plans are the working documents which the technical staff refers to in relation to the scheduling of individual work activities, supply of equipment and materials and hiring of staff and labor. Detailed plans are prepared for various time horizons, ranging from the entire duration of the project, to monthly, weekly and daily work plans. The main purpose of the detailed plans is to secure proper management of all resources used as inputs to produce the planned outputs.

These plans are normally combined with a comprehensive reporting and monitoring system, allowing management to compare actual achievements with the planned target.



- **Planning and scheduling**

Summary

Inputs	Business Case Project Charter Organization Information
--------	--

Tasks	Define the Project Parameters Develop the Work Breakdown Structure Develop Preliminary Estimates and Schedules Develop Preliminary Integrated Schedules Optimize the Project Plan Transition to Plan Management
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Interim work products	Preliminary Cost Estimates Critical Path Preliminary Schedules Preliminary Integrated Schedules Approved Project Plan Adjustments
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Phase deliverables	Project Planning and Scheduling System Project Planning and Scheduling
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Task/Responsibility Matrix

Project Deliverables
Deliverables Approval Process
Project Dependencies
Project Assumptions
Project Scope
Project Stakeholders
Project Flexibility Matrix
Work Breakdown Structure
Project Plan Baseline



Approved Project Plan
Project Execution Stage Launch Communication
Implemented Project Office Processes and Procedures

Reference materials	Project Management Procedures Checklist Rolling Wave Planning Technique Developing a Project Schedule Project Planning and Scheduling
Task/Responsibility Matrix	Sample Work Breakdown Structure Planning Guidance Sample Work Breakdown Structure Responsibility
Matrix	Sample Project Plan A Planning Guidance Alternative - Goal Directed
Project	Management (GDPM)

5.2 Resource requirement

As was mentioned previously one of the major objectives of planning is the effective use of available resources, and we shall in this section of the course be looking at resource analysis and scheduling.

Remember that through effective planning, that the successful control of project resources is achieved.

Although there are other minor resources, the four main resources used on a construction project are:

- ✓ **Human resource** (HR) is the process of managing people within an organization.
- ✓ **Plant and equipment** the term 'plant' refers to machinery, equipment and apparatus used for an industrial activity. Typically, in construction, 'plant' refers to heavy machinery and equipment used during construction works.
- ✓ **Materials** include manufactured products such as components, fittings, items of equipment and systems; naturally occurring materials such as stone, timber and thatch; and backfilling for excavations in connection with building work.
- ✓ **Finance** A budget is a statement of the amount of money that is available to spend over a period of time, or on a specific thing, such as a building.

The selection of transport equipment is determined on the basis of:

- ✓ The amount of gravel required
- ✓ The distance to the gravel source



Self-Check 5	Written Test
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In ructions: Directions: write the letter of correct answer on the space provided under the blanket (12 pts)

1. _____ is the process of managing people within an organization?
 - A. Human resource
 - B. Plant & equipment
 - C. Material remorse
 - D. Financial resource
2. Prepare a plan is one needs to have available essential data and background information except
 - A. Site inspection report
 - B. The amount of gravel required
 - C. List of available equipment
 - D. Contract document with specifications and work drawings

Note: Satisfactory rating – 6 & above points Unsatisfactory - below 6 points

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

Answer Sheet

Name: _____

Date: _____

Score = _____

Rating: _____



Information Sheet 6

Time and resource management

6.1 Time and resource Scheduling

After the point is properly planned it is scheduled. Scheduling is a mechanical process for setting in order the various planned activities by fixing the starting and finishing dates to each part of the work in such a manner that the whole should be done in an orderly and systematically way.

6.2 Advantage of scheduling

- 1) It will give clear idea about the type, quantity of the materials required at different stages of execution of work and the duration of supply of materials.
- 2) it will also show the quantity and duration of various operation for which plant or equipment (if needed) can be arranged well in time, so as to avoid unnecessary expenditure for keeping the plant idle for dates on which it may not be required.
- 3) It will help in arranging labor, both skilled and unskilled, as regards Quantity and period for which it may be needed.
- 4) The money required at different stages will also be known from the different dates.
- 5) The total time to complete the project is known.
- 6) From the actual progress charts, it can be known whether the work is lagging behind or not if the progress is slow, speeding up of activities can be arranged.



6.3 Classification of schedules

a) Construction schedule:- is the roaster prepared for the execution of different operations in the construction of a certain project. Before preparing the schedule chart the following calculations are done as regards:

I) various operation

II) Amount of work

III) Rate of completing work, making allowance for bad weather

IV) Number & type of equipment

Vi) Correlation of various operations

Job No_____ Year_____ project No_____ Location_____ Date of Report_____

S. No	Item of operation	Total quantity	Rate per week	Time required	Name of the month								Name of next month and so on							
					Weeks								Weeks							
					1	2	3	4	5	6	7	8								
					E	A	E	A	E	A	E	A	E	A	E	A	E	A	E	

Note: E= Estimated progress per week
A= Actual progress per week

Table 6.1 **Construction schedule sample**

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b) Material schedule

Schedule for material involves the moving and storing of material in any form. Construction schedule is used as a guide for preparing a material schedule keeping in view that

- I) the material should be delivered at site well in advance before under-taking a particular operation.
- II) Material should not be arranged for in advance as it may not be deteriorated, damaged or lost.

S.No	Materials	Time of Materials required for									
		1	2	3	4	5	6	7	8	9	10
1	Aggregate										
2	Cement										
	Bitumen										
3	Selected material										

Table 6.2 material schedule sample



c) Labor schedule

- Schedule for labor will indicate the nature and quantity of labor required for the execution of different operations on different dates. The advantage of repairing it is to reduce the labor cost.

TIME IN Weeks

S. No	Operation	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Excavation													
2	Foundation													
3	Walls													
4	Roof slabs													
5	Plastering													
6	Flooring													
7	Timber work													
8	White wash													
	Total	15	20	25	23	15	18	8	15	10	16	12	10	4
	Labor	25												
		20												
		15												
		10												
		5												

Table 6.3 labor schedule sample



d) |Equipment schedule:-

Is prepared before the project started to establish the types quantity and date on which equivalent needed so that the same may be arranged as and when required. This is also prepared with help of construction schedule.

