MINISTRY OF FOREIGN AFFAIRS
OF DENMARK
Danida

Uganda Programme for Sustainable and Inclusive Development of the Economy (UPSIDE)

WATER RESOURCES MANAGEMENT (WRM) MANUAL

NURI
Danida

Northern Uganda Resilience Initiative

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DRC DANISH REFUGEE COUNCIL

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Acronyms

CDO	-	Community Development Officer
CMC	-	Catchment Management Committee
CMO	-	Catchment Management Organization
CMP	-	Catchment Management Plan
CMS	-	Catchment Management Secretariat
CRRF	-	Comprehensive Refugee Response Framework
CSA	-	Climate Smart Agriculture
CSF	-	Catchment Stakeholder Forum
CTC	-	Catchment Technical Committee
DANIDA	-	Danish International Development Assistance
DLG	-	District Local Governments
DRWM	-	Directorate of Water Resources Management
DTPC	-	District Technical Planning Committees
DWRM	-	Directorate of Water Resource Management
DWRM	-	Directorate of Water Resource Management
FMNR	-	Farmer Managed Natural Regeneration
IMC	-	Implementation Monitoring Committee
IWRM	-	Integrated Water Resources Management
MAAIF	-	Ministry of Agriculture, Animal Industry and Fishery
MCMC	-	Micro-catchment management committee
m-CMC	-	Micro-Catchment Management Committee
MCMP	-	Micro-Catchment Management Plan
MCMS	–	Micro Catchment Management Secretariat
m-CTC	-	Micro Catchment Technical committee
MEMD	-	Ministry of Energy and Mineral Development
MoFPED	-	Ministry of Finance, Planning and Economic Development
MoWT	-	Ministry of Works and Transport
MTTI	-	Ministry of Tourism, Trade and Industry
MWE	-	Ministry of Water and Environment
MWT	-	Ministry of Works and Transport
NURI-CF	-	NURI – Coordination Function
OPM	-	Office of the Prime Minister
PMC	-	Project Management Committee
RWC	-	Refugee Welfare Council
SCMC	-	Sub-catchment management committee
SCMP	-	Sub-Catchment Management Plan
SCMS	-	Sub Catchment Management secretariat
SCSF	-	Sub Catchment Stakeholder Forum
SDG	-	Sustainable Development Goals
SRHR	-	Sexual and Reproductive Health and Rights
UNHCR	-	United Nations High Commission for Refugee
UNWMZ	-	Upper Nile Water Management Zone
uPVC	-	un-plasticized polyvinyl chloride

1 Chapter 1: Introduction

Background

NURI (Northern Uganda Resilience Initiative) is one of eight development engagements under the Denmark-Uganda Country Programme 2018 – 2022. The Country Programme aims to contribute to poverty reduction through inclusive and sustainable economic growth, promoting democracy, good governance and human rights and support Uganda's stabilizing role in the region.

The Country Program is divided into two Thematic Objectives; UPSIDE (Uganda Programme for Sustainable and Inclusive Development of the Economy) and UPGRADE (Uganda Programme for Governance, Rights, Accountability and Democracy)
NURI is one of the three Development Engagements under UPSIDE and contributes to the objective of sustainable and inclusive economic growth.

The objective of NURI at outcome level is enhanced resilience and equitable economic development in supported areas of Northern Uganda, including for refugees and refugee-hosting communities. NURI will pursue this objective by supporting activities in climate smart agriculture, rural infrastructure, and water resources management. Activities in support of agriculture focus on improving farmers' knowledge on climate-smart production methods, as well as their understanding of and ability to engage with markets and services. Support to rural infrastructure and water resource management are in those areas that contribute to agriculture sector outcomes, particularly access to markets and improving water resource management within the landscape.

In order to support Uganda's progressive refugee policy and the nexus between development and humanitarian action, refugees and their host communities will be among the beneficiaries in those NURI districts hosting refugee settlements.
To address some of the major challenges facing Uganda's economy today including the impacts of climate change, population growth, gender inequality and youth unemployment, NURI will strategically focus on Climate Smart Agriculture (CSA), Rural Infrastructure (RI) and Water Resource Management (WRM) as well as participation and empowerment of women and youth, and improving access to and information on Sexual and Reproductive Health and Rights (SRHR) services.

Integrated Water Resources Management (IWRM)

IWRM is a framework designed to improve the management of water resources based on four key principles adopted at the 1992 Dublin Conference on Water and the Rio de Janeiro Summit on Sustainable Development. These principles hold that:

1) fresh water is a finite and vulnerable resource essential to sustain life, development, and the environment;
2) water development and management should be based on a participatory approach, involving users, planners, and policy makers at all levels;
3) women play a central part in the provision, management, and safeguarding of water; and
4) water has an economic value in all its competing uses and should be recognized as an economic good.

IWRM is based on the equitable and efficient management and sustainable use and protection of water and recognizes that water is an integral part of the ecosystem, a natural resource, and a social and economic good, whose availability and quality determine the nature of its utilization. These principles shall be upheld in the execution of the WRM component of NURI.

Given that each community differs in terms of history, socio-economic conditions, cultural and political context, and differing levels of hydrological degradation, there is no single blueprint for IWRM that can be adapted to resolve the problems faced in each local context. Therefore, the interventions under NURI WRM shall be site/context specific in a given micro catchment.

Water Management and the Sustainable Development Goals

Generally, water is very central for the attainment of each of the 17 Sustainable Development Goals (SDG). Particularly, SDG 6, 15 and 13 in that order are directly achievable through Water Resources Management and investments in Water Infrastructure. These are elaborated below;

SDG6: "Ensure availability and sustainable management of water and sanitation for all":

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated waste water, and increasing recycling and safe reuse globally.

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable recharge planning for fresh water supply" to address water sGR4Wcity, and substantially reduce the number of people suffering from water sGR4Wcity.

6.5 By 2030 implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

6.6 by 2020 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, springlines and lakes.

6.A by 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programmes, including water harvesting and protection, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.

6.B Support and strengthen the participation of local communities for improving water and sanitation management.

Goal 15. "Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss"

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.

15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.

15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development

15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.

The rest of the goal targets remain relevant to but are not directly tagged to WRM.

Purpose and scope of the manual

The purpose of this manual is to provide guidelines for the implementation of the strategic intervention for Water Resources Management in the selected micro catchments under NURI.

These guidelines are aimed at contractors, Danish Refugee Council (DRC) staffs, the participating District Local Governments (DLG), Office of the Prime Minister (OPM) and the United Nations High Commission for Refugee (UNHCR). It is based on the Management Manual, which contains the general guidelines used for implementation of NURI.

Other manuals of relevance for this intervention are:

- RI Manual
- Monitoring and Evaluation (M&E) Manual
- DRC Operational Handbook
- Refugee Management Policy guidelines and documents

Other reference materials are:

- Ministry of Water and Environment (MWE) – catchment planning guidelines, version 2018.
- MWE-Catchment Management Organization (CMO) Procedures Manual 2019
- Comprehensive Refugee Response Framework (CRRF)
- Resilience Design (RD) Manuals and resources.
- Aswa and Albert Nile Catchment Management plans

This manual is intended to provide general guidelines for the design and development of small dams (valley tanks, contour dams, springs, tree system and other water conservation structures in the eight micro catchments. Any person using materials in this manual is expected to exercise due diligence and apply professional judgement on its applicability and appropriateness in the particular circumstances.

Distribution of the manual

This manual is distributed to the stakeholders mentioned in Section 2. A complete distribution list is maintained by DRC. DRC and UNWMZ are responsible for updating the manual, which will be reviewed by NURI-CF and approved by RDE.

2 Chapter 2: Stakeholders roles & responsibilities

Stakeholder organogram

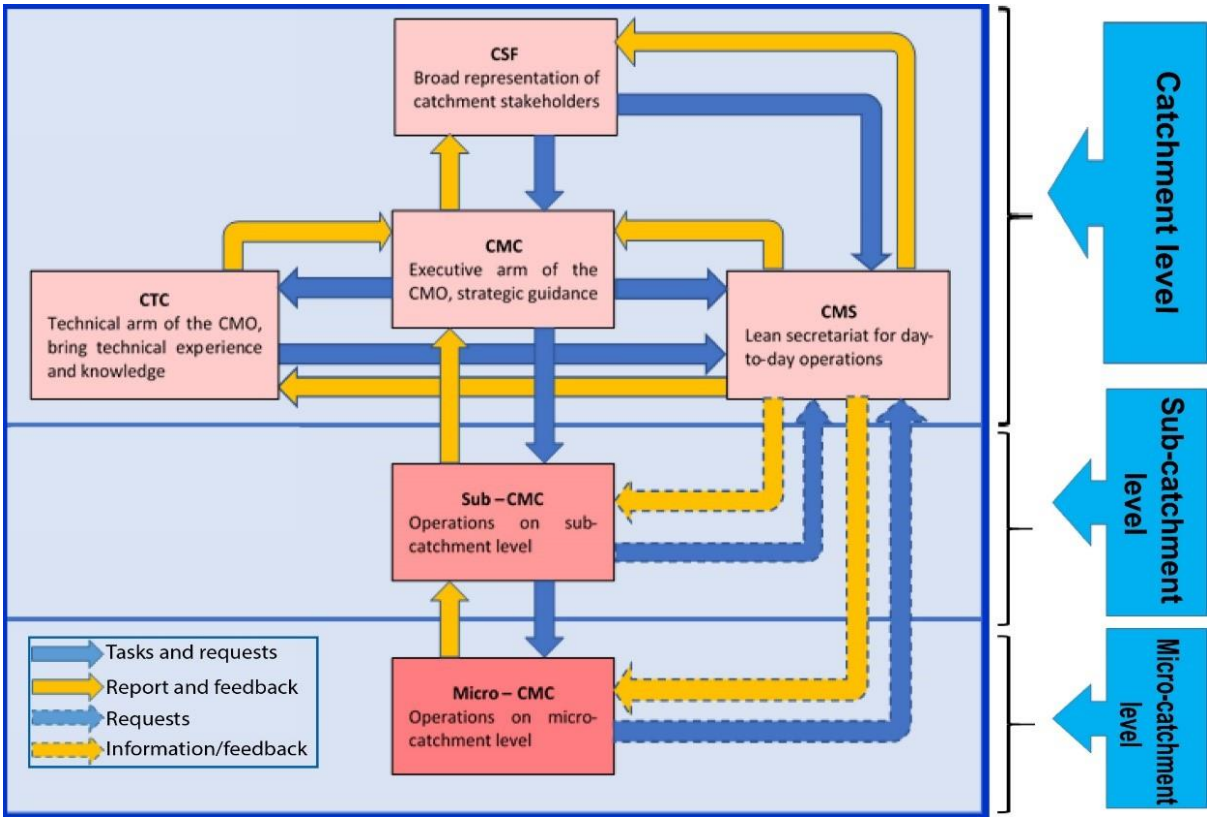


Figure 2:1 Catchment Stakeholder organogram

Steering committee

The steering committee consisting of the RDE, NURI CF, the Permanent Secretary MWE, and the Permanent Secretary Ministry of Finance, Planning and Economic Development (MoFPED) shall meet twice a year, i.e., June (approval of work plan and budgets) and September (approval of annual progress reports). The steering committee may also meet on request by any member of the committee.

Furthermore, Implementation Monitoring Committee (IMC) will be set up to cover all three output areas (CSA, RI and WRM). It will consist of the representatives of the RDE, NURI CF, MoFPED, MWE, leaders of participating district local governments, representatives of other relevant line ministries and organizations (Ministry of Agriculture, Animal Industry and Fishery (MAAIF), Ministry of Local Government (MoLG), Ministry of Works and Transport (MoWT), OPM, UNHCR) and implementing partners.

The IMC will meet annually in a learning and reflection workshop, and will also GR4Wry out overall programme monitoring and performance audits of activities.

NURI coordination function

NURI CF will oversee and support the day-to-day implementation of the engagement and undertake tasks including, but not limited to, the following:

- Review and aggregate annual work plan of the implementing partners
- Review and aggregate financial and progress reports of the implementing partners
- Disburse and monitor use of funds
- GR4Wry out financial and programmatic monitoring on the basis of an annual monitoring plan
- Prepare reviews in cooperation with RDE
- Plan and review programme M&E surveys

- Work closely with the DLGs (participate in DTPC meetings) to ensure that the districts provide oversight, monitoring and supervision
- Prepare implementation guidelines to guide implementing partners
- Develop new or approve existing accounts manuals for each implementing partner
- Assess the capacity of implementing partners on a continuous basis and draw up plans for capacity building and implement them
- Coordinate the activities of the implementing partners
- Provide technical backstopping to implementing partners
- Plan and GR4Wry out procurements that do not require tendering in line with EU rules.
- Plan audits and review audit reports of the implementing partners
- GR4Wry out due diligence and oversight of IPs in relation to implementing partners including through monitoring visits
- Implement recommendations from programmatic or financial reviews
- Together with RDE maintain a close relationship with Ministry of Agriculture, Animal Industries and Fisheries, Ministry of Water and Environment, Office of the Prime Minister, UNHCR, relevant district local governments, other development partners, NGOs, etc. to ensure that activities are coordinated.

MWE/DWRM/UNWMZ

DWRM/UNWMZ has the following responsibilities:

- Development of community-driven micro-catchment management plans based on community engagement and mobilization in the areas identified and quality-assure implementation of plans by the contracted company/National Governmental Organization (NGO) i.e., DRC, including on the basis of the CMO/ Catchment Technical Committee (CTC) structures and in close cooperation with technical staff from DLGs and NURI CF.
- Formation at field implementation level of committees that lead the communities to develop bylaws and enforcement mechanisms with support from NURI CF.
- Development of effective community agreements “bylaws” on natural resources management that emphasize water management.
- Propose annual work plans and budgets at least two months before the beginning of each calendar year.
- Provide quarterly and annual progress reports no later than 30 days after the end of each quarter.
- Certify work Carried out by contractor.

Catchment Management Organizations

A Catchment Management Organization (CMO) is a multi-stakeholder body that include UNWMZ, LDGs and LCs that facilitates collaborative Water Resources Management, playing a key role in developing and coordinating implementation and monitoring of the CMP.

Thus, a CMO is a good foundation for the coordination and supervision of the activities of stakeholders involved in the use and management of water and related resources in the catchment and for reviewing and evaluating the effects of catchment management interventions put in place. Generally, the roles of the CMO include to:

- Coordinate activities of the stakeholders involved in the use and management of water and related resources;
- Arbitrate internal conflicts between or among CMO members relating to: 1) the functioning of the CMO and 2) the management of water and related resources in the catchment.
- Support the process to develop the Catchment Management Plan (CMP);
- Mobilize resources to support activities of the CMO and the implementation of the CMP;

- Monitor progress of CMP implementation;
- Inform districts and other stakeholders of the existence of CMP and support its integration into District Development Plans.

Catchment Management Secretariat

The Catchment Management Secretariat (CMS) provides support to the Catchment Management Committee in coordinating the planning and implementation of activities in the catchment as well as following up of recommended actions by the stakeholders. The CMS acts as an administrative secretariat for the Catchment Management Committee as well as the Catchment Technical Committee.

The CMS has the following functions:

a. Act as an administrative arm for the CMC as well as CTC;
b. Provide support to the CMC and CTC in coordination of planning and implementation of activities in the catchment as well as follow up of the implementation of recommended actions by the stakeholders;
c. Be the main point of contact between the CMC and CTC and the stakeholders (including development partners) in the catchment;
d. Mobilize funds for the implementation of catchment management strategies and interventions of the plan as well as support the CMO operations;
e. Document activities in the catchment for purposes of information sharing, lessons learnt, best practices, new technologies and innovations and cross learning with other catchment areas;
f. Be an information centre for the catchment
g. Coordinate and support the SCMSs and MCMSs and
h. Execute any other functions as shall be determined by the WMZ/DWRM or CSF or CMC from time to time.

Catchment stakeholder Forum

The Catchment Stakeholder Forum (CSF) brings together all actors on catchment management.
The functions of the CSF are to:

a. Be the constituting body that elects the CMC and CTC;
b. Serve as a stakeholder consultation mechanism within the CMO framework, representing interests of the stakeholders in the catchment;
c. Define key water resources related issues in the catchment that require consideration to effectively develop, manage and protect the water resources;
d. Review and endorse annual workplans and budgets of the CMO presented by the CMC Chairperson or designated person appointed by the CMC Chairperson and
e. Advise on policy formulation (including by-laws and ordinances) and revision.

Catchment Management committees

The Catchment Management Committee (CMC) is composed of representatives of all relevant stakeholder groups (government, politicians, and community-based organizations, NGOs, water users, media, academic institutions, and private sector) and collaborates with the WMZ during the formulation of a Catchment Management Plan and plays a steering role during its implementation. The CMC responsibilities include:
The CMC is the Executive arm for the CMO.
The functions of the CMC are to:

a. Spearhead the development, implementation and review of a Catchment Management Plan on behalf of stakeholders in the catchment.

b. Represent all stakeholders in decision making at each step of the catchment planning and implementation process.
c. Endorse the catchment management plan before it is presented to the minister for final approval.
d. Present the catchment management plan to catchment stakeholders including the respective local governments for their awareness, concurrence and adoption.
e. Mobilize funds for the implementation of catchment management interventions as well as support to the CMO operations.
f. Provide strategic guidance and coordination support to catchment stakeholders on the implementation of the catchment management plan.
g. Report to the CSF on the progress of the implementation of the CMP, developments in the catchment and general operation of the CMO.
h. Inform and support the WMZ on issues related to the regulation of the use and management of water and related resources in the catchment.
i. Resolve conflicts between and among CMO members on matters related to the functioning of the CMO.
j. Coordinate the implementation and monitoring of relevant Acts, by-laws, guidelines, regulations, plans and standards.
k. Inform the Water Management Zone Advisory Committee on any issues related to the functioning of Water Management Zones.
l. Oversee the management of financial resources for catchment related activities in the catchment
m. Appoint, in consultation with the WMZ, staff to manage the CMO's activities where necessary.
n. Support sourcing of professional services as and when the need arises.
o. Perform other functions which the CSF determines are relevant to the implementation of coordinated management of water and other related resources in the catchment.

Catchment Technical Committees

The Catchment Technical Committee (CTC) forms the technical arm of the CMO and supports the CMC in their tasks. The CTC brings technical expertise and knowledge during the formulation of the Catchment Management Plan, operationalizes and sometimes implements programmes and projects from the plan, and generally ensures that the different districts collaborate to implement the plan. It comprises of technical people from government, NGOs, private sector, development agencies, and other relevant organizations in the catchment.

The functions of the CTC are to:

a. Provide technical expertise and knowledge to the sector programmes and projects in the catchment during the process of developing, implementing and reviewing the catchment management plan.
b. Take responsibility for operationalizing and implementing programmes, projects and interventions of the CMP including assigning implementation to appropriate district departments.
c. Oversee and foster inter-district cooperation during the implementation phase of the CMP.
d. Organize and coordinate the technical review of projects and programmes planned by catchment stakeholders including development partners.
e. Develop, discuss, and agree practical solutions to problems in the catchment, then make recommendations to the CMC for final decision-making.
f. Provide technical advice to the CMC and other stakeholders on any other matters pertaining to the proper use, protection and management of water and related resources in the catchment.

Sub-catchment management committee (SCMC)

The functions of the SCMC are to:

a. Lead the development, implementation and review of a Sub-Catchment Management Plan (SCMP) on behalf of stakeholders in the sub-catchment.
b. Approve the SCMP and present it for endorsement to the CMC.
c. Present the SCMP to the sub-catchment stakeholders for their awareness and concurrence.
d. Represent all stakeholders in decision making at each step of the implementation process.
e. Mobilize funds for the implementation of sub-catchment management interventions.
f. Provide strategic guidance and coordination support to sub-catchment stakeholders on the implementation of the sub-catchment management plan.
g. Perform any tasks, requests and activities given by the CMC and assure feedback.
h. Report to the CMC on the progress of the implementation of the SCMP where existent and the CMP, developments in the sub-catchment and general operation of the SCMC.
i. Inform and support the CMC and WMZ on issues related to the regulation of the use and management of water and related resources in the sub-catchment.
j. Resolve conflicts in the sub-catchment during implementation of priority investments
k. Coordinate the implementation and monitoring of relevant Acts, by-laws, guidelines, regulations, plans and standards within the sub-catchment.
l. Inform the CMC on any issues related to their functioning.
m. Oversee the management of financial resources for sub-catchment related activities in the sub-catchment.
n. Appoint, in consultation with the CMC, staff and other paid employees to run the SCMC's activities where necessary.
o. Support the CMC in sourcing of professional services as and when the need arises.
p. Perform other functions which the SCSF determines are relevant to the implementation of coordinated management of water and other related resources in the sub-catchment.

Micro-catchment management committee (MCMC)

The functions of the MCMC include to:

a. Lead the development, implementation and review of a Micro-Catchment Management Plan (MCMP) if existent on behalf of stakeholders in the micro-catchment.
b. Lead the identification and/or confirmation of areas of implementation.
c. Approve the MCMP and present it for endorsement to the SCMC.
d. Represent all stakeholders in decision making at each step of the implementation process.
e. Present the MCMP to the micro-catchment stakeholders for their awareness and concurrence.
f. Mobilize funds for the implementation of micro-catchment management interventions.
g. Provide strategic guidance and coordination support to micro-catchment stakeholders on the implementation of the micro-catchment management plan.
h. Perform any tasks, requests and activities given by the SCMC and assure feedback.
i. Report to the SCMC on the progress of the implementation of the MCMP where existent and the SCMP, developments in the micro-catchment and general operation of the MCMC.
j. Inform and support the SCMC on issues related to the regulation of the use and management of water and related resources in the micro-catchment.
k. Resolve conflicts in the micro-catchment during implementation of activities.
l. Coordinate the implementation and monitoring of relevant Acts, by-laws, guidelines, regulations, plans and standards within the micro-catchment.
m. Inform the SCMC on any issues related to their functioning.
n. Oversee the management of financial resources for micro-catchment related activities in the micro-catchment.

o. Appoint, in consultation with the SCMC, staff and other paid employees to run the MCMC's activities where necessary.
p. Recommend to the SCMC procuring of professional services as and when the need arises.
q. Perform other functions which the MCSF determines are relevant to the implementation of coordinated management of water and other related resources in the micro-catchment.

Other Ministries;

Other ministries that by virtue of their mandates and operations, have direct relevance to Water Resources Management are the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), the Ministry of Tourism, Trade and Industry (MTTI), the Ministry of Energy and Mineral Development (MEMD), the Ministry of Health (MOH), Ministry of Works and Transport (MWT) and the Ministry of Local Government (MLG).

(a) **MAAIF** is the lead agency for water use and management of on-farm agricultural water facilities. MAAIF shares the responsibility for water for production with MWE, where MWE is responsible for "off farm" activities, while MAAIF deals with "on-farm" activities.
(b) **MTTI** covers water use and management of industries, commerce, wildlife and tourism.
(c) **MEMD** covers water use and management for hydropower generation.
(d) **MWT** is relevant especially where the potential to use roads and bridges as water harvesting structures can be exploited.
(e) **MOH** is mandated with the role of ensuring that people in the country access quality health services through primary health GR4We. Water plays a key role in health GR4We.
(f) **MLG** is mandated with establishment of structures and frameworks for governance of districts.

District/Sub-county Local Government Authority

At DLG level, several departments are relevant to Water Resources Management:

- The District Natural Resources Department houses other important sub-departments, that include the District Environment Office, the District Forestry Office and District Wetlands Office. The offices are responsible for natural resources management, capacity building, sensitization, enforcement of the law and compliance.
- The District Water Department is responsible for supplying reliable and safe water to mostly urban areas. It is also responsible for supplying water for production. Some of the wetlands act as water reservoirs, hence the importance of the department in activities of IWRM.
- The Agriculture, Livestock and Fisheries Offices fall under the District Production Department. The department is important because it has a direct relationship with natural resources on which communities rely for a livelihood.
- The Department of Community Based Services coordinates all activities related to community development. They also coordinate all activities of Civil Society Organizations, NGOs and other Community Based Structures. The department is in direct contact with communities and mobilize and sensitize them for poverty eradication, gender, probation and social welfare and community development.
- The key function of the Department of Planning is to provide planning services throughout the district. Specifically, the department works with other district departments as well as the lower local governments to ensure timely production of up-to-date and high-quality medium term and operational plans.
- The District Information Office is the official government communication platform at district level. They have free airtime in both private and government media. They also have budgets for community mobilization and sensitization.

Danish Refugee Council (DRC)

DRC, contracted agency, will directly implement the Rural infrastructure component and Water Resource Management of the interventions. DRC has its Country Office in Kampala and Regional Offices in West-Nile and Acholi, which are located in Arua, Adjumani and Kitgum. NURI has 11 field offices but only 6 offices are currently implementing WRM interventions, these are; Rhino camp, Zombo, Nebbi, Obongi, Adjumani and Kitgum field offices.

The staff in West-Nile and Northern Uganda who are directly involved in the implementation of the Water Resources Management projects are:

- Project Manager
- Project Engineer
- Project Water Engineer
- Finance and Administration Coordinator
- Regional Managers/Project Manager-Project Support
- Supervising Engineers/Shelter and Infrastructure Officer
- Finance Officers
- Supply Chain Officers
- Infrastructure Supervisors/Team Leader-Shelter and Infrastructure
- Engineering Assistants/Shelter and Infrastructure Assistants-Engineering
- Infrastructure Assistants/Shelter and Infrastructure Assistants-Public Works
- Assistant Hydrologists (Wash Assistant)
- HR and Administrative Officers
- Finance Assistants
- Supply Chain Assistants
- Environment/Forestry Assistants
- MEAL Officer
- MEAL-Assistants

The main tasks for DRC are:

- Assist in the development, revision and update of micro catchment management plans;
- Develop work plans, budgets and procurement plans;
- Recruit relevant staff required to implement activities;
- Procure relevant tools and materials required to implement activities;
- Supervise construction and maintenance activities according to the Water Resource Management Infrastructure Manual;
- Pay participants involved in labour intensive infrastructure works;
- Quality-control all activities;
- Liaise closely with NURI CF and other stakeholders;
- Report on implementation as per reporting guidelines.
- Cost the Water Resources Management projects and prepare a list of proposed projects for the m-CMC approval
- Prepare agreements for the approved projects
- Organize training for Project Management Committees and project user committees
- Prepare Bill of Quantities for Water Resource Management projects
- Run tenders for WRM projects
- Organize the commissioning and hand over of the projects
- Monitor maintenance

Project Management/Implementation Committees

For community group of 15 to 30 people, a Project Management Committee (PMC) will be formed comprising of 4 members who are selected among the group members where 2 of members should be women.

The members of the PMC serve as work foremen for the members who are working on a project. Before the project starts the PMC will receive training in the technical work and the administrative procedures.

The main tasks for the PMC are:

- Prepare detailed plan for the project
- Receive and handle tools and materials
- Organize and supervise work
- Maintain attendance register
- Support the payment of cash to the members of the community groups
- Hand over tools to the Project User committee at end of project in the presence of lower local government and/or RWC.
- Ensure compliance with the law related to cash for work (refer to DRC SOP on cash for work)

Host Community and Refugee Groups

The promotion of the development of human and physical resources in rural areas requires recognizing the fact that local people themselves are the main implementors of development projects. If the people participate passively in projects, they become inactive and will depend on external inputs. In order to avoid this situation, local decision-making in project planning and implementation is important. In other words, a project that the local people themselves plan and implement is given priority as local materials and human resources are utilized effectively by the local people's initiative and responsibility. Local independence and sustainable development of project outcomes are enhanced by the effective use of local resources.

Host Community and refugees living in the micro catchment areas in West-Nile and Acholi region shall constitute the beneficiary groups of NURI WRM project implementations. The project will encourage eligible existing host community and refugee groups to enroll in the implementation of the labor-intensive infrastructure. The main tasks of the community groups in relation to WRM infrastructure implementation will be:

- Inform the development of the WRM
- Establish leadership to mobilize farmers and coordinate activities
- Work on WRM projects to earn cash
- Spearhead operation and maintenance of WRM infrastructures
- Ensure ownership through the fullest engagement in the assessment, planning, implementation and monitoring of WRM activities.
- Provide local equipment, tools, materials and supplies for work in WRM projects.
- Identify security issues, concerns and threats related to WRM interventions

3 Chapter 3: Implementation Modalities

Rapid industrialization and urbanization coupled with continuous decline in per capita water availability is putting a lot of pressure on the available water resources in the world. The increasing gap between water availability and demand highlights the need for hydrological recharge and conservation of water. The different Government Water Policies also lay stress on conservation of water. It has been stipulated that efficiency of utilization in all the diverse uses of water should be optimized and an awareness of water as a sGR4Wce resource should be fostered.

The overall objective of WRM intervention is "Improved climate change resilience in target areas of Northern Uganda through WRM, including for refugees and host communities."

Water resource management, will contribute to the NURI outcome through:

- Improved water structures through enhanced design of water structure connectivity to strengthen the whole micro catchment hydrology
- Improved access to water for households, livestock and agricultural activities;
- Mitigation of climate and weather extremes while contributing to restoration of community agroecosystems
- Prevention of damage and destruction of road and infrastructure investments
- Application of water design in to ecology and biodiversity
- Spring-line and borehole recharge
- Increased hydration, fertility and productivity of road-adjacent farms
- Passive water harvesting into surface water retention and sub-soil water banking systems

The underlying principle of the strategic intervention for WRM is that enhanced design and management of water resources will improve the enabling environment for small-scale farming by increasing reliable water availability, reducing the impact of climate change and extreme weather events, and countering environmental degradation. This will lead to improved and more stable agricultural yields and decreased incidents of crop failure. This will in turn increase resilience to climate change and thereby promote equitable economic development for people in Northern Uganda.

WRM has a budget of DKK 29 million (excluding DKK 5 million DKK managed by MWE and DKK 1 million managed by NURI CF), and the target is to implement eight micro-catchment management plans with 40 agriculturally-related physical and natural water infrastructures.

Each micro catchment has a budget allocation as in Table 3.1 below where 25% of the total allocation is estimated for public work activities

Table 3.1 Budget Allocations Per Micro-Catchment

WATER RESOURCES MANAGEMENT BUDGET ALLOCATION			
District	**Micro Catchment**	**Net allocation**	**Labor intensive**
Terego /Madi-Okollo	Yelulu	1,443,826,310	490,000,000
Nebbi	Nyarwodho	1,443,826,310	490,000,000
Zombo	Ora	1,443,826,310	490,000,000
Nebbi/Pakwach	Ayila – Abongo	1,443,826,310	490,000,000
Adjumani	Nyivura	1,443,826,310	490,000,000
Moyo/Obongi	Iboa	1,443,826,310	490,000,000
Kitgum	Ogwapoke	1,443,826,310	490,000,000
TBD		1,443,826,310	490,000,000
Total		**11,550,610,480**	**3,920,000,000**

The budget allocations per micro-catchment include the following project implementation costs:

- Participants payments (cash for work)
- Training of PMCs
- Tools and Equipment
- Materials
- Contract payments
- DLG Supervision and monitoring

The watershed/catchment-based approach

A watershed /catchment/ drainage basin is any area of land where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water.

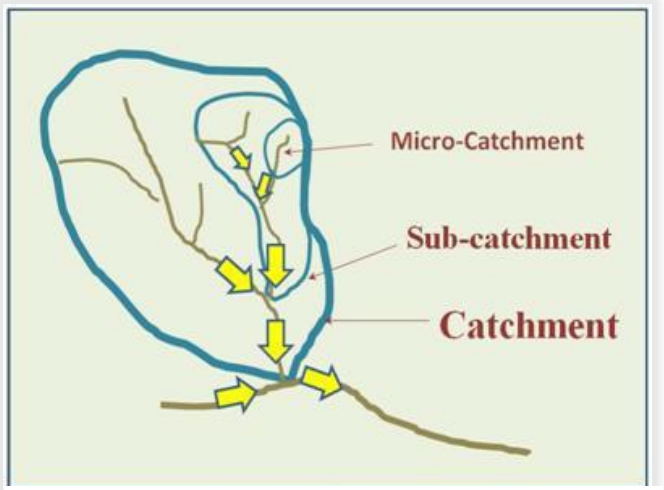


Figure 3:1 Different hierarchies of hydrological units

Figure 3.1 illustrates the different hierarchies of hydrological units.

Uganda has decided to decentralize some of the water resources management functions to the lower levels (catchments and/or water management zones) in order to promote stakeholder participation and the principles of IWRM. A catchment perspective is the key to enhanced water resources management and restoration of community agroecosystems in Uganda and is seen as an opportunity for involvement of all stakeholders.

Under NURI, for WRM interventions, the planning units will be the micro catchments rather than the political administrative units, noting that hydrological units transcend political administrative boundaries. However, the stakeholders and beneficiaries shall be drawn from within the hydrological micro-catchments.

Water Resource Management Infrastructure

Rural communities have different needs for water, such as for household use, subsistence farming, market-oriented farming, livestock watering and off-farm uses. Water storage is a driver -- and often a prerequisite -- for economic growth, and is of particular importance to smooth intra-annual and spatial variations in rainfall that otherwise have significant impacts on Agriculture. Improvements and diversification in water storage, including within hydrated well protected soils, are most needed in poorer communities.

Agriculturally related Water Management Infrastructure

Water storage has a vital role to play in managing water variability, ensuring food security and building resilience for adaptation to climate change.

Among the types of infrastructures to be implemented are:

1. Multi-purpose dams/reservoirs;
2. Valley tanks, Contour dams, embarkment dams
3. Protection of river banks;
4. Spring protection;
5. Earthworks and stone-works for passive water harvesting;
6. Tree and biodiversity regeneration with each plant having a micro water harvesting structure like a smile berm;
7. Other water retention structures in the open landscape (on and off-farm).

<u>Multi-purpose dam/reservoir</u>

Earth dams is one of the important features in the development and management of water resources development of a watershed recharge plan. Dams clearly make a significant contribution to the efficient management of finite water resources that are unevenly distributed and subject to large seasonal

fluctuations by slowing, spreading and sinking water into the soils. Design of dams that is based on natural contours and patterns of the land allows for designing micro-catchment-based networks of dams, ponds and bioswales on contour that not only retain surface water with increased catchment by design, but act as infiltration systems for long-term hydration of soils in degraded landscapes.

A multipurpose dam may combine storing and supplying water for irrigation, industry and human consumption with other uses such as flood control, power generation, navigation, run-off storage and water discharge regulation considered

NURI will construct Multi-purpose dams where its technically highly feasible and economically viable, noting that dams are exceptionally expensive investments compared to other water retention infrastructure.

Valley tanks (dams)

Valley tanks are reservoirs excavated within valley beds to impound surface and/or groundwater for different purposes or uses. In Uganda, valley tanks are commonly excavated in the semi-arid regions to provide water for production (i.e. for irrigation, livestock watering, aquaculture and rural industry) and for domestic use.

NURI will be involved in construction of new or rehabilitation of existing valley tanks. The Rehabilitation can include desilting, fencing and installation of on farm works.

For more detailed descriptions of valley tanks see Annex 10.1

Small Scale irrigation Systems

NURI will engage in small scale irrigation activities that will help to contribute to livelihood development by increasing productivity of food and cash crops and thus reducing pressures on the catchment such as lumbering, sand mining and cultivation in River banks. This project will also encourage crop diversification both to improve the nutritional status of families and so that farmers might earn some income from selling produce. Detailed description of Small-Scale Irrigation system is presented in Annex 10.2

Riverbank protection and restoration

NURI will also support river bank protection and wetland restoration as an ecological restoration modality. Strategies involved here will be to mitigate secondary and tertiary inflows with interventions like rock and living plant check dams and gabions, slowing, spreading and sinking up stream flows out into the broader landscape. Also, strategies to spread out livestock impact to reduce stream bank compaction and erosion will also be supported. Interventions like Gully plugging helps reduce erosion by capturing water and sediment, thus contributing to flow regulation and water infiltration. Details are in Annex 10.5

Tree planting

Reforestation/afforestation will form a major component of the environmental restoration effort under NURI WRM intervention with a focus on restoring indigenous biodiversity and bringing perennial stability to farms and community agroecosystems. They are described in Annex 3.

Soil and Water Conservation (SWC)

Soil and water conservation using resilience design framework will also be supported under NURI. Various techniques designed for the specific site context opportunities and constraints will involve earthworks and stoneworks such as contour planting, terracing, check dams, one rock dams, zuni bowls, rock runs etc. These will be supported as a means to mitigate erosion, Slow, Spread and Sink into the soils for long term banking of water. These are described in detail in Annex 10.5

Other water retention structures in the open landscape (on and off-farm) like Grass strips, Stone bunds, Percolation pits e.t.c., can be supported under NURI WRM interventions in order to capture moisture in to the landscape and regenerate local ecology.

Water Resources Management Infrastructure Projects
Construction or Rehabilitation of a Water Resources Management infrastructure (see section 3.1) constitute a WRM infrastructure project.

Here are some examples of projects:

Construction projects

1. A project will include all components like Construction of a Valley tank and establishing Small Scale Irrigation system including animal watering troughs coupled with significant tree systems and water harvesting structures like bio swale, infiltration pits etc.

Rehabilitation/restoration projects

1. Under rehabilitation of a valley tank constructed years ago. The project includes construction of a fence, desilting, construction/clearing of the spillway and construction of on-farm works as well as source protection activities.
2. Restoration of degraded hotspots through afforestation/reforestation, riverbank protection, soil and water conservation and wetland restoration. The hotspots will be reforested and water conservation technologies implemented.

Under NURI most WRM infrastructure projects, the involved communities will be sensitized about maintenance and the future maintenance organized and the necessary training provided.
This new and more flexible project concept will ensure that we get more value for money in terms of infrastructure constructed and rehabilitated.
For administrative purposes a project may be broken down in sub-projects, which are each managed by its own management committee.

Preparation of Investment Plans
The preparation of infrastructure investment plans per micro catchment is phased:

Table 3.2 Preparation of infrastructure investment plans

Region	Micro-catchment	Location (district)	Implementation period
West-Nile-South	Yelulu	Arua	1/1/2020-30/12/2020
	Ora	Zombo	
	Nyarwodho	Nebbi	
	Ayila Abango	Pakwach	1/1/2021-31/12/2021
West-Nile-North	Nyivura	Adjumani,	
	Iboa	Moyo/Obongi	
Acholi Sub-region	Ogwapoke	Kitgum	1/1/2022-31/12/2022
TBD	**TBD**	**TBD**	**TBD**

The main activities in preparation of infrastructure investment plans are:

1. Review of m-CMPs
2. Preparation of Implementable project documents
3. Screen projects based on selection criteria

4. Cost projects
5. Prioritize projects and compile investment plan
6. Present the plan for approval to the m-CMC

These activities are described in detail in Chapter 4.

The selection criteria used in screening projects are:

- The projects should be included in the micro-catchment or sub-catchment management plans.
- The selected projects should include maintenance aspects, functionality and sustainability of the selected infrastructure.
- The projects should be implemented using labour intensive methods in order to create temporary employment for the host community and refugees. Also, an opportunity to teach the most vulnerable basic concepts in water and nutrient harvesting and recycling.
- The projects should target providing employment to the youth, women and to the extent where possible, other vulnerable groups in the host community and refugees settlements.
- The majority of the projects should support the agricultural development and enhance community agroecosystems e.g., providing water for Agricultural production so that farmers can-do year-round production with increased agrobiodiversity.
- The projects should be fairly spread over the micro catchment but based on hotspot.
- The projects should be able to involve users of the project who live nearby, e.g. along a river bank.
- The projects should be feasible and relevant to the context of the site and the needs of the community.

