Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

WIRCD401

CONSTRUCTION OF SURFACE DRAINAGE INFRASTRUCTURE

CONSTRUCT SURFACE DRAINAGE INFRASTRUCTURE

Competence

RQF Level: 4

Learning Hours 90

Credits: 9

Sector: Agriculture and food processing

Trade: Water and Irrigation technology

Module Type: Specific

Curriculum: TVET Certificate IV in Water and Irrigation

1200

Issue Date: August,2023

<table>
<tr><td>Purpose statement</td><td colspan="6">This module describes the skills, knowledge and attitude required to construct surface drainage infrastructures. At the end of this module, learners will be able to identify the excess water in the plot, prepare for drainage system installation activities, carry out drainage site preparation, construct surface drainage infrastructures. Qualified learners deemed competent to this competency may work alone or with others on routine tasks in marshland, hillside, small scale irrigation, garden, greenhouses, agricultural land, rain water harvesting, in-situ rain water harvesting and ground water harvesting related activities under minimum supervision</td></tr>
<tr><td>Learning assumed to be in place</td><td colspan="6">N.A</td></tr>
<tr><td rowspan="6">Delivery modality</td><td colspan="2">Training delivery</td><td>100%</td><td colspan="2">Assessment</td><td>Total 100%</td></tr>
<tr><td colspan="2">Theoretical content</td><td>30%</td><td rowspan="4">Formative assessment</td><td>30%</td><td rowspan="4">50%</td></tr>
<tr><td colspan="2">Practical work:</td><td rowspan="3">70%</td><td rowspan="3">70%</td></tr>
<tr><td>Group project and presentation</td><td>20%</td></tr>
<tr><td>Individual project /Work</td><td>50%</td></tr>
<tr><td colspan="3"></td><td colspan="2">Summative Assessment</td><td>50%</td></tr>
</table>

Elements of Competence and Performance Criteria

Elements of competence	Performance criteria
1. Identify the excess water in the plot	1.1. The excess water in the plots to be drained is carefully diagnosed.
	1.2. Different sources of excess water already identified in the plots are systematically investigated.
	1.3. Possible consequences of excess water are properly determined in order to propose alternative solutions.
	1.4. Excess water variation in the plot for more drainage project design is regularly monitored.

2. Prepare for drainage system installation activities	2.1. The construction site and construction method for the drainage system are completely identified according to the drainage system specifications.
	2.2. The surface drainage layout is correctly read for efficient implementation.
	2.3. Materials, tools, equipment, and machinery are properly selected according to drainage system design requirements.
3. Carry out drainage site preparation	3.1. Readings in the field book are properly recorded in order to perform calculations of elevations.
	3.2. The site is completely surveyed, measured, and marked out, and soil characteristics relevant to the planned drainage system are confirmed according to plan specifications.
	3.3. Drainage layout is suitably established in terms of alignment design by applying the results of surveying.
	3.4. Land is properly graded for drainage towards the main drainage system.
4. Construct surface drainage infrastructures	4.1. The main drain for the drainage system, which receives flow from lateral ditches and sometimes other mains, is completely excavated.
	4.2. Field drains and lateral ditches are completely excavated in accordance with the drainage layout without damage to services, facilities, features, and established plants according to plan specifications.
	4.3. The drainage system is properly tested for geometrical configuration, flow rates, and capacity consistent with the drainage system plan.
	4.4. The supervisor is continuously consulted, and remedial actions are taken when the drainage system operation does not meet the plan specifications.
	4.5. The site is adequately restored and waste material removed from the site is disposed of in an environmentally aware and safe manner according to enterprise work procedures.

Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Identify the excess water in the plot 2. Prepare for drainage system installation activities 3. Carry out drainage site preparation

	4. Construct surface drainage infrastructures
Learning outcome 1: Identify the excess water in the plot	Learning hours: 10

Indicative content

- Diagnosis of the excess water in the plots
- Investigation of different sources of excess water
  - ✓ Water table measurement
  - ✓ Source of excess water
    - Rainfall
    - Excess irrigation
    - Rising of ground water table (GWT)
    - Seepage from canals and reservoirs
    - Leaching of soil
    - Artesian wells
  - ✓ Investigation procedures of excess of water
- Determination of possible consequences of excess water
  - ✓ Effect of excess water:
  - ✓ water ponding
  - ✓ water logging
  - ✓ water salinity
  - ✓ Rising of water table
  - ✓ Prevention measures for excess water in the scheme.
- Monitoring of excess water variation in the plot
  - ✓ **Steps for testing excess water in the scheme:**
    - Visual checking
    - Water level measurement
    - Water table measurement

Resources required for the learning outcome	
Equipment	• Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller

Materials	• Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, similation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Learning outcome 2: Prepare for drainage system installation activities	**Learning hours: 20**
Indicative content	