S.no	Classification of equipment	Total quantity required	Name of month January				Name of month February				And so on	
			Weeks				Weeks					
			1	2	3	4	5	6	7	8		
1	Bull dozer	4	1	1	1	2	2	2	2	2		
2	Road roller	1	1	1	1	1	-	-	-	-		
3	Concrete mixer	2	-	-	-	-	1	1	1	2		

Table 6. 4 **equipment schedule sample**



e) Financial schedule

A construction schedule may be used to estimate the amount of funds that a contractor must provide in financing a project during construction. Most construction contracts specify that the owner will pay to the contractor stated percentage of the value of the work completed during each month or each week usually 90% money is paid and 10% retained.

Project No_____ Location_____ (Estimated

Weeks after starting	Activity under construction	Expenditure per week	Cumulative expenditure

Table 6.5 financial schedule sample



Self-Check 6	Written Test
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Instructions: Directions: write the letter of correct answer on the space provided under the blanket (10 pts)

- A. -----is not the type of resource?
- A. Manpower
 - B. Equipment
 - C. contractor
 - D. Material
- B. Is prepared before the project started to establish the types quantity and date on which equivalent needed so that the same may be arranged as and when required?
- A. Manpower
 - B. Equipment
 - C. contractor
 - D. Material

Note: Satisfactory rating – 5 & above points Unsatisfactory - below 5 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____



Information Sheet 7

Duties and responsibility of employ and employer

7.1 Duties and responsibility of employ and employer

Roads are built up in several layers, consisting of sub-grade, sub-base, base and surface layer. These layers together constitute the pavement. Pavements made from good quality building materials spread the forces caused by the traffic so that the loads exerted on to the road foundation is protected from overloading and deformation.

The pavement can be constructed from a wide variety of materials and mixtures of materials consisting of gravel, stone, bitumen, concrete or improved soils.

• DEFINITION OF A CONTRACT

A contract is an understanding made between two or more persons, by which, rights are acquired on the one side to acts or forbearances on the other.

To make an agreement which results in a contract, there must be an offer and acceptance which leads to a binding force of obligation.

A Contract is a voluntary agreement, between two or more competent parties representing a promise to be performed for valid consideration.

• TWO PARTIES IN A CONSTRUCTION CONTRACT

- A. Simplest form
- B. Complex form

Simplest form – two parties

- Between owner and architect/engineer
- Between owner and contractor
- Between owner and construction manager

Complex form – multiple parties

- Owner and several contractors simultaneously
- By trade – electrical, mechanical, plumbing and general
- By task – site clearing, underground utilities, civil/structural, interior Finishes, etc.



7.2 NATURE OF CONSTRUCTION CONTRACT

The element of a valid contract is to offer to do something for a consideration, and by acceptance of this offer and once an offer has been accepted the contract is made.

Although in most cases a legal agreement (deed of contract) is subsequently executed by the parties concerned. It should also be borne in mind that the offer must be definite, and the acceptance must be unconditional and must be communicated to the person making the offer.

A qualified acceptance is merely a counter offer, and does not bind the parties; indeed, the original offer lapses if a counter offer is made.

7.3 WHY USE CONTRACTS IN CONSTRUCTION?

1. Describe the scope of work
2. Establish time frame
3. Establish cost and payments provisions
4. Set forth obligations and relationship
5. Manage multiple risks
6. Establish control mechanism
7. Minimize dispute
8. Improve economic return on investment

7.4 BASIC CONTENT OF A CONSTRUCTION CONTRACT:

1. Identity of parties
2. Promises and responsibilities
3. Scope of work
4. Price and payment terms
5. Commercial terms and conditions
6. Project execution plan

7.5 CONTRACT PARTIES AND THEIR RESPECTIVE OBLIGATIONS

We have seen above that there are various parties involved in a construction contract and that each party has his/her own respective obligations. Here, we will look at the parties and their respective obligations in a more elaborate manner. In the strict sense of the term, the parties involved in a construction contract are the employer and the contractor.

A. The Employer (Client);

- The employer is the person for whom the project (construction) is being undertaken.

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- This person may be variably referred to as “client, project owner, or developer”.

B. The Architect;

- The architect is the person who is employed by the employer so as to design the project and oversee that the construction is being undertaken per contract.
- He/she, thus, designs the plans and specifications for the construction. An architect is a person who designs buildings and superintends of their erection.

C. The Civil Engineer;

- The structural design of contemporary buildings, and the design of their mechanical and electrical installations, has become so sophisticated and complex that it is beyond the technical knowledge and experience of architects, and is, therefore undertaken by engineers trained and experienced in this type of work.

D. The Quantity Surveyor;

- The quantity surveyor is a person who calculates the quantity of labor and materials that are required to erect the building and compiles this information in a document known as a bill of quantities, which is used by tender as a basis for estimating the cost of the project and formulating their tenders.

E. The Contractor and Sub-Contractors

- The contractor has to first secure the consent of the employer before he/she can hire any sub-contractors.
- Subcontractors are persons employed by the contractor so as to undertake part of the construction work.



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

Instructions: Directions: write the letter of correct answer on the space provided under the blanket (9pts)

1. _____ Is not basic content of a construction contract
 - A. Identity of parties
 - B. Promises and responsibilities
 - C. Manage multiple risks
 - D. Price and payment terms
 - E. Commercial terms and conditions
2. Why use contracts in construction?
 - A. Identity of parties
 - B. Improve economic return on investment
 - C. Promises and responsibilities
 - D. Price and payment terms
3. Basic content of a construction contract?
 - A. Establish cost and payments provisions
 - B. Set forth obligations and relationship
 - C. Scope of work
 - D. Manage multiple risks

Note: Satisfactory rating – 5 & above points Unsatisfactory - below 5 points

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

Answer Sheet

Name: _____

Date: _____

Score = _____

Rating: _____



Information Sheet 8

Environmental protection requirements

8.1 Environmental protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

• ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, the Contractor shall submit an Environmental Protection Plan for review and approval by the Contracting Officer.

The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental, natural and cultural resources, and historic preservation issues which the Contractor must address during construction.

• Environmental Management System

- ✓ Many organizations have developed an EMS. An EMS provides the means to identify, manage and monitor environmental risk associated with an organization's activities, products and services.
- ✓ Such systems focus on pollution prevention, resource management, and continuous improvement in environmental performance and provide the means to demonstrate ongoing environmental compliance.