Costing of the projects should be based on the following principles:

1. The participants from the host community and refugees should be paid UGX 6,000 per day worked.
2. The standard costs for PMC training, tools, materials, and structures included in the annexes should be used. Modifications should, however be done where it is established that the structures require extra materials and works. If these adjustments are not made, there will be risk of cost overruns that makes it impossible to implement the investment plan.
3. Include standard cost for maintenance sensitization and training (see section 4.3)

When it comes to prioritization and compilation of the plan the total cost for m-CMC/ OPM facilitation and a contingency of 5% should be included. In case the buffer is not used additional projects can be selected later
The investment plans should be reviewed annually and revised if necessary.

Preparation of implementation plans
The implementation of infrastructure projects in the selected micro catchments is phased:

Table 3.3 Preparation of implementation plans

Region	Micro-catchment	Location (district)	Implementation period
West-Nile-South	Yelulu	Arua	1/1/2020-30/12/2020
	Ora	Zombo	
	Nyadrwodho	Nebbi	
	Abango	Pakwach	1/1/2021-31/12/2021
West-Nile-North	Nyivura	Adjumani,	
	Iboa	Obongi	

Acholi Sub-region	Ogwapoke	Kitgum	1/1/2022-31/12/2022

The main activities in preparation of WRM infrastructure implementation plans will be through a participatory process aimed to:

1. Prepare detailed design and estimates where standard design and BOQs cannot be used
2. Select the host community and refugee participants (in order to be sure that the necessary number of participants are available)
3. Prepare time schedule for implementation of the projects
4. Approval of implementation plan

These activities are described in detail in Chapter 5.

Construction and Rehabilitation

The construction and Rehabilitation of WRM infrastructure include the following activities:

1. Participatory community sensitization where community will input on their landscape, perceived needs and constraints to help inform the project.
2. Hold Shared Learning Dialogues (SLDs) with local committees and local government to raise awareness about Resilience Design and permaculture approaches and impacts
3. Group formation that comprises of host community only, mixture of host community and refugees encouraged for refugee settlements and groups comprising of only refugees can be considered if there are no host community members
4. Train project management committees
5. Hold site dialogue meetings
6. Hire capable contractors
7. Procure tools and materials
8. Distribute tools and materials
9. Supervise construction work (together with technical teams)
10. Monitor construction works together with mCMC
11. Pay contractors
12. Pay host community and refugees

These activities are described in detail in Chapters 6.

Most WRM infrastructure projects will be constructed by DRC directly using labour intensive approach. In exceptional cases, DRC will fully contract out complex projects identified during screening on WRM projects. Valley tank and multipurpose dam construction will be contracted out through DRC's procurement process. Supervision and training of contractors in specific infrastructure construction techniques based on RD specific approaches will be done by DRC engineers in close cooperation with the UNWMZ and m-CMC Engineers.

Procurement of tools and materials shall be done in accordance with DRC's procurement guidelines.

The frequency of payment of cash for work will depend on the nature of the projects but normally payment will only be made once the project is completed.

Maintenance

To best handle the maintenance of WRM infrastructures, NURI will address maintenance challenges in the following ways:

1. Maintenance will be considered during project selection and prioritization
2. User committees/associations will be established and trained in maintenance aspects of the project
3. Infrastructure projects will be handed over and commissioned ceremoniously.

These maintenance approaches are described in Chapter 7.

Commissioning and other ways of handing over completed projects are very important milestones and make it clear for the communities that the responsibility of maintenance is now theirs.

Monitoring and quality assurance
The guidelines for monitoring are described in the M&E Manual.
DRC's role in monitoring will be described in detail in chapter 8.
The m-CMC and OPM role in monitoring is described in the NURI Management Manual.
Quality assurance activities undertaken by DRC are described in chapter 8.

4 Chapter 4: Preparation of Investment Plans

This chapter explains the process of developing the investment plans for the implementation of the WRM infrastructure project. Detailed explanation of developing infrastructure investment plans, getting approval, implementation, annual review, and maintenance is provided in the below sections.

Development, review and updating m-CMPs and SCMPs

DRC will collaborate with the authorities at UNWMZ, m-CMC, SCMC levels where necessary, to undertake an assessment of the availability and quality of existing Management plans. This assessment will undertake a review of the planning period, coverage (e.g., if there have been changes in administrative unit since) and how inclusive and participatory the process of developing the plan has been. The review process shall be guided by the catchment planning guidelines of MWE, 2014:

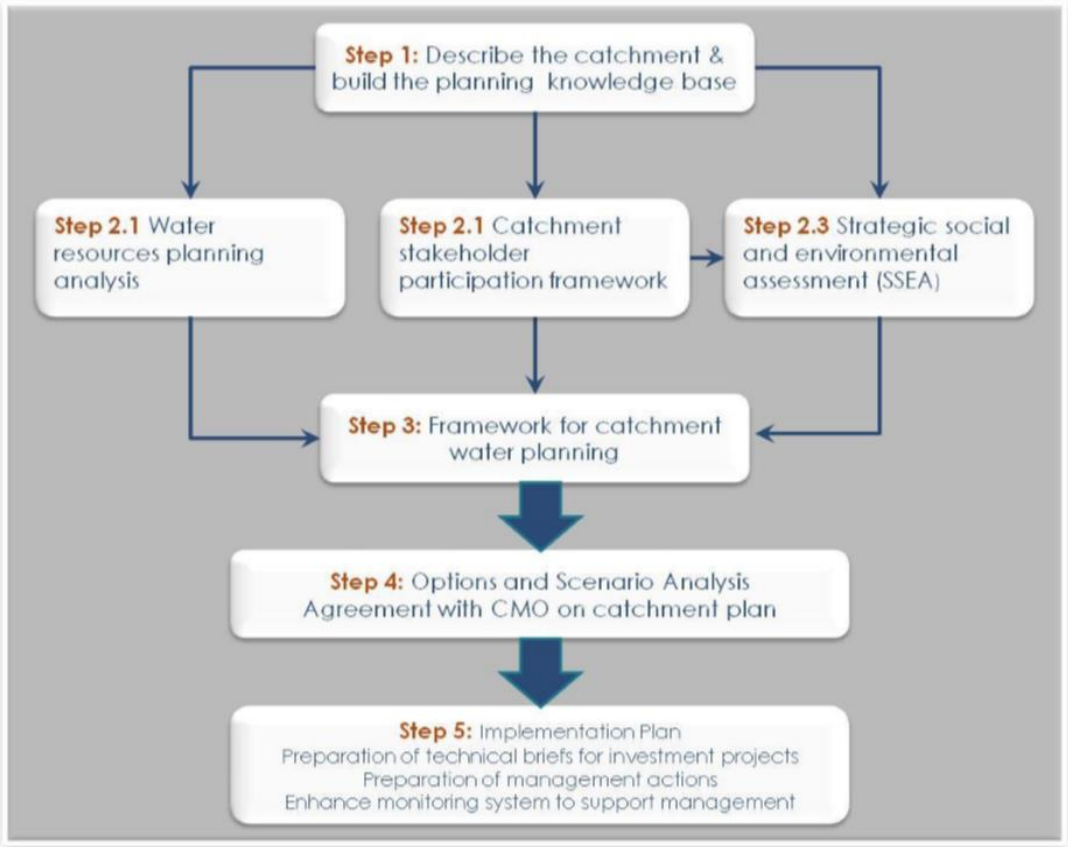


Figure 4:1 Development, review and updating m-CMPs and SCMPs

This assessment will inform which of three possible planning processes a given micro catchment will undergo; picking projects from existing m-CMPs, Participatory Rural Appraisal of plans or a full participatory planning process. UNWMZ will lead the process.

Screen projects based on selection criteria

The starting point for selection of WRM infrastructure projects is the micro catchment management Plans and Sub-Catchment Management Plans (existing, re-validated or newly developed versions as specified above).

At micro-catchment level, the CTC select and recommend projects that are included in the management Plans and fulfil the selection criteria listed in section 3.3

This is done in consultation with the DRC staff to ensure that the projects are as evenly distributed as possible over micro catchment. In order not to raise expectations too high only 3-5 projects should be pre-selected per micro catchment depending on the size (cost) of the projects.
The DRC staff will ensure that projects are identified and described in format shown in Appendix 1.

Cost projects
All projects should be assessed, which will include a site visit. After assessment the following costs elements should be estimated and the total costs calculated.

1. Participants payments (cash for work)
2. Training of PMCs
3. Tools, materials and Equipment
4. Contract payments
5. Fee for payments
6. Compaction of roads
7. Structures
8. Maintenance sensitization, training and support

The standard cost in the annexes can be used where relevant but if there are special conditions the extra cost involved should be estimated and included.
In addition to the costs in the annexes the following unit costs are used:

1. Training of one PMC costs UGx. 260,000
2. Maintenance training costs UGx. 1,000,000 per project.
3. Training of one project user committee costs UGx. 1,000,000
4. Commissioning of completed project cost UGx. 1,500,000 projects except food forest, soil and water conservation

The costs of a project should be documented in the format shown in Appendix 1.

Prioritize projects and compile investment plan
As the total costs of the screened projects most likely will exceed the total infrastructure budget for the micro catchment, prioritization of projects will be done through following criteria:

- The total cost of projects plus the costs for commissioning and m-CMC supervision should stay within the total budget for the micro catchment, which should cater for a 5% buffer (contingency).
- For each intervention category the total cost of projects should be within the budget per sector. The budget per sector is decided by the m-CMC based on the severity of the problem it addresses.
- Total number of worker days should be as close as possible to the target worker days for the micro catchment.

This will be done in a consultative process first between DRC staff and m-CMC.
DRC in collaboration with the m-CMC prepares the investment plan. The investment plan consists of the overview (Appendix 2) and the project descriptions of the selected projects (Appendix 1).

Present the plan for approval by the m-CMC
The m-CMC and UNWMZ reviews the Investment Plan and is responsible for approval of final project selection, design and costing. The m-CMC/UNWM are expected to complete the review and approval of Investment Plans within a timeline of 3 weeks upon submission. Upon approval, tripartite Infrastructure Project Agreements will be made between DRC, the m-CMC and Project Management Committee. This agreement should form the basis for agreed implementation of the WRM infrastructure project.

5 Chapter 5: Preparation of Implementation Plans

The WRM projects will be implemented in accordance with the investment plans described in the previous chapter. But before implementation can start, implementation plans have to be prepared.

Prepare detailed designs and BOQs

Where the standard designs cannot be used the technical designs of WRM infrastructure will follow the government standards. Where variations are required owing to peculiarity of the sites, the DRC Engineering team, the m-CMC and NURI CF will agree before changing the designs. See annexes for details of standard of WRM infrastructures.

Where the standard BOQs cannot be used a detailed costing of the infrastructure projects will be prepared. DRC Technical Team will be responsible for preparing the BOQs.

Select Project Beneficiaries

Together with local authorities DRC will identify host community and refugees who will benefit from the WRM projects and who are willing to participate in the construction and Rehabilitation and will commit themselves to future maintenance of the infrastructure.

Household/Beneficiary Selection and Targeting

The following criteria will be used for selection and targeting of WRM infrastructure works participants.

- Members will be within walking distance to the project site
- 50% of the participants will be women
- 60% of the participants will be 18 to 28 years
- For refugee areas 50% of the group members should be refugees and 50% nationals
- A Household should send only one person to the group.
- a community who is already involved in another cash for work activity for another project/organization should not be selected.
- A community member with a formal job (e.g teacher) will be excluded to give priority to people without income or those relying on sell of their products (informal economy).

The reason for having many youths under WRM public works is to create temporary employment for young people such that they can earn money for engaging in productive activities like buying livestock or starting a business.

- The executive members of the m-CMC will be members of the project implementation committee and responsible for selection of public participants. After selection of participants, the names will be forwarded to RWC3 and Sub County Community Development Officer (CDO) for verification and submission to DRC. After receiving the lists of participants from the sub counties, DRC will issue smart saver GR4Wds to the group members for identification.

The selection of community groups should be the documented in the project files and a list of all groups compiled.

Prepare time schedule

A time schedule that shows when the different projects will be implemented should be prepared.

Approval of implementation plan

The implementation plan should be reviewed and approved by the m-CTC.

6 Chapter 6: Construction and Rehabilitation

Sensitization and Site Dialogue meeting
Site dialogue meeting shall be done immediately after approval and the investment plan. Host Community and Refugee information meetings will be held on project activities and participation selection criteria in liaison with m-CMC, LC-Is, LC-IIIs and RWCs as an entry point to the target population.

DRC project staff will proactively engage in conflict mitigation in relation to access to land and water for project sites. This will be done through Site Dialogue Meetings, which will be Carried out before project works is commenced. The template to be used in this meeting is in Appendix 11.6. The meeting is to take place at the site of the implementation and include the following stakeholders:

- Sub-County Chief/RWCs/Settlement Commandant/m-CMC
- Landlords and LC1 of the project site
- DRC Infrastructure supervisor (Team Leader-Shelter and Infrastructure)

The purpose of the meeting is to ensure that all stakeholders have full information about the details of the construction, and that safe access to the project site is agreed upon.

The meeting is Carried out with the following agenda:

1. Welcome and introduction (m-CMC)
2. Brief presentation of the NURI project (DRC)
3. Presentation of participatorily selected projects, its technical design and location
4. Selection criteria for participation in cash-for-work (incl. no. of group members for various project types)
5. Conflict reporting and management, Project feedback and complaints mechanism
6. Community hand-over and maintenance process (m-CMC and DRC)
7. Questions and answers
8. Signing agreement on project site access with land owners witnessed by local authorities.
9. Announcement of date for group formation and registration of beneficiaries

Group formation and election of project management committees
This will be a participatory beneficiary selection and group registration. DRC will welcome inclusion of existing host community groups, mixed groups and refugee only groups that fulfil project selection criteria as a means to promote local sustainability, trust and cooperation within the groups, and to strengthen the component on savings and investment at group level where existing structures are an enabling factor. Newly formed groups will be assisted by DRC in development of by-laws and selection of group leaders.

While the communities and their leaders decide who participates in NURI, it has to be ensured that the selection criteria in section 5.2 are adhered to.

Groups of 30 members are formed (depending on no. of workers required for type of project). An initial group meeting is organized, in which a self-organization with election a Project Management Committee of 4 members is elected. The PMC is to have members with specific duties as Chairperson, Treasurer and Secretary. There should be 50% women in leadership positions. Additional members are ordinary members.

Train project management committees
Project Management Committees will be provided with training to have adequate skills to manage the project implementation. This responsibility rests with the relevant m-CMC and DRC.

The PMCs will receive two-day training in:

- The technical specifications of the particular WRM project they are to manage
- The technical methods to apply and demonstrations of how to use tools safely
- The conditions under which tools are provided, and how they should be managed in the project period
- Project cycle management and inter-personal supervision skills
- Record-keeping of attendance
- Thorough briefing on the work norms and conditions for payment together with the rest of the group members in line with national policy on cash for work
- Basic training on how to use the first aid kit, which is provided to the group
- Training modules on feedback and complainants' mechanisms
- Reporting mechanisms for conflicts to relevant stakeholders

The groups will agree on a modality of verifying attendance records on a weekly basis before they are forwarded to the payment register on a monthly basis. Group members will also be provided with a demonstration on use of relevant construction tools /equipment in order to ensure both effective technical utilization and the safety of the users. At the end of the Project Management Committee training, the Hydrologist will facilitate a post-training verification to ensure that the members' technical skills are at a level that qualifies them to supervise works, which is further elaborated in chapter 8.
The first task of the Project Management Committee will be to undertake consultation with the host community and Refugee members that have been selected to develop work schedules according to the project implementation plan.

Hire of local technicians and contractors
The WRM Intervention comprises projects that primarily are implemented using labor-intensive methods through cash for work. However, some highly specialized infrastructure will be beyond the capacity of community workers. Among these, DRC will directly implement infrastructure projects. This will be managed by DRC's Engineering Team and Carried out by local technicians/masons employed as service providers whose payments shall be applicable to statutory deductions. DRC's template for contracts for service providers will be utilized for local technicians/masons.

Bi-annual procurement plans will be developed in collaboration between the Supervising Engineers (Shelter and Infrastructure Officer) after the final detailed project designs have been approved by the m-CMC, and the detailed BOQs have been prepared for each project. The procurement department and the Regional Managers (Project Manager-Project Support) will be responsible for this. The procurement process will follow DRC's Procurement Guideline (DRC Operations Handbook Chapter 3), which is compliant to DANIDA's standard procurement procedures. This will involve public announcement of contract notices and a competitive value-for-money evaluation.
Construction of large storage reservoirs will be contracted out through DRC's procurement process as specified in DRC's operational Handbook Chapter 3. The construction works contracts will have a clause committing contractors to GR4Wry out the works with local labour from the area, and making contractors aware that their works are bound by DRC's complaints mechanism. Alternatively, construction equipment can be obtained from the ministry of water and environment, Water for Production Center-North to be used for construction of specialized infrastructure.

Procure tools and materials
Based on the Infrastructure Investment Plan and the annual work plan for implementation per micro-catchment, a bi-annual procurement plan will be developed in collaboration between the Infrastructure

teams and the Supply Chain Department of DRC. The procurement plans will stipulate clear milestones and deadlines for delivery of tools and materials. DRC's procurement procedures will be used for procurements.

Distribute tools and materials

Description	Responsibility
The tools and materials to be delivered to a project are given in the project agreement. Based on this the Project Materials Issuing Form is filled in triplicate.	Infrastructure/Hydrology Assistant Assistant)
The items are taken out of the store and the stock GR4Wds are updated with date, number on issuing form and quantity taken.	Supply Chain Assistant (SCA)
The SCA hands over the tools and materials to the IA who signs for them on a copy of the Issuing Form.	SCA / IA
The IA brings the tools and the materials to the PMC, where the IA signs as the one delivering and the PMC Chairperson signs as the one receiving on two copies of the issuing forms. The PMC chairperson keeps the original.	IA / PMC Chairperson
When the IA returns, he hands over the duplicate of the issuing form to the SCA who files in the project folder.	IA / SCA

Supervise and Monitor construction work (together with Technical team)

DRC/UNWMZ/CMC and DLGs will GR4Wry out monitoring visits to project sites on a weekly basis (or more frequently if needed) while activities are on-going. Supervision activities are coordinated through the group work schedules that PMCs submit to the Infrastructure Assistants. For each type of infrastructure, DRC's Engineers will develop a quality checklist that will be designed to be based on observations and recommendation and simple onsite tests. These observations and recommendation and simple onsite tests will be recorded in the real-time monitoring system for effective quality monitoring and management.

Description	Responsibility
The Infrastructure Assistant/Hydrology Assistant is responsible for the day-to-day supervision of the infrastructure activities. S/he will involve the relevant sector specialists of the mCMC in the training of the PMCs. S/he will also involve the relevant sector specialists in the district to provide guidance at the beginning of each stage of infrastructure works activities so that the recommended guidelines are followed.	Infrastructure Assistant/Engineering Assistant
In the course of implementation, the Assistant Hydrologist will identify & document gaps which need technical guidance from the sector specialist of the WFPRC-N and UNWMZ. The Project Water Engineer will prepare a work plan within its budget for infrastructure & liaise with the relevant sector specialist of the WFPRC-N and UNWMZ to validate & document the identified gaps.	Infrastructure Supervisor (Team Leader-Shelter and Infrastructure), The Supervising Engineer (Shelter and Infrastructure Officer), Project Manager-Project Support and the Project/Water Engineer
The sector specialist will prepare a report on the identified gaps and share this with the key stakeholders)	Infrastructure Supervisor (Team Leader-Shelter and Infrastructure), District Technical Team, Project

	Manager-Project Support and Project Water Engineer
There will be quarterly monitoring by the CMC, OPM, mCMC, RWCs and DRC team during which they will provide general guidance and support. The monitoring officers will produce their monitoring reports and share with DRC, other IPs and the relevant sector specialists through the CMO	Infrastructure Supervisor (Team Leader-Shelter and Infrastructure), CTC, Project Manager-Project Support, Project/Water Engineer and Project Manager

These quality assurance and supervision procedures apply to the labor-intensive as well as contracted works, which, however, will follow separate modalities of payments as specified below.

When interacting with the primary stakeholders, the DRC staff should encourage them to establish and use savings and credit associations like VSLA. They should also explain that it is the goal of NURI to increase the agricultural production so the money they earn should be invested in agriculture.

Pay technicians/contractors

Upon evaluation of the contracted works and issuance of certificate of completion, DRC will provide payments to technicians/masons and contractors following payment procedures as specified in the NURI Management Handbook and DRC Operation Handbook. Payments will be Carried out in compliance with requirements for thresholds for cash/bank transfers less statutory deductions (withholding tax 6% for payments above one million) and requirements for companies to provide official business bank accounts.

Pay local communities

In NURI, participants will be paid in cash and encouraged to use it to procure agricultural inputs. This payment should be seen as the program's contribution (in addition to tools and materials), which makes it possible for the host community and Refugees to realize the projects they have selected during the local planning process.

It is important to understand the programme does NOT employ the participants to do a specific job at a given task rate but instead provides a fixed amount as an assistance to the host community and Refugees so that they can implement their own projects.

A single cash payment will be made to the groups on completion of the WRM infrastructure works. Before making cash payments, the following steps should be followed;

- DRC will validate attendance sheets for participants engaged in WRM Infrastructure Project. This will be through compiling attendance records from the PMCs on a monthly basis.
- Display attendance list to all the group members to confirm the number of days they have worked and the amount of money they expect
- DRC will then prepare and make payment to the beneficiaries through post bank

7 Chapter 7: Maintenance of WRM Infrastructure

The maintenance of the created assets relies heavily on the willingness and involvement of the primary stakeholders (host communities and refugees) involved in the project, and the willingness of the m-CMC to include these projects in their plans. Hence the project puts a lot of effort on ensuring that the m-CMC and CMC are involved in each step of the project planning and implementation.

Maintenance is considered under project selection

While selecting the project, possibility of longer-term maintenance, both from the host community and Refugee and as part of the parish, sub-county, district and MWE maintenance plans should be considered, and priority should be given to project that has a distinct possibility of this.

Traditional ways of organizing maintenance are supported

NURI will consider the well-recognized maintenance approach provided by the MWE for maintenance of the WRM infrastructure developed. This will be through formation and empowerment of user committees/associations who will take responsibility of O&M of the projects.

Ceremonious handing over of infrastructure projects and tools

After the project is completed a hand-over ceremony will be organized at the project site. At this event

- The infrastructure will be released for use by the community members and ownership handed over to the local government and project user committees.
- Responsibility for maintenance will be clarified for the different types of projects: Here O&M Manual will be handed over to the project committee.
    - For soil and water conservation in open landscape on private land, the individual owners will take responsibility.
    - For water projects, the water user associations/committees will be responsible for Operation and Maintenance
    - For reforestation, the institution is responsible or individual in refugee's settlements
- Shared learning on Resilience design at community level will also be strengthened at this event.
- A certificate of completion will be issued by the Sub-county to the host community and refugees

The tools that have been used by the local communities will be handed over in the presence of the m-CMC, Settlement Commandant and RWCs as follows:

- For water projects the tools will be handed over to the user committees
- For Reforestations the tools will be handed over to the institutions.

Commissioning of infrastructure

NURI aims at supporting Local Authorities and target host community and Refugee in construction of rural infrastructure. At completion of projects, DRC, DLGs and UNWMZ/m-CMC Officials will GR4Wry out a joint completion inspection and issue a certificate of completion to the community group or contractor. When all certificates of completion have been issued in a year of implementation, DRC together with the UNWMZ/ CMC will GR4Wry out a commissioning ceremony for all completed projects in the District. The commissioning marks the hand-over of ownership of the WRM assets to the m-CMC, Sub-County, RWCs who subsequently are in charge of ensuring that maintenance activities are carried out.

8 Chapter 8: Monitoring and Quality Assurance

The general guidelines for monitoring are described in the MEAL Manual.

UNWMZ/CMO/m-CMC Monitoring

The UNWMZ/CMO/mCMC role in monitoring and supervision are described in sections 2.4 and 6.8 and in other sections where it is relevant.

DLG, CMO/mCMC officials (technical staff and political leaders) involved in the monitoring and supervision of WRM infrastructure projects will be paid safari day allowance based on approved LDPG rates. The allowances will be paid by DRC in line with their approved work plan. The implementing partners will inform the CMO/mCMC and DLG officials about their approved work plans.

Table 8.1 UNWMZ/CMO/m-CMC Monitoring

Activity	**Officials**
Routine Supervision of WRM Infrastructure Projects	NURI- Focal Engineer, m-CMC Chairperson, District Forest /Environment Officer, District Water Officer
Field screening of projects selected from the micro catchment management Plans	NURI- Focal Engineer, m-CMC Chairperson, Parish Chiefs/RWCs
BoQ Approval	CMTC/UNWMZ Engineer/WfP-RCN
Project Commissioning	UNWMZ/WfP-RCN Officials, m-CMC officials, RWCs, LDGs and LLGs
Training of Project Management Committees/Project User Committees	NURI- Focal Engineer, WfP-RCN, District Forest Officer, Community Development Officers, Parish Chiefs, RWCs

When they are involved, the drivers of district, officials will be considered for safari day allowance as of approved LDPG rates

Training allowance

A facilitation allowance of UGx 80,000/= per day will be paid to technical staff engaged in training project management committees (PMC).

Methodology to pay allowances

For routine supervision, technical support and training by m-CMC members (i.e., routine supervision, field screening of projects, BOQ preparation, PMC training), DRC will pay direct to the concerned officials after s/he has produced the necessary supporting documents and has followed all the required accountability procedures.

Facilitation for Monitoring and Supervision

Fuel for Focal Point Officers will be given 10 litres. Fuel and SDA for technical supervision shall be paid according to approved work plan and mileage. Quarterly monitoring by MWE/UNWMZ/m-CMC and DLG. 1 GR4W will be provided and 20 litres of fuel per supervision will be provide.

DRC Monitoring

DRCs role in monitoring is described in the M&E manual and in sections 2.3 and other sections of this manual.

DRC Quality Assurance

DRCs role in quality assurance is described in their Technical Proposal from where the table below has been copied.

Table 8.2 DRC Monitoring and Quality Assurance

Quality management activity	Purpose	Method	Timing	Standards for Quality Assurance/control	Responsibility
Internal review of engineering Designs, drawings, BOQs	To ensure high standard of technical screening of projects designs before joint screening with district	Desk review of drawings, designs and manuals	After approval of the Manual by CF and RDE	Water Supply Design Manual, Ministry of Water & Environment Manuals; WRM and/or RI Manuals;	DRC Engineers, CSA IP and MWE/UNWMZ, NURI - CF
Conducting community Site dialogue meeting, meetings	To promote social accountability, stakeholder engagement and mitigate potential conflict	Meetings at the district, S/C and refugee settlements	Within 2 months from start date	Common Humanitarian Standards (CHS)	DRC staff, CF and District staff
Select implementable projects from mCMPs developed by UNWMZ	To ensure Water Resources Developments project are in line with NURI Scope of work	Desk review and presentation to NURI – CF and UNWMZ	After receiving mCMPs from the MWE/UNWMZ	mCMPs and WRM Manual	DRC staff, CF and District staff and MWE/UNWMZ
Joint screening with the district technical team and compile Investment Plans for approval by DTPC and mCMC	To ensure very high standard of technical screening of projects jointly with districts.	Meeting at district and also at the sub-counties within the MC	After receiving the mCMPs from UNWMZ	WRM Manual and Implementable project document	DRC Engineering staff in co-operation with District Engineers, LLG officials and CSA Partners
Development of procurement plans	To ensure timely and effective delivery of project inputs that conform to the highest quality standards	Bilateral discussion between supply chain team and the programs team	After approval of investment plan by the DTPC	Approved Investment plan, work plans and budgets	DRC's supply chain team, and PM, PM-PS, PE, PWE, TLs and Engineering Assistants
Developing project risk register and continuously updating risk matrix	To monitor and track projects risks and take proactive measures to mitigate them	Quarterly review meetings	Done on a quarterly review	DRC Operational handbook; Danida's anti-corruption code of conduct and the principles of the UN Global Compact	DRC project managers, Finance manager & Engineers

Undertake WRM resilient design training for all DRC engineering staff	To equip DRC Staff with a thorough understanding, knowledge and skills on resilient water Management	In house training by the consultant	November 2020	Resilience Deign manuals	Consultant and RD Design coordinator and Project Engineers
Approval of Investment Plans	Stakeholders scrutinize the proposed projects and costs	Meeting at the district headquarters	After preparation of the investment plans	Draft investment plans and BoQs	DRC Engineers, DTPC and mCMC
Production of annual Work plans and Budgets	For funding by NURI - CF and RDE	Work plans and budgets prepared and submitted to NURI - CF	Annual	Approved investment plans and approved WRM Manual and DED	DRC, NURI - CF and RDE
Group Formation	Inclusion of all the target beneficiaries, refugees and host communities, youth and women	At the project sites	After approval of the Investment Plans	Approved Investment plans and SOP for group formation	DRC staff and local leaders for both refugees and the host communities and CSA IPs
Selection and training of PMCs	To ensure functional technical skills of community project leaders	Hands-on training	After group formation	PMC training Manual, WRM Manual	DRC Staff and District Technical team
Site dialogue meetings and conflict sensitivity and safety assessments	To resolve any land issues and ensure safety of staff and community participants	Meetings at the project sites	Before commencement project implementation	WRM Manual and Inputs from local leaders	DRC staff and sub county authorities, Local leaders and land owners
Sensitization of the beneficiaries and stakeholders on DRC Complaints mechanism	Get feedback from the beneficiaries and local authorities on the performance of DRC staff, contractors and masons and quality of infrastructure and structures	Radio talk shows, meetings at the project sites and distribution of templates	Throughout the project life span	Complaint Mechanism template	DRC staff, beneficiaries, local authorities and refugees

Quality assurance of structure/infrastructure projects	To ensure that quality standards are met for each project as design	Supervision visits by DRC and District and sub county staff	Monthly and quarterly	Quality assurance plan/standards	RDE, NURI-CF, MWE/UNWMZ, DEC, LLG and DRC Staff
Quarterly monitoring	To ensure that quality standards are met as per the design and approved quality assurance plans (from DRC and contractors) or all the structures constructed by the project	Supervision visits by DRC, DEC, CSA and sub county staff.	Monthly and quarterly by DEC members and district technical staff	Quality assurance plan/standards	NURI-CF, MWE/UNWMZ, DEC, LLG CSA and DRC Staff
Formation of User Committees	To ensure that created assets are maintained	Conducted at the project sites by DRC and LLG Authorities	After project completion	WRM Manual	DRC Infrastructure team and district and sub county staff, LCs and Community
Formation of maintenance plans and bye laws by the village councils (community level)	To ensure that maintenance activities are aligned with government structures and policies	Meetings at the project sites	After completion of the projects	WRM Manual	MWE/ UNWMZ and CSA IPs and DRC
Tracking of implementation of maintenance plans	To monitor degree of implementation of schedules maintenance activities	Monitoring visits	After creation of the assets	(MoWE) Water Resource Management Manual	CSA IPs and DRC Infrastructure (Team)
Commissioning of completed projects	As part of maintenance all completed projects will be ceremoniously handed over to the communities and local authorities capture positive and negative feedback from all stakeholders	At the project sites	After completion of Implementation of the projects	End of project report	RDE, NURI-CF, MWE/UNWMZ, DEC, LLG and DRC Staff and community

Participate in Project Reviews Evaluation	A review of project performance against the defined project target, output, processes used to produce the outputs; and document Lessons learnt from the project	Evaluation and review meetings with IPs	2021 and 2022	M&E Manual	RDE, NNURI – CF, DRC project staff, M&E
Conducting budget follow up (BFU)/tracking meetings	To monitor burn rate vis-à-vis project implementation	BFU meetings	Monthly	Work plans and Budgets	Finance and program teams
Conducting Mini Surveys	To inform implementation strategies and provide beneficiaries feedback on quality, utilization and benefits of the project outputs	Assessment	On Needs basis	NURI – CF M&E Manual, DRC MEAL SOP	DRC MEAL and Programme staff
Conducting Monitoring and verification of project outputs	To ensure project deliverables conforms to the highest quality standards, and to inform implementation strategy	Routine data collection and analysis	Monthly basis	Project document, Approved Investment plans and DED	MEAL team, DRC Programme team and Engineers

9 Chapter 9: Record Keeping

Project file

DRC will keep a file for each project with the following content:

a. Project description (Project briefs) and cost estimate where necessary
b. Detailed design and BOQs
c. Information about involved community groups
d. Agreements with community groups
e. Receipt for tools and materials delivered
f. Records from visits to the project
g. Attendance registers
h. Completion certificate

Contract file

DRC will keep a file for each contract with technicians/masons and contractors with the following content.

1. Contract
2. Engineers estimate (where relevant)
3. Notes from site inspections
4. Variations
5. Payment certificates
6. Completion report
7. Completion certificate

10 ANNEXES

Technical designs and corresponding BOQs are in indicative prices as they stood at the time of developing this manual. Specific designs and corresponding BOQs shall be done in the implementation process for special conditions encountered. The designs and prices will change depending on each location, availability of materials, and the local market prices. Hence these prices should be used as guides only and a comprehensive costing of each WRM project should be done during investment planning and implementation planning.

10.1 Annex 1: Technical Design – Valley Tank

Standard design

Valley tanks are reservoirs offset away from the valley beds using diversionary drain to impound surface and/or groundwater for different purposes like irrigation, livestock watering, aquaculture and rural industry.

The standard specification (dimensions) recommended by the Ministry of Water and Environment is Vol = 20,000m^3 (min), with a maximum depth of 4.5m. 3 CfW groups will be working at the valley tank site for 20 days, A valley tank or dam constructed will have auxiliary like livestock watering and local industry.

Valley tank construction will be characterized by:

- An impermeable seal on the bottom and side slopes that prevents seepage into the ground. Use of compressed impermeable soil or butyl/geo-membranes will be considered
- A live and productive fence initially established with barbed wire around the site that prevents the livestock from accessing the tank and destroying its side slopes.
- Installation and construction of water pumping system, intake and water troughs.

Land for tank construction

Voluntary Land agreements will be signed between the m-CMC and land owners for reservoir construction and auxiliary components.

Sites for valley tanks/reservoirs

The tank must be sited as high up in the landscape as possible to allow for natural head-pressure to move water. The site must allow Reservoir flowage that interfere as little as possible with the established property rights, close proximity to the intake of the communities served and locations that suit service by gravity flow.

As a greater strategy of water harvesting for the valley tank, extending dam catchment areas with swales and drains should be practiced.

Tasks for Valley tank

It's practically challenging to undertake the whole operation of valley tank construction entirely by labour. Therefore, valley tank construction will be contracted using an integrative approach of machinery and labour. Machinery will be employed for excavation of the earth works then other tasks like reshaping, levelling, compacting etc shall be done using labour intensive approach.

The tasks that the project group will undertake shall include;

- Construction/opening of access road to the site
- Bush clearing at the site while moving the top soils to one piling so that it can be used later in the revegetation process
- Lifting of materials and tools at the site

- Valley tank reshaping, levelling, compaction
- A live and productive fence with barbed wire around the site that prevents the livestock from accessing the tank and destroying its side slopes.
- Planting of native grass and bamboo around the berm while Planting of key shade trees on the west side of the reservoir to limit evaporation and to keep the water cooler.
- Source protection and recharge with water harvesting earthworks and tree systems above the source.

Tasks for rehabilitation of a valley tank

For Rehabilitation of valley tanks/reservoirs, the following tasks are normally involved:

- Clearing of vegetation (grass) around the facility
- Desilting of the inlet, reservoir and spillway and establish maintainable silt traps
- Re-forming of the berm/embankment, revegetating with grasses, with species like vetiver, bamboo, banana, etc.
- Repairing of fencing
- Repair/installation of on-farm works

These activities should be done in dry seasons.

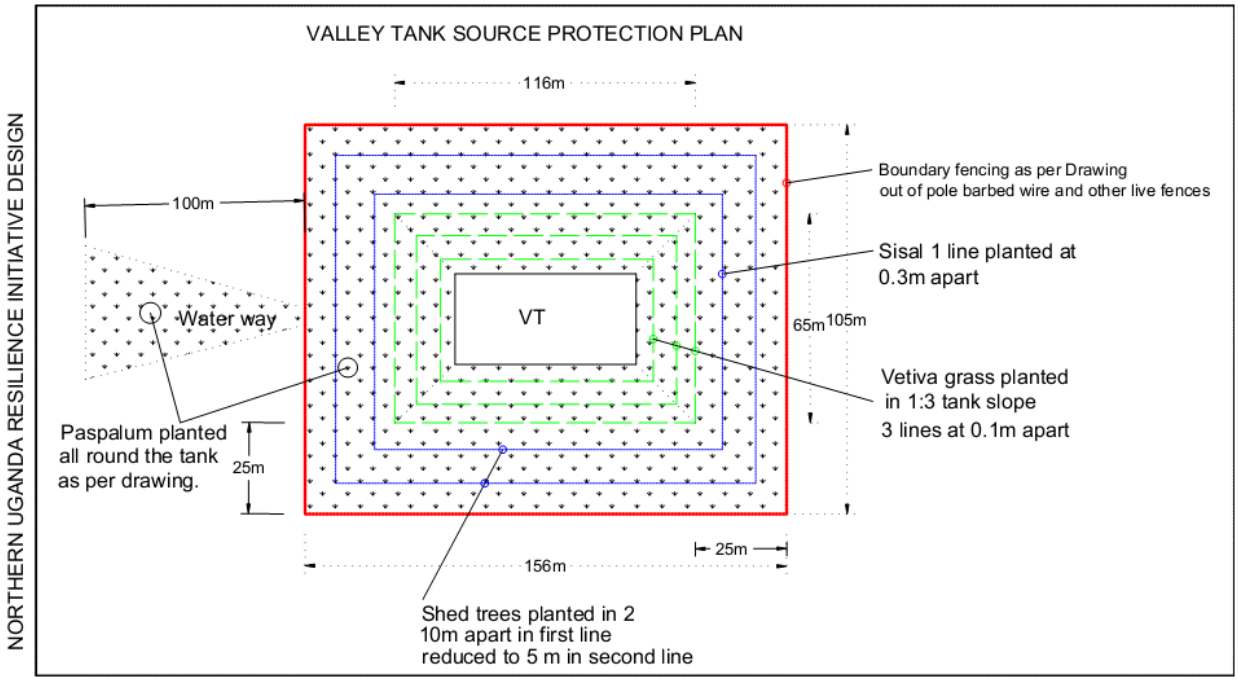
Sediment basin (traps) and spillway

Use sediment traps in areas where high sediment loads are observed in storm water. The concept here is to create a place where water will pool momentarily to allow coarse sediments to drop out of storm water before it spills over into the main bio retention feature.

The spillway should be designed with a wide base and a gentle slope, which will reduce water velocity and spillway soil erosion. The spillway base and sides should also be seeded to grass or riprap (a collection of loose stones) alone or in combination with geotextile material may be used if the base slope of the spillway is steep.

Source protection programming

Every water harvesting structure must have source protection programming which must include cutoff drains (Bioswales) Trees systems and grassing to reduce evaporation from the water surface.