- Identification of construction site and construction method
  - ✓ Drainage site characteristics:
    - Types of soil
    - Types of crops grown
    - Topography
    - Quantity of water to be drained
  - ✓ **Methods of drainage:**
    - Surface
    - Sub surface drainage
- Reading of surface drainage layout
  - ✓ Components of surface drainage system
  - ✓ Components of Sub-surface drainage system
  - ✓ Surface drainage layout
- Selection of materials, tools, equipment and machinery
  - ✓ Quality of materials, tools and equipment for surface irrigation
  - ✓ Factors affecting selection of tool, materials, equipment and machinery used in drainage

Resources required for the indicative content

Equipment	Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Materials	Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, simulation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Learning outcome 3: Carry out drainage site preparation	Learning hours: 20
Indicative content	

• Recording of readings in field book
✓ Field data collection:
  ✓ Surveying
  ✓ Leveling
• Survey, measurement and marking out of the site
  ✓ Surveying and marking of the site
  ✓ Soil physical and chemical properties
• Establishment of drainage layout
✓ Layout establishment procedures:
  ✓ Drainage component	

- Drainage specifications
- Sketching
- Final layout

- Grading of land for drainage
  - ✓ Cut and fill process
  - ✓ Furrow grade
  - ✓ Cross slope

Resources required for the indicative content	
Equipment	Tractor, Steel Rule, Feeler gauge, Engineer's square, Divider spring joint, Drift punch copper, pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack, T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Materials	Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, Hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, simulation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Learning outcome 4: Construct surface drainage infrastructures	**Learning hours: 40**

Indicative content	
• Excavation of the main drain for the drainage system • Excavation of field drains and lateral ditches ✓ Types of drainage structures ✓ Drain excavation procedures ✓ Excavation equipment • Testing of drainage system ✓ Flow rate ✓ Drain capacity • Consultation of the supervisor and remedial actions taken ✓ Benefits of drainage The soil is better aerated The crops can root more deeply The choice of crops to be grown is greater There will be fewer weeds Fertilizers will be used more efficiently There will be less denitrification The land is more easily accessible The soil has a better workability and tilth The soil permeability is increased The soil temperature is higher ✓ Effect of poor drainage system: The soil is not aerated The crop dies of lack oxygen ✓ Preventive measures for excess water • Restoration of the site and waste material removed ✓ Land restoration guide lines ✓ Waste disposal guidelines	
Resources required for the indicative content	
Equipment	Tractor, Steel Rule, Feeler gauge, Engineer's square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack, T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller

Materials	Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, Hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, simulation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Integrated/Summative assessment

Integrated situation

Rwanda's primary aim within the MDGs is to reduce underdevelopment and poverty by achieving economic growth. Agriculture constitutes the main economic activity, engaging around 80% of the Rwandan population as farmers. However, due to climatic changes and unexploited land resulting from limited technology, current production falls short of meeting people's needs.

The Kabuye wetland is situated 3 km from Nyabugogo Taxi Park, below the KIGALI-GATUNA road and adjacent to Kabuye sugar works. Two primary diversion channels, one on the right side and the other on the left, were designed to irrigate the entire area of 637.12 ha. The Kabuye wetland was initially designed and implemented by the Chinese before 1994. However, post-1994, the irrigation and drainage network suffered damage from

flooding and sedimentation, resulting in a situation where every farmer designs their plots based on personal preferences.

The Nyabugogo river, the primary source of irrigation water, does not adequately serve all plots, particularly those located near the elevated road areas. In the lower zones of the perimeter, existing drainage channels have become ineffective. During heavy rains, water accumulates in the plots, causing the Nyabugogo river to overflow and drain back into the inadequate drainage channels.

As a consequence of these inappropriate drainage systems, the Kabuye Rice Project (KRP) faces a significant flooding problem during the rainy season, leading to notably low crop yields. The main objective of this project is to "construct appropriate surface drainage infrastructures for this scheme," with a designated time duration of 8 hours.

The tasks for this project are expected to adhere to the following specifications:

- Identification of excess water within the plot
- Alignment of main and field drains according to the design specifications
- Construction of surface drainage infrastructures

Resources

Equipment	Tractor, Steel Rule, Feeler gauge, Engineer's square, Divider spring joint, Drift punch copper, pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack, T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, hand vice, Spanner

	(adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Materials/ Consumables	Oil can, Grease Gun Hand/Pneumatic