• Benefits of an EMS

- ✓ Facilitates meeting your mission ,
- ✓ Improves the environmental condition,
- ✓ Minimizes accidents and problems, or lessens impact and response time if they do occur,
- ✓ Reduces redundant paperwork,
- ✓ More efficient use of resources,
- ✓ Facilitates compliance with requirements,
- ✓ Responds to public scrutiny trends



Self-Check 8	Written Test
---------------------	---------------------

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

1. _____ Is not the Benefits of an EMS
 - a. More efficient use of resources,
 - b. Facilitates compliance with requirements,
 - c. Responds to public scrutiny trends.
 - d. Manage multiple risks
2. Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction
 - a) True
 - b) false

Note: Satisfactory rating – 5 & above points Unsatisfactory - below 5 points

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

Answer Sheet

Name: _____

Date: _____

Score = _____

Rating: _____

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List of Reference Materials

- LABOUR BASED ROAD CONSTRUCTION _97
- https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/genericdocument/wcms_101285.pdf
- ERA manual
- https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/genericdocument/wcms_101009.pdf
- <http://www.ruralworks.com/reports/otherreports/TechnicalManual.pdf>
- https://www.ilo.org/dyn/asist/docs/F1287477762/lb_road_course.pdf
- https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/instructionalmaterial/wcms_asist_8075.pdf
- https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/instructionalmaterial/wcms_asist_8075.pdf



Road civil work

Level II

NTQF

Learning guide 39

Unit of Competence: Conduct Gravel Pavement Works (Labor Based)

Module Title: Conducting Gravel Pavement Works (Labor Based)

LG Code: CON RCW2 M10 LO2-39

TTLM Code: CON RCW2 TTLM 0919 v1

LO 2: Principle and procedure of quarry site selection

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Instruction Sheet

Learning Guide 39

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

- Principle and procedure of quarry site selection
- Quarry material quality and **work order**
- Labor base material production techniques

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 –

- Select Quarry site and quality of material insured according to the work order.
- Produce Selected material is using the practice and procedure of labor based road construction material production techniques

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks”. in each information sheets.
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-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next information sheet



1.1 Principle of quarry site selection

Prior to quarry development, a site selection process must be conducted to insure that the expected quality and quantity of construction materials will be obtainable. Following site selection, quarry layout considerations are necessary to insure efficient operations. For clarification purposes, the term quarry (and pit) refers to sites where open excavations are made for the purpose of removing rock for use in construction projects.

The distinction between pits and quarries is based on the manner in which the site is excavated. Pits are sites from which materials can be removed, generally without blasting. Quarries usually require drilling, cutting, or blasting for the excavation of the materials.

1.2 Site Selection for Quarrying

- The quarry should be selected based on some conditions as follows.
- The site should be near to human living areas where labor and tools are always available, required materials also should be available.
- At least one of type transportation facilities (road or railway or port or all) should be available.
- Clean water source should be available near the quarry site.
- Good quality and quantity of stone should be available.
- The site should be far from permanent structures like bridges, dams etc. because the vibrations due to blasting in the site may cause harm to them.
- Non-living area should be available to dump the refuse obtained in quarrying.
- Proper drainage facility should be available.
- Geological information of site should be read.

1.3 Considerations for Quarrying

After the site selection, some important considerations are to be followed before starting quarrying of stones. Which are as follows?

The rock surface should be properly checked for cracks and fissures. The presence of these may cause planes in the stones, along which they may split. Then, the quarrying will be easy and quick as well as economical.



Layout should be prepared which contains different stages involved in quarrying operation.

The machines used should be tested to operate them easily and quickly.

If the top surface of site contains soft soil, then it should be removed and dumped.

The removal of stones should be done carefully otherwise there may be chances of landslides or slips which can cause severe damage to the lives of labor.



Self-Check 1	Written Test
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Directions: Choose & write the letter of correct answer on the space provided under the blanket (10 pts)

1. site selection process must be conducted to insure that the expected quality and quantity of construction materials will be obtainable
 - a) true
 - b) false
2. Is not the Site Selection for Quarrying
 - a) Clean water source should be available near the quarry site.
 - b) Proper drainage facility should be available.
 - c) Geological information in population growth
 - d) Good quality and quantity of stone should be available.

Note: Satisfactory rating – 5 & above points Unsatisfactory - below 5 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____



Information Sheet 2	Quarry material quality and <i>work order</i>
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2.1 Quarry site material quality evaluation

• Road gravel material quality

The material used in embankment, sub-grade, shoulders, etc. shall be soil, gravel, a mixture of these or other material approved by the Engineer.

It shall be free from logs, stumps, roots, rubbish, etc.

A good gravel surface should contain 35-65% stone for strength, 20-40% sand to fill the gaps between the stone and 10-25% clay.

The quality of gravel needs to be determined well in advance of commencing surfacing works. This enables the project to prepare and negotiate gravel sub-contracts with local contractors well in advance and allows project management to schedule the gravel works to the optimal period of the year (dry season).

The main criteria for selecting a quarry are quality of the gravel, access to the quarry and the hauling distance. Much depends on which materials are available in close proximity to the roadwork sites. Suitable surface layers have been made of materials ranging from coral to crushed stone.

The quarry must contain a reasonable quantity of gravel. Quarries in low places should be avoided or drained before commencing excavation, as they may flood and become unworkable during rains.

The following aspects need to be considered when selecting a quarry:

- The quarry should contain sufficient gravel of adequate quality.
- The depth of topsoil, preferably not exceeding 30 centimeters. Removal of topsoil is expensive and time consuming.
- The quarry should be as close as possible to the work site.
- There should be good access from existing roads to the quarry, as opening new access roads to the quarry will increase costs.
- The quarry should avoid farmlands or land already in use for other purposes.
- Land ownership and compensation issues, quarry concession rights and royalty fees need to be arranged at an early stage.