Excavated material

The material excavated from the valley tank shall be track rolled to a height that does not exceed 1m to form the embarkment of the tank 30-35m wide at all sides to increase stability of the side slopes. It can also be hauled away when too sandy which cannot be compacted in the embarkment and borrowed material used for compaction.

After excavation, compaction of the embarkments, black top soil should be keyed back and then immediately planted using indigenous seeds of grasses to immediately lock in soils and protect the banks and avoid erosion.

Maintenance of valley tank

Valley tank maintenance work will include cleaning and reshaping activities to its original design dimensions. This serves to remove flow restrictions within the canal (inlet and outlet) and allow for original flow design capacities. These activities will involve reaching the tank and canal banks to remove excess soil, vegetation, sediment, silt/sand or other debris such as beaver dams.

Fencing

MATERIALS FOR FENCING OF 116x65*4.5 Valley tank under NURI WRM 2020 (PERIMETER=540m)					
S/N	**DESCRIPTION**	**UNIT**	**QTY**	**Rate**	**Amount**
1	Barbed wire roll 600m, gauge 12.5, Zinc coated, galvanized (JIS3533)	Rolls	8	180,000	1,440,000
2	U-nails kg (dia3.5)	Kgs	20	8,000	160,000
3	Binding wires	Kgs	50	5,000	250,000
4	Sprouting poles (200mmdia, 2.3m high) planted in (0.3*0.3*0.3) m hole @2.5m apart CfW	No.	216		0
5	Assorted wire nails kg	Kg	15	7,000	105,000
6	First aid kit	No.	1	80,000	80,000

7	Kai apples	No.	4600	500	2,300,000
	Total				**2,035,000**
	VAT				366,300
	Total materials				**2,401,300**

Bills of quantity for chain-link fencing of Pump house, solar system and the pump					
S/N	**D E S C R I P T I O N**	**Unit**	**Qty**	**Rate**	**Amount**
0	**PRELIMINARIES**				
0.1	Mobilization of personnel, tools and equipment on site and setting up of temporary storage and facilities for protection of works from inclement weather	Lump sum			-
	Total cost of preliminaries				
1	**FENCING**				
	Scope of works: fencing off pump house with new chain-link fence. Perimeter is 80m				
1.1	Excavate for fencing post bases 300mm x 300mm, 500mm deep	cm	1.4		-
1.2	Supply and install approved fencing posts of 50mmx50mmx6mm steel angle section with appropriate anchors and painted with red oxide prior to installation at 3m c/c post spacing and cast 500mm into concrete tired with 3-line galvanized wire strands	No	12	90,000	1,080,000
1.3	Provide for supply and installation of inclined struts of the same make as posts 9m c/c spacing	No	9	90,000	810,000
1.4	Cast class 20/20 concrete at base of fencing posts (300mmx300mm, 500mm deep)	cm	1.4	350,000	490,000
1.5	Galvanized chain-link fence gauge 10, 2.1m(7ft) high, secured to posts by galvanized guiding wire (G10), galvanized binding wire galvanized G16 barbed wire at the top	m	4	240,000	960,000
1.6	Excavate at bottom of chain-link line 100mm deep and 200mm wide for anchoring chain-link fence	cm	1.6	10,000	16,000
1.7	Cast class 15/20 concrete strip (300mmx200mm section) at base of chain-link to provide firm anchorage. Allow for drainage at various spots to the approval of the engineer	cm	1.6	350,000	560,000
1.8	Paint fencing using 2 coats of silver high gloss enamel paint (white and blue in colour)	No	36	10,000	360,000
1.22	Metallic gate (3.2m x 2.4m) made of 40mm hollow sections installed in class 20/20 concrete columns(300sqm) reinforced with 4T12 bars and R8 shear rings spaced at 200mm c/c	No	1	600,000	600,000
	Total cost of chain-link fencing				**4,876,000**

Tools

The standard tool kits that will be provided to one group for construction of a valley tank:

Tool	No.	Price	Total
Measuring tape 100 m	1	45,000	45,000
Measuring tape 7.5 m	1	10,000	10,000
Nylon strings 100 m	3	15,000	45,000
Jerry can	2	10,000	20,000
Drinking cup	10	1,000	10,000
Hoe incl. Handles	20	13,000	260,000
Slasher	10	6,000	60,000
Panga	5	6,000	30,000
Axe incl. handles 5kg	2	15,000	30,000
Pick-axe incl. handles	10	22,000	220,000
Spade with metallic handles	10	20,000	200,000
Rake incl. Handle (Need to get locally made type with metallic handle)	2	15,000	30,000
Wheelbarrow (Reliance)	1	160,000	160,000
First aid	1	80,000	80,000
Total			**1,200,000**
VAT			216,000
Total			**1,416,000**

Cash

The amount in cash to be paid for 2 CfW groups working for 20 days

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount total
Construction	60	20	1200	6,000	7,200,000

The work days and cash can be adjusted if work is light.

BoQ

Table 10.1 Cost estimates for construction of 20,000m^3 valley tank

ITEM DESCRIPTION	**UNIT**	**QTY**	**Rate**	**Amount**
PRELIMINARY AND GENERAL ITEMS				
TEMPORARY WORKS				
Clearance of access roads to the valley tank site.	(CfW)			
De-watering; Allow for work in water affected areas, including all temporary works, pumping, protection, access, etc to ensure the works are completed as specified.	Sum	1	2,000,000	2,000,000
Supply, install and maintain Signboard during the Construction period.	No	1	500,000	500,000
TOTAL (A)				**2,500,000**
EARTH WORKS, INLET CHANNEL, Intake and Silt trap to VALLEY TANK				

Clearing of Valley Tank basin of all papyrus & other vegetation, trees and stamps by stripping off top soil, GR4Wt to spoil using earth moving equipment	Day	1	2,500,000	2,500,000
Hire of excavators (26,608.5m3)	days	20	1,600,000	32,000,000
Fuel for excavator	Liters	9000	4,300	38,700,000
Hire of bull dozer	Days	40	1,600,000	64,000,000
Hire of low bed	Days	4	2,500,000	10,000,000
EARTH BUNDS				
Construction of earth bunds around valley tank reservoir using excavated material to stable slopes. Maximum height 1m high.	m^3	4400	4,500	19,800,000
Masonry works				
INLET CHANNEL, Silt trap and spillway to VALLEY TANK				
Stone pitching 382.12 m^2 of the inlet channel and silt trap, 300mm thick on the slopes of the channel as per drawings.				
Hard core	Trips	55	50,000	2,750,000
Sand	Trips	14	45,000	630,000
Cement 1:3	Bags	300	33,000	9,900,000
Water	Jerican	1782	500	891,000
Transport	Lps	1	7200000	7,200,000
Labour 25%				
Hire of excavator @1,500,000/Day	Day	10	1,500,000	15,000,000
Hire of Bull dozer for 1 days@1,500,000	Day	10	1,500,000	15,000,000
Fuel for Bull dozer, 150L/Day @4000/L	Day	10	645,000	6,450,000
Hire of Low bed for Bulldozer@5,000,000	Lp	1	5,000,000	5,000,000
Hire of Low bed for Excavator@5,000,000	Lp	2	5,000,000	10,000,000
Fuel for excavator, 150L/Day @4300/L	Day	10	645,000	6,450,000
CONSTRUCTION OF CATTLE RAMP				
Excavation for the cattle ramp through the valley tank side slopes to gradient of 1:3 as per drawings.	m^3	171.25	7,000	1,198,750
Stone masonry of thickness 300mm to the bottom and side slopes of the cattle ramp	m2	67.5	20,000	1,350,000
Ground beams in reinforced concrete as per drawings	m^3	6.75	400,000	2,700,000
50mm galvanized iron pipes cast in concrete at 2.0 m c/c to a height not exceeding 1.0m. Firmly secured by 50mm diameter GI pipes at a spacing of 500mm c/c	m	6.25	50,000	312,500
Construction of guard rails in concrete class C20/25 along the sides of the cattle ramp	m^3	1.25	400,000	500,000
FENCING				
Live fencing with barbed wire 600m, gauge 12.5, Zinc coated, galvanized (JIS3533) 4 lines. Treated poles (200mmdia, 2.3m high) planted in (0.4*0.4*0.4) m hole @2.5m apart in C20	Lp	1	35,580,540	35,580,540
Fencing of water abstraction system using Galvanized chain-link fence gauge 10, 2.1m(7ft) high, secured to	Lp	1	11,186,000	11,186,000

posts by galvanized guiding wire (G10), galvanized binding wire galvanized G16 barbed wire at the top				
VALLEY TANK SITE PROTECTION AND LANDSCAPING				
Spreading of all loose material around the site, maximum height 1m	m2	2050	1,000	2,050,000
Grassing and planting of shrubs all round valley tank site using appropriate local plants.	m2	1025	4,000	4,100,000
Sub Total (B)				**305,248,790**
CONSTRUCTION OF STEEL TOWER				
Excavation for Foundations	m^3	4	18,500	74,000
IN SITU CONCRETE				
Provision of concrete: Design mixes to BS 5328 with ordinary Portland cement to BS 12 and aggregates to BS 882.				
Concrete class C20/20	m^3	0.55	400,000	220,000
Concrete class C25/20	m^3	8	550,000	4,400,000
IN SITU CONCRETE				
Placing of concrete				
Reinforced concrete				
Class 25 footing; thickness 300 - 500mm	m^3	6	550,000	3,300,000
Stub columns; area 0.1 - 0.25150m^2	m^3	2	550,000	1,100,000
CONCRETE ANCILLARIES				
Formwork - Fair Finish				
Plane vertical; width exceeding 0.2 - 0.4m	m^2	9.2	20,700	190,440
Reinforcement; high yield type 2 deformed bars to BS 4449				
nominal size 8 -12mm	m	0.225	4,600,000	1,035,000
Pipework				
Plastic pressure pipes				
HDPE pipes to UNBS US 482:2003				
OD50 mm depth not exceeding 1.5m complete with all associated fittings to meet the requirements of Drawing Nr……	m	80	15,000	1,200,000
Galvanized steel tube to B.S.1387 in trench depth not exceeding depth not exceeding 1.5m.				
40 mm GI; not in trench	m	12	42,688	512,256
Fittings and Valves				
40mm gate valve	No	2	127,080	254,160
40 mm Long screws	No	3	57,500	172,500
40 mm GI back nuts	No	3	23,000	69,000
DN50 gate valve	No	2	136,280	272,560
50 mm Non return valve including its fittings as per drawing	No	2	747,500	1,495,000

OD 40 mm GI elbows	No	4	15,750	63,000
OD 40 mm GI Union	No	2	31,400	62,800
40 mm stainless Steel Strainer	No	1	287,500	287,500
10-m structural steel tank support structure complete to match size and load of tank under Item Z524.1 to Z 524.3 including foundations in grade C25 reinforced concrete.	sum	1	8,000,000	8,000,000
Supply and install plastic tank of the following capacities and fittings as per drawing				
10,000 litres; vertical cylindrical tank	No	1	4,000,000	4,000,000
Supply materials and construct a 3.0 x 3.0m superficial floor pump storage house per drawings	item	1	15,603,477	15,603,477
VERTICAL ABSTRACTION SYSTEM				
Excavation for foundations				
Depth n.e 1.5m	m^3	2.7	12,800	34,560
Filling to structures; selected excavated materials other than topsoil or rock	m^3	2.1	52,487	110,223
IN-SITU CONCRETE				
Designed mix to BS 5328, with ordinary Portland cement to BS 12, 10 mm aggregate to BS 882 as follows:				
Provision and Placing Concrete				
Grade C25/20 Reinforced Concrete				
Base slab; thickness n.e 300mm	m^3	0.7	550,000	385,000
Column; cross sectional area n.e 0.25-1m2	m^3	0.06	550,000	33,000
Mass; blinding concrete; thickness not exceeding 150mm C15	m^3	0.225	380,000	85,500
CONCRETE ANCILLARIES				
Formwork; class S2 finish; concrete components of constant cross-section				
Base slab vertical sides	m^2	1.8	21,187	38,137
Reinforcement				
High yield square twisted bars to BS 4449; nominal size 6 - 16mm	Kg	85.32	4,952	422,505
Concrete accessories				
Finishing of top surfaces	m^2	2.4	35,000	84,000
PIPEWORK-PIPES				
DN250mm flanged and puddled pipes not in trenches				
Length: n.e 5m	No	1	595,661	595,661
DN 250 x 250 Tee	No	1	2,800,000	2,800,000
DN 250 flanged end cap	No	2	550,000	1,100,000
MISCELLANEOUS WORKS				
Allow for erecting the entire assembly in the wet (filled valley tank)				
Sub-Total C				**48,000,278**

SOLAR POWERED SUBMERSIBLE PUMP				
Grundfos Solar Water Pump as SQF8a-5, 1.4KW motor, 30-300VDC,1x90-240AC. 50/60HZ frequency. Q =20m3/hr, H = 35m.	Nr	1	26,854,200	26,854,200
Dayliff crystalline solar panels 24V/195Wp Peak voltage is 17.5V, short circuit is 7.88A	No	10	1,114,754	11,147,540
Lighting Protection: (arrestor, copper tape, copper mat, copper clamp, copper bolt & conductivity improvement materials)	item	1	1,393,443	1,393,443
SOLAR PANNEL GROUND MOUNTING GALVANISED STRUCTURE				
C/W Metallic structures and civil platforms, about 4.5m off the ground	item	1	5,573,771	5,573,771
Provide power pack to convert AC to DC	item	1	1,035,000	1,035,000
Earthing System: (25mm2 earth wire, copper mat, copper clamp concrete earth)	item	1	1,393,443	1,393,443
ELECTRICAL ACCESSORIES: cable ties, flexible conduits, solar panel	item	1	4,184,012	4,184,012
Sub Total (D)				**51,581,409**
TOTAL (A+B+C+D)				**407,330,477**
15% VAT				**73,319,486**
GRAND TOTAL				**480,649,963**

Table 10.2 BOQ for Pump house

Description	**Unit**	**Qty**	**Rate**	**Amount**
GRAND SUMMARY				
Preliminaries and General Items				800,000
Measured works				
Construction of one pump house				12,423,286
Sub Total				**13,223,286**
Add 5% contingencies (Excluding Preliminaries and General items)		**0%**	**N/A**	
Total exclusive of contingencies				
Percentage Discount Offered (As per Bid submission sheet)	**0%**			
Sub Total VAT Exclusive				**13,223,286**
Add 18% VAT		18%		2,380,191
Grand Total for Lot ……				**15,603,477**
Preliminaries and General Items				
Mobilization	LS	1	450,000	450,000
Insurance	LS	1	-	N/A
Performance bond	LS	1	-	N/A
Preparation of final report	LS	1	-	N/A
Total to be Carried to Grand Summary No. 1>>>>				**800,000**
MEASURED WORKS – Construction of the House				

Descriptions	Units	Qty	Rate	Amount
ELEMENT NO. 1: SUBSTRUCTURE (All provisional)				
Excavations and Earthworks				
Excavate for over site to remove topsoil average 150mm deep and stock pile near site for tree planting around the market	m^2	25	2,000	50,000
Excavate to reduce level & remove from site(provisional)	m^3	1.2	7,500	9,000
Excavate trenches for wall foundations: commencing from reduced levels: not exceeding 1.5m deep.	m^3	7.2	7,500	54,000
Treat surface of subsoil or fillings and surroundings with approved chemical anti-termite solution: provide ten-year guarantee.	m^2	47.2	2,000	94,400
Disposal of excavated material				
Selected excavated material in filling to foundation trenches: around walling: placed in 200mm layers: watered and compacted to Engineer's satisfaction	m^3	4.8	10,000	48,000
Insitu concrete class 20/20mm aggregates as in:				
Foundation trench 150mm thick with mix 1:3:6/20mm	m^3	1.8	400,000	720,000
100mm floor slab with provisions of drop holes and vent pipe mix 1:2:4	m^3	4	480,000	1,920,000
High yield steel bar including working and fixing				
Mesh reinforcement Ref No. A98 size 200 x 200 mm weighing 1.54 kg per square meter: in floor slab:	m^2	10.24	15,000	153,600
Sawn formwork as described to:				
Edge of Slab 100mm high	m	8	8,000	64,000
Reinforced concrete (1:2:4/20mm aggregate) in Columns, ring Beam	m^3	2	480,000	960,000
High yield steel bar including working and fixing				
T12	Kg	341	6,500	2,216,448
R8	Kg	13	6,500	84,728
Plinth Wall;				
Selected burnt clay bricks bedded and jointed in 1:4 mortar one and half brick thick (350mm), with and including 25x3 mm hoop iron strips laid horizontally every alternate 2 courses	m^2	8	47,000	376,000
Splash Apron:				
Excavation for foundation trench not exceeding 1.0m	m^3	2.304	7,500	17,280
Return fill and ram selected excavated material around foundation	m^3	1.536	7,500	11,520
150mm thick bed of imported hard core fill in and rolled ready to receive concrete 20/20	m^3	1.152	400,000	460,800
75mm thick plain concrete 20/20mm aggregate	m^3	0.576	400,000	230,400
150mm thick walling in cement sand (1:4)	m^2	9.6	30,000	288,000

15mm Thick cement and sand plaster to plinth walls with wood float finish.	m^2	9.6	15,000	144,000
30mm cement and sand screed trawled (1:3mix)	m^2	7.68	17,500	134,400
Substructure Sub-total to summary.				**8,036,576**
ELEMENT NO. 2: SUPERSTRUCTURE.				
Ring beam construction				
Reinforced concrete grade 20/19mm aggregate in ring Beam	m^3	0.32	480,000	153,600
High yield steel bar including working and fixing				
T12	Kg	35.52	6,500	230,880
R8	Kg	11.85	6,500	77,025
Sawn formwork as described to: Sides and soffits of beams	m^2	4.8	25,000	120,000
Walling				
150m wide Damp-proof course laid and bedded in cement and sand mortar 1:3 with 300mm laps	m	8	1,500	12,000
Selected burnt clay bricks bedded and jointed in 1:4 mortar one and half brick thick (350mm), with and including 25x3 mm hoop iron strips laid horizontally every alternate 2 courses 150mm thick, with and including 25x3 mm hoop iron strips laid horizontally every alternate 2 courses	m^2	24	30,000	720,000
900X150 mm high well burnt clay vent bricks in cement sand mortar (1:4) including any other equal.	No	2	10,000	20,000
Superstructure Sub-totals to summary.				**1,333,505**
ROOF CONSTRUCTION AND COVERINGS				
Roof structure:(Sawn treated softwood)				
75x100m wall plate	m	8	8,000	64,000
50x100mm rafter/struts/tie beam	m	20	7,500	150,000
50x100mm purlins	m	102.4	7,500	768,000
25x230 fascia board in planed cypress.	m	12.8	10,000	128,000
Knot, prime, stop and apply three coats of gloss oil paint to wood fascia 200-300mm girth. On fascia board	m	12.8	6,500	83,200
Covering:				
28 Gauge pre-painted roofing sheets including side laps filler blocks and; fixed with approved capped roofing nails or screws to Engineer's specification and manufacturer's instructions.	m^2	16	35,000	560,000
Roofing Sub-totals to summary.				**1,576,700**
DOORS WINDOWS				
Metallic frames including hoisting and fixing in position				

Supply and fix Purpose made steel casement door complete with frames, louvres; size 900x2400 high, including shutters of 2.2mm thick MS plate welded to 40x20RHS 1.5mm thick, with 300mm long pad bolt with padlock as directed by the engineer, with Burglars and glazing of 900mm x600mm high	No	1	300,000	300,000
purpose made steel casement window complete with frames, louvres; size 900x900mm high in top hung, including shutters of 1.2mm thick MS plate welded to 40x20RHS 1.2mm thick, with 300mm long tower bolts bolt double stays as directed by the engineer, with Burglars.	No	1	150000	150,000
Painting use sadolin paints or equivalent:				
Prepare and apply one under coat and two finishing coats of gloss paint on general surface of doors.	m^2	2.97	6,500	19,305
Doors Sub -totals to summary.				**469,305**
INTERNAL FINISHES				
12mm cement and sand (1:4) mortar to walls and beam steel troweled hard and smooth on walls including 100mmx10mm thick skirting internally.	m^2	25.6	12,000	307,200
Prepare, prime and apply one under coat and 3 coats of emulsion paint on plastered walls internally.	m^2	25.6	6,500	166,400
25mm cement and sand (1:3) screed finished smooth.	m^2	4	15,000	60,000
Internal Finishes Sub -totals to summary.				**533,600**
EXTERNAL FINISHES				
12mm cement and sand render to wall with wood float finish including 200x10mm high skirting.	m^2	25.6	12,000	307,200
Cement and sand roughcast finish on rendered wall.	m^2	12	6,500	78,000
Prepare, prime and apply one under coat and 3 coats of emulsion paint on plastered walls externally.	m^2	13.6	6,500	88,400
External Finishes Sub -totals to summary.				**473,600**
Description				
SUMMARY				
Substructure				8,036,576
Superstructure				1,333,505
Roof construction and coverings				1,576,700
Doors				469,305
Internal Finishes				533,600
External Finishes				473,600
Total for Pump house				**12,423,286**

Table 10.3 Cost estimates for construction of 10,000m^3 valley tank

ITEM DESCRIPTION	UNIT	QTY	Rate	Amount
PRELIMINARY AND GENERAL ITEMS				

TEMPORARY WORKS				
Clearance of access roads to the valley tank site.	(CfW)			
De-watering; Allow for work in water affected areas, including all temporary works, pumping, protection, access, etc	Sum	1	1,500,000	1,500,000
Supply, install and maintain Signboard during the Construction period.	No	1	500,000	500,000
TOTAL (A)				**2,000,000**
EARTH WORKS, INLET CHANNEL, Intake and Silt trap to VALLEY TANK				-
Clearing of Valley Tank basin of all papyrus & other vegetation, trees and stamps by stripping off top soil, GR4Wt to spoil using earth moving equipment	Day	1	2,500,000	2,500,000
Volume of earth works 13,541m3				
Hire of excavators	days	10	1,600,000	16,000,000
Fuel for excavator	Liters	4200	4,300	18,060,000
Hire of bull dozer	Days	18	1,600,000	28,800,000
Hire of low bed for transporting earth moving equipment	Days	4	2,500,000	10,000,000
EARTH BUNDS				-
Construction of earth bunds around valley tank reservoir using excavated material to stable slopes. Maximum height 1m high.	m^3	1856	4,500	8,352,000
Masonry works				-
INLET CHANNEL, Silt trap and spillway to VALLEY TANK				-
Stone pitching 382.12 m2 of the inlet channel and silt trap, 300mm thick on the slopes of the channel as per drawings.				-
Hard core	Trips	26	50,000	1,300,000
Sand	Trips	8	45,000	360,000
Cement 1:3	Bags	160	33,000	5,280,000
Water	Jerricans	1200	500	600,000
Transport	Lps	1	7,200,000	7,200,000
Labour 25%				-
Hire of excavator @1,500,000/Day	Day	3	1,500,000	4,500,000
Hire of Bull dozer for 1 days@1,500,000	Day	3	1,500,000	4,500,000
Fuel for Bull dozer, 150L/Day @4000/L	Day	3	645,000	1,935,000
Hire of Low bed for Bulldozer@5,000,000	Lp	1	5,000,000	5,000,000
Hire of Low bed for Excavator@5,000,000	Lp	2	5,000,000	10,000,000
Fuel for excavator and bull dozer, 150L/Day @4300/L	Day	6	645,000	3,870,000
CONSTRUCTION OF CATTLE RAMP				-

Excavation for the cattle ramp through the valley tank side slopes to gradient of 1:3 as per drawings.	m^3	121.5	7,000	850,500
Stone masonry of thickness 300mm to the bottom and side slopes of the cattle ramp	m2	30.5	20,000	610,000
Ground beams in reinforced concrete as per drawings	m^3	3.5	400,000	1,400,000
50mm galvanized iron pipes cast in concrete at 2.0 m c/c to a height not exceeding 1.0m. Firmly secured by 50mm diameter GI pipes at a spacing of 500mm c/c	m	3.5	50,000	175,000
Construction of guard rails in concrete class C20/25 along the sides of the cattle ramp	m^3	1.25	400,000	500,000
FENCING				-
Live fencing with barbed wire 600m, gauge 12.5, Zinc coated, galvanized (JIS3533) 4 lines. Treated poles (200mmdia, 2.3m high) planted in (0.4*0.4*0.4) m hole @2.5m apart in C20	Lp	1	16,750,100	16,750,100
Fencing of water abstraction system using Galvanized chain-link fence gauge 10, 2.1m(7ft) high, secured to posts by galvanized guiding wire (G10), galvanized binding wire galvanized G16 barbed wire at the top	Lp	1	11,186,000	11,186,000
Sub Total (B)				**148,542,600**
CONSTRUCTION OF STEEL TOWER				-
Excavation for Foundations (CfW)				-
IN SITU CONCRETE				-
Provision of concrete: Design mixes to BS 5328 with ordinary Portland cement to BS 12 and aggregates to BS 882.				-
Concrete class C20/20	m3	0.55	400,000	220,000
Concrete class C25/20	m3	8	550,000	4,400,000
IN SITU CONCRETE				-
Placing of concrete				-
Reinforced concrete				-
Class 25 footing; thickness 300 - 500mm	m3	6	550,000	3,300,000
Stub columns; area 0.1 - 0.25150m2	m3	2	550,000	1,100,000
CONCRETE ANCILLARIES				-
Formwork - Fair Finish				-
Plane vertical; width exceeding 0.2 - 0.4m	m2	9.2	20,700	190,440
Reinforcement; high yield type 2 deformed bars to BS 4449				-
nominal size 8 -12mm	m	0.225	4,600,000	1,035,000
Pipework				-
Plastic pressure pipes				-

HDPE pipes to UNBS US 482:2003				-
OD50 mm depth not exceeding 1.5m complete with all associated fittings to meet the requirements of Drawing	m	200	15,000	3,000,000
Galvanized steel tube to B.S.1387 in trench depth not exceeding depth not exceeding 1.5m.				-
40 mm GI; not in trench	m	12	42,688	512,256
Fittings and Valves				-
40mm gate valve	No	2	127,080	254,160
40 mm Long screws	No	3	57,500	172,500
40 mm GI back nuts	No	3	23,000	69,000
DN50 gate valve	No	2	136,280	272,560
50 mm Non return valve including its fittings as per drawing	No	2	747,500	1,495,000
OD 40 mm GI elbows	No	4	15,750	63,000
OD 40 mm GI Union	No	2	31,400	62,800
40 mm stainless Steel Strainer	No	1	287,500	287,500
10-m structural steel tank support structure complete to match size and load of tank under Item Z524.1 to Z 524.3 including foundations in grade C25 reinforced concrete.	sum	1	8,000,000	8,000,000
Supply and install plastic tank of the following capacities and fittings as per drawing				-
10,000 litres; vertical cylindrical tank	No	1	4,000,000	4,000,000
Supply materials and construct a 3.0 x 3.0m superficial floor pump storage house per drawings	item	1	15,603,477	15,603,477
Construct a tap stand for domestic water use as per drawing	No.	1	1,150,000	1,150,000
VERTICAL ABSTRACTION SYSTEM				-
Excavation for foundations				-
Depth n.e 1.5m	m^3	2.7	12,800	34,560
Filling to structures; selected excavated materials other than topsoil or rock	m^3	2.1	52,487	110,223
IN-SITU CONCRETE				-
Designed mix to BS 5328, with ordinary Portland cement to BS 12, 10 mm aggregate to BS 882 as follows:				-
Provision and Placing Concrete				-
Grade C25/20 Reinforced Concrete				-
Base slab; thickness n.e 300mm	m^3	0.7	550,000	385,000
Column; cross sectional area n.e 0.25-1m2	m^3	0.06	550,000	33,000
Mass; blinding concrete; thickness not exceeding 150mm C15	m^3	0.225	380,000	85,500

CONCRETE ANCILLARIES				-
Formwork; class S2 finish; concrete components of constant cross-section				-
Base slab vertical sides	m^2	1.8	21,187	38,137
Reinforcement				-
High yield square twisted bars to BS 4449; nominal size 6 - 16mm	Kg	85.32	4,952	422,505
Concrete accessories				-
Finishing of top surfaces	m^2	2.4	35,000	84,000
PIPEWORK-PIPES				-
DN250mm flanged and puddled pipes not in trenches				-
Length: n.e 5m	No	1	595,661	595,661
DN 250 x 250 Tee	No	1	2,800,000	2,800,000
DN 250 flanged end cap	No	2	550,000	1,100,000
MISCELLANEOUS WORKS				-
Allow for erecting the entire assembly in the wet (filled valley tank)				-
Sub-Total C				**50,876,278**
SOLAR POWERED SUBMERSIBLE PUMP				-
High Pressure Diesel Engine Irrigation Pump LAUNTOP LDTP. Max head = 65m, Max Discharge = 30m3/h.	Nr	1	15,081,967	15,081,967
SOLAR PANNEL GROUND MOUNTING GALVANISED STRUCTURE				-
C/W Metallic structures and civil platforms, about 4.5m off the ground	item	1	5,573,771	5,573,771
Earthing System: (25mm2 earth wire, copper mat, copper clamp concrete earth)	item	1	1,393,443	1,393,443
ELECTRICAL ACCESSORIES: cable ties, flexible conduits, solar panel	item	1	4,184,012	4,184,012
Sub Total (D)				**26,233,193**
TOTAL (A+B+C+D)				**227,652,071**
18% VAT				40,977,373
GRAND TOTAL				**268,629,444**

Table 10.4 BoQ for tank house, office and store

DESCRIPTION: TANK HOUSE-CIVIL WORKS				
ITEM DESCRIPTION	**UNIT**	**QTY**	**Rate**	**Amount**
Preamble:				
EARTHWORKS				
Excavation for foundations				

Topsoil				
Strip top soil, depth not exceeding 0.25m for site of new works; allow for storage for re-use in landscaping	m^2	72.00	4,500	324,000
Ordinary Soil				
General Excavation for foundations in material other than topsoil, rock or artificial hard material, commencing surface is the formation level				
Depth 0.25 - 1 m	m^3	77.88	6,500	506,220
Excavation for footings, for pump house, in material other than topsoil, rock or artificial hard material, commencing surface is the formation level				
Depth 1-2m	m^3	77.88	7,500	584,100
Rock				
Excavation for foundations in rock, commencing surface is the exposed surface of the rock				
Depth 0.25 - 2 m	m^3	2.00	50,000	100,000
Excavation Ancillaries				
Preparation				
Preparation of excavated surfaces in the following materials				
Material other than topsoil, rock, or artificial hard material inclined at an angle not exceeding 45 degrees to the horizontal	m^2	87.18	3,500	305,130
Rock surfaces inclined at an angle not exceeding 45 degrees to the horizontal	m^2	2.00	8,000	16,000
Disposal of Excavated Material				
Disposal of excavated material to sites as specified and as directed by the Engineer	m^3	23.36	17,500	408,870
Total for Pump House Carried to Collection>>>>>>>>>>>>>>>>>				**2,244,320**
Rock	m^3	1.00	17,500	17,500
Filling				
Structures				
Filling to footings by methods specified and to depths as shown in the drawings with the following materials				
Imported material other than topsoil, rock or artificial hard material	m^3	5.70	25,000	142,500
Filling to structure, by methods specified and to depths as shown in the drawings with the following materials				
Imported hardcore, compacted in-situ, - 300 mm thick layer	m^2	28.50	15,000	427,500
Filling Ancillaries				
Trimming of Filled Surfaces				

Trimming of surfaces filled with material other than topsoil, rock or artificial hard material, for the following types of work surfaces				
Surfaces inclined at an angle not exceeding 45 degrees to the horizontal	m^2	1.82	6,125	11,148
IN-SITU CONCRETE				
Placing blinding concrete, for ground floor slab and strip footings, grade C15, and 50mm thick	m^3	3.89	350,000	1,362,900
Placing Strip Footing concrete, for ground floor slab and strip footings, grade C20, and 230 mm thick	m^3	4.99	450,000	2,245,950
Reinforced Concrete				
Concrete, design mix: grade C25, to BS 5328, with ordinary Portland cement to BS 12, 10mm aggregate to BS882, and nominal reinforcement enhanced with fibremesh for the following r.c elements:				
Pad footing	m^3	22.47	520,000	11,685,440
Floor ground slab 100mm thick and 250mm thick suspended slab	m^3	9.98	520,000	5,187,000
beam size: 450 x 230mm	m^3	3.21	520,000	1,668,420
Columns	m^3	1.90	520,000	990,288
Total for Tank House Carried to Collection>>>>>>>>>>>>>>>>>				**23,738,646**
CONCRETE ANCILLARIES				
Formwork-Rough Finish				
Rough Finish Plane Vertical				
Plane Rough finish vertical formwork of the following width				
Formwork-Rough Finish	m^2	89.52	25,000	2,238,000
Reinforcement				
High Yield Steel				
High yield square twisted bars to BS4449 and of the following sizes				
Nominal size, 16mm	Kg	1,138	6,000	6,825,600
Ditto 20mm	Kg	1,897	6,000	11,381,760
Ditto 25mm	Kg	687	6,000	4,124,160
Ditto 10mm	Kg	338	6,000	2,027,640
Concrete Accessories				
Finishing of Top Surfaces				
Finishing of top surfaces by the following methods				
Wood float	m^2	57.00	5,000	285,000
BRICKWORK, BLOCKWORK AND MASONRY				
Dense Concrete Blockwork				

Dense concrete blockwork to BS 7263, jointed with ordinary 1:4 cement mortar, and of the following thicknesses				
230 mm thick in plinth wall and superstructure wall	m^2	111.60	65,000	7,254,000
Surfaces of blinding inclined at an angle not exceeding 30 degrees to the horizontal	m^2	0.00	2,950	-
Flexible Sheeting				
Flexible polyethylene sheeting, gauge 1000, or similar approved, laid to the surface of blinding concrete or sand blinded hardcore fill				
Surfaces of blinding inclined at an angle not exceeding 30 degrees to the horizontal	m^2	33.00	3,000	99,000
Damp proof course of bitumen impregnated fabric to BS 6398 for the following wall thickness				
200 mm wide	m	33.00	3,500	115,500
Total for Tank House Carried to Collection>>>>>>>>>>>>>>>>>				**34,350,660**
WATER PROOFING				
Rendering / Plastering work				
Surfaces to walls inclined at an angle not exceeding 60 degrees to the horizontal, ordinary cement mortar to External and Internal walls	m^2	182.40	12,700	2,316,480
Protective Layers				
Cement: Sand (1:3) screed to surfaces of floors inclined at an angle not exceeding 30 degrees to the horizontal and average thickness of 50 mm	m^2	28.50	18,000	513,000
PAINTING				
High Gloss				
Weather guard Paint (External grade)				
Smooth Concrete Surfaces				
Smooth concrete surfaces inclined at an angle not exceeding 30 degrees to the horizontal; include surface preparation as specified	m^2	78.00	15,000	1,170,000
Emulsion Paint (internal grade)				
Smooth Concrete Surfaces				
Smooth concrete surfaces inclined at an angle not exceeding 30 degrees to the horizontal; include surface preparation as specified	m^2	104.40	12,000	1,252,800
MISCELLANEOUS WORKS				
Supply and fix Solid steel single leaf door, size 0.9m by 2.4m; include frame, all ironmongery and locking arrangements	nr	3.00	550,000	1,650,000
Total for Tank House Carried to Collection>>>>>>>>>>>>>>>>>				**6,902,280**
Supply and fix Solid casement steel window, 1m by 0.9m clear opening; include frame, all iron mongery and 3coats of Gloss paint	nr	3.00	250,000	750,000

Concrete splash apron around the building, 0.7m wide x 0.3 thick, including screeding	m	26.00	45,000	1,170,000
Total for Tank House Carried to Collection>>>>>>>>>>>>>>>>>				**1,920,000**
COLLECTIONS				
Collection, III-W 4.1				2,244,320
Collection, III-W 4.2				23,738,646
Collection, III-W 4.3				34,350,660
Collection, III-W 4.4				6,902,280
Collection, III-W 4.5				1,920,000
				69,155,906
VAT 18%				12,448,063
Total for Tank House Carried to Summary >>>>>>>>>>>>>>>>>				**81,603,968**

Source Protection plan

For each Valley tank or dam constructed, there must be a source protection plan to save guard the dam and the environment.