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
1. Identify the excess water in the plot	1.1. The excess water in the plots to be drained is carefully diagnosed.	The diagnostic process for identifying excess water is evaluated in terms of quality and precision.			2
		The methods used to identify excess water are examined.			2
		Relevant factors such as soil type, elevation, and rainfall patterns are taken into consideration			2
	1.2. Different sources of excess water already identified in the plots are systematically investigated.	The systematic investigation of identified sources of excess water is assessed.			2
		Potential contributors to excess water are included in the investigation.			2
		The depth of understanding gained through the investigation is considered.			2
	1.3. Possible consequences of excess water are properly determined in order to propose alternative solutions.	The accuracy of consequences identified due to excess water is evaluated.			2
		The viability and feasibility of proposed alternative solutions are assessed.			2
		Economic, environmental, and sustainability factors are taken into account.			2
	1.4. Excess water variation in the plot for more drainage project design is regularly monitored.	The frequency and consistency of excess water monitoring are reviewed.			2
		The effectiveness of monitoring methods and data collection is examined.			2
		The utilization of monitored data in shaping decisions for drainage project design is assessed			2

2. Prepare for drainage system installation activities	2.1. The construction site and construction method for the drainage system are completely identified according to the drainage system specifications.	The thoroughness and accuracy of site and method identification are assessed.			2
		Alignment with drainage system specifications is ensured.			2
		Consideration of factors like topography, soil composition, and proximity to water sources is taken into account.			2
	2.2. The surface drainage layout is correctly read for efficient implementation.	The precision in interpreting the drainage layout is evaluated.			2
		Accurate translation from design plans to implementation is examined.			2
		Alignment with design elements like gradients, flow directions, and discharge points is checked.			2
	2.3. Materials, tools, equipment, and machinery are properly selected according to drainage system design requirements.	The appropriateness of selected components is assessed.			2
		Suitability in relation to drainage system design is ensured.			2
		Consideration of factors like durability, local environment, and safety standards is taken into account			2
3. Carry out drainage site preparation	3.1. Readings in the field book are properly recorded in order to perform calculations of elevations.	The accuracy and completeness of readings recorded in the field book for subsequent elevation calculations are assessed.			2
		Suitability for subsequent elevation calculations is ensured.			2
	3.2. The site is completely surveyed, measured, and marked out, and soil characteristics relevant to the planned drainage system are confirmed according to plan specifications.	The thoroughness and effectiveness of site surveying, measurement, and marking are evaluated.			3
		Confirmation of soil characteristics as per plan specifications is conducted.			3
	3.3. Drainage layout is suitably established in terms of alignment design by applying the results of surveying.	The appropriateness of drainage layout establishment based on survey outcomes is evaluated.			2
		Alignment with efficient water flow and topography is ensured.			2
	3.4. Land is properly graded for drainage towards the main drainage system.	The accuracy and adequacy of land grading for directing drainage are assessed.			3
		Prevention of water accumulation and efficient flow towards the main drainage system are ensured.			3

4. Construct surface drainage infrastructures	4.1. The main drain for the drainage system, which receives flow from lateral ditches and sometimes other mains, is completely excavated.	The complete excavation process of the main drain, which receives flow from lateral ditches and sometimes other mains, is thoroughly assessed for its effectiveness.			3
		Unhindered flow reception from lateral ditches and sometimes other mains is ensured through the complete excavation of the main drain.			2
		Alignment with drainage system design is verified.			2
	4.2. Field drains and lateral ditches are completely excavated in accordance with the drainage layout without damage to services, facilities, features, and established plants according to plan specifications.	Adherence to the drainage layout during excavation of field drains and lateral ditches is evaluated.			2
		Prevention of damage to services, facilities, features, and established plants is ensured during the excavation process.			2
		Alignment with plan specifications is maintained.			2
	4.3. The drainage system is properly tested for geometrical configuration, flow rates, and capacity consistent with the drainage system plan.	The drainage system undergoes proper testing to ensure its thorough functionality.			2
		Consistency with geometrical configuration, flow rates, and capacity specifications is confirmed during the testing process.			2
		Alignment with the drainage system plan is maintained through proper testing.			3
	4.4. The supervisor is continuously consulted, and remedial actions are taken when the drainage system operation does not meet the plan specifications.	Continuous consultation with the supervisor is emphasized, and remedial actions are taken when deviations from the drainage system operation occur.			3
		Timely implementation of remedial actions in case of deviations is ensured.			3
		Realignment with drainage system plan is maintained through continuous consultation and remedial actions.			3
	4.5. The site is adequately restored and waste material removed from the site is disposed of in an environmentally aware and safe manner according to enterprise work procedures.	The site is adequately restored post-construction, and waste material removed from the site is disposed of in an environmentally aware and safe manner according to enterprise work procedures.			3

		Environmentally conscious disposal of waste material is ensured.			3
		Adherence to enterprise work procedures is maintained during waste material disposal and site restoration.			3
Total marks					100
Percentage Weightage					100%
Minimum Passing line % (Aggregate): 70%					

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