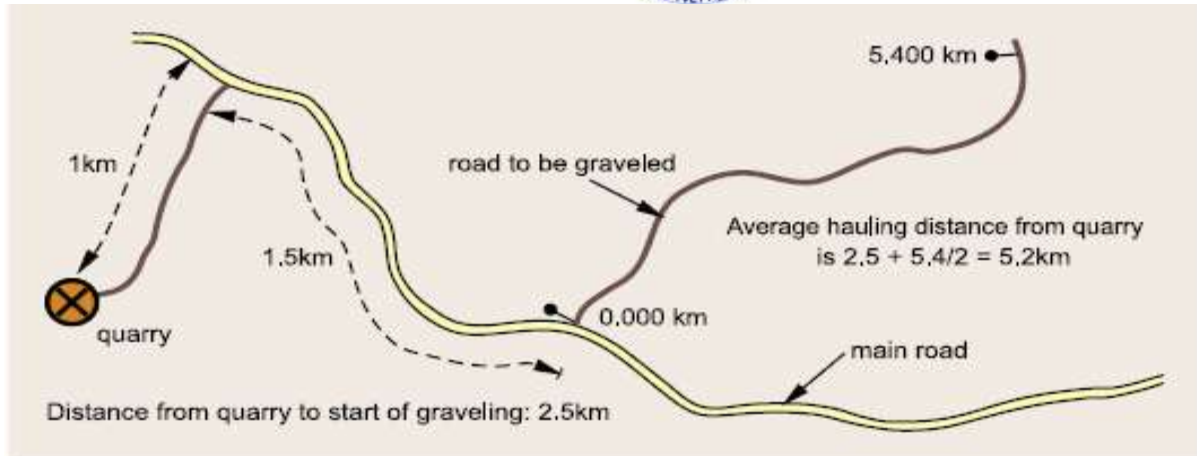


Figure 2.1 Quarry Site plan

• Work order and Procedures

The graveling operation consists of three major components:

- quarrying works,
- Transport of materials
- The surfacing works at the roadwork site.

Each of these components needs to be carefully planned, thereby ensuring that they are properly fine-tuned to work efficiently together. A major objective during the planning of this type of works is therefore to ensure that the production rates in each of the main group of activities are at sufficient levels thereby avoiding that any activity causes delays to the other works.

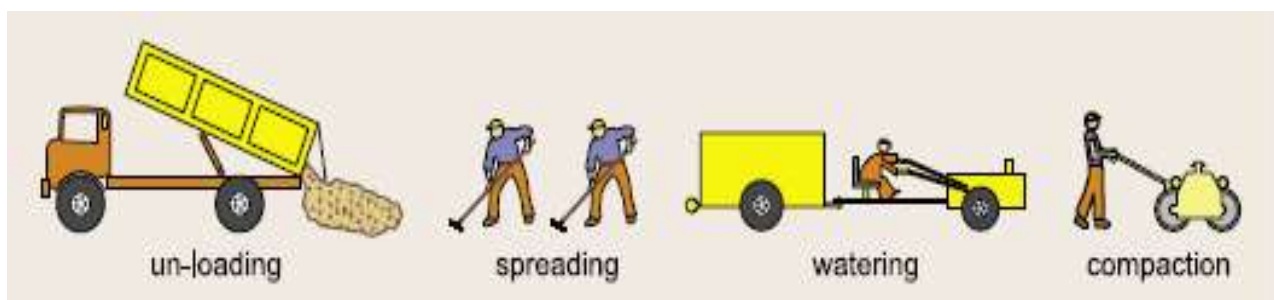


Figure1.2.2 working procedure

The gravel surfacing activities can be divided into two distinct groups depending on the location. The quarry work s includes excavation work s, stockpiling materials and loading. In addition, there are several activities relating to the overall operation of the quarry, such as maintaining access roads, removing topsoil and other unsuitable materials, and eventually restoring the quarry or sections of it to its original condition.

At the other end of the chain of activities, where the gravel material is delivered, there needs to an effective organization which ensures that unloading, spreading, watering and compaction are carried out to the expected rate of progress.



Before carrying out any gravelling works, it is necessary to first check that the earthworks have been properly carried out to exact levels and required standards. Equally, all levels need to be checked and the camber investigated to ensure that it has not been damaged.

Careful planning and preparation is required in order to secure the necessary progress under each work activity. The gravel works rely on a combination of inputs including equipment, tools and labor. To avoid any idle time on any of the resource inputs, it is essential that this operation is properly planned. This plan should contain details on inputs (number of workers and equipment), productivities, outputs and timing of the work.

- **Work Plan**

The selection of transport equipment is determined on the basis of the amount of gravel required and the distance to the gravel source. With gravel readily available along the road line, both excavation and transport can be organized using manual labor.

However, this is not often the case as good quality gravel is only found at certain locations, which may be at a considerable distance from the road site.



Self-Check 2	Written Test
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Instructions: Directions: write the letter of correct answer on the space provided under the blanket (10 pts)

- 1 The graveling operation consists of the major components except
 - a. quarrying works,
 - b. work plan
 - c. Transport of materials
 - d. The surfacing works at the roadwork site.
- 2 The following aspects are not need to be considered when selecting a quarry:
 - a) The quarry should contain sufficient gravel of adequate quality.
 - b) The depth of topsoil, preferably not exceeding 30 centimeters. Removal of topsoil is expensive and time consuming.
 - c) Manpower development
 - d) The quarry should be as close as possible to the work site.

Note: Satisfactory rating – 5 & above points Unsatisfactory - below 5 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____



Information Sheet 3

Labor base material production techniques

3.1 Labor base Material production method

A number of important issues must be considered in the planning of a quarry site:

The overburden is stockpiled so that it will not hinder future extension, and that it can eventually be used to return to the quarry;

Tractor/trailers and/or trucks can enter and leave without disturbing each other;

The quarry can be exploited fully with removal of the maximum amount of gravel;

Environmental damage by drainage and erosion is mini- minimized both during and after exploitation of the quarry; the best material is taken in cases where gravel quality is variable within the quarry.

The quarry is developed so that it drains effectively when it rains during the execution of the works.

3.2 Labor base material Excavation and Loading techniques

Unless the soils are very loose and easy to excavate, it is common practice to carry out the excavation works in advance of the loading and transport of the materials. The loading place for the vehicles needs to be excavated at a gradient thereby ensuring that it is well drained and remains dry after rains.

Excavating and loading gravel can be carried out using a large variety of work methods and equipment. In all cases, it is important to organize the works in an orderly fashion in which equipment and labor have ample space to operate without being in conflict with each other. The excavation can be carried out with a front-wheel loader, an excavator or using hand tools such as pickaxes, crowbars, hoes and shovels.

If natural gravel is not available, it may be necessary to obtain materials from solid rock. The source would then either be loose rock and boulders or from drilling and blasting. Quarried rock produces a stronger aggregate as only the top surface layer has been exposed to the natural elements and has become weathered. Crushing rock can be done either with a (mobile) rock crusher or by hand. Crushed rock is an excellent road building material; however, it is more expensive than natural gravels.



Areas where gravel is quarried are covered by topsoil of varying thickness.