Source Protection plan cost estimates				
Item	**Unit**	**Qnty**	**Unit Price**	**Amount**
Vertiva grass - 3 lines round the perimeter planted at 0.1m	no	16200	200	3,240,000
Sisal - 1 line planted all-round the tank at 0.3m apart	no	1800	500	900,000
Shed trees - Shade trees - 2 lines at spacing of 10m apart in the first line then 5m apart in the outer second line	no	162	5000	810,000
Paspalum	Bags	25	500,000	12,500,000
Bio swales	no	2	5,000,000	10,000,000
Infiltration Pits - up stream	no	30	300,000	9,000,000
Grassing all-round the valley tank with paspalum 1:3 slope, surrounding 25m, water way before silt trap up to 120m and then spillway up to 15m	no	25	200,000	5,000,000
Total				**41,450,000**
Add 18% VAT				7,461,000
Grand Total				**48,911,000**

Typical layout of valley tank and water troughs for livestock

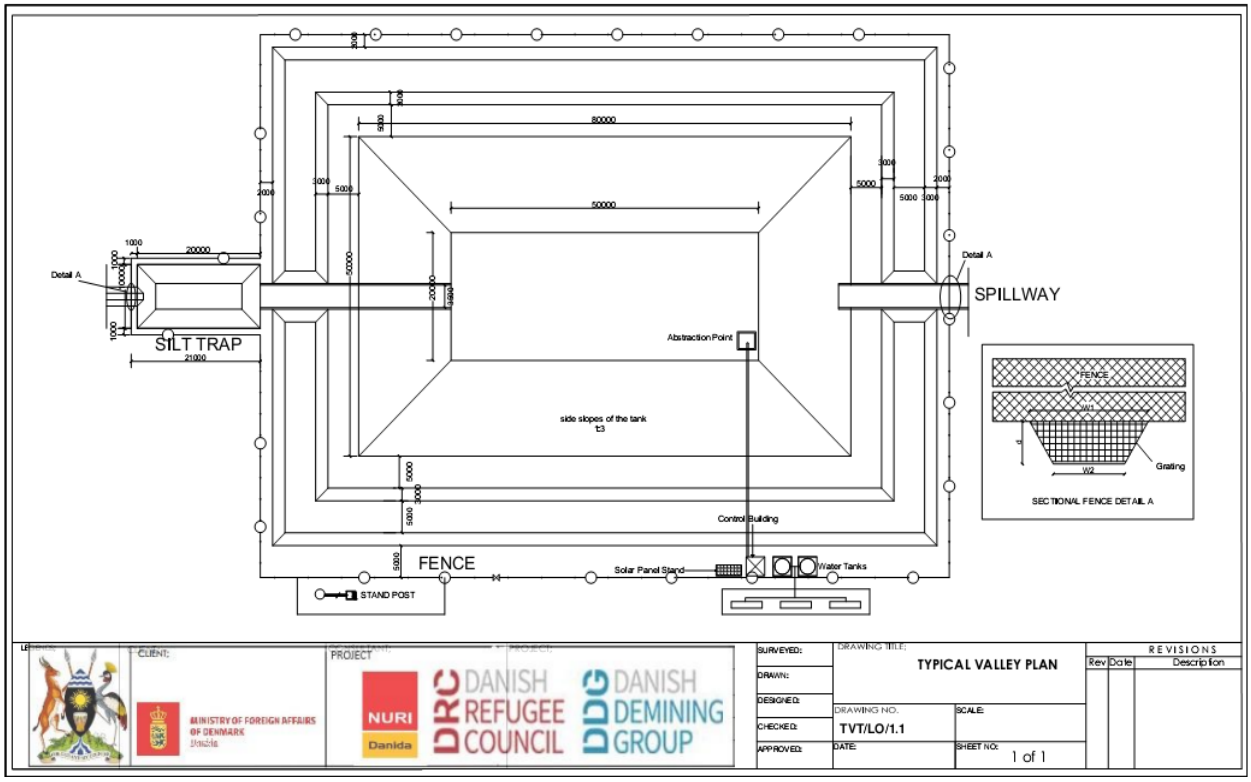
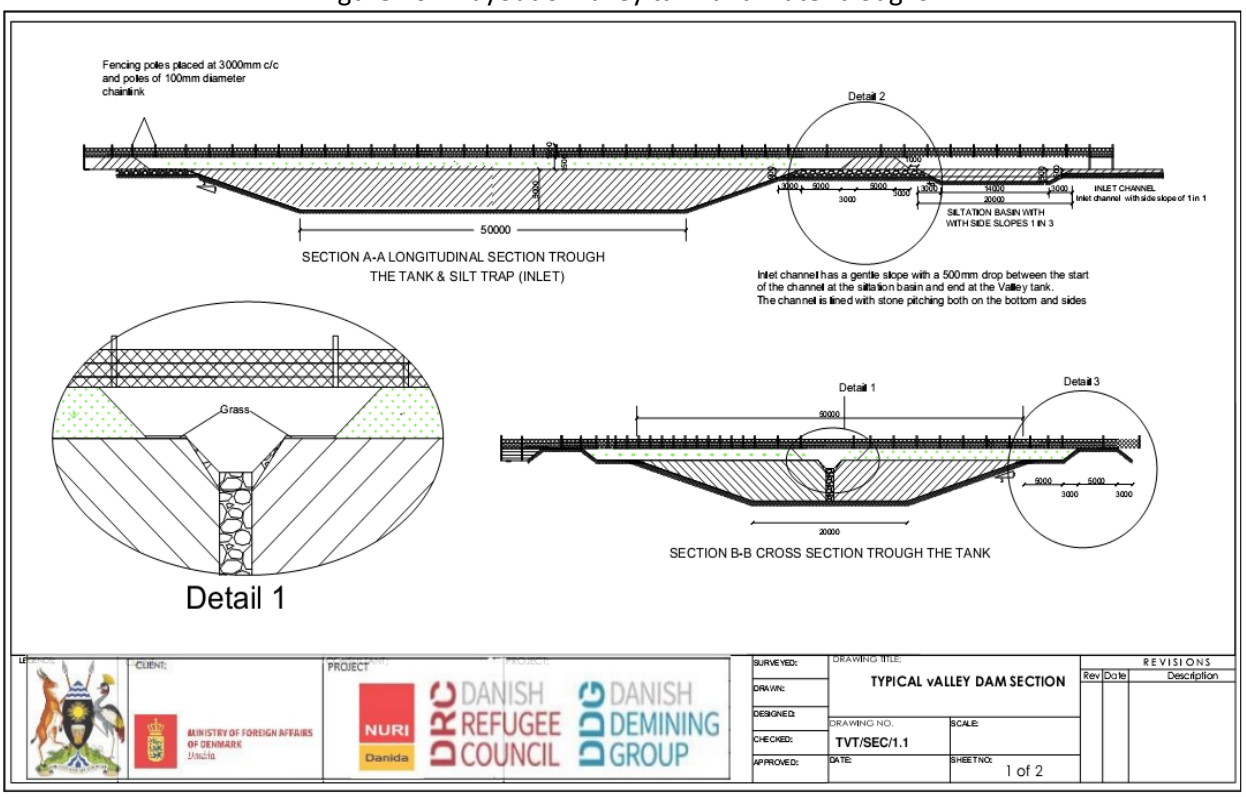
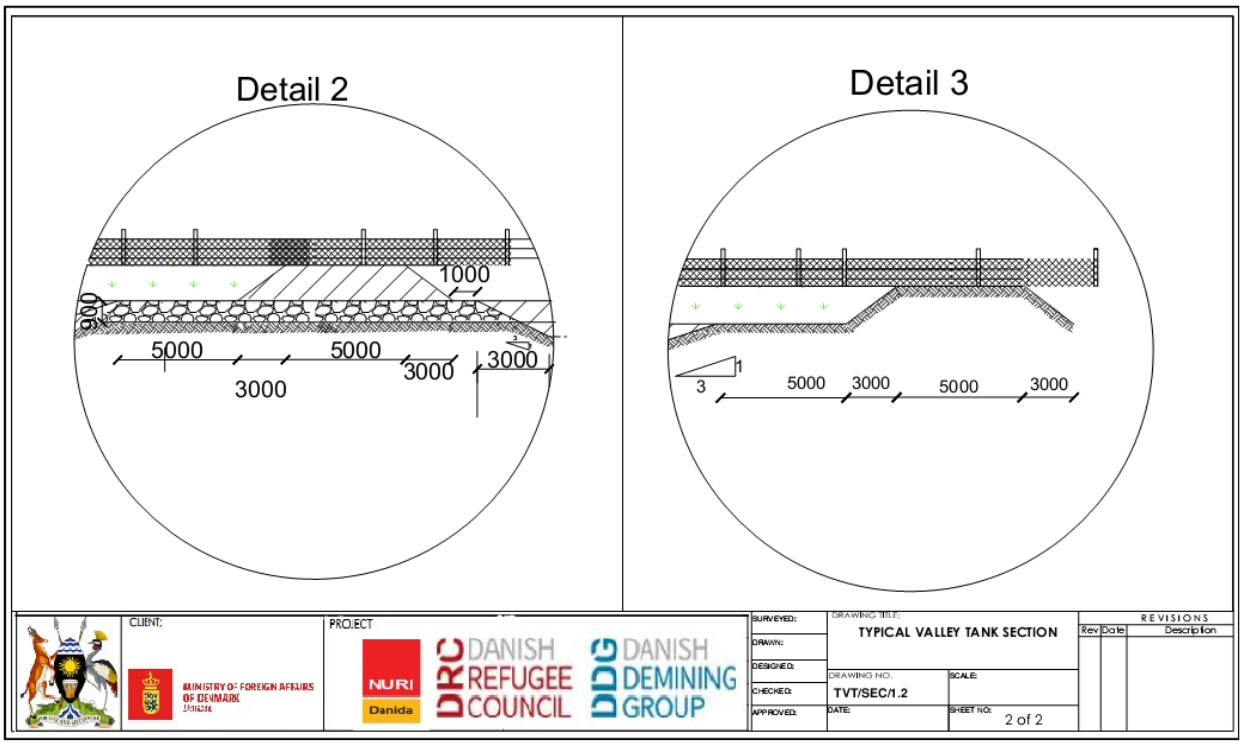
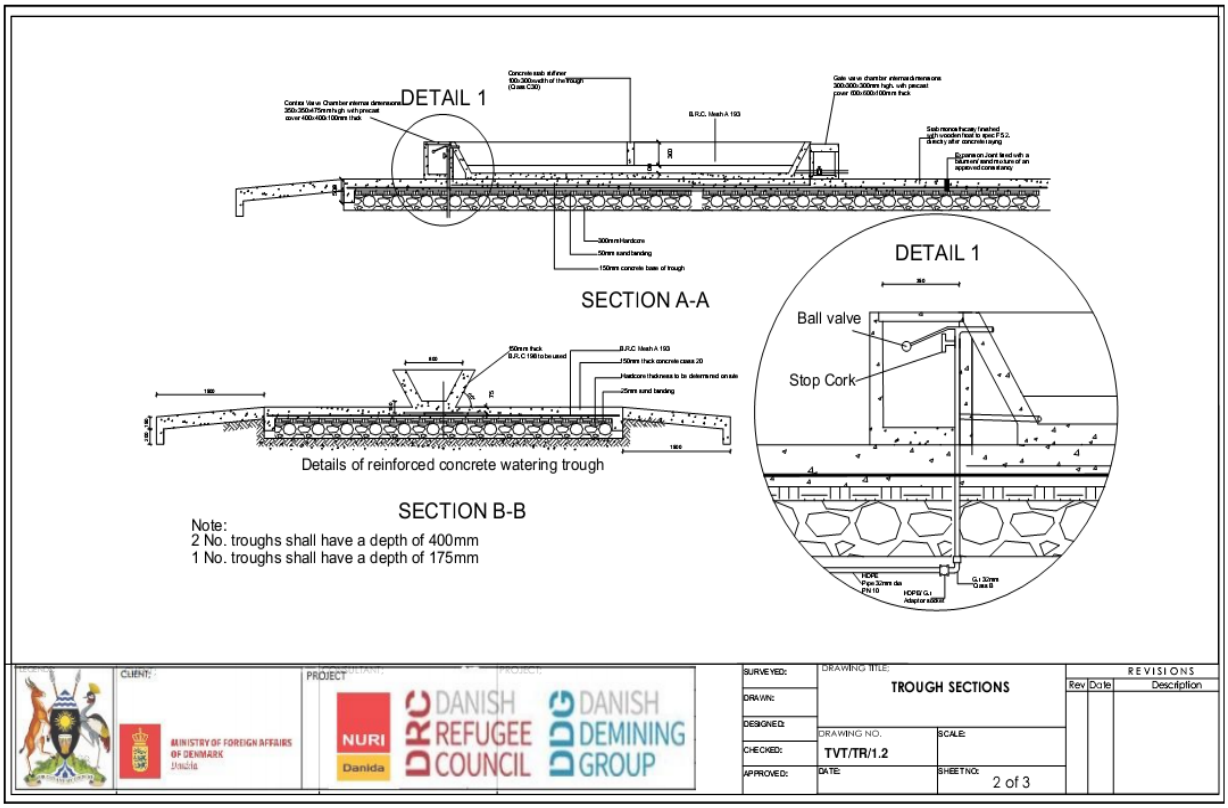
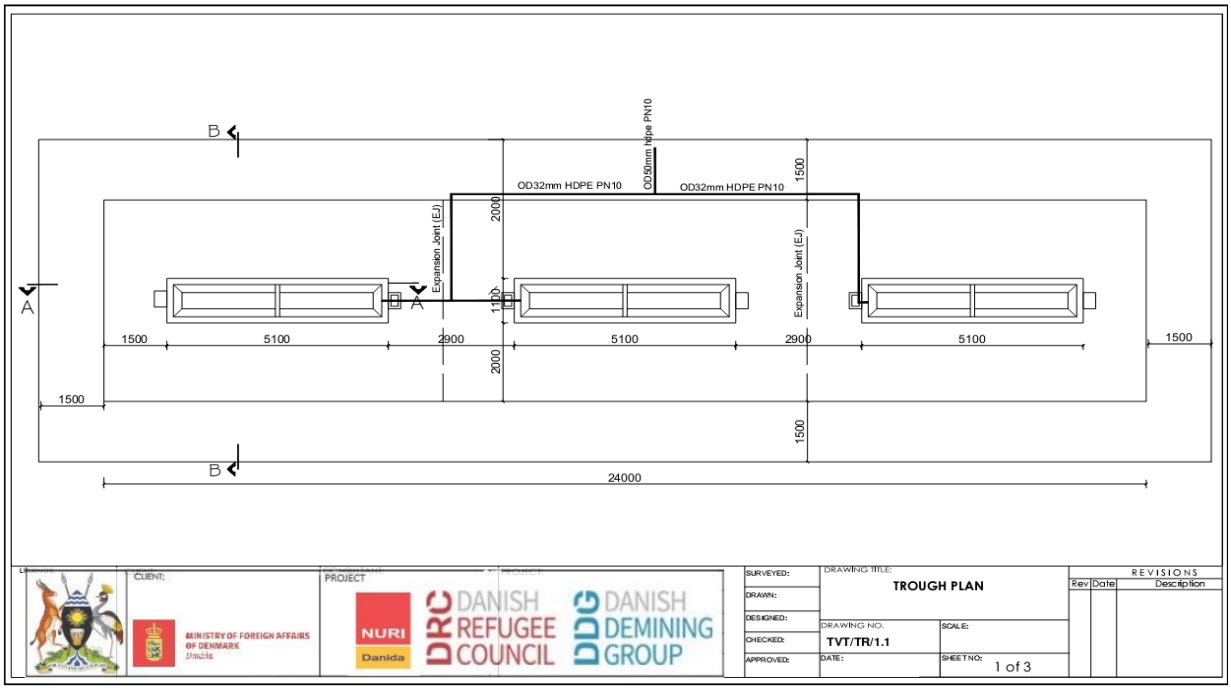


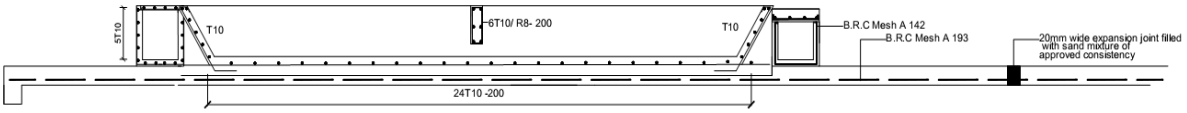
Figure 10:1 Layout of valley tank and water troughs



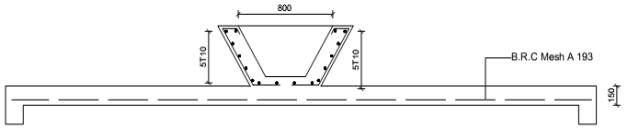

Detail 2
1000
900
5000
5000
3000
3000
3000
Detail 3
3
1
5000
3000
5000
3000
CLIENT:
MINISTRY OF FOREIGN AFFAIRS OF DENMARK
PROJECT
NURI
Danida
DRC DANISH REFUGEE COUNCIL
DDG DANISH DEMINING GROUP
SURVEYED:
DRAWN:
DESIGNED:
CHECKED:
APPROVED:
DRAWING TITLE:
TYPICAL VALLEY TANK SECTION
DRAWING NO.
TVT/SEC/1.2
SCALE:
DATE:
SHEET NO:
2 of 2
REVISIONS
Rev
Date
Description


DETAIL 1
Concrete sub stiffner
Gate valve chamber internal dimensions
Centre Valve Chamber internal dimensions
B.R.C. Mesh A 193
300mm Hardcore
50mm sand bedding
150mm concrete base of trough
SECTION A-A
DETAIL 1
Ball valve
Stop Cork
Details of reinforced concrete watering trough
SECTION B-B
Note:
2 No. troughs shall have a depth of 400mm
1 No. troughs shall have a depth of 175mm
CLIENT:
MINISTRY OF FOREIGN AFFAIRS OF DENMARK
PROJECT
NURI
Danida
DRC DANISH REFUGEE COUNCIL
DDG DANISH DEMINING GROUP
SURVEYED:
DRAWN:
DESIGNED:
CHECKED:
APPROVED:
DRAWING TITLE:
TROUGH SECTIONS
DRAWING NO.
TVT/TR/1.2
SCALE:
DATE:
SHEET NO:
2 of 3
REVISIONS
Rev
Date
Description



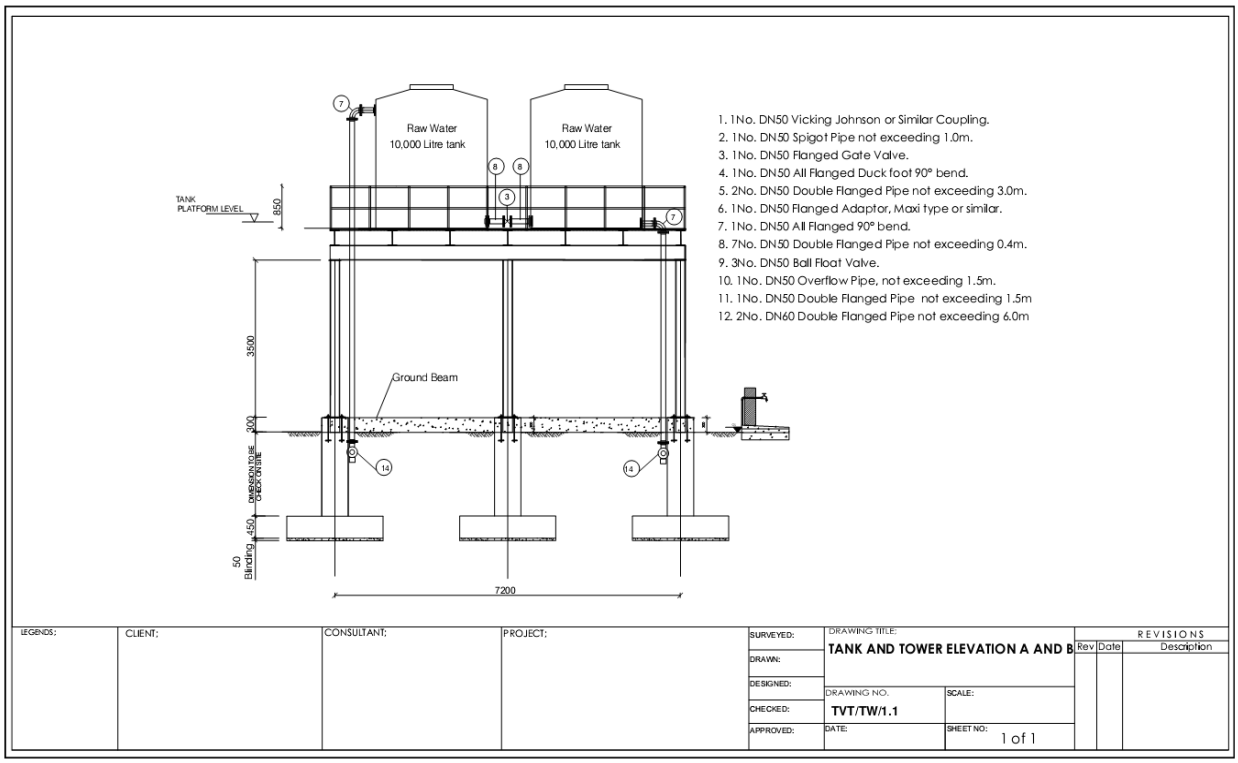


SECTION A-A



Details of reinforced concrete watering trough

SECTION B-B



10.2 Annex 2: Technical details - Small Scale Irrigation System

Small Scale irrigation systems shall be an annex to a valley tank or dam or protected spring. This is to improve the enabling environment for smallholder farming by increasing water availability, reducing the impact of climate change and extreme weather events, which will lead to improved yields and decreased incidents of crop failure.

Gravity flow systems shall be considered with no or minimal concrete and pipe works where there is sufficient pressure head to support irrigation. Whereas pressurized systems (sprinkler and drip) shall be considered where there is need to avail water through uplift pressure.

Irrigation water shall be abstracted from reservoirs gravity, pumping or siphoning using flexible HDPE pipes.

For a 10-acre irrigation scheme, a group of 40 farmers will be formed by CSA IP taking into consideration the land owners (land lord) who will take full responsibility to operate and maintain the scheme.

CfW group of 30 people will work for 20 days during the installation of the irrigation system. This group will be the core members whose 40 beneficiaries will be drawn from.

To make these irrigation systems resilient, a number of multifaceted interventions shall be considered in an integrative manner to harvest, retain, spread and sink water in the irrigation command areas. These are;

- Planting rain and rainwater harvesting and protection to “bank” the water in the rainy season for dry season growth.

- Deep-soil preparation (>60cm) of the irrigation command area
- West side shading of the command area with planted trees
- Heavy mulching to prevent irrigation water from being stolen by the sun, wind and slope
- Adding wood chips and leaves to strike a balance between alkalinity of irrigation water and acidity of the soil.
- Irrigation management should include watering after sunset or in the evening to reduce evaporation and irrigation water temperatures to better allow for deep water infiltration

Sprinkler system

Water is applied at the point of use by a system of nozzles (impact and gear driven sprinkler or spray heads) with water delivered to the sprinkler heads by surface and buried pipelines, or by both.
Sprinkler irrigation is suited for most row, field and tree crops and water can be sprayed over or under the crop canopy. Sprinkler irrigation is adaptable to any farmable slope, whether uniform or undulating. The lateral pipes supplying water to the sprinklers should always be laid out along the land contour whenever possible. Sprinklers are best suited to sandy soils with high infiltration rates although they are adaptable to most soils. The average application rate from the sprinklers (in mm/hour) must be chosen to be less than the basic infiltration rate of the soil so that surface ponding and runoff can be avoided.

Tasks for sprinkler irrigation system

CfW groups will be involved during construction activities of sprinkler irrigation systems to do the following tasks.

- Setting out the irrigation layout
- Trenching
- Pipe laying
- Back-filling
- Pressure testing and final back-filling

On average, an unskilled labourer can dig 10 meters of trench 0.9 m deep by 0.5 m wide per day in heavy soils, for light soils the rate increases to 18 meters per day and 14 meters per day for medium type soils. Backfilling require half the labour required for trenching.

Cash

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount total
Construction	30	20	1200	6,000	**3,600,000**

Tools

Tool	No.	Price	Total
Measuring tape (100m)	1	45,000	45,000
Measuring tape (5m)	1	5,000	5,000
Jerry can	2	10,000	20,000
Drinking cup	10	1,000	10,000
Hoe incl. handle	10	13,000	130,000
Trenching Shovel 4''	1	65,000	65,000
Panga	2	6,000	12,000
Spade with metallic handle	2	20,000	40,000

Wheelbarrow	1	160,000	160,000
Hacksaw with spare blade	1	40,000	40,000
Permanent Marker	10	5,000	50,000
First Aid Kit	1	80,000	80,000
Total			**657,000**
VAT			118,260
Total tools			**775,260**

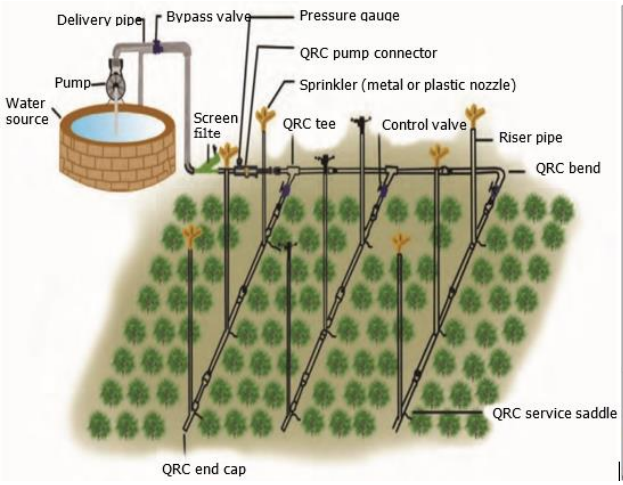
Special tools (Materials)

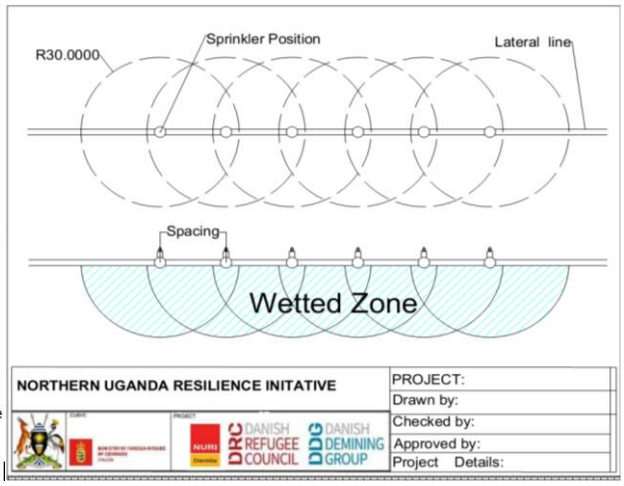
Items	**No**	**Price**	**Total**
Mattock 18''	1	98,000	98,000
PVC pipe cutter	1	130,000	130,000
Hose punch	1	8,000	8,000
Take-off tool	1	120,000	120,000
Solvent Cement	20	6,000	120,000
Telfon tape	50	3,000	150,000
Jute	1	75,000	75,000
GI threaded joint synthetic compound	1	100,000	100,000
Pressure gauge with adopter and nozzle	1	35,000	35,000
Spanner set	2	35,000	70,000
Screw driver	2	30,000	60,000
Pliers	3	6,000	18,000
Total			**984,000**
VAT			177,120
Total Special tools			**1,161,120**

a. BoQs

	QUOTATION FOR A COMPLETE PORTABLE LUXOR SPRINKLER IRRIGATION SYSTEM 2 acres				
No		Unit	Qty	Rate	Amount
1	High pressure Diesel Engine Irrigation Pump LAUNTOP LDP. Max head = 65m, Max Discharge = 30m3/h	Pcs	1	3,200,000	3,200,000
2	Luxor Sprinkler, Max Radius = 35m	Pcs	3	1,300,000	3,900,000
3	Sprinkler stand 11/2''	Pcs	3	190,000	570,000
4	Delivery Hose pipe 2'', 30m/roll	Roll	10	250,000	2,500,000
5	Steel reinforced suction pipe 2''	Meter	21	25,000	525,000
6	GI Foot Valve 2''	Pcs	3	150,000	450,000
7	GI Long nozzle 2''	Pcs	6	35,000	210,000
8	Clips 2''	Pcs	48	5,000	240,000
9	Hose Connectors 2''	Pcs	6	30,000	180,000
10	Plumbing Fittings	Set	1	100,000	100,000
Total					**11,875,000**
VAT					1,781,250
Grand Total					**13,656,250**

b. Drawings





Drip System

Water is applied to the point of use (root zone) through low pressure, low volume discharge devices (i.e., drip emitters, line source emitters, micro spray and sprinkler heads, gravity and low-pressure bubblers) supplied by small diameter surface or buried pipelines. Drip irrigation is most suitable for row crops (vegetables, soft fruit), tree and vine crops where one or more emitters can be provided for each plant. Generally, only high value crops are considered because of the high capital costs of installing a drip system.

Cash

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount total
Construction	30	20	600	6,000	**3,600,000**

Tools

Tool	No.	Price	Total
Measuring tape (100m)	1	45,000	45,000
Measuring tape (5m)	1	5,000	5,000
Jerry can	2	10,000	20,000
Drinking cup	10	1,000	10,000
Hoe incl. handle	10	13,000	130,000
Trenching Shovel 4''	1	65,000	65,000
Panga	2	6,000	12,000
Spade with metallic handle	2	20,000	40,000
Wheelbarrow	1	160,000	160,000
Hacksaw with spare blade	1	40,000	40,000
Permanent Marker	10	5,000	50,000
First Aid Kit	1	80,000	80,000
Total			**657,000**
VAT			118,260
Total tools			**775,260**

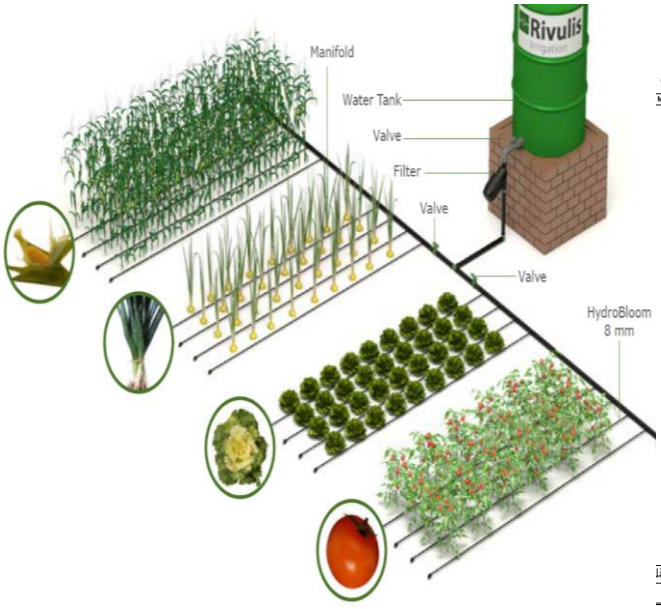
Materials (Special tools)

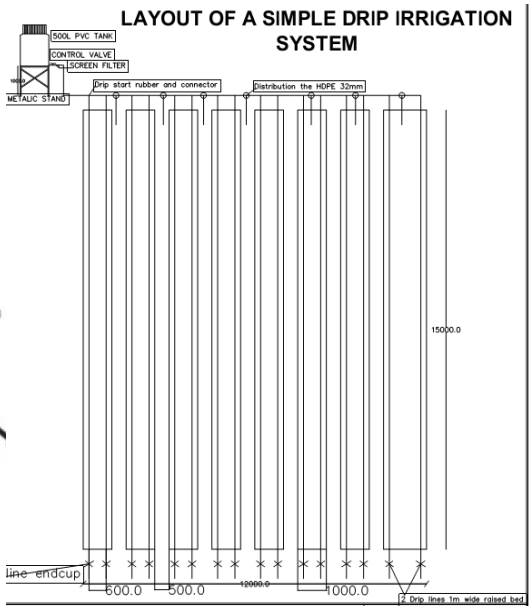
Items	No	Price	Total
PVC pipe cutter	1	130000	130,000
Hose punch	1	8000	8,000
Take-off tool	1	120000	120,000
Solvent Cement	20	6000	120,000
Telfon tape	50	3000	150,000
Pliers	3	6000	18,000
Total			**546,000**
VAT			98,280
Total Special tools			**644,280**

BoQ

QUOTATION FOR SIMPLE DRIP IRRIATION SYSTEM FOR 1 ac				
Item/Description	**Unit**	**Qty**	**Rate**	**Amount**
Dripline 16mmx30cm	Meters	4400	1200	5,280,000
Drip Start Rubber 16mm	Pcs	360	800	288,000
Drip Start Connector 16mm	Pcs	360	800	288,000
Drip End Cap 16mm	Pcs	360	800	288,000
Screen Filter 1''	Pcs	20	80000	1,600,000
Control Valve 1''	Pcs	20	50000	1,000,000
Thread Tape	Pcs	110	2000	220,000
Tank Connector 1''	Pcs	23	10000	230,000
PE Female Adapter 32mmx1''	Pcs	68	15000	1,020,000
PE Male Elbow 32mmx1''	Pcs	45	15000	675,000
PE Elbow 32mm	Pcs	45	10000	450,000
PE End Cap 32mm	Pcs	23	10000	230,000
HDPE Pipe 32mm PN6	Meters	338	3500	1,183,000
Water Tank 5000L	Pcs	1	300000	300,000
Metallic Tank Stand 3m High	Pcs	1	300000	300,000
Transport and Installation	Lps	1	100000	100,000
Total				**13,452,000**
VAT				2,421,360
Grand TOTAL				**15,873,360**

Technical drawings





10.3 Annex 3: Technical Design – Green Roads for Water (GR4W)

Standard design

The recommended standard design from Ministry of Works is shown below. The standard specification for the GR4W shall be as follows: Bush clearing 8m, Ditch 0.4m wide x 0.3m deep each side, back and side slopes 0.8m each side and Carriageway of 4m wide. Templates such as camber boards; ditch boards shall be fabricated out of timbers/Steel to ensure that quality required is achieved. Ditches sizes may be depending on hydrological assessment to determine how much water is expected at the ditch location.

A table showing the quantity of water expected in different regions with respect to catchment size, runoff coefficients and mean annual rainfall depth per 1km of the road is shown below:

	Design rainfall (mm yr-1)								
	350 mm			500 mm			700 mm		
Catchment	Runoff coefficient			Runoff coefficient			Runoff coefficient		
area (ha)	10%	20%	30%	10%	20%	30%	10%	20%	30%
10	3,500	7,000	10,500	5,000	10,000	15,000	7,000	14,000	21,000
15	5,250	10,500	15,750	7,500	15,000	22,500	10,500	21,000	31,500
20	7,000	14,000	21,000	10,000	20,000	30,000	14,000	28,000	42,000
30	10,500	21,000	31,500	15,000	30,000	45,000	21,000	42,000	63,000
50	17,500	35,000	52,500	25,000	50,000	75,000	35,000	70,000	105,000
100	35,000	70,000	105,000	50,000	100,000	150,000	70,000	140,000	210,000
500	175,000	350,000	525,000	250,000	500,000	750,000	350,000	700,000	1,050,000

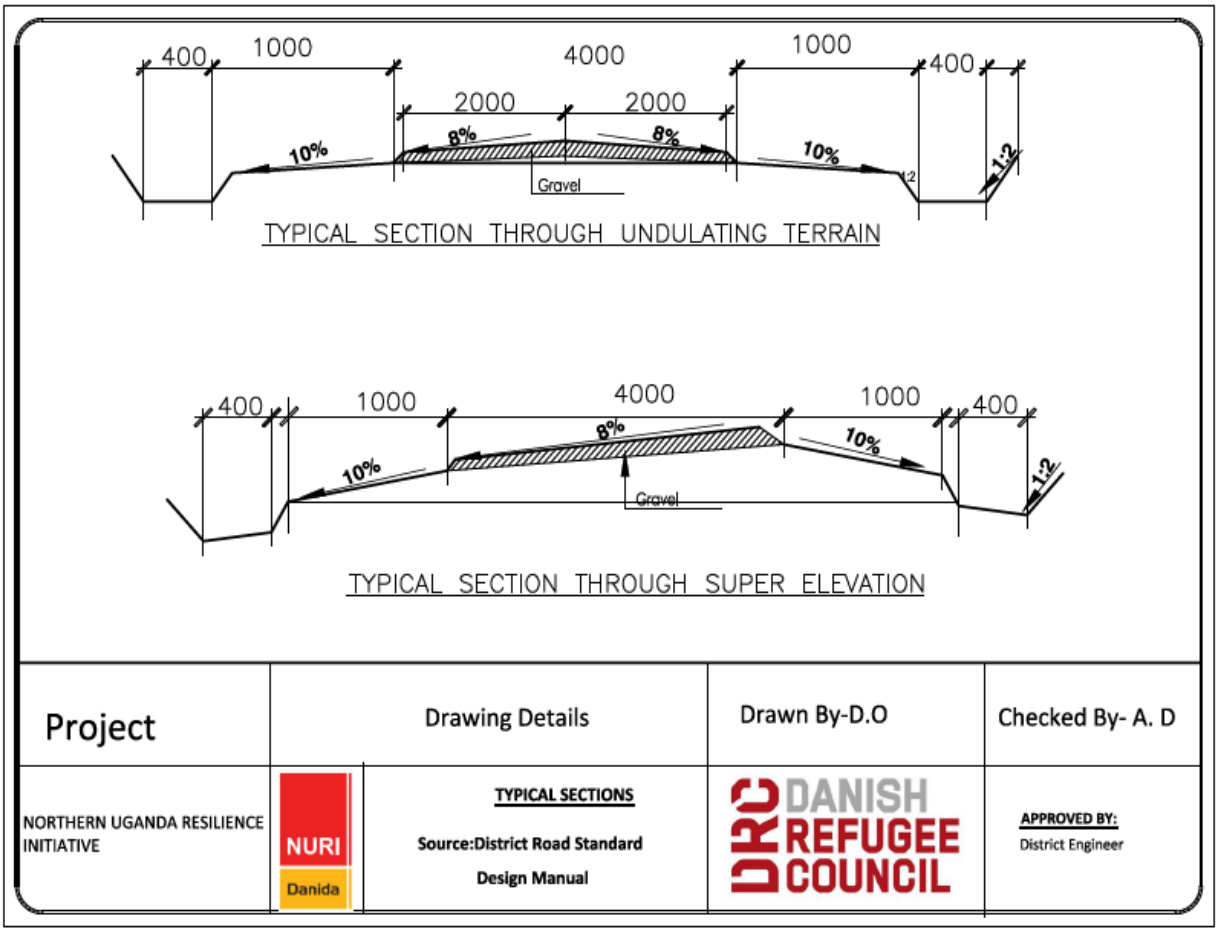
Tree planting will be done along all GR4W in all micro catchments in staggered pattern with a spacing of 6 meters in areas where Land Lords agree to maintain. In bushy areas, trees will not be planted but existing trees may be managed using farmer managed natural regeneration (FMNR).

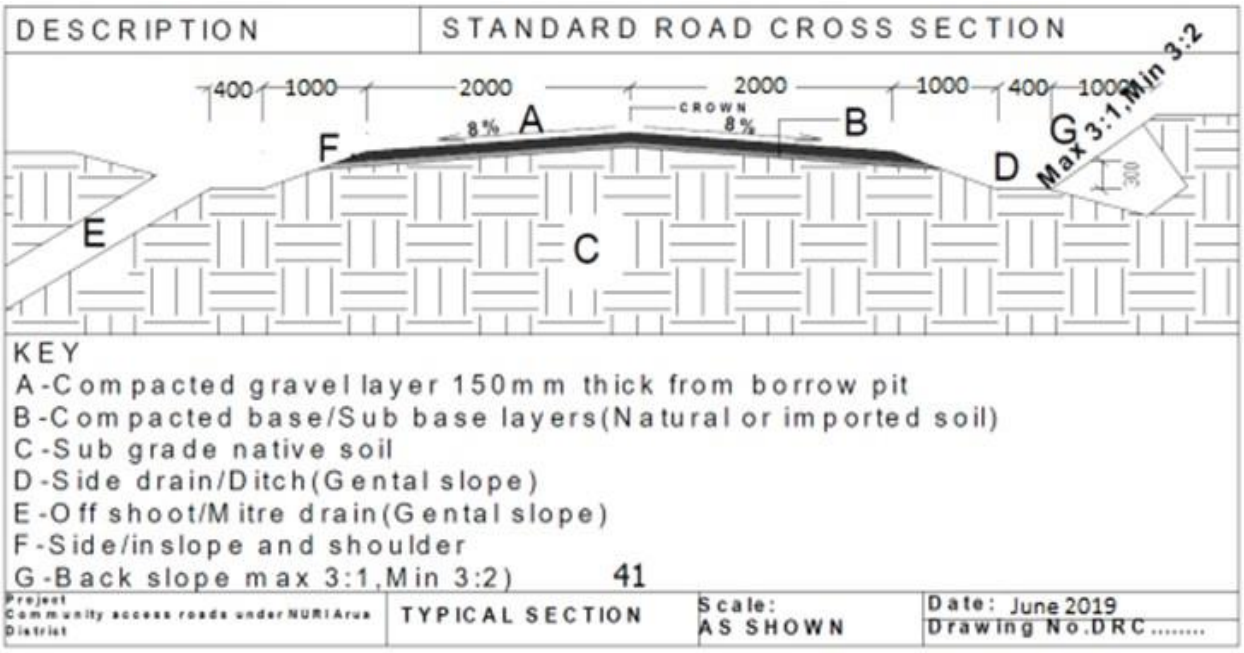
If the slope is steep, pits are recommended. A ditch is designed with similar dimensions, and blocked after 2m length, leaving 0.5-1m of original soil level in between followed by another ditch of similar dimensions like the one before. This provides more security as the water does not get the opportunity to flow and scour out the soil.

If the slope percentage is high it is important to consider scour checks on the side, levelling/blocking the flow of water. Grasses like Vetiver can be used to do so. But also, other grasses could function well in combination with trees.