This overburden needs to be removed in order to access the gravel material. The overburden should be stockpiled away from the gravel source at a safe location and ready for use when restoring the quarry to an environmentally suitable standard after the gravel has been exhausted in a particular section of the quarry

Any oversized material, which is hard and cannot be broken down, should be removed from the excavated gravel before loading. The oversized material should be stockpiled in a safe place in the quarry area out of the way of equipment and labor.



Figure3.1: labor base material production

When loading materials manually into trailers or trucks, work should be organized in such a way that the loading height is kept at a minimum this is most important when the loading height is **1.5 m or more**. The loading heights can be reduced by arranging loading bays and directing the trucks and trailers to the lowest spot of the loading area.

If trailers are fitted with tailgates, they should be kept closed in order to simplify the loading. The trailers should be loaded to the rim of the trailer sides. There should be enough space for the workers when loading. On flat ground **1.5 – 2 m** is required between the trailer and the loader. Shovels are the most efficient tools when loading soil and gravel by hand. Head baskets or stretchers can be used when stockpiling materials.





Self-Check 3	Written Test
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Instructions: Directions: write true or false the correct answer on the space provided under the blanket (6 pts) f

- Trailers or trucks, work should be organized in such a way that the loading height is kept at a minimum this is most important when the loading height is **1.5 m or more**?
 - True
 - False
- Is not common practice to carry out the excavation works in advance of the loading and transport of the materials?
 - True
 - False

Note: Satisfactory rating – 3 & above points Unsatisfactory - below 3 points

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

Answer Sheet

Name: _____

Date: _____

Score = _____

Rating: _____

**Operation sheet—1****perform gravel Surfacing material production**

Direction: - perform surfacing material production?

Procedures:-

Step.1 selects the required tools and equipment

Step.2 selects and set out material

Step.3 evaluate material quality and quantity

Step.4 Excavate and Loaded material

Quality Criteria:

The depth, length and width of the road pavement to be construct by the given size.



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

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 3 hours.

Task 1- perform gravel surfacing material production

List of Reference Materials

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- LABOUR BASED ROAD CONSTRUCTION _97
- https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/genericdocument/wcms_101285.pdf
- ERA manual
- https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/genericdocument/wcms_101009.pdf
- <http://www.ruralworks.com/reports/otherreports/TechnicalManual.pdf>
- https://www.ilo.org/dyn/asist/docs/F1287477762/lb_road_course.pdf
- https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/instructionalmaterial/wcms_asist_8075.pdf
- https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/instructionalmaterial/wcms_asist_8075.pdf



Road civil work

Level II

Learning guide 40

Unit of Competence: Conduct Gravel Pavement Works (Labor Based)

Module Title: Conducting Gravel Pavement Works (Labor Based)

LG Code: CON RCW2 M10 LO3-40

TTLM Code: CON RCW2 TTLM 0919 v1

LO 3: Conduct, surfacing /paving work

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Instruction Sheet

Learning Guide 40

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

- Setting out of sub-base and surfacing levels
- Method and techniques of material transport
- Damping space and laid out according to the work order.
- material spreading and compaction

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 –

- Set and laid out Road width, thickness and damping space according to the work order.
- Transport surfacing material using the appropriate hauling means.
- Compact Surfacing material is spread according to the work order /using labor based surfacing techniques.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks”. in each information sheets.
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-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets and LAP Tests if any”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result;
8. Then proceed to the next information sheet



Information Sheet-1

Setting out of sub-base and surfacing levels

1.1 Setting out of road width, thickness and damping space

The principal concerns during construction of the gravel surface should be:-

The formation or foundation for the gravel surfacing should be properly shaped and compacted beforehand. The road drainage system must be adequate and functioning properly.

Gravel quality should be carefully controlled at the quarry by experienced supervisors, and an appropriate level of testing, if feasible¹.

Layer thickness control is essential, simple pegs or profile boards may be used for this purpose. Regular checks should be made by excavating through the compacted gravel surface. Initial checks should be made on number of loads delivered loose per unit length of road.

Large (oversize) particles should be removed by hand or broken down with sledgehammers.

The laid gravel material should be at moisture content suitable for compaction; water should be added if necessary.

Compaction by vibrating roller will considerably improve durability of the gravel surface. It is important to ensure that the loose gravel is spread evenly prior to compaction to ensure a uniformly dense and even surface.

Finished compacted cross fall (3 – 7%) should be checked, for example with a chamber board or template, or using strings stretched longitudinally, transversely and diagonally between the settings out pegs.

Based on the design specification the pavement road width needs to be set out properly. Then the surfacing materials need to be dumped depending on the loose volume of hauling equipment capacity per load, road width and the compacted designed thickness specified to surface the road with.



Self-Check 1	Written Test
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Directions: Choose & write the letter of correct answer on the space provided under the blanket (8 pts)

1. The laid gravel material should be at moisture content suitable for compaction; water should be added is not necessary
 - a) True
 - b) False
2. Gravel quality should be carefully controlled at the quarry by experienced supervisors, and an appropriate level of testing?
 - a) True
 - b) False

Note: Satisfactory rating – 4 & above points Unsatisfactory - below 4 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____



Information Sheet 2	Method and techniques of material transport
----------------------------	--

2.1 Methods and techniques of graveling

Before carrying out any gravelling works, first check that the earth works have been properly carried out and leveled to the exact and required standards.

Set up the profile boards once again, and ensure that all levels are correct and that the camber has not been damaged.

Placing the gravel, involves four activities, namely unloading, spreading, watering and compaction.

The gravel surfacing activities can be divided into two distinct groups depending on the location. The quarry works includes excavation works, stockpiling materials and loading. In addition, there are several activities relating to the overall operation of the quarry, such as maintaining access roads, removing topsoil and other unsuitable materials, and eventually restoring the quarry or sections of it to its original condition.

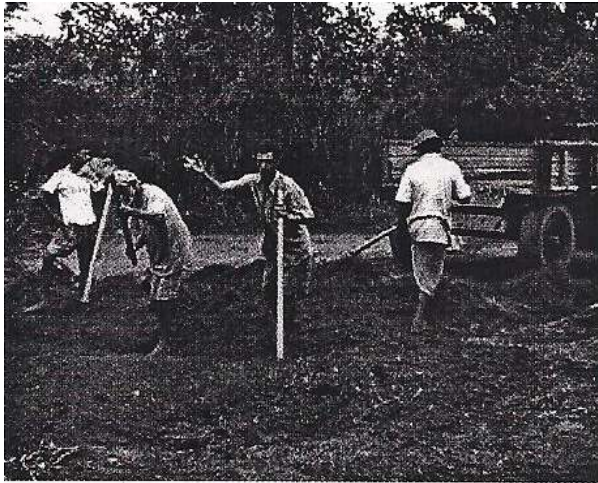
At the other end of the chain of activities, where the gravel material is delivered, there needs to be an effective organization which ensures that unloading, spreading, watering and compaction are carried out to the expected rate of progress. Before carrying out any gravelling works, it is necessary to first check that the earthworks have been properly carried out to exact levels and required design standards.

Equally, all levels need to be checked and the camber investigated to ensure that it has not been damaged.

- **Hauling Gravel**

Gravel transport can be organized in many ways, depending on the distance from the gravel source to the road site and the type of equipment available to the project. When gravel is readily available in the vicinity of the work site, it can be transported using wheelbarrows. However, once the distance exceeds 150 meters, it is recommended to consider other means of transport. If the quantities required are limited, it may be feasible to rent some form of transport available in the local communities, such as animal drawn carts or tractors with trailers.

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Distance	Transport Mode
10 - 150m	wheelbarrows
150 - 2000m	animal carts
500 m - 8 km	tractors and trailers
1 km -	trucks

Figure 3.2: Hauling equipment

Tractors towing trailers can be an economic mode of transport when the hauling distance does not exceed 8km.

The trailers are more suited to manual loading than Lorries, which have a taller loading height. Several trailers can be used for one tractor so that while one is loaded, the other transports material to the site. On the other hand, trucks are better suited for longer haul distances. River-based transport is sometimes used when distances are exceptionally long.



Figure 3.1: Hauling equipment



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

Instructions: Directions: write the letter of correct answer on the space provided under the blanket (8 pts)

MACHING

- | A | B |
|-------------|--------------------------|
| 1. 10-150m | A. TRACTORS AND TRAILERS |
| 2. 150-200m | B. EXCAVATER |
| 3. 500m-8km | C. TRUCKS |
| 4. 1km- | D. WHEELBARROWS |
| | E. ANIMAL CARTS |

Note: Satisfactory rating – 4 & above points Unsatisfactory - below 4 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____



Information Sheet-3

Damping space and lied out according to the work order.

3.1 Unloading work order of graveling

Unloading should be organized in such a way that waiting time for the vehicles is minimized. There must be sufficient turning and meeting places available along the road. There are two ways to organize offloading of gravel, either towards or away from the quarry. Graveling towards the quarry can be organized in such a way that the vehicles have very short waiting times for un-loading, reducing congestion when several vehicles arrive at the same time. The emptied equipment can immediately return to the quarry without delay. However, this method requires the trucks to drive over the road sections still not graveled, which may cause damage to the road surface, especially during rainy periods.

Graveling away from the quarry implies that the trucks will pass over the newly surfaced road sections. This arrangement has the advantage that the vehicles frequently pass over the newly leveled gravel and thereby provide some compaction to the gravel surface. However, this method also has some disadvantages. It requires that the delivered material is leveled before the next vehicle can dump its gravel and may therefore delay the unloading. Finally, the transport vehicles may cause ruts and deformations to the newly laid gravel surface. To avoid this, the vehicles should be directed to drive in such a way that the whole road width is compacted and ruts are not created.

Before unloading it is useful to once again check the levels and quality of the surface on which the gravel is placed. Since the completion of the sub-grade or base course, the surface may have been damaged from traffic and weather. If any repairs are required, these should be carried out before the gravel is added to the road.

Drivers should be instructed to dump the entire load within an area clearly marked with pegs and string lines, thereby ensuring that the final thickness is according to the drawings. To make spreading easier, instruct the drivers to move slowly forward while dumping, so that the gravel is evenly distributed along the length of the rectangular area.

The area set out for each load of gravel depends on (i) the dimensions of the gravel surface and (ii) the average load carried by each of the trucks or trailers. The site supervisor is responsible for calculating the area in order to ensure the correct distribution and thickness of grave



Example:

With a carriageway width of 7 m and a desired gravel thickness of before compaction 20cm, then 50m length of the road will need a gravel volume as follows:

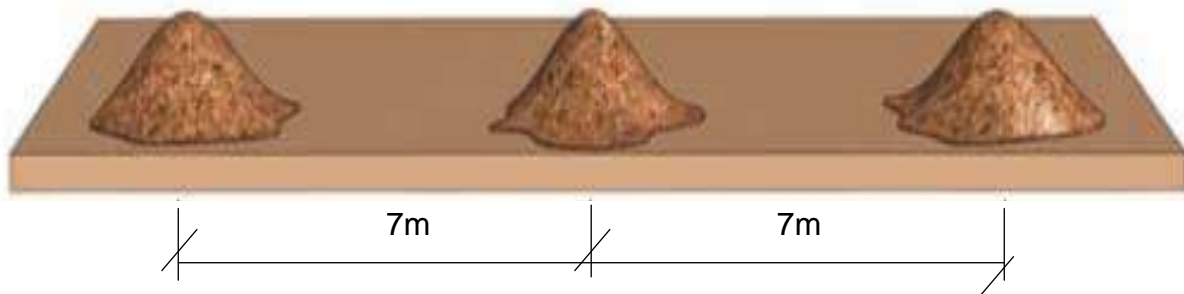
$$V = h \times w \times l = 0.2m \times 7m \times 50m = 70m^3$$

If the average load of a truck is $10m^3$, this load covers a road section with the following length (L):

$$\text{number of trucks} = \frac{70m^3}{10m^3} = 7 \text{ trucks is available}$$

$$\text{damping space} = \frac{50m (\text{length of road})}{7 (\text{truck})} = 7 \text{ meter}$$

Based on the design specification the pavement road width needs to be set out properly. Then the surfacing materials need to be dumped depending on the loose volume of hauling equipment capacity per load, road width and the compacted designed thickness specified to surface the road with.