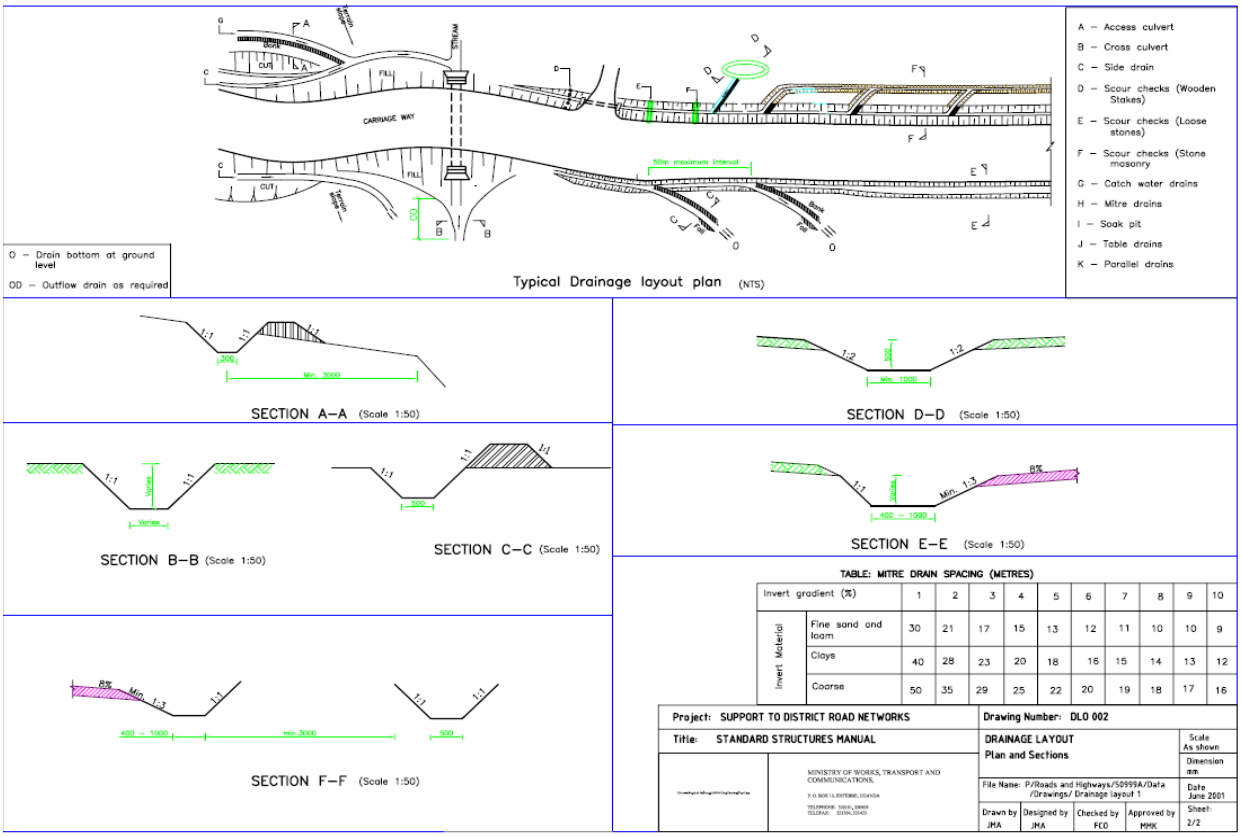
Bottlenecks on the newly constructed GR4W shall be identified, culverts of standard sizes varying from 600mm – 900mm, Steel culverts of up to 2500mm, Box culverts, drifts, and Vented Drifts shall be installed complete with head wall, wing walls and concrete aprons as per the standard designs. The number of lines of culverts per spot shall depend on the size and peak discharge of the river/stream across. The culverts, Drifts and Box culverts shall be installed by the technicians/masons during construction of the Community access roads.

Typical standard design for road cross section





TYPICAL DRAINAGE LAYOUT



Source: MOW - District Road Works Manuals Vol.4A

Tasks for GR4W

The construction (opening) of a GR4W involves the following tasks for the project group:

1. Setting out the road (pegging)
2. Bush clearing
3. Stripping and grubbing
4. Removal of trees, stumps, boulders and anthills
5. Levelling (excavation to level)
6. Ditching
7. Back sloping
8. In sloping
9. Camber formation
10. Opening mitre drains and scour check construction
11. Gravel spreading using labour intensive method
12. Scarification of hardened formed road sections to achieve proper compaction

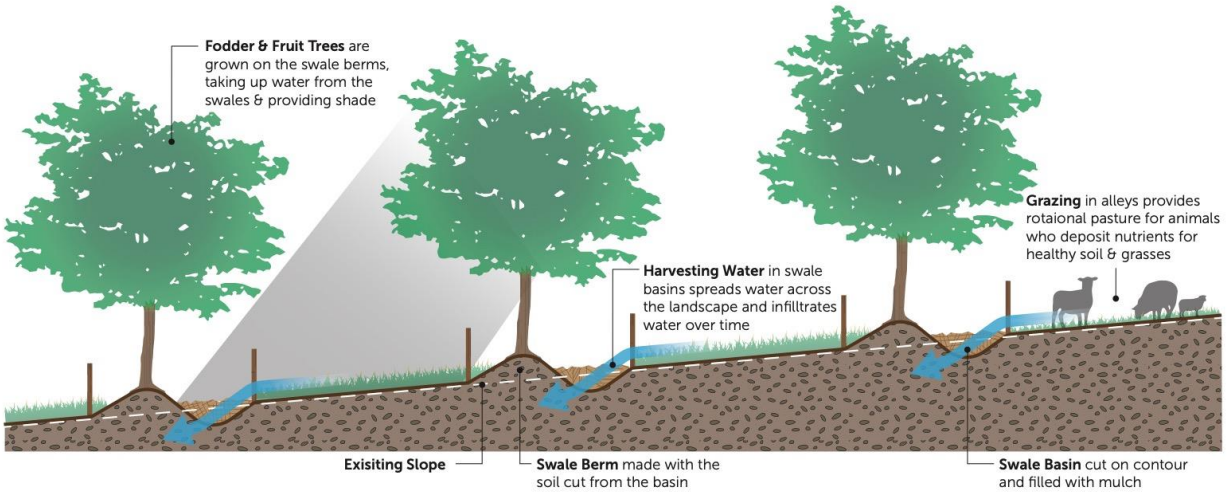
Where a community select a rehabilitation project, a group will do 2km of GR4W for light rehabilitation as a project, where the scope of rehabilitation is intensive 1km shall be a project, rehabilitation of drainage structures will be done by technicians/masons selected through the DRC supply chain process.

SUMMARY SPACING FOR MITRE DRAINS, CROSS DRAINAGE STRUCTURES AND SCOUR CHECKS

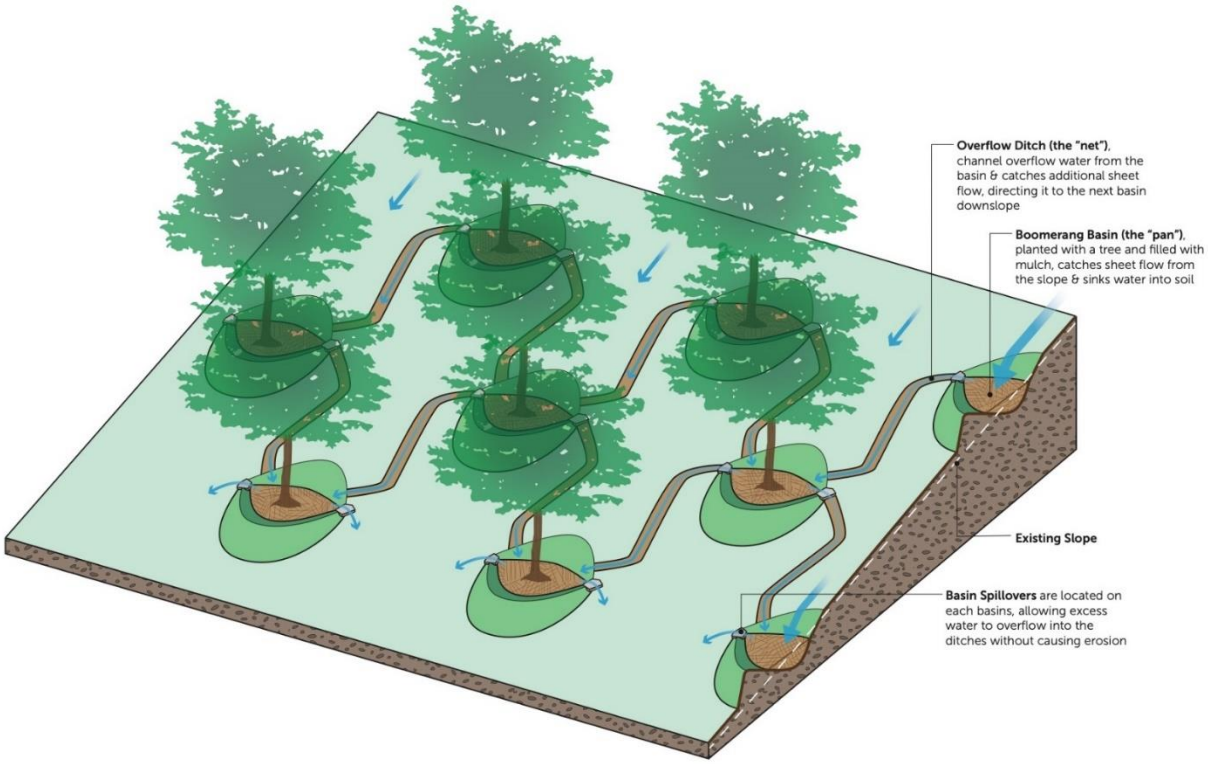
Longitudinal road gradient	Maximum mitre drain interval	Recommended interval between cross drainage structures	Scour check spacing
1% ~ 2%	50m	200m	not required
3%	200m	150m	
4%	200m	150m	
5%	180m	135m	20m
6%	160m	120m	15m
7%	120m	100m	10m
8%	120m	100m	7.5m
9%	80m	80m	6m
10%	80m	80m	5m
11%	40m	60m	4m
12%	40m	60m	4m
above 12%	40m	60m	line with masonary

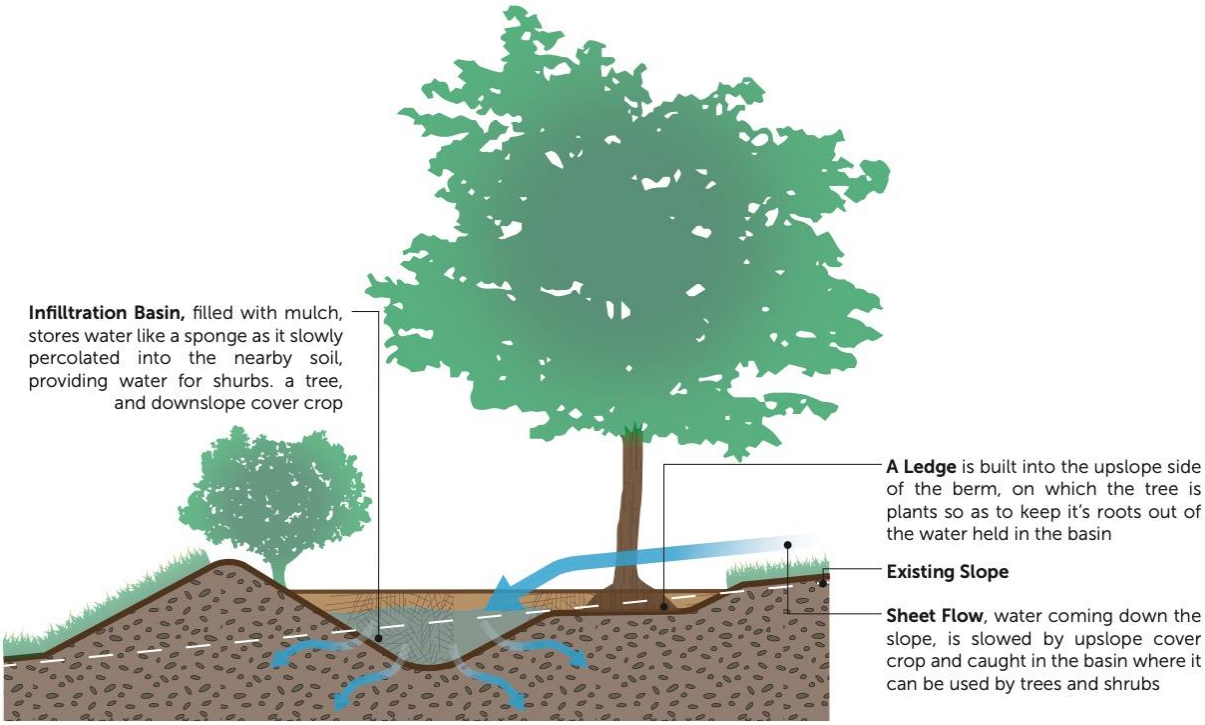
Source: MOW - District Road Works Manuals Vol.4A

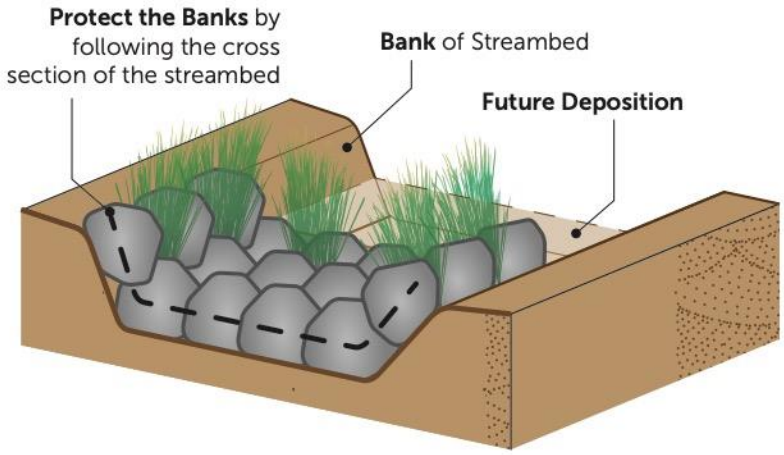
Mitre drains will terminate into systems of ponds for livestock and/or bio swales for crop productions. Run on water may be slowed, spread and infiltrated into the upslope agricultural systems using multiple strategies including bioswales, small one-rock check dams, infiltration pits and ponds, net and pan systems of smile berms, etc. or be controlled by Catch water drains which will be introduced on the uphill side of the road to prevent floods based on sites context. This will be done by machines and/or labour-intensive approach where land owners allow.

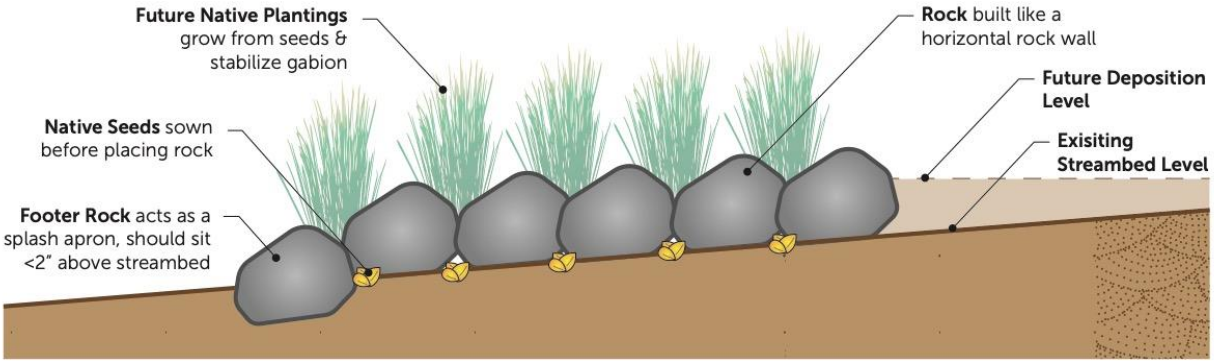


On upstream buffering of water flowing down. It is advantageous that infiltration pits/bio-swales and net and pan systems of planting trees with smile berms and then utilizing the spaces in between the smile berms for growing crops and fodder should be put in place. In case of stone rich areas, low stone bunds anchored in the soil can be implemented too. In all cases it is best to combine with vegetation. Grasses can help a lot in holding the soil together and stabilize the area from erosion.

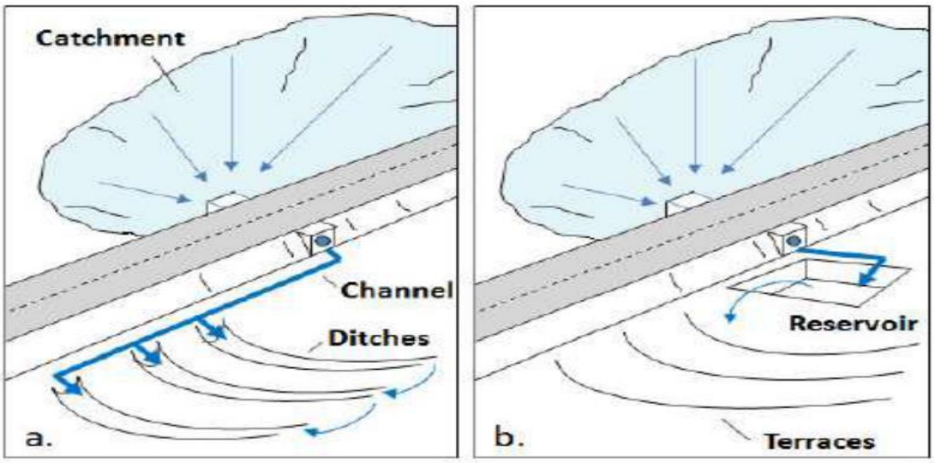



Infilltration Basin, filled with mulch, stores water like a sponge as it slowly percolated into the nearby soil, providing water for shurbs. a tree, and downslope cover crop
A Ledge is built into the upslope side of the berm, on which the tree is plants so as to keep it's roots out of the water held in the basin
Existing Slope
Sheet Flow, water coming down the slope, is slowed by upslope cover crop and caught in the basin where it can be used by trees and shrubs


Protect the Banks by following the cross section of the streambed
Bank of Streambed
Future Deposition


Future Native Plantings grow from seeds & stabilize gabion
Native Seeds sown before placing rock
Footer Rock acts as a splash apron, should sit <2" above streambed
Rock built like a horizontal rock wall
Future Deposition Level
Exisiting Streambed Level

Water from culvert outlets is large in volume compared to the one from mitre drains. Therefore, it can be managed and be more impactful where it ends up into. It can be collected into reservoirs/ponds for animal drinking, irrigation in farms, through equal spreaders or made to move through terraces across the farm contours. The final use of this water from culverts must be decided upon on mutual discussions with the intended farmers. Some of the uses and water management options are shown below:



The activities 1-4 should be done in the dry season while the other activities are done after the rains have started.

For Minor Rehabilitation of GR4W, the following tasks are normally involved:

1. Removal of vegetation (grass)
2. Repairing ditches
3. Re-shaping the road
4. Repairing mitre drains
5. De-silting of culverts
6. Installation of culverts
7. Gravelling (Spot or Entire section)

These activities should be done before the rain starts

For Major Rehabilitation of GR4W, the road has been abandoned because a major structure made the road inaccessible for a very long period of time and road has been reduced to a footpath and completely lost shape and the following tasks are normally involved:

1. Re-Setting out the road (pegging)
2. Bush clearing
3. Stripping and grubbing
4. Removal of trees, stumps, boulders and anthills
5. Levelling (excavation to level)
6. Ditching
7. Back sloping
8. In sloping
9. Camber formation
10. Opening mitre drains and scour check construction
11. Gravel spreading using labour intensive method

12. Scarification of hardened formed road sections to achieve proper compaction

Tools

The standard tool kits that will be provided for opening 1 km of GR4W are and other additional tools can also be procured if included in the investments and also unforeseen circumstances warrant:

Tool	No.	Price	Total
Measuring tape 100 m	1	45,000	45,000
Measuring tape 7.5 m	2	10,000	20,000
Nylon strings 100 m	2	15,000	30,000
Jerry can	2	10,000	20,000
Drinking cup	10	1,000	10,000
Hoe incl. Handles	10	13,000	130,000
Slasher	2	6,000	12,000
Panga	5	8,000	40,000
Axe incl. handles 5kg	4	15,000	60,000
Pick-axe incl. handles	6	22,000	132,000
Spade with metallic handles	5	20,000	100,000
Rake incl. Handle (Need to get locally made type with metallic handle)	6	10,000	60,000
Claw hammer, metallic handles	2	15,000	30,000
Wheelbarrow (Reliance)	1	150,000	150,000
Spirit level	1	20,000	20,000
Ditch Slope template	1	80,000	80,000
Camber board 8%	1	42,000	42,000
Boning rod B	5	25,000.00	125,000
Total			**1,106,000**
Add VAT			199,080
Grand Total			**1,305,080**

There are 3 Cardinal tools, hoes, pickaxe and spades in labour-based road construction. Depending on the various site conditions, 5% of the total quantities of tools in micro catchment will be added to cater for unforeseen challenges in the implementation.

Where conditions require the following special tools can be provided:

Special Tool	No.	Price	Amount
Crow Bar	1	42,000	42,000
Sledge Hammer 20Ibs	1	100,000	100,000
Sub Total			**142,000**
VAT			25,560
Total Special Tools			**167,560**

Materials

Materials	No.	Price	Total
Anti-termite chemical-1 Litre	1	60,00	60,000

First aid kit	1	80,000	80,000
Bow Saw with blade	1	45,000	45,000
Total			**185,000**
VAT			33,300
Total Materials			**218,300**

Gravelling

Selected existing GR4W / District roads will be gravelled according to Sections F 2.8 to F2.9, Volume IV of the district road manual. Gravel of satisfactory quality shall be supplied, spread, watered and compacted to a minimum thickness of 100mm layers. Spot gravelling will be done on sections with problem soils and points of culverts installations. In case of extensive problem soils, the entire road link will be gravelled.

Spreading of gravels will be done using equipment and labour-based approaches. During gravelling; shorter length <2000m will be gravelled using labour-based approach, greater lengths >2000m will be gravelled using equipment. Due to high costs of watering, most compaction works will be done during rainy season, however; whenever necessary water bowsers will be engaged.

While screening, soil investigations (test pits) for preliminary observation may be undertaken to ascertain the nature of the soils if necessary.

The rates of the equipment hire needed shall be determined at the time of hire using DRC procurement procedures in case the District Equipment are not made available for use for the Project or the District does not own the equipment.

Gravel materials shall be procured by either of the two methods below;

1. Gravel supply will be tendered to local contractors at an average cost of 140,000/= per trip ($3.0m^3$) within a radius of 20km from site location, for more distant locations beyond 20km, additional payments will be considered based on valid justification for extra kilometres covered and additional kilometres covered, a reasonable sum will then be topped up but will in no case exceed UGX3,000/= per km of $3.0m^3$. This will be delivered at spacing of 3-meter c/c to site, and spread by technicians hired at 6,000 per trip.
2. Gravel materials will be procured directly from the local land owners, excavated, loaded and delivered to site by selected suppliers. This is most preferred because it is cheaper, ensures right quality and quantity and hence value for money will be realized.

A borrow pit will be established in some sub counties along one of the GR4Ws being constructed by DRC where possible. Borrow pits provide the source material for the construction of road embankments, which depending on the local area are: gravel/aggregates, silica sands, laterite sands and calcite. These borrow pits will become major assets in local water security. Thus, as soon as the pits are no longer used for the mining of building materials, the excavated structure can become an important and valuable water supply source if the land lords allow. More specifically for rainwater harvesting irrigation management, rather than backfilling the pits or leaving them unattended, borrow pits can be systematically converted into sources of off-season small-scale irrigation

During wet periods, borrow pits can store rainwater and runoff from roads, and/or act as a recharge pond everywhere. In addition, in areas with high levels of shallow groundwater, borrow pits may also serve as a seepage pond, which are constantly recharged with seeping shallow groundwater from adjacent areas. Either way, borrow pits may serve as source of stock water, irrigation, fishery and with proper treatment even drinking water.

However, borrow pits for rainwater harvesting and off-season small-scale irrigation are currently used without planning. As a result of this, some borrow pits are unsafe and/or not reusable and/or sources of contaminated water. Due to this, there is a need to systematically approach the 'second life' of borrow pits as road water harvesting ponds for off-season small-scale irrigation. This requires to look at the following 4 factors: Siting of borrow pits; Shaping of borrow pits; Special protection measures and Management of borrow pits.

Therefore, for a 1km gravelling, an excavator will be hired for 5 days and 8 trucks of 3.0 cubic meter will also be hired for 5 days to haul gravel (a minimum of 10 trips per day depending on nature of road/distance) at estimated cost below.

S/No.	Item description	Unit	Qty	Rate	Amounts
1	Procurement of borrow pits	No.	1	1,500,000	1,500,000
2	Mobilization & demobilization of excavator-Lowbed hire	route	2	2,500,000	5,000,000
3	Hire of excavators	days	5	1,600,000	8,000,000
4	Fuel for excavator	Litres	500	4,300	2,150,000
5	Hire of tipper trucks	days	40	350,000	14,000,000
6	Fuel for tipper trucks	Litres	2000	4,300	8,600,000
Total					**39,250,000**

Similarly, where there is available man power, for a 1km gravelling, 30 persons will be hired for 20 days to excavate and load gravel and 8 trucks of 3.0 cubic meter will also be hired for 5 days to haul gravel at estimated cost below.

SNo.	Item description	Unit	Qty	Rate	Amounts
1	Procurement of borrow pits	No.	1	1,500,000	1,500,000
2	Labour	Workdays	600	6,000	3,600,000
3	Hire of tipper trucks	Days	40	350,000	14,000,000
4	Fuel for tipper trucks	Litres	2000	4,300	8,600,000
Total					**27,700,000**

The rate of the hire of equipment and trucks may vary from the above rates depending on the market rate after DRC procurements are concluded.

Gravel supply for spot gravelling which is less done 1km shall be pro-rated accordingly by the engineering team.

An additional 5 days will be added to a group that will be working along a road where a borrow pit is converted into a pond to finish working on the pond at the cost below.

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount total
Construction	30	5	150	6,000	900,000

In difficult terrains with hills, valleys and swamps where roads are susceptible to destruction by floods, the run off and run on will be directed from the roads and catchment areas into bio swales and water ponds that can be used for production. The waters pond constructed in such a scenario will be regarded as a project to be implemented both using machines and community groups.

In principle NURI does not support District roads, however, where there are very specific cases which link to other NURI activities and investments, these may be considered on a case-by-case basis.

Spreading: The material from one truck is off loaded and spread within a "box" marked out by pegs and strings. The pegs are set at the Centre line and edges of the box with the aid of camber board and spirit level to ensure satisfactory cross fall (of 8%) and the longitudinal gradient checked using boning rods.

The width of the box is equal to the carriage way width (4m) and 0.8m of shoulders on either side to be gravelled and its length can be calculated according to the Truck capacity to ensure that material is spread to the correct loose thickness. See formula below.

$$Length\ of\ box = {}^{Trailer}/_{Truck\ Capacity}$$

Extra Gravel spreading:

All extra gravel shall be delivered by Local private contractors or DRC hired trucks and spreading will be done by the technicians at a rate of 6000/= per group member for one trip of gravel (3.0m^3) delivered to site

In cases where a grader is hired for gravelling, the estimated dry rate shall be not more than 2,500,000 per day (8Hrs) and a maximum of 120 litres of fuel shall be issued.

Compaction

Compaction shall be carried out with a vibrating roller of approved total weight and dimension. GR4W will be compacted immediately after the road has been shaped. However, compaction can only be done when the soil is moist. Normally the compaction will be done in the early part of the rainy season. In case, compaction is not done immediately, scarification will be done before compaction provided the cost of compaction will be within the budgeted amount in the investment plan. In any case compaction is delayed due to unforeseen circumstances, the road will be scarified and compacted.

Gravel compaction; The gravel is laid evenly and the surface smoothness longitudinal and transverse checked watered (to achieve approximate optimum moisture content) using towed bowsers fitted with a sprinkler bar from service provider or by labour using watering cans and small truck fitted with tanks of minimum 1000 litres hired at 350,000 per day at for 5 days of compaction of formed road 200m per day. In case a 3-ton pedestrian roller is hired, a dry rate of 350,000 is estimated. The number of days required for watering and compaction for spot gravelling shall be based on 200m length per day and number of days for compaction around the culverts shall be estimated by engineers depending on the scope of works along the road project. The rate of hire of the towed bowsers and rollers shall be finally determined by the market rate at the time of DRC procurement.

A minimum number (to be specified by the Engineer) of passes of compaction shall be applied or until no roller imprint on the surface can be recognised. It shall be noted that the standard specification as per the contract data be achieved regardless of the number of rollers passes. Each gravel layers to be

compacted should normally not exceed 200 mm loose. The camber of the compacted formation will be checked to ensure it does not exceed a cross fall of 8% or that specified by the design.

Preferably 2 pedestrian rollers (3ton) shall be procured per district/location and compaction shall be done directly by DRC. The operator shall be hired and paid at a rate of 35,300/= per day or employed for a short period of implementation as a casual labourer hired by DRC Procedures. At the end of a day's business, the pedestrian roller shall be kept at a nearby safe place e.-g Police post, sub county headquarters, LC 1 executive home, PMC member whichever is near.

Government rates for paying operators and assistants will be used for paying District operators/drivers and assistants.

Casual labour rates of 15,000 per day will be paid for guards and Local Government Council Representatives where the machines are kept during implementation and as machines are awaiting to be demobilised. 3 people shall be paid for a day- 2 guards and 1 local government council representative.

Cash

The amount in cash to be paid for 1 km of GR4W with RD approach

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount total
Construction	30	25	750	6,000	4,500,000

The amount in cash to be paid for 1 km of minor rehabilitation of GR4W with RD approach

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount total
Rehabilitations	30	13	390	6,000	2,340,000

The work days and cash for major rehabilitations will be the same as for opening new GR4W.

2 Kilometres of a road will be considered as a project for rehabilitation.

Obstacles for Road Construction

Where there are many obstacles like, trees and anthills they should be counted and the number of workdays to remove them should be calculated.

Depending on the total number of workdays, Nature and amount of the obstacles to be removed by a particular project group, the length of the road section for that group can be reduced from 1 km to 750m or 500 meters or additional 10 days will be added for the group members to complete the 1km road link.

Calculation of work days (WD) to remove obstacles

Obstacle	Size	Unit	WDs	No. of trees	Total WDs
Tree	30-64 cm	girth	0.5		
Tree	65 – 125 cm	girth	1		
Tree	126 – 200 cm	girth	2		

Tree	201cm -	girth	4		
Anthill	5 – 10 meters	girth	2		
Anthill	11 – 20 meters	girth	4		
Rock out Crops	200cm-400cm	girth	2		
Rock out Crops	401cm- 600cm	girth	4		
Heavy Cut and Fill	2 m^3	Volume	1		
Grand Total					

The "No." column is filled in with the actual no. of trees and anthills and the total no. of work days

The girth is the circumference of the object. For trees it is measured at one meter's height and for anthills at the ground and for rock out crops at the ETL level.

Trees with a girth of less than 30 cm and anthills with a girth of less than 5 meter are assumed to be part of the general bush clearing. Heavy volume of cut and fill will be considered after exceeding cutting of 30cm, otherwise a cut of up to 30cm is considered normal ETL.

NB: At screening level, the technical persons at the sites shall try to avoid the obstacles as much as possible.

Calculation of Extra days for removing obstacles

In 2022 projects an estimate of obstacles shall be done during screening and re assessed during implementations for un foreseen obstacles.

While in 2021, after site clearance and during implementation all the obstacles will be established and calculated before payments to establish the days earned for obstacle removal.

Total WDs for removing obstacles	WDs to be earned for removing obstacle days
0 - 30	0
31-60	30
61 - 90	60
91-120	90
121-150	120
151-180	150

A maximum of 150 earned obstacle work days shall be paid during the implementation. Work days earned shall be recorded and certified by the DRC team.

It is assumed that the first 30 work days for removing obstacles are included in the 750 work days that 1 km should require.

10.4 Annex 2: Technical Design - Culvert Crossing

The designs of different types of culvert structures are described in District Road Works Manuals, Vol. 4B, and Standard Design Manual.

Activities/Specifications:

- Site clearance of shrubs, herbs and trees
- Setting out of the culvert lines
- Excavation of the culvert line to the required length, width and depth, bed slope of 3% - 5%
- Stabilisation/densification of the natural or fill sub-grade
- (Re)alignment of the culvert rings fitting male and female parts
- Sealing of the joints with 1:2 mortar mix
- Back fill with well graded granular material containing a small amount of silt or clay in order to achieve dense, stable fill and fill material must be free from deleterious materials, rocks and hard earth clods larger than 75 mm in size. It must not contain any sod, cinders or earth containing organic matter and compact in 150mm - 200mm thick layers to at least 90% Standard Proctor Density (AASTHO T99). Minimum cover required is ¾ of internal diameter of Culvert specified.
- Where the stream bed is weak for considerable depth, 150-200mm approved hard core is placed, compacted and levelled before placing stable Layer.
- Construct Head and Wing walls in 1:3 mortar mix as per the designs including aprons with 400mm x 150mm cut-off mass concrete wall to prevent under cutting and water ponding.
- Excavate discharge ditch to safely discharge water from the culverts.
- Excavate side and mitre drains at approaches to dispose excess running water
- Construct scour checks where flow velocity in side drains is too high.
- Provide adequate culvert rump to maximum of 5% slope on both sides

The most commonly used culvert rings are of cement and with a diameter of 600 or 900 mm. A culvert installation can have one or multiple lines. In any case a bigger diameter culvert is required to be installed, designs and bills of quantities shall be done for the specific sites.

Other types of culvert installations are:
- ARMCO (Corrugated steel pipes)
- Arch culverts
- Box culverts

Standard Costs

The Table below shows the Standard costs for different culvert installations with 6 Culvert rings per line and with head and wing walls. Labour cost for culvert installation being 25 % of the Total materials cost and average transport costs may also be included. All access culverts shall have 7-8 culverts to enable long trucks to negotiate safely for all installations for projects implemented from season B 2020. 8 lines

Summary cost of culvert Installation			
No. of lines	**Diameter of rings (mm)**	**Un encased**	**Encased**
1	600	5,323,250	6,707,560
2	600	8,239,750	12,937,225
3	600	11,507,375	15,505,200
1	900	7,128,625	10,032,950
2	900	11,095,645	18,334,250
3	900	15,895,370	26,170,925

The engineers will determine whether the culverts should be encased or not depending anticipated traffic loads and conditions of soil. In most parts of refugee settlements where there is heavy traffic and in rift valley belts where the soils are weak will require the culverts to be encased with concrete.