Self-Check 3	Written Test
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Directions: Choose & write the letter of correct answer on the space provided under the blanket (8 pts)

- ❖ With a carriageway width of 7m and a desired gravel thickness of before compaction 25cm, then 100m length of the road will need a gravel volume as follows the truck amount is 15m³ capacity
1. What is the material volume?
 - a) 1.75m³
 - b) 175m³
 - c) 157m³
 - d) 17500m³
 2. What is the number of trucks is?
 - a) 12
 - b) 11
 - c) 11.6
 - d) 116
 3. What is the dumping space/interval?
 - a) 11.6m
 - b) 12m
 - c) 8.4m
 - d) 8.3m

Note: Satisfactory rating – 5 & above points Unsatisfactory - below 5 points

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

Answer Sheet

Name: _____ Date: _____

Score = _____

Rating: _____



Information Sheet 4

material spreading and compaction

4.1 Placing, spreading of materials and compacting sub base and surface levels

• Spreading Gravel

Spreading is effectively done manually, using common hand tools such as rakes, shovels and hoes. Take care to spread immediately before compaction to make use of the natural moisture content in the materials. If the gravel is left on the road for some days before spreading and compaction takes place, it will dry out and then requires more water when compacted.

Spreading is best carried out from the centre line towards the shoulders, leveling one side of the centre line at the time. Any oversize pieces of rock should be removed or crushed using a sledgehammer. Like all pavement layers, the levels of the gravel surface are set out using profile boards. When the leveling is carried out by manual labor, it is useful to indicate the final levels using pegs and string.

Practical guidelines and productivities for spreading

Usually the material is spread to level, watered and mixed by being turned over a few times by a team of laborers with shovels. The material is not mixed from side to side or longitudinally, as would be the case with a grader. The resulting material and its moisture content are non-uniform across the width and length of the section.

Most water bowlers throw water unevenly: more in the centre and less at the sides. If water is applied by hand using a hose, the application is probably even more non-uniform. To solve the problems enumerated above, the following method is proposed:

The material to be compacted in the layer should be placed along the middle of the road, in the correct quantity to produce a compacted layer at the correct level.

The material should be opened out to form a flattened heap about 2 to 2.5 m wide, roughly leveled across the top.

This 'windrow' should then be watered, preferably with a water bowler. If a hose is used, particular care must be taken to obtain an even application of water.

The material should then be mixed by a labor team, using shovels or forks which best suit the soil.



The material will probably need additional applications of water, which should be done as above. The extra water should be mixed into the soil to produce uniform moisture throughout the flattened heap.

Once uniform and at moisture content somewhat higher than optimum, the heap should be spread across the road width and leveled using string-lines from profiles for level control, making allowance for bulking (33% to 50%). The soil should be above OMC to allow for evaporation during placing and leveling.

Rolling should commence, working from the sides towards the middle to preserve the camber, or from the low side to the high side to preserve the cross fall. The first pass of the roller should be without vibration, to press the soil into shape without much compaction. The shape and level must immediately be carefully checked and corrected, with all hollows being filled and all bumps being skimmed, by a small skilled labor team. Compaction then continues, using vibration. The shape and level must be continually checked and corrected during the first few compaction passes, as, unlike with conventional plant construction, it is practically impossible to use labor to provide a smooth final cut.

- **Compaction and watering**

Once the surface material has been spread to the correct thickness and levels, compaction works can commence. Make sure that there is sufficient supply of water so optimal moisture content can be maintained in the gravel during compaction. If the gravel is spread immediately after excavation, it will have natural moisture content very close to the optimal, thereby reducing the demand for watering. Regular density testing should be organized to ensure that the compaction has been carried out to the prescribed levels.

Gravel compaction is best carried out using steel drum rollers. Any roller with a minimum weight of one tone, preferably with a vibrating mechanism, will be effective as long as the material is spread in layers not exceeding a thickness of 15cm. When the surface is designed with a camber, the compaction should start at the shoulders. Compaction should always begin at the lowest point of the cross-section, ending up with the last passes at the highest point of the road, i.e. the crown.

When the gravel has been spread and compacted, profile boards are erected along the centre line and the road shoulders. Using a traveler, it is then possible to control that the road surface is smooth, to the desired levels, and that the required camber or cross slope has been achieved throughout the road line.

The road formation, gravel surface layers and backfill of culvert trenches are compacted.

Compaction is required to improve the properties of the soil, because it:

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Reduces hollow spaces in the soil Increases bearing capacity of the soil Reduces settlement of the soil Reduces permeability of the soil, and Increases the shearing strength.

A road which has been compacted can stand erosion and traffic better than a loose embankment. Compaction results in a dense surface which can carry substantial loads without getting depressions. It also helps to ensure that rainwater cannot penetrate the layer and soften the gravel or the base. In simple terms, compaction is pressing soil together to make it denser, by getting the air out. In this way the soil becomes stronger and more particles touch each other. Soil consists of three components, solid particles, water and air. The air does not contribute to strength and must be removed by compaction.

Water acts as a lubricant to pack the soil particles and allow them to settle in a dense mass. However, water should not be too much, and also not too little. Each soil has a certain "Optimum Moisture Content" (OMC), which varies between 8% and 10% of the total volume. If the soil has already some moisture, less water need to be added. If the soil is wet, e.g. after a heavy rain, the soil needs to be left to dry before compaction starts.

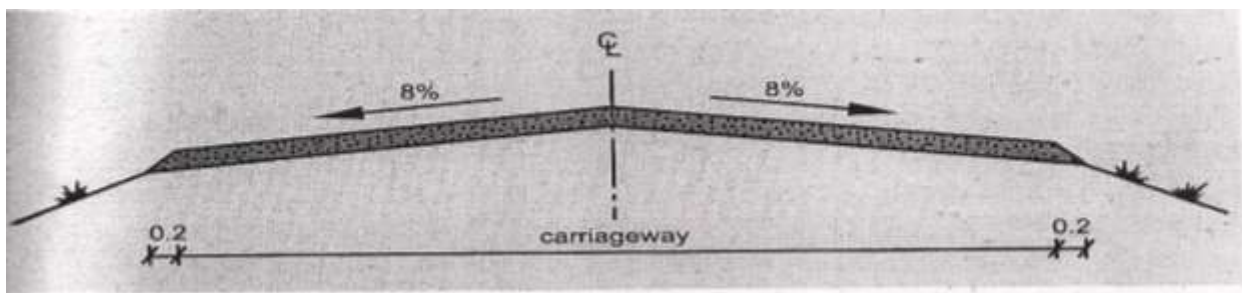


Figure 4.1 labor base spreading and compaction

- **Methods of compaction**

Manually or mechanically operated tampers or rammers,

Deadweight rollers, vibrating compaction, Natural compaction

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- **Tampers and Rammers**

Tampers and rammers compact the soils by impact. Hand rammers are cheap to produce, and consist of a long wooden handle with a cast iron or concrete weight at the end. It is lifted and dropped on the surface repeatedly to produce compaction. The weight is usually 6 to 8 kilograms.