Standard BOQs for Installation of various sizes of culverts (One trip = 3.0m3)

A	**600mm Single Line**			**NURI**	
no.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	600mm culvert pieces	No	6	180,000	1,080,000
2	Cements	Bags	10	33,000	330,000
3	Hardcore	Trip	1	50,000	50,000
4	Fine aggregates	Trip	1	45,000	45,000
5	Coarse aggregates (Black)	Trip	1	250,000	250,000
6	Marram	Trip	15	40,000	600,000
7	Sawn form work 300x25x4m	Pcs	4	25,000	100,000
8	Water (20 litre jerrican)	Litres	20	500	10,000
	Sub-Total				**2,465,000**
9	Labour			25%	616,250
10	Transportation				1,900,000
	Total				4,981,250
	Add 18% VAT				342,000
	GRAND TOTAL				**5,323,250**

B	**900mm Single line**			**NURI**	
no.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	900mm culvert pieces	No	6	250,000	1,500,000
2	Cements	Bags	15	33,000	495,000
3	Hardcore	Trip	2	50,000	100,000
4	Fine aggregates	Trip	2	45,000	90,000
5	Coarse aggregates (Black)	Trip	1	250,000	250,000
6	Marram	Trip	20	40,000	800,000
7	Sawn form work 300x25x4m	pcs	4	25,000	100,000
8	Water (20 litre jerrican)	Litres	25	500	12,500
	Sub total				**3,347,500**
9	Labour			25%	836,875
10	Transportation				2,600,000
	Total				6,784,375
	Add 18% VAT				602,550
	GRAND TOTAL				**7,386,925**

C	600mm Two lines			NURI	
No.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	600mm Culvert pieces	Pieces	12	180,000	2,160,000
2	Cements	Bags	16	33,000	528,000
3	Hardcore	Trips	2	50,000	100,000
4	Fine Aggregates	Trips	2	45,000	90,000
5	Coarse Aggregates	Trips	1	250,000	250,000
6	Marram	Trips	20	40,000	800,000
7	Sawn form work 300x25x4m	Pcs	4	25,000	100,000
8	Water (20 litre jerrican)	Litres	30	500	15,000
	Sub-Total				**4,043,000**
9	Labour			25%	1,010,750
10	Transportation				2,700,000
	Sub Total				**7,753,750**
	Add 18% VAT				486,000
	GRAND TOTAL				**8,239,750**

D	900mm Two line			NURI	
No.	Item description	Unit	Qty	Unit price	Amount
1	900mm Culvert pieces	Pieces	12	250,000	3,000,000
2	Cements	Bags	18	33,000	594,000
3	Hardcore	Trips	3	50,000	150,000
4	Fine Aggregates	Trips	2	45,000	90,000
5	Coarse Aggregates	Trips	2	250,000	500,000
6	Marram	Trips	25	40,000	1,000,000
7	Sawn form work 300x25x4m	Pcs	4	25,000	100,000
8	Water (20 litre jerrican)	Litres	35	500	17,500
	Sub-Total				5,451,500
9	Labour			25%	1,362,875
10	Transportation				3,300,000
	Sub Total				10,114,375
	Add 18% VAT				981,270
	GRAND TOTAL				**11,095,645**

E	600mm Three lines			NURI	
No.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	600mm Culvert pieces	Pieces	18	180,000	3,240,000
2	Cements	Bags	20	33,000	660,000
3	Hardcore	Trips	4	50,000	200,000
4	Fine Aggregates	Trips	2	45,000	90,000
5	Coarse Aggregates	Trips	2	250,000	500,000
6	Marram	Trips	25	40,000	1,000,000

7	Sawn form work 300x25x4m	Pcs	4	25,000	100,000
8	Water (20 litre jerrican)	Litres	35	500	17,500
	Sub-Total				**5,807,500**
9	Labour			25%	1,451,875
10	Transportation				3,600,000
	Sub Total				**10,859,375**
	Add 18% VAT				648,000
	GRAND TOTAL				**11,507,375**

F	**900mm Three lines**			**NURI**	
No.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	900mm Culvert pieces	Pieces	18	250,000	4,500,000
2	Cements	Bags	23	33,000	759,000
3	Hardcore	Trips	6	50,000	300,000
4	Fine Aggregates (River sand)	Trips	4	45,000	180,000
5	Coarse Aggregates	Trips	2	250,000	500,000
6	Marram	Trips	35	40,000	1,400,000
7	Sawn form work 300x25x4m	Pcs	4	25,000	100,000
8	Water (20 litre jerrican)	Litres	40	500	20,000
	Sub-Total				7,759,000
9	Labour			25%	1,939,750
10	Transportation				4,800,000
	Sub Total				**14,498,750**
	Add 18% VAT				1,396,620
	GRAND TOTAL				**15,895,370**

Standard BOQs for Installation of various sizes of culverts (One trip minimum = 3.0m3)

A	**600mm Single Line Encased**			**NURI**	
no.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	600mm diam.X 1.0m long Concrete culvert pipe rings 80mm thick and manufactured with Concrete C25 and BRCA142 mesh	No	6	180,000	1,080,000
2	Portland Pozzolana Cement in packs of 50kg net weight	Bags	16	33,000	528,000
3	Hardcore of igneous stones in 3 Cubic metre	Trip	1	50,000	50,000
4	Fine aggregates (lake/river sand) in 3 cubic metre	Trip	2	45,000	90,000
5	Coarse aggregates (Black igneous stones) in a 3 cubic metre trip	Trip	1	250,000	250,000
6	Marram	Trip	20	40,000	800,000
7	Sawn form work 300x25x4m	Pcs	16	25,000	400,000
8	Sawn form work 100x50x4m	Pcs	2	9,000	18,000
9	Assorted wire nails	Kg	8	7,000	56,000
10	Water (20 litre jerrican)	Litres	40	500	20,000

	Sub-Total 1				**3,292,000**
	Add 25% labour				823,000
	Transportation				2,000,000
	Sub Total 2				**6,115,000**
	Add 18% VAT				592,560
	GRAND TOTAL				**6,707,560**

B	**600mm Two Lines Encased**			NURI	
no.	**Item description**	**Unit**	Qty	Unit price	Amount
1	600mm diam.X 1.0m long Concrete culvert pipe rings 80mm thick and manufactured with Concrete C25 and BRCA142 mesh	No	12	180,000	2,160,000
2	Portland Pozzolana Cement in packs of 50kg net weight	Bags	45	33,000	1,485,000
3	Hardcore of igneous stones in 3 Cubic metre trip	Trip	2	50,000	100,000
4	Fine aggregates (lake/river sand) in 3 cubic metre trip	Trip	4	45,000	180,000
5	Coarse aggregates (Black igneous stones) in a 3 cubic metre trip	Trip	2	250,000	500,000
6	Marram	Trip	25	40,000	1,000,000
7	Sawn form work 300x25x4m	Pcs	20	25,000	500,000
8	Sawn form work 100x50x4m	Pcs	4	9,000	36,000
9	Assorted wire nails	Kg	10	7,000	70,000
10	Water (20 litre jerrican)	Litres	40	500	20,000
	Sub-Total 1				**6,051,000**
	Add 25% labour				1,512,750
	Transportation				3,400,000
	Sub Total 2				**10,963,750**
	Add 18% VAT				1,973,475
	GRAND TOTAL				**12,937,225**

C	**600mm Triple Line Encased**			**NURI**	
no.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	600mm diam.X 1.0m long Concrete culvert pipe rings 80mm thick and manufactured with Concrete C25 and BRCA142 mesh	No	18	180,000	3,240,000
2	Portland Pozzolana Cement in packs of 50kg net weight	Bags	58	33,000	1,914,000
3	Hardcore of igneous stones in 3 Cubic metre trip	Trip	2	50,000	100,000
4	Fine aggregates (lake/river sand) in 3 cubic metre trip	Trip	4	45,000	180,000

5	Coarse aggregates (Black igneous stones) in a 3 cubic metre trip	Trip	2	250,000	500,000
6	Marram	Trip	30	40,000	1,200,000
7	Sawn form work 300x25x4m	Pcs	20	25,000	500,000
8	Sawn form work 100x50x4m	Pcs	6	9,000	54,000
9	Assorted wire nails	Kg	12	7,000	84,000
10	Water (20 litre jerrican)	Litres	40	500	20,000
	Sub-Total 1				**7,792,000**
	Add 25% labour				1,948,000
	Transportation				3,400,000
	Sub Total 2				**13,140,000**
	Add 18% VAT				2,365,200
	GRAND TOTAL				**15,505,200**

A	**900mm Single Line Encased**			**NURI**	
no.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	600mm diam.X 1.0m long Concrete culvert pipe rings 80mm thick and manufactured with Concrete C25 and BRCA142 mesh	No	6	250,000	1,500,000
2	Portland Pozzolana Cement in packs of 50kg net weight	Bags	27	33,000	891,000
3	Hardcore of igneous stones in 3 Cubic metre trip	Trip	2	50,000	100,000
4	Fine aggregates (lake/river sand) in 3 cubic metre trip	Trip	3	45,000	135,000
5	Coarse aggregates (Black igneous stones) in a 3 cubic metre trip	Trip	2	250,000	500,000
6	Marram	Trip	25	40,000	1,000,000
7	Sawn form work 300x25x4m	Pcs	12	25,000	300,000
8	Sawn form work 100x50x4m	Pcs	4	9,000	36,000
9	Assorted wire nails	Kg	10	7,000	70,000
10	Water (20 litre jerrican)	Litres	60	500	30,000
	Sub-Total 1				**4,562,000**
	Add 25% labour				1,140,500
	Transportation				2,800,000
	Sub Total 2				**8,502,500**
	Add 18% VAT				1,530,450
	GRAND TOTAL				**10,032,950**

A	**900mm Double Line Encased**			**NURI**	
no.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**

1	600mm diam. X 1.0m long Concrete culvert pipe rings 80mm thick and manufactured with Concrete C25 and BRCA142 mesh	No	12	250,000	3,000,000
2	Portland Pozzolana Cement in packs of 50kg net weight	Bags	73	33,000	2,409,000
3	Hardcore of igneous stones in 3 Cubic metre trip	Trip	5	50,000	250,000
4	Fine aggregates (lake/river sand) in 3 cubic metre trip	Trip	6	45,000	270,000
5	Coarse aggregates (Black igneous stones) in a 3 cubic metre trip	Trip	7	250,000	1,750,000
6	Marram	Trip	30	40,000	1,200,000
7	Sawn form work 300x25x4m	Pcs	16	25,000	400,000
8	Sawn form work 100x50x4m	Pcs	6	9,000	54,000
9	Assorted wire nails	Kg	11	7,000	77,000
10	Water (20 litre jerrican)	Litres	120	500	60,000
	Sub-Total 1				**9,470,000**
	Add 25% labour				2,367,500
	Transportation				3,700,000
	Sub Total 2				**15,537,500**
	Add 18% VAT				2,796,750
	GRAND TOTAL				**18,334,250**

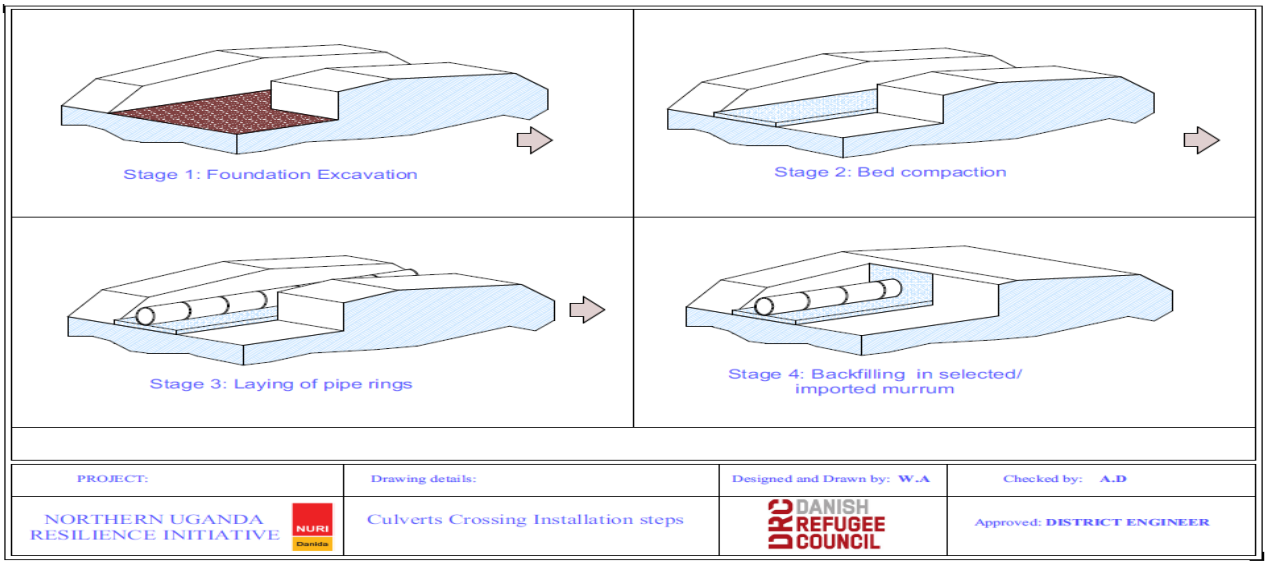
A	**900mm Triple Line Encased**			**NURI**	
no.	**Item description**	**Unit**	**Qty**	**Unit price**	**Amount**
1	600mm diam.X 1.0m long Concrete culvert pipe rings 80mm thick and manufactured with Concrete C25 and BRCA142 mesh	No	18	250,000	4,500,000
2	Portland Pozzolana Cement in packs of 50kg net weight	Bags	95	33,000	3,135,000
3	Hardcore of igneous stones in 3 Cubic metre trip	Trip	8	50,000	400,000
4	Fine aggregates (lake/river sand) in 3 cubic metre trip	Trip	7	45,000	315,000
5	Coarse aggregates (Black igneous stones) in a 3 cubic metre trip	Trip	9	250,000	2,250,000
6	Marram	Trip	40	40,000	1,600,000
7	Sawn form work 300x25x4m	Pcs	20	25,000	500,000
8	Sawn form work 100x50x4m	Pcs	8	9,000	72,000
9	Assorted wire nails	Kg	13	7,000	91,000
10	Water (20 litre jerrican)	Litres	160	500	80,000
	Sub-Total 1				**12,943,000**
	Add 25% labour				3,235,750
	Transportation				6,000,000
	Sub Total 2				**22,178,750**
	Add 18% VAT				3,992,175
	GRAND TOTAL				**26,170,925**

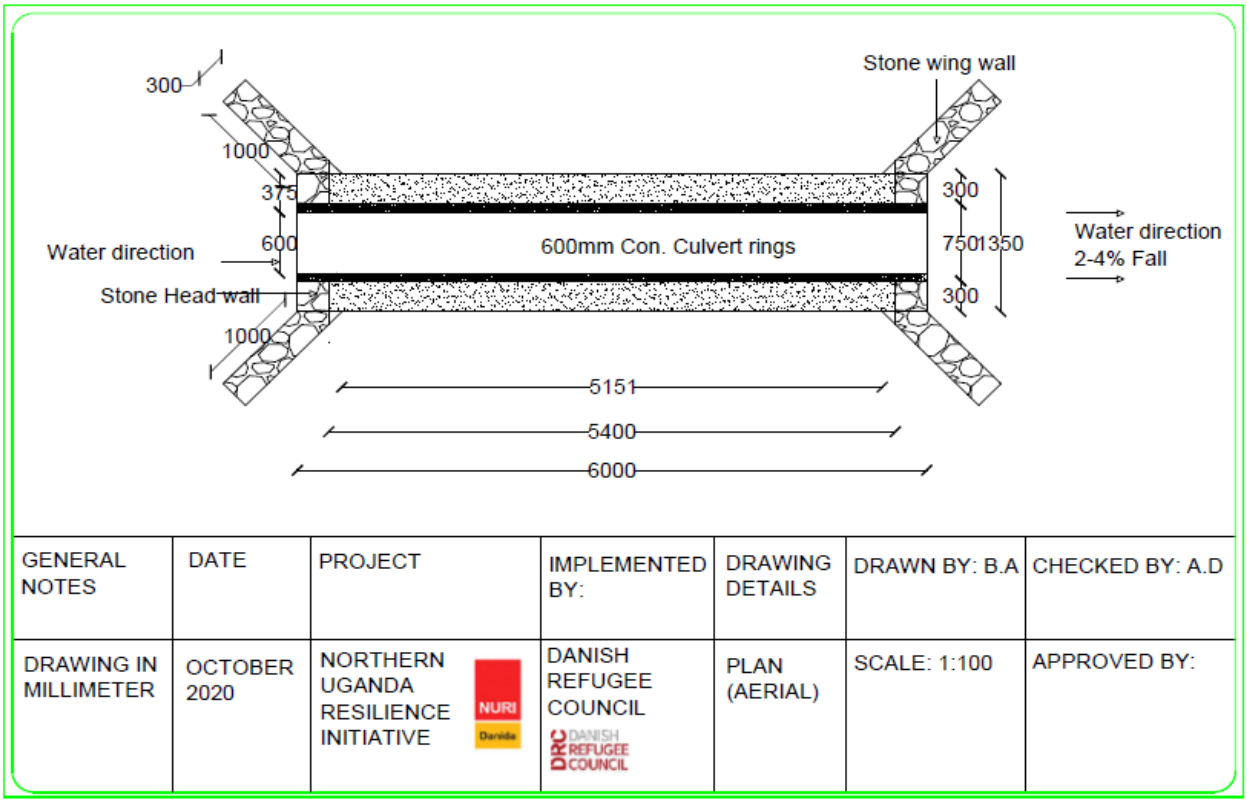
Standard designs

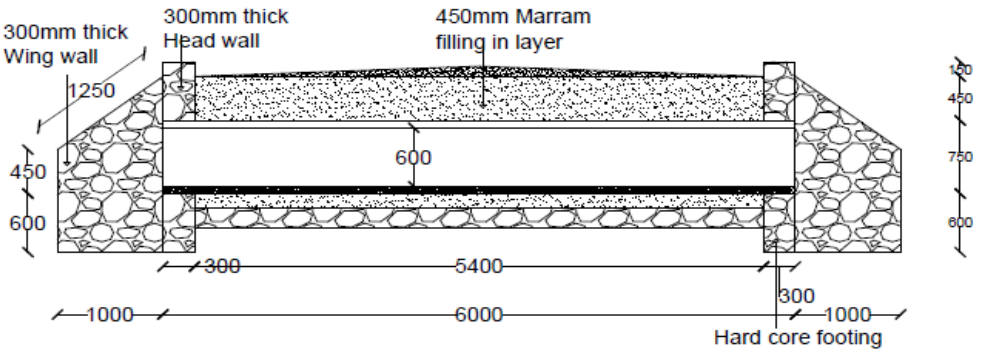
Design drawings showing Apron, Plan, Wing walls, Front are available for each of the following culvert types 1 line, 600 mm, 2 lines, 600 mm, 3 lines, 600 mm, 1 line, 900 mm, 2 lines, 900 mm and 3 lines, 900 mm

Relief structures.

Drop Inlets shall be constructed for relief culverts as described in District Road Works Manuals, Vol. 4B, and Standard Design Manual.







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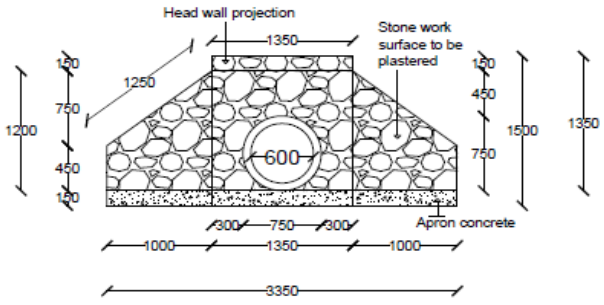

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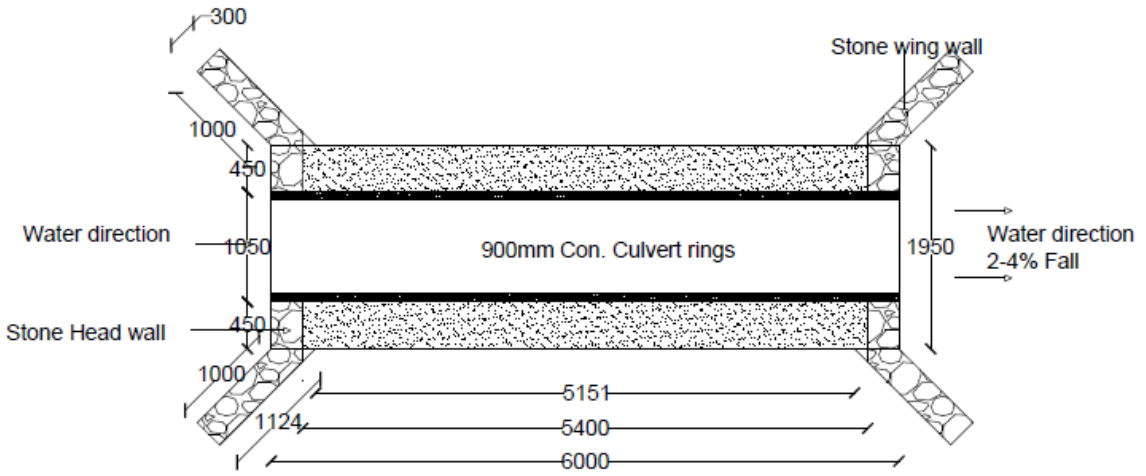

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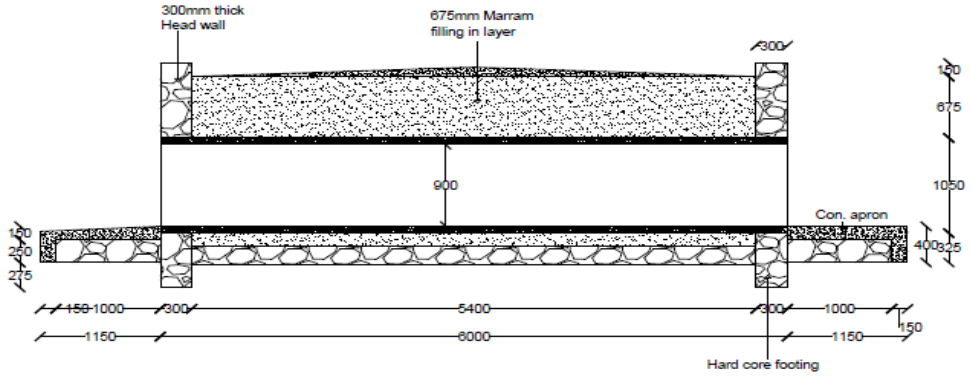

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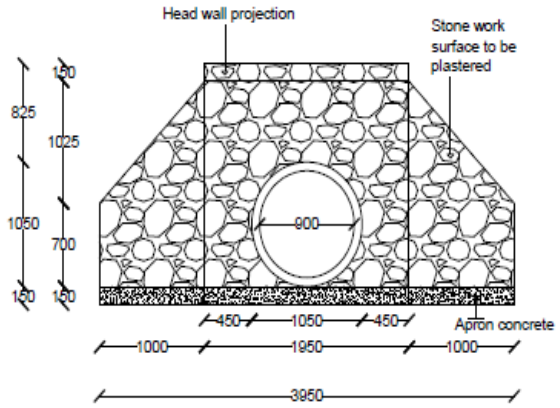

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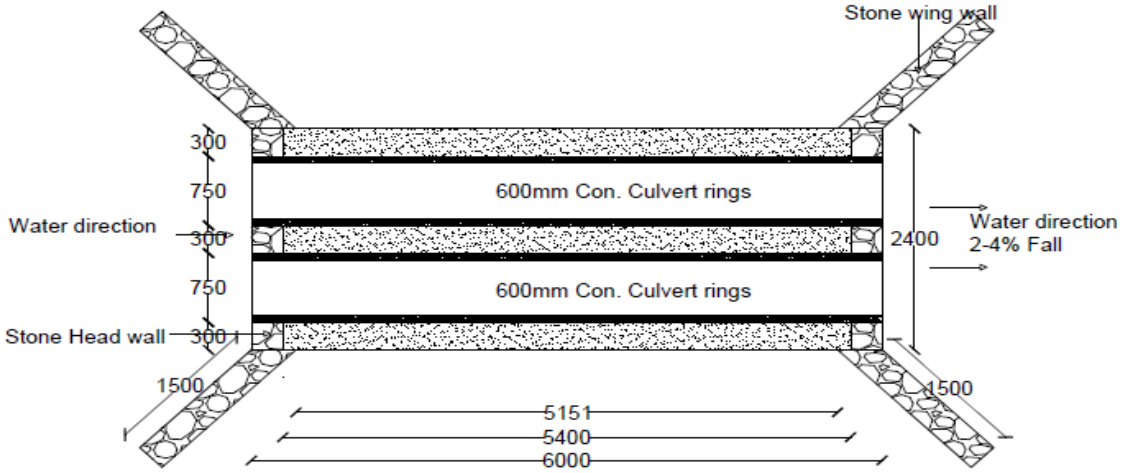

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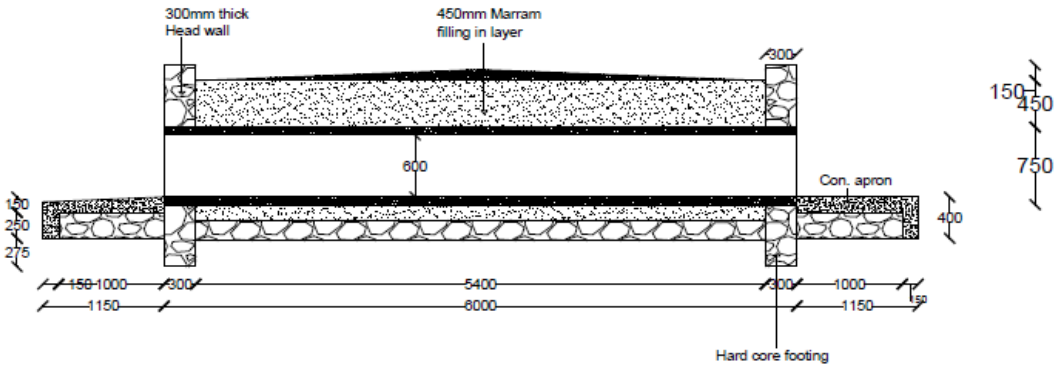

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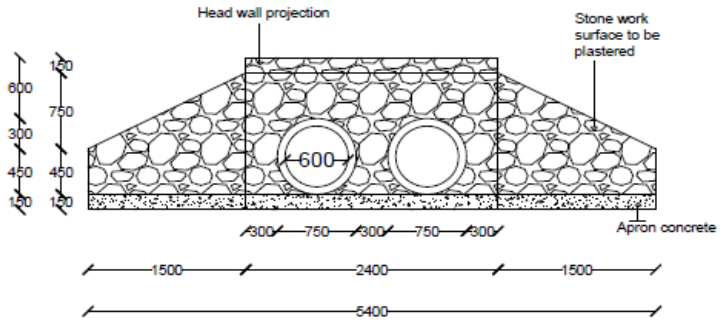

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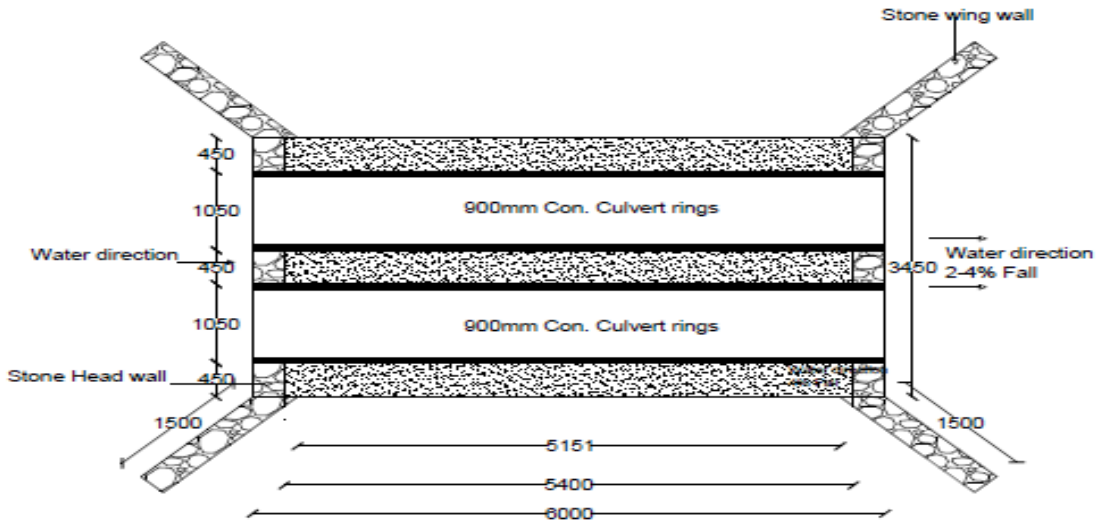

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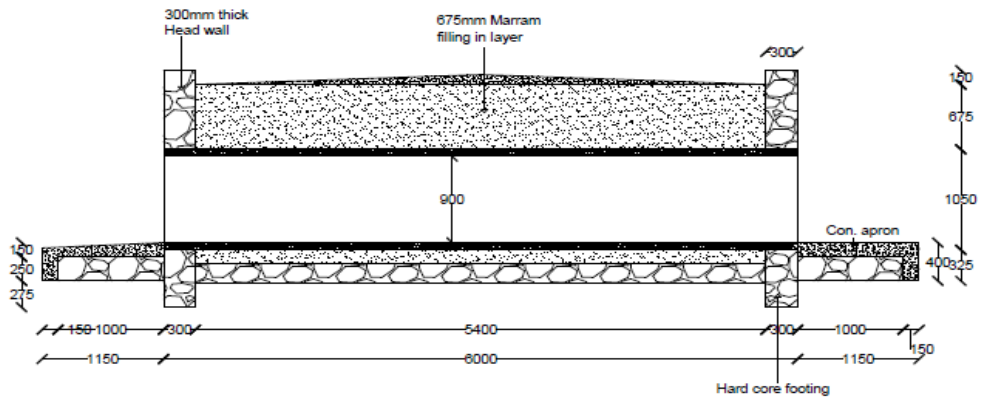

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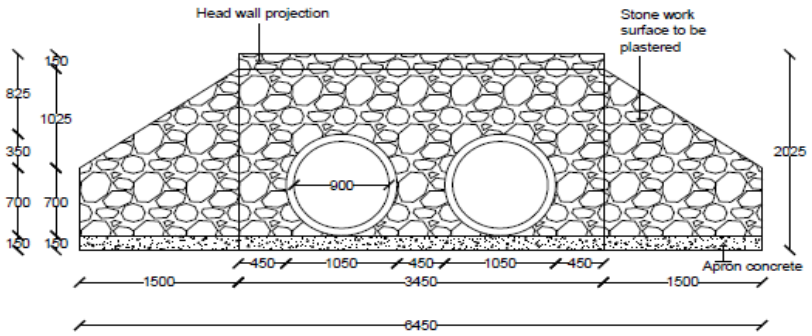

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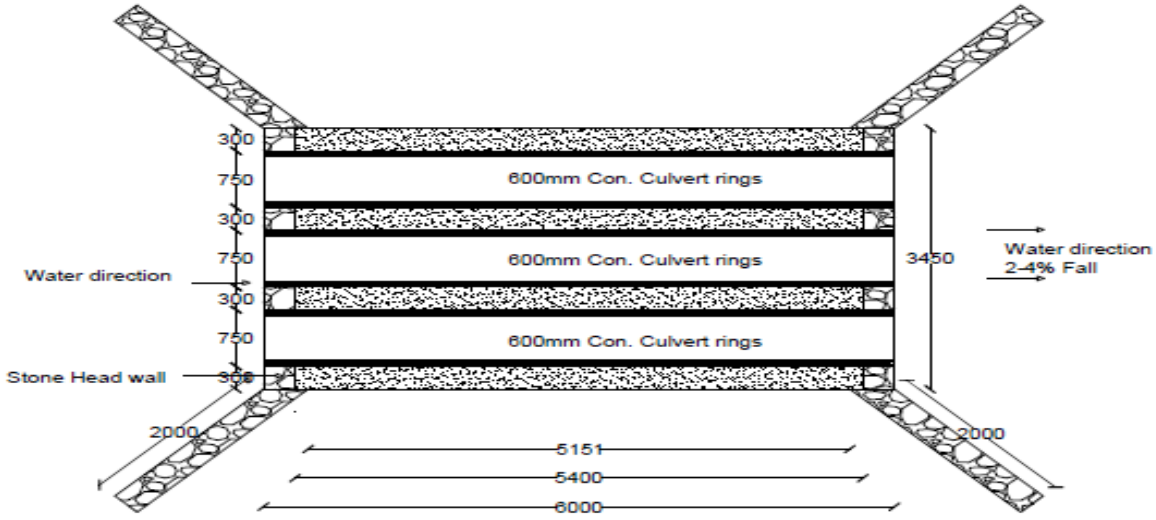

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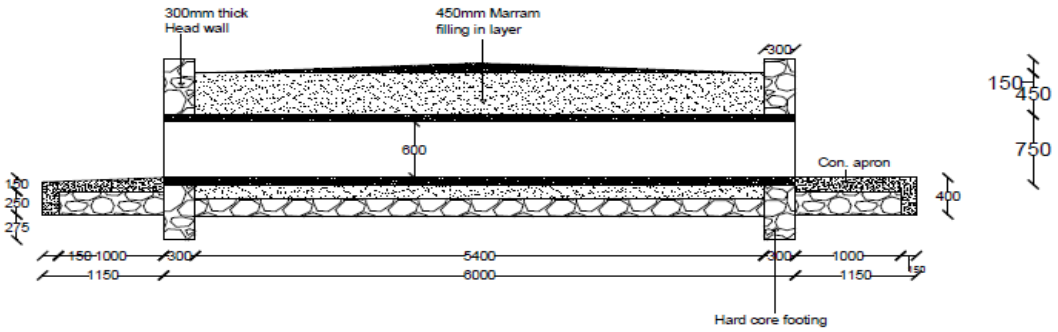

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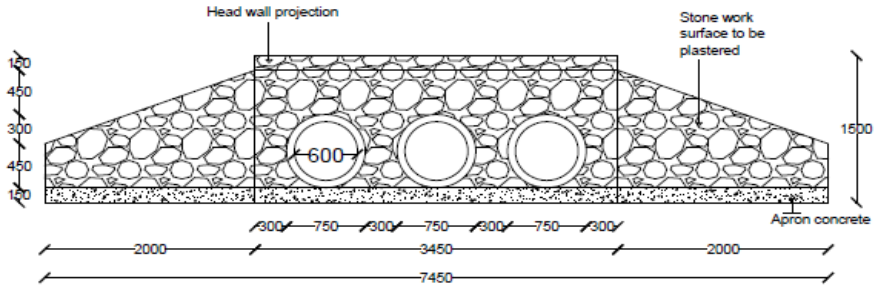

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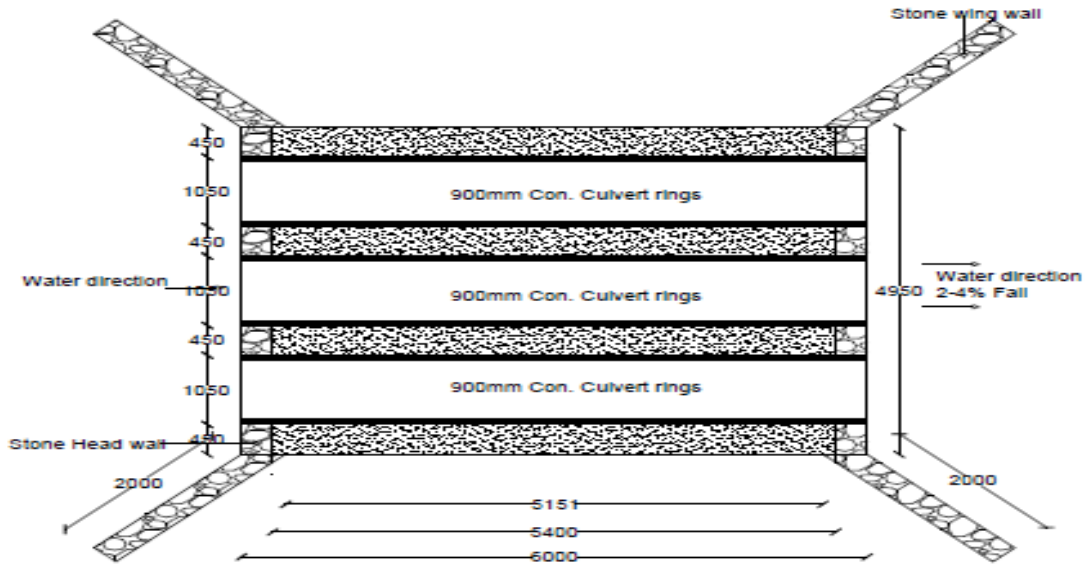

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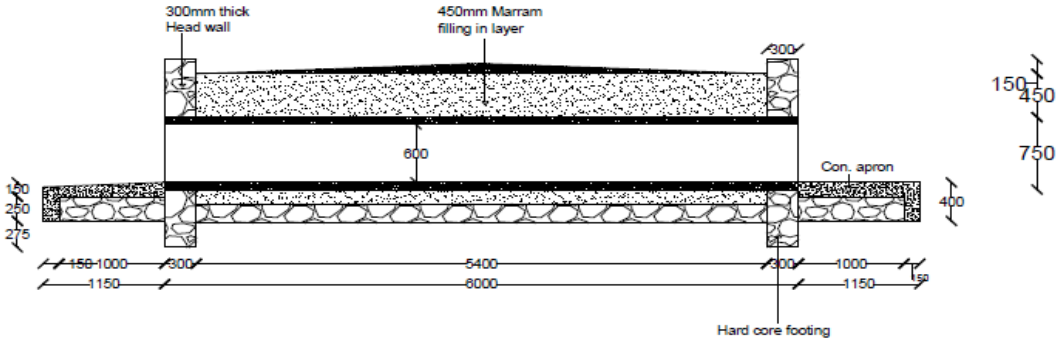

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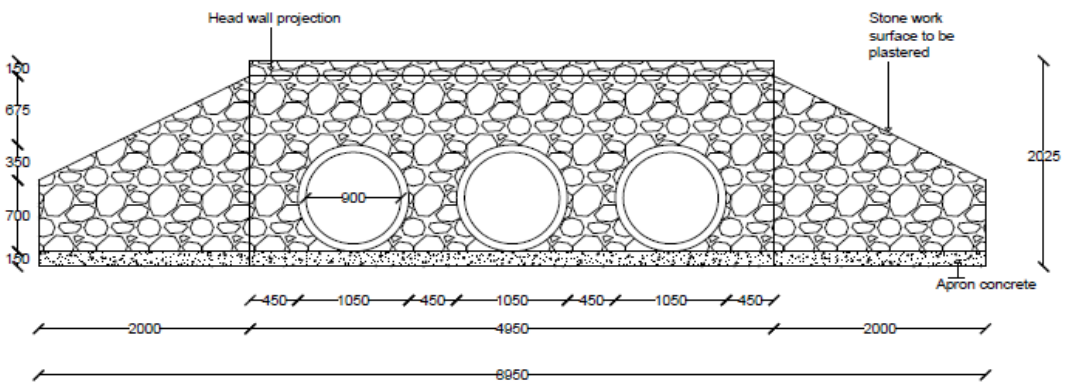

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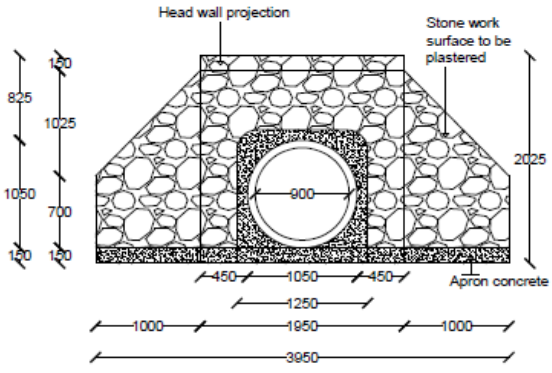

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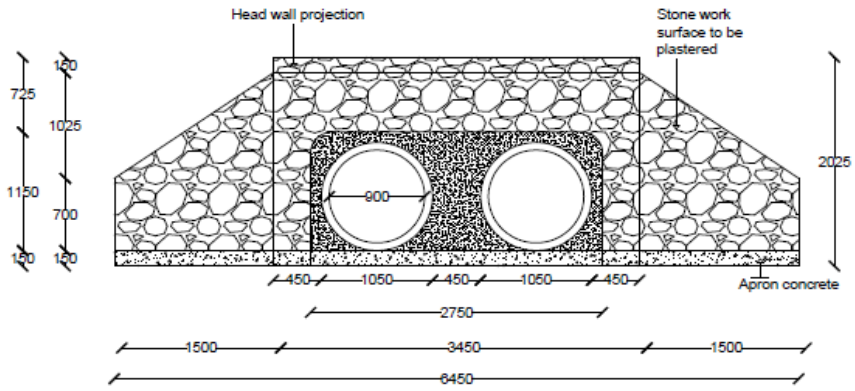

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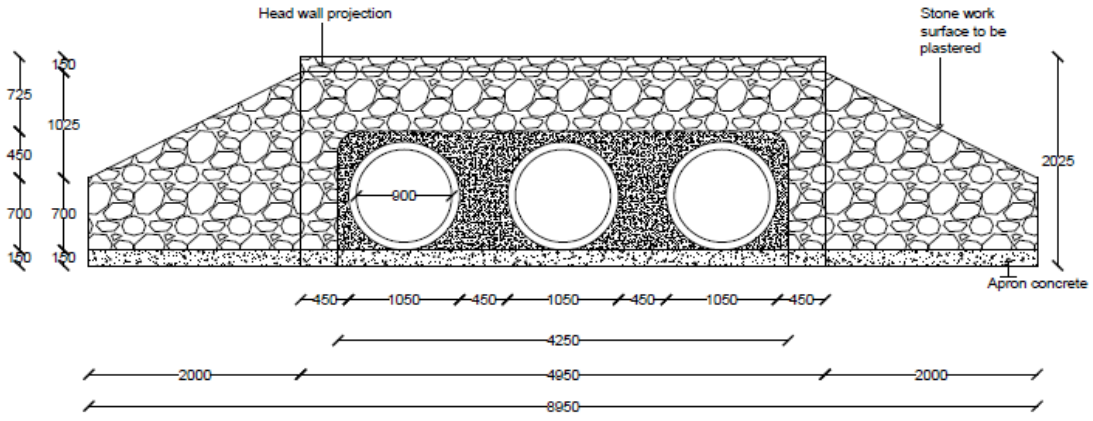

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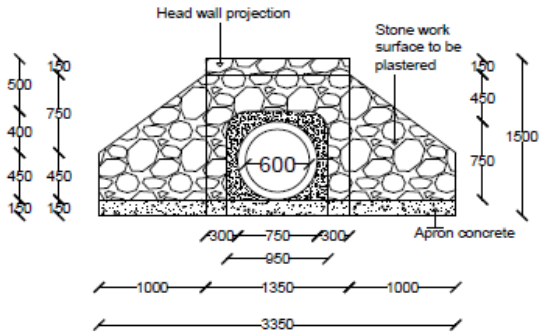

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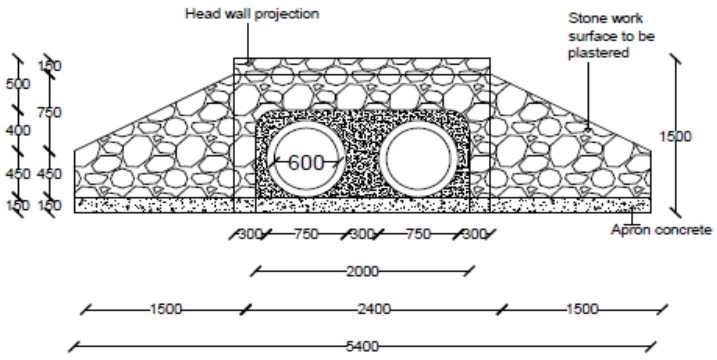

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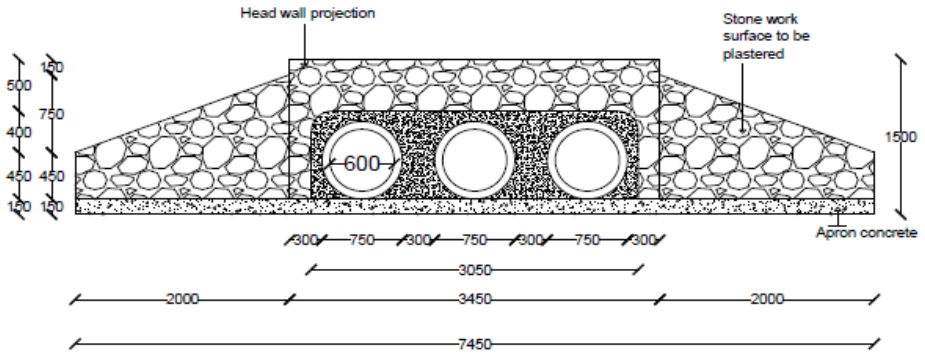

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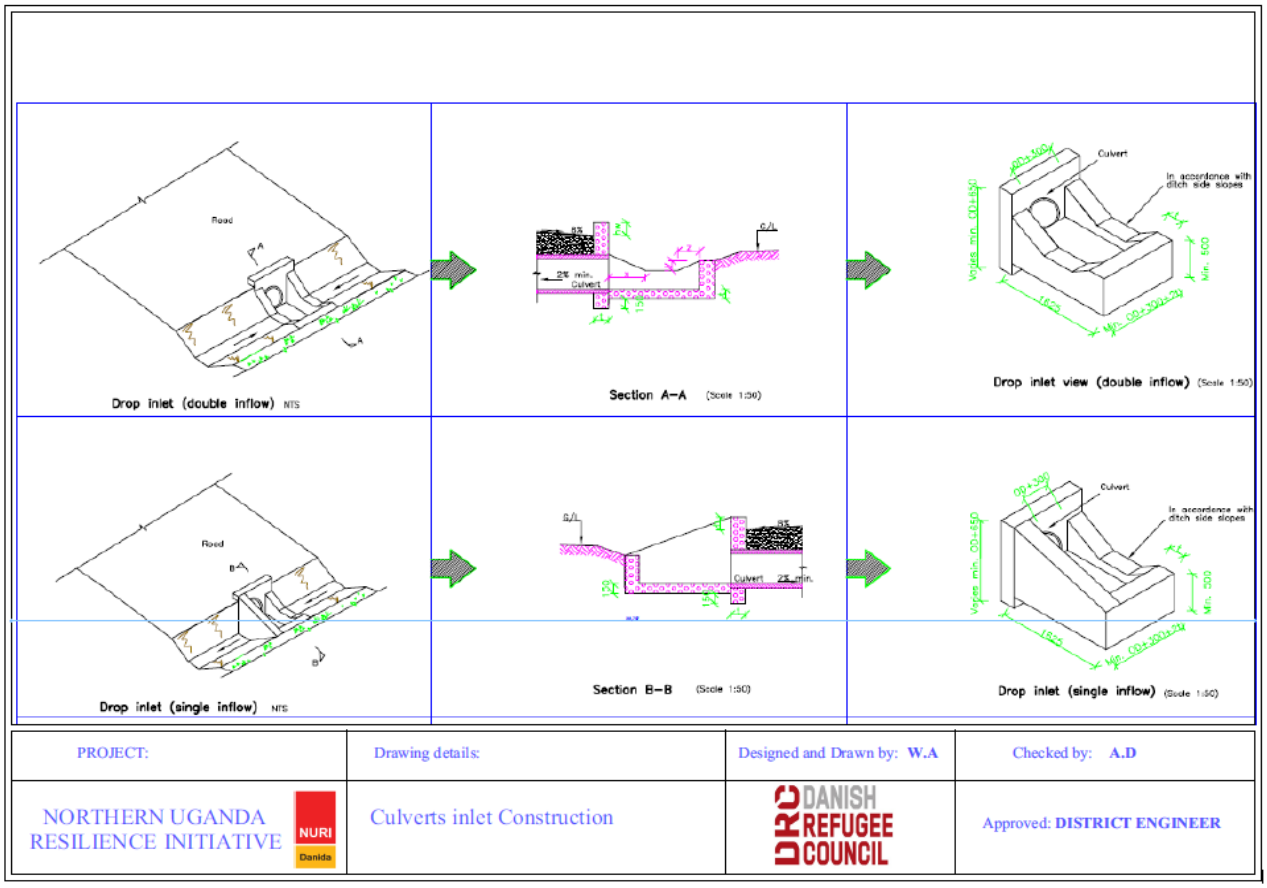
Table for Head and Wing Wall Thicknesses					
S/N	Culvert Dia (mm)	Excavation width, B (mm)	Concrete End Structures	Concrete Block End Structures	Stone masonary Block End Structures
1	600	2,900	200	230	300
2	900	3,200	200	230	300
3	1,000	3,300	200	230	300
4	1,200	3,500	200	230	300
5	1,500	3,800	200	230	300

Table for Earthworks for various Culverts sizes						
S/N	Culvert Dia O.D (mm)	Excavation width, B (mm)	Excavation depth, D (mm)	Spacing btn multiple culverts (mm)	Minimum fill cover; H (mm)	Bedding Material
1	600	O.D+600	Varies	300	400	Gravel or Class 1 concrete
2	900	O.D+600	Varies	450	500	Gravel or Class 1 concrete
3	1000	O.D+600	Varies	600	600	Gravel or Class 1 concrete
4	1200	O.D+600	Varies	600	700	Gravel or Class 1 concrete
5	1500	O.D+600	Varies	600	800	Gravel or Class 1 concrete



The drawings can be obtained from DRC's Country Office in pdf format.

The drawings given above are for Drop Inlets which are culvert end structures meant for Relief culverts. Drop Inlet structures enhance the performance of relief culverts by trapping and directing excessive amount of water running in the side drains into the culvert for safe disposal to avoid scouring of side drains/road pavement.

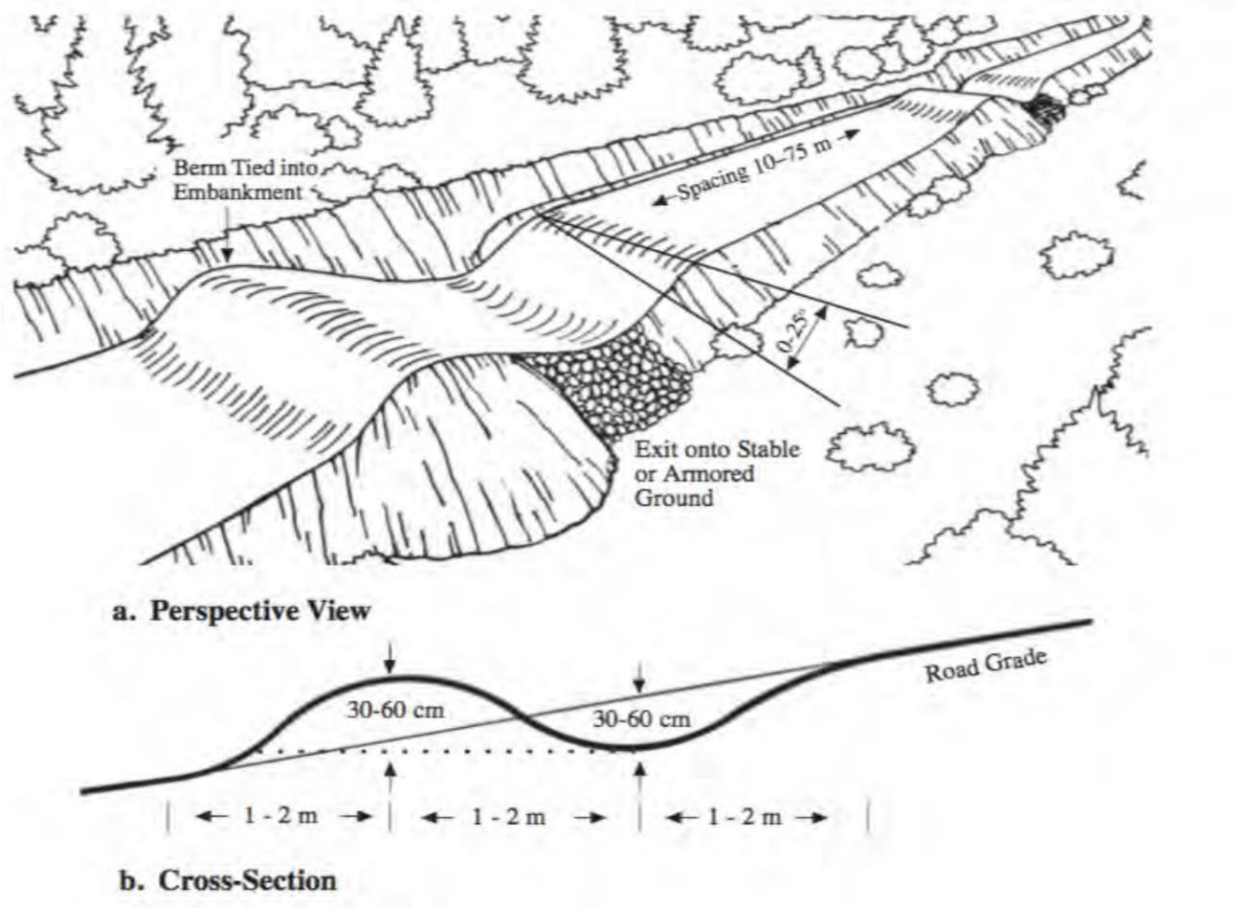
We have mostly been constructing culvert inlets with ordinary wing walls at 45^0 on relief culverts which do not trap, collect and direct well the running water from the side drains into the relief culverts for proper disposal hence these culverts have not been functioning effectively as intended.

Further to that, in rolling and mountainous terrain, where culvert installation depths are more, the inlets need to be protected to avoid scouring and premature failure of the culvert line.

Drop Inlets should therefore be adopted for Relief culvert structures for better performance.

The drawings can be obtained from DRC's Country Office in pdf format.

In some stretches along the road, rolling dip/ water bars may be employed to cater for unforeseen extra needs for culverts. This is a type of gentle bump, constructed diagonally across the road. Aimed to direct water from one side of the road to the other, similar to a cross-culvert but cheaper. Its design and the diagrammatic view is shown below:



Care must be taken on the placing and frequency determination of the culverts. This is because often people living near the road are very weary when a culvert is to be constructed with an outlet to their farmland, they fear erosion of their land. Since culverts are expensive and therefore their frequency is reduced, and they are concentrated in few sites which increases the amount of water collected through these culverts and diverted to roadside farmers'' farmlands. It is recommended to opt for smaller culverts and increase their frequency as a first step and thereby put structures in place upstream which buffer the water flow, and downstream which spread the water over a wider area.

Elements of Resilience Design Approach in Culvert Installations

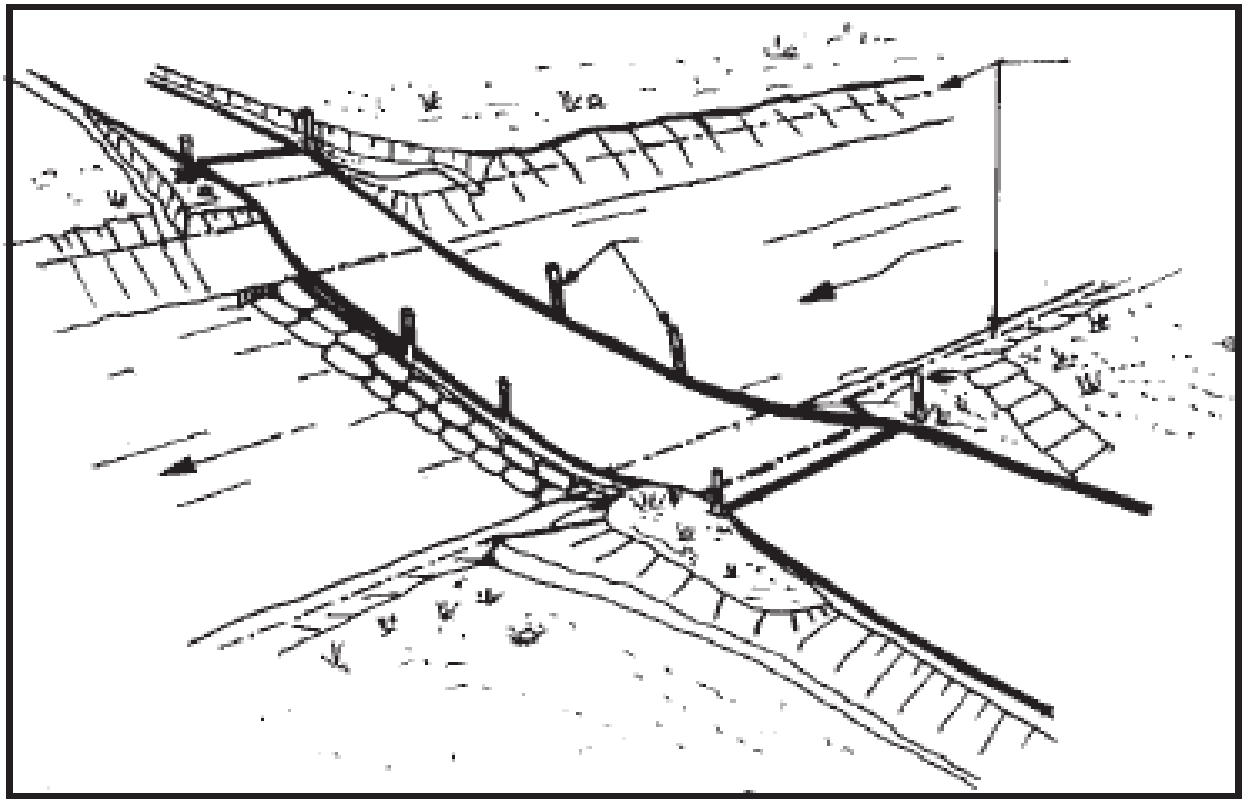
1. Vegetating around the culvert masonry and leading into it with ground spreading type plants, will help to prevent erosion around the structure and will help deter other plants that could potentially block the flows of water and cause more damage or for the system not to function properly.
2. Using bio swales or shallow drains (2-3% grade to move the water away from the road) to extend the water out into the landscape to slow, spread and infiltrate it into the ground.
3. Each culvert should have a landscape integration plan that is developed with farmer's/community member's need for water in the area
4. Water from culverts is to be drained out further into the landscape from the road, both for hydrological purposes and to protect the road so that we can also make the best use of the water

5. Utilizing stone and vegetation check dams on the upslope part of the catchment before it enters a culvert, can reduce pressures of water and silt loads before getting to the culvert.
6. Vegetating the side walls with spreading ground covers will help the drains maintain their structure
7. It would be good to mention that where the marram is harvested, if it is well sighted and situated in the landscape, it could potentially become a livestock pond, especially when associated with rainwater catchment from the road and from bio swales
8. Using direct seeding or seed balls encased in clay and compost, can help with post construction dust issues ensuing from wind erosion which creates adverse air quality long after construction is completed. It seems imperative that NURI protects people's health in this way.

10.5 Annex 5: Technical Design - Drift

A drift, also sometimes called a splash, is a low-level structure constructed to allow water from the drains and/or natural water course to safely cross over the road at bed level.

FIGURE 3-A3: DRIFT



Drifts are surface structures, and thus, easy to maintain. The volume of excavation required is minimal and drift efficiency is directly related to drift invert slope and cross-sectional area.

Due to the discomfort of driving over drifts, too many of them will cause significant delays in journey time due to forced slowing down.

Drifts are likely to cause less erosion than culverts from their discharge.

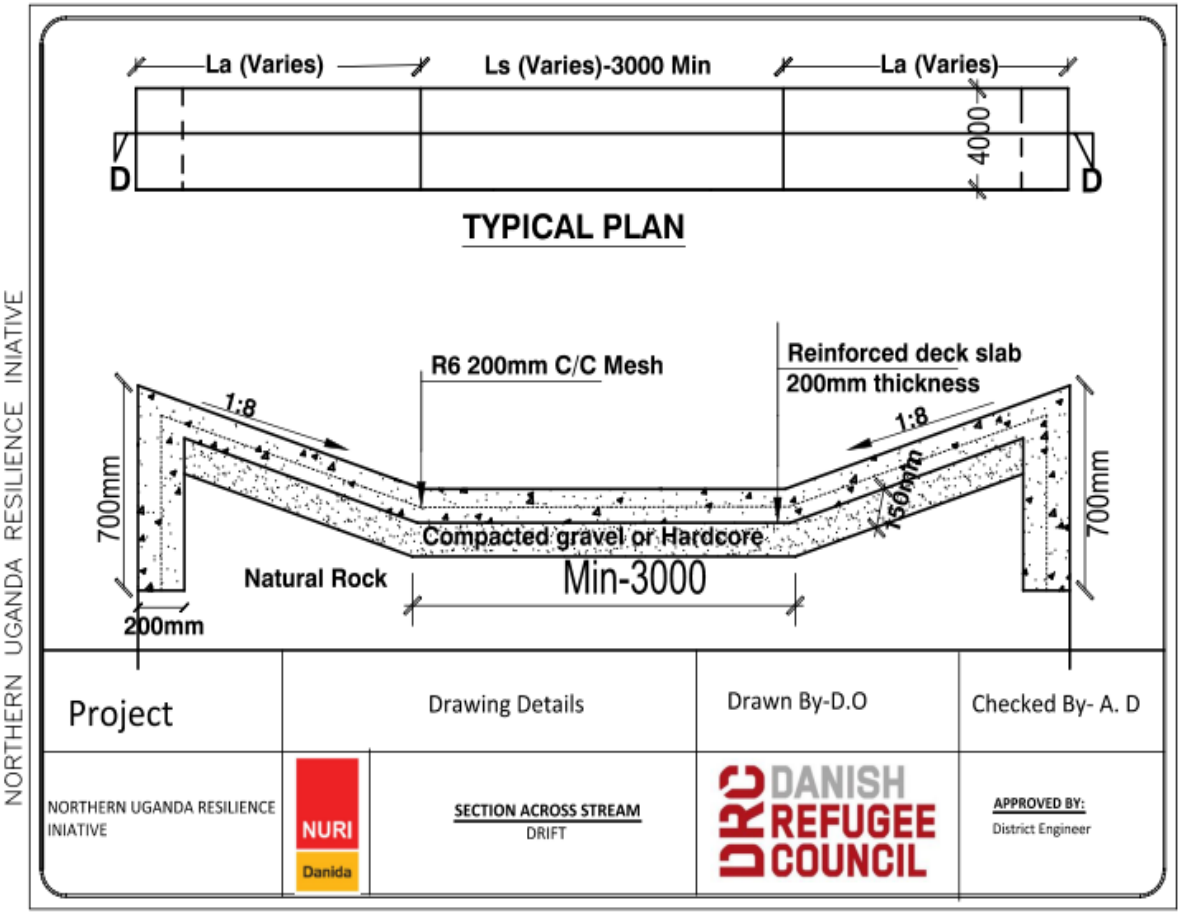
Drifts should be used where the following conditions apply:

- The difference in elevation between the invert of the side drain and/or natural watercourse and the roadway shoulder break point is not greater than 300mm.
- Where the water level is estimated to exceed 200mm, the approaches must be lengthened to accommodate high water level.
- The sub-grade material is rocky and difficult to excavate
- There is evidence that the natural soils of the side drain and/or watercourse are silt and could lead to the rapid blocking of culverts.
- Where discharge occurs into a farmer's field.
- Where the cost of a culvert of similar capacity is significantly higher than the cost of a drift.

Where possible, drifts should be located to simultaneously discharge water from the side drains and allow water in natural watercourses to safely cross over the roadway.

Standard Design and Costs

As drifts have different sizes and designs, standard designs and costs will be based on the size of the drift to be constructed. The standard designs from MoWT will be adopted.



Vented Drift

Vented drifts are constructed in areas of bottle necks where various culvert sizes alone cannot handle the volume of water flow or flooding along a road.

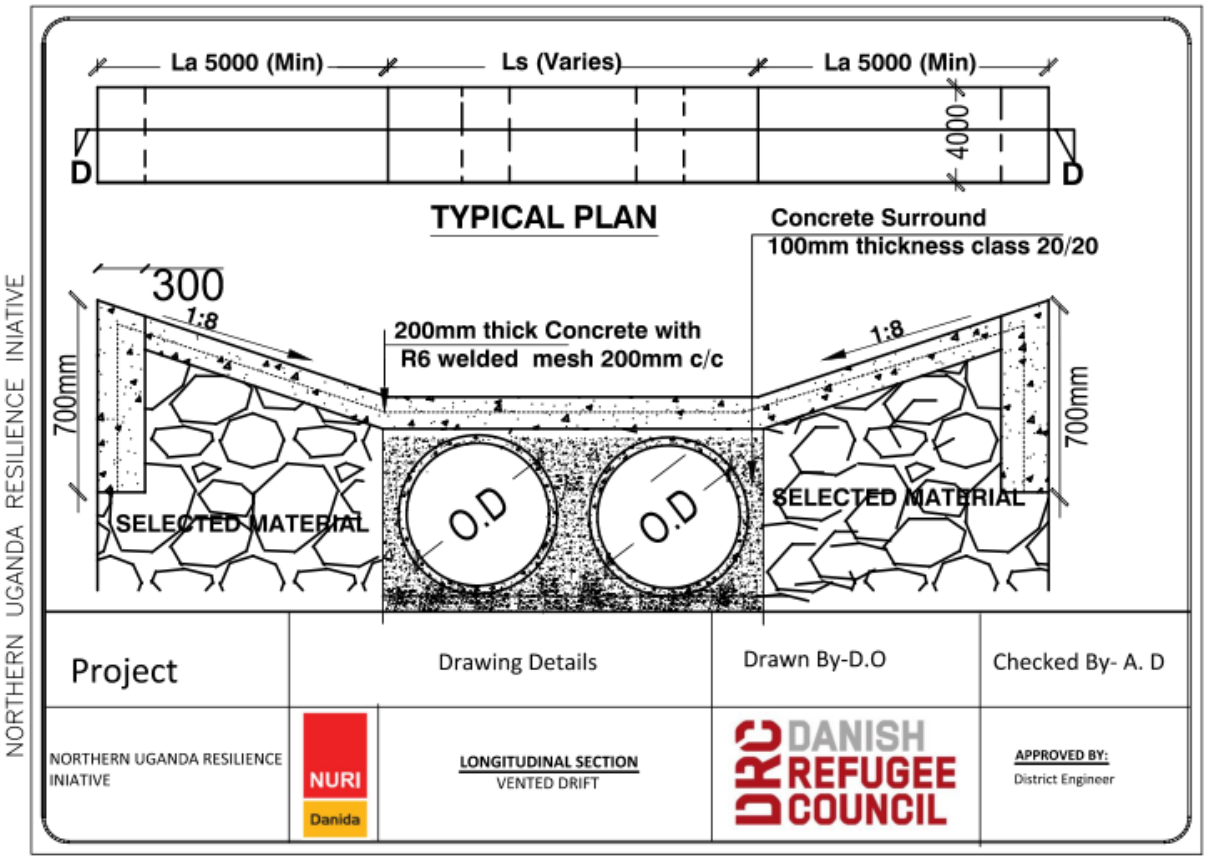
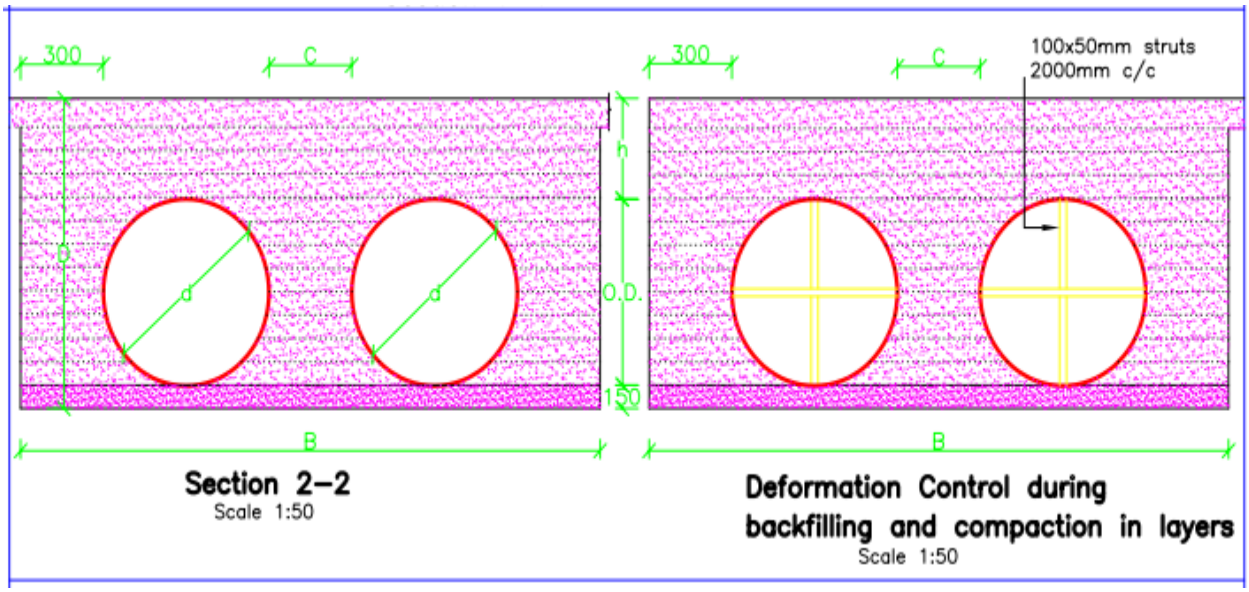


TABLE FOR VARIOUS CULVERT SIZE INSTALLATIONS



S/N	Culvert diameter, d (mm)	Excavation Width, B (m)	Excavation Depth, D (mm)	Space between Culverts, C Min. (mm)	Minimum fill Cover, H (mm)	Carriageway width, W (mm)	Shoulders (mm)	Deformation Control	Bedding Material
1	600	0.6+(nxOD) +0.3(n−1)	Varies	300	300	Varies	Varies	No	Gravel, Sand, or Class lean concrete
2	900	0.6+(nxOD) +0.3(n−1)	Varies	300	450	Varies	Varies	No	Gravel, Sand, or Class lean concrete
3	1000	0.6+(nxOD) +0.3(n−1)	Varies	300	500	Varies	Varies	Yes	Gravel, Sand, or Class lean concrete
4	1200	0.6+(nxOD) +0.3(n−1)	Varies	300	600	Varies	Varies	Yes	Gravel, Sand, or Class lean concrete
5	1500	0.6+(nxOD) +0.3(n−1)	Varies	300	750	Varies	Varies	Yes	Gravel, Sand, or Class lean concrete

n = Number of lines

Table for Various culvert sizes

Drifts will have site specific designs and will be contracted to either the local masons or contractors

10.6 Annex 6: Afforestation/reforestation/ Food forest

Landscape restoration involves processes aimed at regaining ecological functionality of degraded or deforested forest landscapes, while enhancing human well-being. Restoring forest landscapes enhances the provision of ecosystem services, and enhancing water provision services is a common target in forest restoration projects. Under NURI WRM, reforestation and afforestation will constitute a considerably large part of the interventions. This will be done through establishing community forest lots.

1. **Reforestation Systems, Design and Species**

Reforestations and planting areas should be planted with a diversity of species and layers, anchored primarily by indigenous species. Exotic species must be responsible exotics such as common fruit trees, e.t.c. that GR4Wry no threat of invasiveness and ecological harm. Invasive exotic species such as eucalyptus are discouraged to be planted since eucalyptus is ecologically harmful, contributes to soil erosion and chemically precludes growth of other species. Trees such as Grevillea or Pine are more acceptable, but the priority is to identify local options that have the same purpose and ensure proper planting, soil conservation and fertility as well as forest and tree management to boost tree health, growth, and companion planting relationships. Local varieties of bamboo which will not become invasive if introduced in open landscapes should be prioritized as a high value and multi-use plant, especially integrated with grey water systems.

Diversity and Creating 3-Dimensional Agroforestry Systems will be encouraged. Each forestry system (Reforestation) should stack functions to enhance the number of livelihoods opportunities. For example, we can have tall timber trees interplant with fruit trees, then shade loving trees such as coffee beneath, and even climbers such as passion fruits or high value vanilla. The agroforestry systems should major in perennial/permanent plants but can also be interspersed with annual plants including vegetable and grain

crops planted by the groups that are maintaining the food – forest. The species of trees that can be planted in various layers are in Table 10.2 below

Every planting must be provided with a micro water and nutrient harvesting plan as well as a protection plan like a small smile berm or micro-ditch to concentrate water at the plants roots and to have some form of protective caging to ensure they are not grazed upon

Table 10.5 Species of trees that can be planted in various layers

Layer	Examples
Canopy Layer	Ficus (Multi-purpose), Mvule (Fiber), Shear Nut (Multi-purpose), Afzelia Africana-Mahogany (Fiber), Teak – (Fiber including paper pulp), Neem (multi-purpose), Jackfruit (food), Bacamia Ritea, Dates, JaGR4Wanda, Papaya, Tamelina, Acacia, Mizopsis, Mulberry, Tall palms
Fruit trees (Small tree Layer)	Shorter Palms, Bananas/Matoke, Bamboo, Moringa, Oranges, Lemons, Coliandra, Sesbania, Lucaena, Guava, Tree Tomato, Apples, Prosopis
Shrub Layer	Black Berry, Lantana, Pigeon Pea, Jinga, Sisal, Aloe Vera, Hibiscus, Acacia Senegalesis (gums and resins) Cactus
Herbaceous Layer	Cow Peas, Mint, Chillies, Red/Sweet Peppers, Elephant Grass, Poison Ivy, Stinging Nettle, Black Jack, Eggplant, Green Gram, Osobi, Kalabi, Dodo
Soil/groundcover cover layer	Pumpkin, Sweet Potato, Melons, Irish Potatoes, Desmodium, Gourds, Lucerne
Rhizome layer (Tubers, Rhizomes, etc)	Ginger, GR4Wrots, Onions, Tumeric, Sweet potato, Cassava, Yams, Garlic
Vining /climbing layers	Passion Fruit, Gourds, Vanilla, Perennial Beans, Climbing Yams, Climbing Nuts

Biodiversity regeneration is about keeping the landscape woven together through permanent tree species that secure the soils, GR4Wbon and hydrological cycles. In addition to these permanent trees which are not to be cut down, trees from the following categories need be integrated:

1. **Food:** Fruit, seeds, nuts, leaves, oils, berries
2. **Fodder:** Livestock and Pollinators (flowering trees)
3. **Fiber:** Building timbers, weaving timbers, textiles, crafts, roofing materials, paper pulp, biomass, mulch
4. **Fuel (Energy) and shade:** Sustainable charcoal, biogas, fuel wood, biofuel
5. **Fertility:** Nitrogen fixation, soil conditioning, beneficial soil relationships
6. **Pharmaceuticals:** Medicinal properties, healing properties, antibiotic, antiseptic, antifungal, antimicrobial, traditional medicine, pest and disease management in plants.
7. **Wind breaks and Boundary trees**

Standard Layout

Community groups of 30 members will be mobilized to establish and maintain one Reforestation system working for 22 days.

Willing institutions, communities, Registered CBO's, Faith based organizations are to benefit from the reforestation establishments.

Multi-layered seedlings will be planted beginning with a spacing of 2m of with a dominance of support species like nitrogen fixers that will get thinned to create more organic matter to support the higher value

trees that will be planted at 3m spacing or spread out through the 2m spacing net or triangle pattern boomerangs each with half-moon/Smile berms.
If the system is at risk from domestic animals the edges of the reforested area will be fenced with barbed wire (10 lines) and 2 metres between the poles. Mix of dry poles and vegetative fertility plants like Tithonia, nitrogen fixing perennial trees like luecaena, Fiderbia albizia, acacia, etc. will be planted alternately for fencing. Dry poles to be nailed immediately and vegetative poles should be nailed after sprouting and root development.
Where complete fencing is not possible like in the river bank restoration, the option of woven tree protectors will be used.

All Reforestations to be done in the first year of implementation to allow time for maintenance in the remaining years of the project life cycle. Food forest establishment to be done within 6 months and 1.5 Years to be used for maintenance of up to 30 days in the one and half years (20 days per year). The continuation of the maintenance in season 2 and 3 will depend on the condition of the trees planted as advised by the District Forest Office and availability of funds

To ensure sustainability and ownership, the community members /individuals should be engaged right from group formation so that the owners can be trained to maintain the reforestation system. Involvement of education department, school, SMC, pupils, teacher's, PTA (stakeholders) in the group formation should be considered and in schools, teachers who are in charge of agriculture/environment to be part of the group.
The project will plant 3 layers Canopy layers, short trees and shrubs and the beneficiary communities are encouraged to plant the remaining 4 layers.

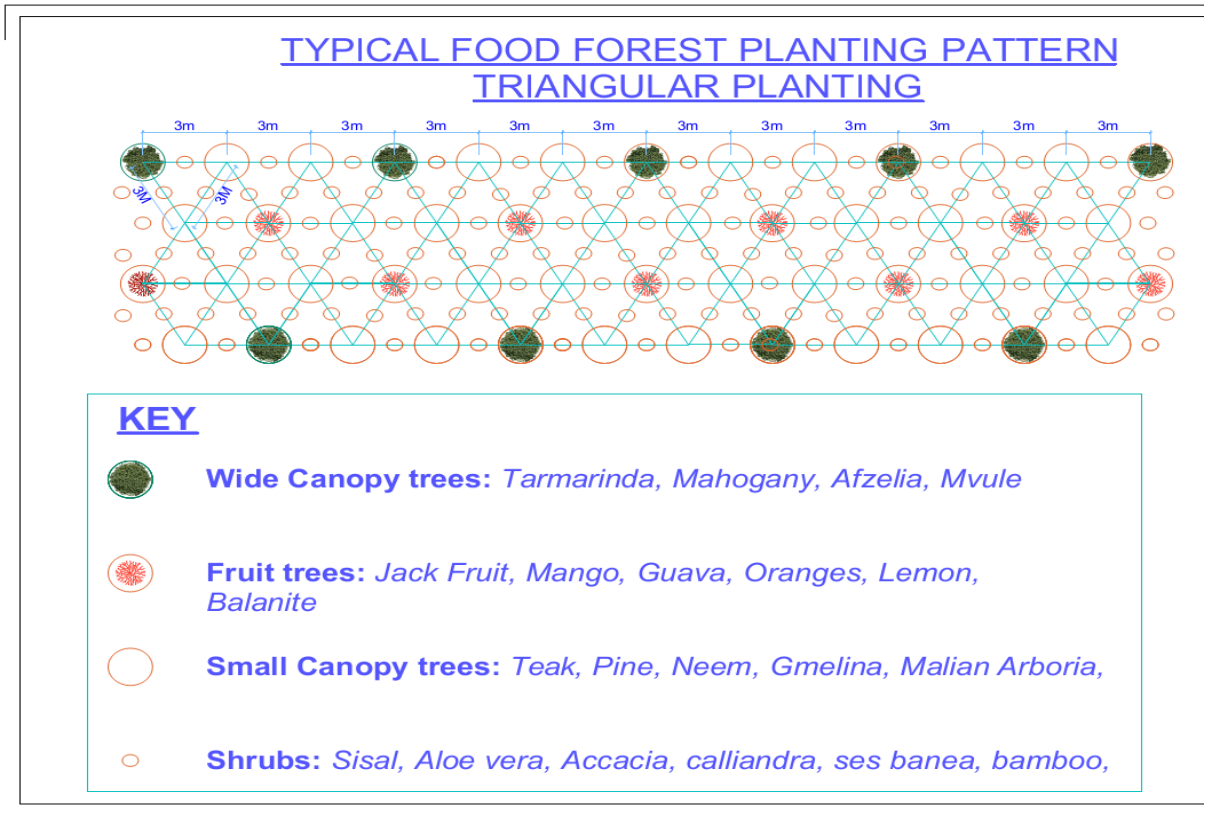


Figure 10:2 Net or triangle pattern boomerangs
Note: There are many species in each group as indicated on Table 10.2

Tasks

Key Guidelines for Tree Planting:

1. No land clearance by chopping trees, shrubs. Animals such as cows, pigs, goats and chickens can be leveraged to "clear" land by eating vegetation, mechanically imprinting the land with their hoof traction, and manure. Chickens in particular can be brought in after the larger livestock in order to eat the maggot larvae breeding in the large livestock manure.
2. Thinning of land- instead of clearing land, vegetation can be heavily thinned with pruning and Farmer Managed Natural Regeneration (FMNR) to do "chop and drop," whereby branches, sticks, twigs and leaves are heavily cut from trees, leaving 2-3 primary trunk/branches. The remaining biomass should be dropped to the ground and chopped in to smaller pieces and left to decompose and naturally build the forest floor and soil health. This will immediately become the food for beneficial insects such as termites who prioritize dried/brown organic matter. Only if there is no dead GR4Wbon/organic matter will termites then turn to eat live plant material.
3. NO pesticides, insecticides, fungicides or herbicides will be used in the Reforestations or otherwise since they are extremely harmful and hazardous poisons. Integrated Pest Management (IPM) and Integrated Disease Management (IDM) methods will be used to resolve plant health issues. A multi strategy nutrient plan including planting of fertility plants, integration of animals and using biofertilizers are a better pathway for long term resilience of the planting system.
4. Each individual tree to be planted using water harvesting structures such as "Smile Berms," on contour for passive water harvesting. Each berm is measured for contour using A Frame, Bunyip Water Level, Laser Level or other. The pattern for planting is in an offset "fish scale" pattern which is also called Net and Pan or Pit and Pan patterning.
5. Tree Spacing will be different based on the aim of the forest. Ensure that nitrogen fixing trees are planted in between every 4-5 trees to naturally feed the soil and surrounding trees.
6. For Food Forest: Minimum spacing, 3 meters between trees.

The planting of a Reforestation system involves the following tasks for the project group:

1. Thinning of land through "chop and drop"- branches, sticks, leaves to be placed on the ground to build soil and soil health and fertility for trees.
2. Marking and pegging
3. Pitting including smile berms
4. Planting with natural inputs including animal manures, charcoal dust, etc.
5. Ring weeding
6. Keeping fire line clear
7. Watering (if needed)
8. Mulching
9. Fencing
10. Placement of protective baskets (woven tree protectors) where need be.