Using hand rammers is expensive and difficult to apply evenly over large areas. A lot of manpower and direct supervision is needed to produce a steady output of reasonable quality. Hand rammers are most useful in small and confined areas such as around culverts, pot-holes and other places where it is impractical or difficult access for rollers.

- **Deadweight Rollers**

There are several types of deadweight rollers, ranging from single or double steel drums, towed or self-propelled or with a load container to hold the deadweight. A major concern when choosing the appropriate type of compaction equipment is: Its availability in the region of your road works activities, How to deliver it to the construction site,

How easy is it to operate and how easily can it be reversed, and its cost and reliability.

Large and heavy towed rollers may have good compaction qualities but may prove difficult to turn and operate in hilly or steep terrain. Self-propelled rollers can normally be operated in both directions; however, they are more prone to breakdowns. Some rollers can be ballasted with weights up to 1 tons or more, using water sand or stones.

- **Vibrating Rollers**

A vibrating roller will generally compact to a greater depth than a deadweight roller.

The effect of the vibrating motion will depend on the intensity of the vibrations and the type of material on which it is used. They also require lower moisture content than deadweight rollers. However, it is important to maintain an even speed to achieve even compaction. With deadweight rollers this is less important. The first passes, should be done without vibration, to avoid that the roller gets "bogged down" into the soil. The speed should be around 3 kilometers per hour or slow walking speed.

- **Natural Compaction**

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The simplest method of compaction is by leaving soil to settle naturally by just leaving it for a **period of time**. The soil by its own weight, rainfall and people, animals and vehicles travelling on it will eventually consolidate enough to carry traffic loads. This so-called 'indirect compaction' method or natural consolidation is a slow process.



Self-Check 4	Written Test
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Instructions: Directions: Choose & write the letter of correct answer on the space provided under the blanket (6 pts)

1. _____ Is the simplest method of compaction is by leaving soil to settle naturally by just leaving it for a period of time?
 - a. Deadweight Rollers
 - b. Vibrating Rollers
 - c. Natural Compaction
 - d. Tampers and Rammers
2. _____ Are not the types of compaction equipment?
 - a. Deadweight Rollers
 - b. Shovel and spade
 - c. Vibrating Rollers
 - d. Tampers and Rammers

Note: Satisfactory rating – 3 & above points Unsatisfactory - below 3 points

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

Answer Sheet

Score = _____

Rating: _____

Name: _____

Date: _____



Operation sheet—1

perform setting out tasks of sub base and surface levels

Direction: - perform setting out tasks?

Procedures:-

Step.1 Prepare all the tools and equipments

Step.2 read and interpret drawing and specification project plan

Step.3 Surveying and leveling the ground (labor based serving method)

Step.4 setting out the road boundary

Quality Criteria:

The depth, length and width of the road pavement to be construct by the given size.

**Operation sheet 2****perform pavement material spreading of sub base and surface levels**

Direction: - perform pavement material spreading.

Procedures:-

Step.1 Prepare all the tools and equipment

Step.2 read interpret specification

Step.3 Transport filling materials

Step.4 calculate the damping interval

Step.5 dumping the specific damp space

Step.6 spreading

Quality Criteria:

The depth, length and width of the road pavement to be construct by the given size

**Operation sheet—3****Perform surfacing & compaction of sub base and surface levels**

Direction: - carry out & Perform surfacing & compaction construction.

Procedure:-

Step.1 Prepare all the tools and plant and equipment

Step.2 read and interprets specification

Step.3 calculate compaction depth of before and after compaction

Step.4 Watering/showering

Step.4 Compaction

Quality Criteria:

The depth, length and width of the road pavement to be construct by the given size.



LAP Test	Practical Demonstration
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Name: _____ Date: _____
Time started: _____ Time finished: _____

Instruction:- given necessary tools & materials you are required to perform the following tasks with in 2hr.

Task 1- perform setting out tasks of sub base and surface levels

Task 2- perform pavement material spreading of sub base and surface levels

Task 3- Perform surfacing & compaction of sub base and surface levels



List of Reference Materials

- LABOUR BASED ROAD CONSTRUCTION _97
- https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/genericdocument/wcms_101285.pdf
- ERA manual
- https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/genericdocument/wcms_101009.pdf
- <http://www.ruralworks.com/reports/otherreports/TechnicalManual.pdf>
- https://www.ilo.org/dyn/asist/docs/F1287477762/lb_road_course.pdf
- https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/instructionalmaterial/wcms_asist_8075.pdf
- https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/instructionalmaterial/wcms_asist_8075.pdf



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No	Name	Qualification level	TVET Bureau
1	AYELE	A	(ADIS ABABA TVET Bureau)



Answer key lo 1

Self-Check 1	Written Test Answer key
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1. A, Rubber boot
2. C. spade

Self-Check 2	Written Test Answer key
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1. D, Material strength.
2. C, Aggregate hardness

Self-Check 3	Written Test Answer key
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1. B, Rakes
2. C, Animal carts
3. D, rakes

Self-Check 4	Written Test Answer key
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1. A, true
2. B, false
3. E, all

Self-Check 5	Written Test Answer key
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1. A, Human resource
2. **B**, The amount of gravel required



Self-Check 6	Written Test Answer key
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1. C, contractor
2. B, Equipment

Self-Check 7	Written Test Answer key
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1. C, Manage multiple risks
2. B, Improve economic return on investment
3. C, Scope of work

Self-Check 8	Written Test Answer key
--------------	-------------------------

1. D, Manage multiple risks
2. A, true

Answer key lo 2

Self-Check 1	Written Test Answer key
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1. A, true
2. C, Geological information in population growth

Self-Check 2	Written Test Answer key
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1. B, work plan
2. C, Manpower development

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Self-Check 3	Written Test Answer key
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1. A, true
2. B, false

Answer key lo 3

Self-Check 1	Written Test Answer key
--------------	-------------------------

1. B, false
2. A, true

Self-Check 2	Written Test Answer key
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1. a. wheelbarrows
2. c. animal carts
3. d. tractors and trailers
4. e. trucks

Self-Check 3	Written Test Answer key
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1. B, 175m³
2. A, 12 truck
3. D, 8.3m

Self-Check 4	Written Test Answer key
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1. C, Shovel and spade
2. B, Natural Compaction