For maintenance of a Reforestation the following tasks are involved:

1. Gap filling
2. Ring weeding
3. Slashing/Chop and Drop of organic matter/biomass for soil building
4. Keeping fire line clean
5. Organic pest and disease control only in extreme cases
6. Watering (if needed)
7. Mulching

Tools

The standard set of tools that will be provided for preparing and planting 2 acres of Reforestation is:

Tool	No.	Price	Total
Measuring tape (100m)	1	45,000	45,000
Nylon strings 100 m	2	15,000	30,000
Jerry can	2	10,000	20,000
Drinking cup	10	1,000	10,000
Hoe incl. handle	10	13,000	130,000
Axe incl. handle	2	15,000	30,000
Panga	3	8,000	24,000
Slasher	4	6,000	24,000
Spade with metallic handle	5	20,000	100,000
Pick-axe incl. handle	5	22,000	110,000
Rake incl. Handle (Need to get locally made type with metallic handle)	4	8,000	32,000
Claw hammer. Metallic handle	3	15,000	45,000
Pliers	2	10,000	20,000
Pruning clippers	2	15,000	30,000
Watering can	4	10,000	40,000
Basin	6	6,000	36,000
Total			**726,000**
VAT			130,680
Total tools			**856,680**

Special Tool	No.	Price	Total
Spray pump for biofertilizers and bio pesticides.	1	150,000	150,000
Total			**150,000**
VAT			**27,000**
Total special tool			**177,000**

Materials

Materials (1. Season)

The materials needed for planting 2 acres of Reforestation system are:

Materials	No.	Price	Total
Seedlings (1)	1,500	1000	1,500,000
Barbed wire (roll of 600m)	6	160,000	960,000
Live Fence (Kei apple)	1805	500	902,500
U-nails (kg)	9	8,000	72,000
Assorted wire nails	5	7,000	35,000
Mulching Materials	1	50,000	50,000
First aid kit	1	80,000	80,000
Total			**3,599,500**
VAT			647,910
Total materials			**4,247,410**

The groups will provide the dry and sprouting poles for fencing.
In exceptional cases, when communities fail to supply poles and the PMCs acknowledge in writing, the below optional materials shall be procured

Optional Materials

Materials	**No.**	**Price**	**Total**
Sprouting poles-2.0m	200	4000	800,000
Dry Fence poles-2.0m	200	4000	800,000
Total			1,600,000
VAT			288,000
Total materials			**1,888,000**

Materials (2. Season)
The materials needed for planting 2 acres of Reforestations are:

Materials for gap filling	**No.**	**Price**	**Total**
Seedlings for gap filling	300	1500	150,000
Mulching	2	50,000	100,000
Liquid fertilizer	6	25,000	150,000
Total			**700,000**
VAT			126,000
Total materials			**826,000**

In case of very dry weather where the growth has been stunted, liquid fertilizer can be considered to boost the growth. The costs will be 150,000 (6 litres of Ushs. 25,000)

Cash
The amount in cash to be paid for planting and maintaining 2 acres of Reforestation is as follows including Resilience Design approaches;

Project		**No. of participants**	**Days per participant**	**Total no. of work days**	**Amount per day**	**Amount**
Planting		30	22	660	6,000	3,960,000
Mtc	(Season 1)	30	10	300	6,000	1,800,000
	(Season 2)	30	10	300	6,000	1,800,000
	(Season 3)	30	10	300	6,000	1,800,000
Total		**30**	**70**	**2,100**	**6,000**	**9,360,000**

10.7 Annex 7: Protected Spring

Springs are found mainly in mountainous or hilly terrain. A spring may be defined as a place where a natural outflow of groundwater occurs. Spring water is usually fed from a sand or gravel water-bearing soil formation called an aquifer, or a water flow through fissured rock. Where solid or clay layers block the underground flow of water, it is forced upwards to the surface. The water may emerge either in the open as a spring, or invisibly as an outflow into a river, stream, pond, lake or the sea.

Spring water quality
In general, spring water is of good quality. Pathogenic contamination is unlikely if the source meets certain criteria. These include the thickness of the soil layer, the type of soil and the velocity of infiltration of the surface water. The soil formation should be thick enough for natural filtration and biological action to remove pathogenic organisms before the water enters the aquifer feeding the spring. The type of soil determines the speed of the flow through the voids in the soil and so influences the purification mechanisms and the concentration of suspended solids. If the soil layer is not thick enough, any human activity should be restricted or even forbidden in the catchment area. Otherwise, local farmers may be allowed to conduct some agricultural activities in the catchment area (but outside the protection area around the spring eye) under some restrictions such as no use of artificial fertilizers or harmful chemicals.

One of the key signs of a good spring is that the water maintains a constant temperature throughout the day. The water should also be colorless. Variation of water temperature during the day and coloration of water shortly after rains are indications of a poor-quality spring source. It may have its water-bearing soil layer not deep enough or rapid infiltration of surface water through the topsoil.

If users note this temperature and colour changes, but they still favour the spring over alternative water sources, then the community needs to be advised to include water treatment as part of the water supply system. This treatment may be incorporated in the intake chamber or outside the spring. For small communities, household-based water treatment may be the most feasible option.

Laboratory testing of the water quality is a necessary part of the feasibility study even if there are no changes in the water temperature and colour. Testing should extend over a reasonable period of time, especially if there are human activities in the recharge area of the source. DRC NURI will conduct physical, chemical and Bacterial tests of all spring water before construction.

The spring water quantity
The quantity of water a spring produces is known as its yield. Information about the yield is crucial in the decision-making process for the tapping of a spring. Yield is studied in terms of flow rate and consistency. Variation in the yield of a spring during the dry season and the rainy season is an important criterion to determine whether the spring is a suitable source***. If the ratio between the highest yield in the rainy season and the yield in the dry season is below 20***, ***then the spring has an acceptable consistency and can be regarded as a reliable source in both wet and dry seasons.*** Take into account that the highest and the lowest yield do not occur at the beginning of the rainy season and at the end of the dry season but typically a couple of weeks (or even months) later, depending on the soil characteristics.

A proper feasibility study of a spring source should be conducted and last for at least one year. A longer duration is preferred as there may be dry and wet years. The study will indicate the variation in yield of the spring throughout the year, and the maximum, minimum and estimated average flow. Critical study periods are used to give a rapid estimation of the yield. The best time to use is the transition period of dry and rainy seasons when the flow is minimal. The times of peak and minimum spring yield do not necessarily correspond to the peak and minimum rainfall periods. In fact, the lowest spring yield usually occurs about a few weeks to several months into the rainy season.

A rapid assessment of potential environmental impact is a sensible first step. This involves identifying possible environmental consequences of developing a spring. These can include risks of landslides, erosion, or contamination of the source. The environmental assessment includes investigating the flow direction of surface run-off above the spring; human activities and water uses in the catchment area, i.e. habitation, farming, grazing, etc.; and the type of plants growing in the catchment or recharge area. If the groundwater

contamination risks are too high, then such locations are not suitable. Some trees and plants are undesirable too. Eucalyptus trees, for instance, compete for water with the spring and can significantly reduce the yield. Raffia palms, though harmless, increase the iron content of the water, changing its taste and colour enough to deter consumers. If these kinds of plants are around, the best solution is to make the community members aware of the repercussions and hold discussions about moving or removing them.

Identification of spring source

Local people, especially women (as drawers of water), but also farmers, hunters and grazers, have a good knowledge of the location of springs and their characteristics. These people are the primary sources of information in the identification process. In the dry season, green vegetation in a dry area may also be an indication of a spring source. Some springs form small ponds where animals drink and people may well also scoop water from there. Others flow as small streams in valleys and can be traced back to the source. The source, though, is not necessarily the first upstream point at which the stream emerges from the ground.

The springs will be made sustainable by planting trees, providing bioswale and infiltration pits 60m above the spring eye where land and Land Lords permits. Screening shall be done during wet seasons and revalidated in dry seasons before constructions using the highlighted criteria above.

Depending on the needs during assessments, overflow from high yield springs will be channeled into earth ponds for animal watering or irrigating down-stream gardens. Where land for the pond is not available but land lord accepts, simple water harvesting structures like bioswale shall be put downstream with tree systems to recharge underground aquifers.

The structures of the spring will be done by a contractor who will be required to follow drawings, BoQs supplied to them by supervising Engineer. All springs shall be fitted with guard rails along the gentle steps to the spring to ease movements in and out by elderly and people with disabilities.

The eye of the spring shall be fenced and planted with ever green hedges (K-apples) and a series of species of perennial trees will be planted along the spring line as was well as swales to enable recharging.

One group of 15 people will be involved in the construction of a protected spring for 20 days including resilient design components like upstream percolation pits, tree planting and grassing.

Tasks

- Clear road to spring site
- Clear bush around the spring site.
- Excavate the reservoir
- Excavate the water collection box
- Excavate the drainage
- Fence the spring area
- Plant trees around the spring area.
- Swales on contour planted to harvest and recharge springs
- Plant the well area with star grass or paspalum.
- Maintain the spring area.

Tools

Tool	No.	Price	Total
Measuring tape (100m)	1	45,000	35,000
Nylon strings 100 m	2	15,000	30,000
Jerry can	2	10,000	20,000

Drinking cup	10	1,000	10,000
Hoe incl. handle	5	13,000	65,000
Axe incl. handle 5Kg	2	15,000	30,000
Panga	2	6,000	12,000
Slasher	4	6,000	24,000
Pick-axe incl. handle	2	22,000	44,000
Rake incl. Handle (Need to get locally made type with metallic handle)	2	8,000	16,000
Spade with metallic handles	3	20,000	60,000
Claw hammer, metallic handles	2	15,000	30,000
Wheelbarrow	2	160,000	320,000
Sub Total			**706,000**
VAT			108,280
Total tools			**814,280**

Materials

Materials	No.	Price	Total
Barbed wire roll of 600m	1	160,000	160,000
U-nails kg	1	8,000	8,000
Assorted nails	2	7,000	14,000
Buckets	2	15,000	30,000
Tree seedlings	500	1,000	500,000
First aid kit	1	80,000	80,000
Total			**792,000**
VAT			142,560
Total materials			**934,560**

Cash

The amount in cash to be paid for one pond is:

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount
Construction	15	20	300	6,000	1,800,000
Rehabilitation	15	20	300	6,000	1,800,000
Water pond	30	20	600	6000	3,600,000

Standard BOQ for contractor constructing high yield spring

	Description	Unit	Qty	Rate	Amount
No	**GRAND SUMMARY**				
1	Preliminaries and General Items				500,000
	Measured works				
2	Construction of one protected spring				5,413,000
	Sub Total				**6,163,000**
	Add 5% contingencies (Excluding Preliminaries and General items)		**0%**		-

	Total inclusive of contingencies				**6,163,000**
	Stone slate one peace				**50,000**
	Sub Total VAT Exclusive				**6,213,000**
	Add 18% VAT		18%		1,118,340
	Grand Total for Lot ……				**7,331,340**
Preliminaries and General Items					
	Removal shrubs, trees and grass	m^2	N/A		0
	Remove top soil average 150mm and keep for re-use	m^2	N/A		0
	Excavate from striped level not exceeding 3m for collection reservoir	m^3	N/A		0
	Ditto but for water collection box and stair case	m^3	N/A		0
	Ditto but for wings	m^3	N/A		0
	Back fill selected materials to side of excavations	m^3	N/A		0
	Remove surplus excavated material from site	m^3	N/A		0
	Excavate from striped level to open eye not less than 3m	m^3	N/A		0
	Excavate to open drain channel not less than 10m from the box and back fill	m^3	N/A		0
	Mobilize for tools and labour	ITEM	1	250,000	250,000
	Visibility such as Bill boards	ITEM	1	250,000	250,000
Total to be Carried to Grand Summary					**500,000**
MEASURED WORKS - Construction of one protected spring					
	Descriptions	**Unit**	**Qty**	**Rate**	**Amount**
3	**CONCRETE**				
	150mm reinforced concrete 1:2:4	m^3	2	400,000	800,000
	Reservoir base				0
	Collection box base	m^3	0.5	400,000	200,000
	Top of reservoir	m^3	1	400,000	400,000
	Stair case	m^3	1	400,000	400,000
	Drainage slab	m^3	0.5	400,000	200,000
	Formwork to soffit and edge	m^2	31	12,000	372,000
	TOTAL CONRETE				**2,372,000**
4	**WALLS**				
	230mm reinforced concrete Retaining wall	m^3	4	400,000	1,600,000
	230mm stone masonry wall for eye channel in well-seasoned clay mortar	m^2	1	40,000	40,000
	T-12 re bars fixed and tied in position	Kgs	360	6000	2,160,000
	TOTAL WALLS				**1,640,000**
5	**FINISHES**				

	Plaster 1:2 cement: sand mortar to the surface of stone masonry wall	m^2	24	14,000	336,000
	30mm screed 1:2 to floor surface of reservoir and internal wall surface of reservoir and box	m^2	17	20,000	340,000
	30mm screed 1:2 to top surface of reservoir and wood float	m^2	7	20,000	140,000
	TOTAL FINISHES				**816,000**
6	**EYE CHANNEL**				
	Hardcore filling to bring to level sides and bottom excavation of eye	m^3	2	50,000	100,000
	150mm clay packing to the surface of hard core	m^3	1	40,000	40,000
	150mm nontoxic gravel packing to filter water from the eye	m^2	1	80,000	80,000
	150mm clay packing to the surface of gravel packing and Hard core	m^3	1	40,000	40,000
	TOTAL EYE CHANNEL				**260,000**
7	**FITTINGS**				
	50mm PVC cased in 75mm GI spout 3m long and 1m long respectively	No	1	80,000	80,000
	25mm GI taps	No	3	20,000	60,000
	100mm GI pipe wash out	No	1	55,000	55,000
	25mm GI over flow	No	1	20,000	20,000
	100mm GI pipe for vent	No	2	55,000	110,000
	Install welded round hollow metallic guardrails of diameter 32mm thickness 3mm imbedded in concrete to the sides of the stairs	M	12	20,000	240,000
	TOTAL FITTINGS				**325,000**
	SUMMARY				
	CONCRETE WORKS				2,372,000
	WALLS				1,640,000
	FINISHES				816,000
	EYE CHANNELING				260,000
	FITTINGS				325,000
	TOTAL				**5,413,000**

Low yielding springs which is a priority for the community and there is no other alternative will be protected and where feasible boosted with a reservoir as shall be advised by the District Water Departments; Community members must be made aware that this kind of spring may dry out during dry season, however, it can be boosted by up stream activities like planting water infiltrating trees, bioswale with infiltration pits upstream and will turn to be perennial with time.

Standard BOQ for contractor constructing a protected low yield spring

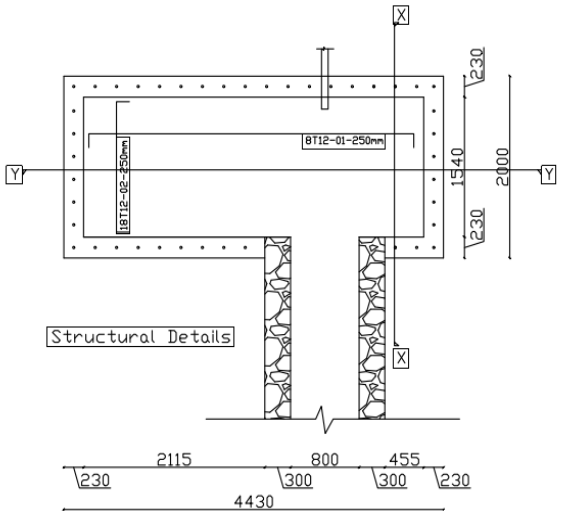
	Description	Unit	Qty	Rate	Amount
No	**GRAND SUMMARY**				

1	Preliminaries and General Items				750,000
	Measured works				
2	Construction of one protected Normal spring				**9,876,000**
	Sub Total				**10,626,000**
	Add 5% contingencies (Excluding Preliminaries and General items)		**0%**		-
	Total inclusive of contingencies				**10,626,000**
	Percentage Discount Offered (As per Bid submission sheet)			**0%**	**-**
	Stone slate 0ne peace				**50,000**
	Sub Total VAT Exclusive				**10,676,000**
	Add 18% VAT		18%		1,921,680
	Grand Total for Lot ……				**12,597,680**
3 Preliminaries and General Items					
	Removal shrubs, trees and grass	m^2	N/A		0
	Remove top soil average 150mm and keep for re-use	m^2	N/A		0
	Excavate from striped level not exceeding 3m for collection reservoir	m^3	N/A		0
	Ditto but for water collection box and stair case	m^3	N/A		0
	Ditto but for wings	m^3	N/A		0
	Back fill selected materials to side of excavations	m^3	N/A		0
	Remove surplus excavated material from site	m^3	N/A		0
	Excavate from striped level to open eye not less than 3m	m^3	N/A		0
	Excavate to open drain channel not less than 10m from the box and back fill	m^3	N/A		0
	Mobilize for tools and labour	ITEM	1	400,000	400,000
	Visibility such as Bill boards	ITEM	1	350,000	350,000
Total to the Grand Summary					**750,000**
MEASURED WORKS - Construction of one protected spring					
	Descriptions	**Unit**	**Qty**	**Rate**	**Amount**
4	**CONCRETE**				
	150mm reinforced concrete 1:2:4				
	Reservoir base	m^3	2	400,000	960,000
	Collection box base	m^3	1.5	400,000	720,000
	Top of reservoir	m^3	1	400,000	480,000
	Stair case	m^3	1	400,000	480,000
	Drainage slab	m^3	0.5	400,000	240,000
	Formwork to soffit and edge	m^2	31	12,000	775,000
	Nails	Kg	10	6000	70000
	TOTAL CONRETE				**3,725,000**
5	**WALLS**				

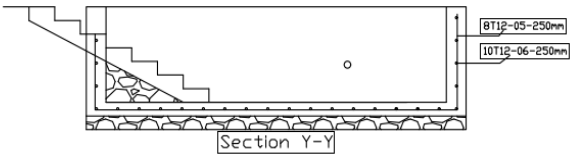
	230mm reinforced concrete Retaining wall	m^3	4	480,000	1,920,000
	230mm stone masonry wall for eye channel in well-seasoned clay mortar	m^2	1	80,000	80,000
	T12- re bars fixed and tied in position	Kg	360	6,500	2,340,000
	TOTAL WALLS				**4,340,000**
6	**FINISHES**				
	Plaster 1:2 cement: sand mortar to the surface of stone masonry wall	m^2	24	14,000	336,000
	30mm screed 1:2 to floor surface of reservoir and internal wall surface of reservoir and box	m^2	20	20,000	400,000
	30mm screed 1:2 to top surface of reservoir and wood float	m^2	7	20,000	140,000
	TOTAL FINISHES				**876,000**
7	**EYE CHANNEL**				
	Hard core filling to bring to level sides and bottom excavation of eye	m^3	2	50,000	250,000
	150mm clay packing to the surface of hard core	m^3	1	40,000	120,000
	150mm nontoxic gravel packing to filter water from the eye	m^2	1	40,000	80,000
	150mm nontoxic gravel packing to filter water from the eye	M^3	1	40,000	40,000
	TOTAL EYE CHANNEL				**450,000**
8	**FITTINGS**				
	50mm PVC cased in 75mm GI spout 3m long and 1m long respectively	No	1	80,000	100,000
	25mm GI taps	No	3	20,000	60,000
	100mm GI pipe wash-out	No	1	55,000	55,000
	25mm GI over flow	No	1	20,000	20,000
	100mm GI pipe for vent	No	2	55,000	110,000
	Install welded round hollow metallic guardrails of diameter 32mm thickness 3mm imbedded in concrete to the sides of the stairs	M	12	20,000	240,000
	TOTAL FITTINGS				**485,000**
	SUMMARY				
	CONCRETE WORKS				3,725,000
	WALLS				4,340,000
	FINISHES				876,000
	EYE CHANNELING				450,000

	FITTINGS				485,000
	TOTAL				**9,876,000**

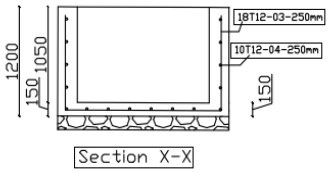
Technical drawings – high yield

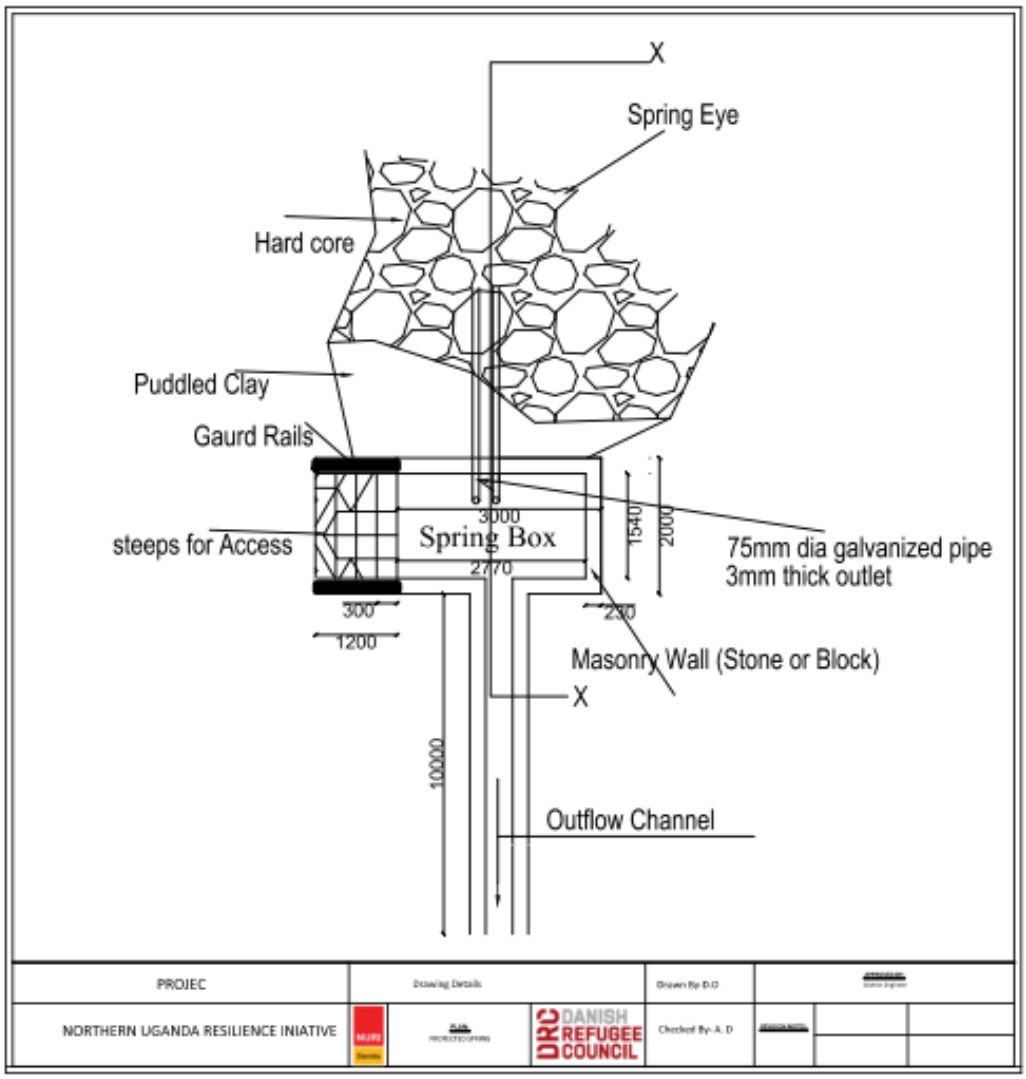


Structural Details for Spring Box

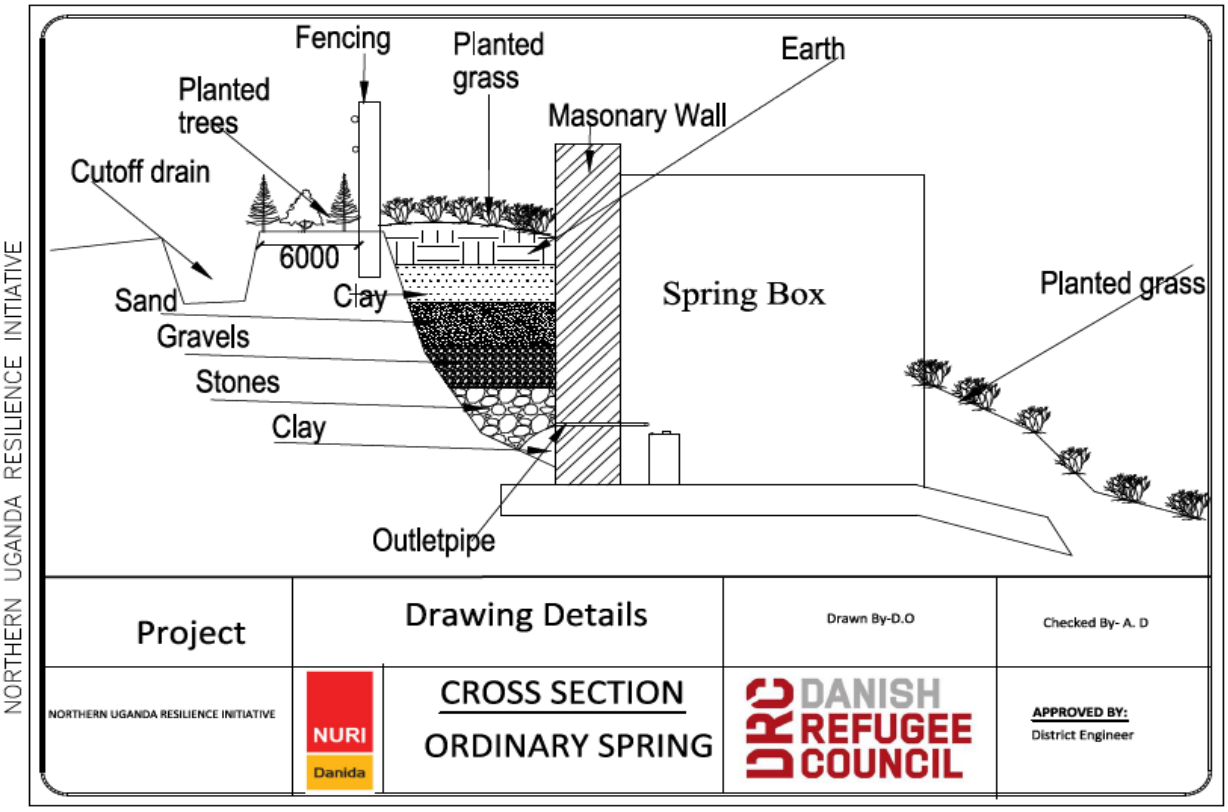


150mm thick hardcore at the bottom
Wall height depends on site condition but should vary between 0.75m to 1.8m
Length of drain channel should be atleast 3m

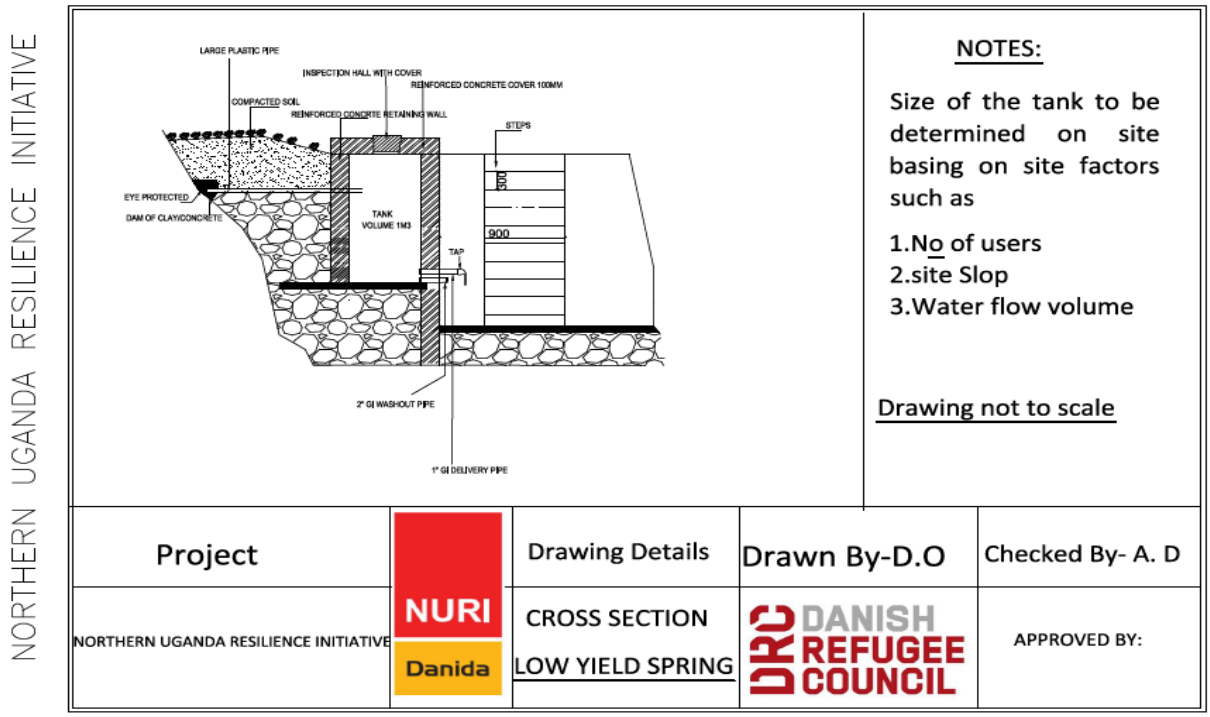




Technical drawings – low yield - <u>Plan view-Protected Springs</u>



Section View of protected spring



Section View of a tank protected spring

10.8 Annex 8: Soil and water conservation structures

Soil quality is an integral part of water conservation. Well-developed soil allows irrigation water and rain to infiltrate rather than run off; it also has the capacity to retain the water that soaks in. Plant roots penetrate easily and deeply in quality soil and can reach water reserves held low in the soil profile. All of these attributes result in a reduced need for landscape irrigation. In addition, properly managed soil means reduced soil erosion, fewer fertilizer and pesticide inputs, and less chance of chemical runoff - all of which contribute to cleaner, healthier water resources.

NURI WRM component will support soil and water conservation projects such as; Bench Terraces (other types of terraces will not be included), Contour berms, Check dam, Gulley plugging, One Rock dams, Grass strips, Mulching etc.

Bench terraces

Bench terraces are a series of level or virtually contour levelled strips running across the slope at vertical intervals, supported by steep banks or risers reinforced with plantings of plants like vetiver, tithonia etc. The objectives of bench terraces are; to reduce run-off or its velocity and to minimize soil erosion, to conserve soil moisture and fertility and to facilitate modem cropping operations i.e. mechanization, irrigation and transportation on sloping land.

Locations and conditions for use

Bench terraces are particularly suited to locations/sites with the following macro conditions:

- Severe erosion hazards.
- Areas with small holdings and a dense population.
- Areas where there are food shortages or high unemployment rates.
- For high and moderate rainfall, areas inward sloping and for dry areas level bench terrace is suitable.
- On slopes above 22%. In areas of unstable soils, the increases in infiltration can cause high water pressure in the soil pores and collapse terrace embankments. In such areas it would not be advisable to make bench terraces on slopes over 22^0.
- On sites which are not dissected by gullies and not too stony.

Design specifications

Length: The length of a terrace is limited by the size and shape of the field the degree of dissections and the permeability and erodibility of the Soil. The longer the terraces, the more efficient they will be. But it should be borne in mind that long terraces cause accelerated run-off and greater erosion hazards. A maximum of 100 m in one draining direction is recommended for typical conditions.

Width: The width of the bench (flat part) is determined by soil depth, crop requirements, tools to be used for cultivation, the land owner's preferences and available resources. The wider the bench, the more cut and fill needed and hence the higher the cost. The optimum width for handmade and manual-cultivated terraces range from 2.5 to 5 m.

Table 10.6 Bench width based on soil depth and slope of the area

Slope (%)	Soil depth			
	50cm	75cm	100cm	125cm
20	5.63	8.44	11.25	14.05
30	3.54	5.31	7	8.83

40	2.5	3.25	5	6.25
50	1.9	2.8	3.75	4.65

Gradients: Slopes can be measured by using a hand level or a clinometer. In design of terraces, a representative slope or a mode slope should be obtained from the field. The maximum and minimum suitable slopes for construction of bench terrace depends on whether it is handmade or machine made. If we build terraces by hand, the appropriate slope range vary but it is recommended to be 12% to 30 degrees (or 60%). while for machine-based construction slope range recommended is in the range between 7 degrees to 20 degrees (or 12.3% to 36.4%)

Risers and riser slopes: Riser material can be either compacted earth -protected with grass, or rocks. In order to ensure easy maintenance, terrace riser height should not exceed 2 m, after allowing for settling. Riser slopes is a ratio of the horizontal distance to the vertical rise. 0.75:1 will be used for Hand-made benches with earth material.

Use $VI = \frac{0.3(S+2)}{4}$ to calculate Vertical interval of a bench terrance

General guidelines to constructing terraces

- Clear the sites for clear vision to GR4Wry-out survey.
- Surveying and staking should start at the top and proceed downward
- Stake the graded contour lines
- Stakes should be placed at every 5 to 10 m and at all points where topography changes
- All the staked lines, waterways, roads etc. should be leveled.
- Construct when soil is not too dry or too wet.
- Begin the cut at the top and fill in the bottom
- After each 30 cm fill, the soil should be compacted
- The edge of the terrace should be little higher than required to take GR4We of settling of soil.

Activities during construction of terrace

- Remove the topsoil and pile it convenient place.
- Dig the foundation and start to construct the riser along the contour
- Dig the sub soil on the cut section and fill on the fill section, with raising the riser, until it makes level,
- Finally spread the top soil all across the terrace. Use the figure below for construction steps
- The riser/ terrace wall needs to be compacted during construction of earthen raisers/ terrace wall should be inclined at a slope of 1:1
- In areas where stones are plenty raiser can be constructed with stone wall.
- Earthen terrace wall or riser would be stabilized with grass

The Construction procedure (see Appendix 4: Construction steps)

1. Using an A-frame, mark at least two contour lines on a hillside. The vertical distance should not be more than 1.5 meters. Generally, the vertical distance will be about 1.0 meter. The distance along the slope will vary.
2. Find the midline between the two contour lines.

3. Using draft animals or hand tools such as shovels, begin removing the soil from the upper half of the strip, i.e., midline to upper contour line (the cut) and place it on the lower half (the fill).
4. Continue the process until the area above the midline and the soil piled below the midline is levelled.
5. The front of the level area called the riser should be constructed so it slants back toward the hillside. The angle of the riser should be between 15° and 45° depending upon the type of soil and the riser height. The angling of the riser will give it more stability. Further riser stabilization is done by planting the riser with grasses.
6. A small canal is excavated at the base of the terrace. This canal is used to GR4Wry off excess rain water during heavy rains and saves the terrace below from being washed away. GR4We must be taken to integrate the drainage of the bench terrace into the overall drainage system of the farm
7. Slope the new front area of the terrace slightly upwards. At the front of the terrace and on the top of the riser, construct a small mound or lip. This will prevent water from washing over the front and eroding the riser

Inspection, protection, maintenance, management and integration requirements

New terraces should be protected at their risers and should be GR4Wefully maintained, especially during the first two years. After cutting a terrace, its riser should be shaped and planted with Vertiva zizanioides L. Nash, also known as Vetiver grass, a densely tufted, perennial clump grass, with stiff leaf blades. The foliage is mostly basal with the leaf sheaths closely overlapping, strongly compressed and keeled which creates a physical barrier of great density at the ground surface.

- Bench terraces require regular GR4We and maintenance; water must not be allowed to accumulate in any part of the terrace. Grasses and weeds should be removed from the benches but allowed to grow on the risers. Correct gradients should be maintained and reshaped immediately after crops are harvested. Ploughing must be Carried out with GR4We so as not to destroy the toe drains and the grade.
- Deep ploughing, or sub-soiling is needed to improve the structure of the soils on the cut part of the bench terraces. Green manuring, or compost application is needed in the initial period in order to increase soil fertility. Soil productivity should be maintained by means of proper crop rotation and the use of fertilizers

Tools/Equipment

The equipment usually consists of the following:

Tool	No.	Price	Total
Measuring tape (100m)	2	45,000	90,000
Nylon strings 100 m	4	15,000	60,000
Jerry can	4	10,000	40,000
Drinking cup	20	1,000	20,000
Hoe incl. handle	20	13,000	260,000
Axe incl. handle	4	15,000	60,000
Panga	6	6,000	36,000
Slasher	8	6,000	48,000
Spade with metallic handle	10	20,000	200,000
Wheel barrow (Reliance)	3	160,000	480,000
Pick-axe	10	22,000	220,000
Rake incl. handle	8	8,000	64,000

Claw hammer. Metallic handle	6	15,000	90,000
A-frame Materials	1	200,000	200,000
Total			**1,868,000**
VAT			249,840
Total tools			**2,117,840**

Materials to stabilize the bench riser

Item	**No**	**Cost**	**Amount**
Lateral creeping vine	1	200,000	200,000
Total			**200,000**
VAT			36,000
Total tools			**236,000**

Cash

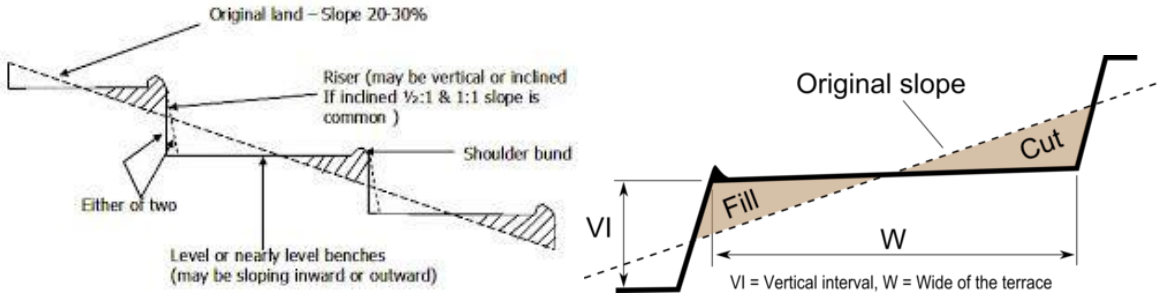
A person can construct 2m long bench terrace per day, without considering the volume of cut and fill that could vary based on the width and slope of the land as well as the addition labour required for collecting, and construction of risers. Generally-speaking, a person can cut and fill 3 to 4 cubic m of earth working eight hours of supervised work, although output may vary depending on the type of soil and if rocks are present. If a terrace is wider than 4 m, output will be reduced because the transporting of the earth requires extra time. A team of 3 persons/m for narrow terraces and 4 persons/m for wider terraces is recommended for efficient terracing work, two persons should be employed for cutting, the third for compacting and consolidating the risers, and the fourth for transporting the soil. In a day this team can do 5.1m and 6.8m respectively each person doing 1.7m. The number of people to be temporarily employed for different areas of terracing is as below

Total length of terrace (m)	**Number of participants required for work**	**Number of groups needed**
200	8	0
500	15	0
1000	29	1
1500	44	1
2000	59	2
3000	88	3
4000	118	4
6000	176	6

Project	**No. of participants**	**Days per participant**	**Total no. of work days**	**Amount per day**	**Amount total**
Construction	60	20	1200	6,000	**7,200,000**

Drawings and Pictures

Figure 10:3 Bench Terrace



<u>Technical design Contour ploughing, Grass strips</u>

Contour bunds are a physical measure to control erosion, enhance infiltration and increase yields. Bunds are constructed on hillsides on slope up to 20^0 along contours – dividing the slope into several smaller micro-catchments. By slowing down the speed of runoff, water is given time to infiltrate and soil moisture is augmented. Bunds exist in many different designs and have been globally used as a mean of water buffering and soil conservation. Soil bunds, stone bunds, tied ridges, and stone face bunds are some examples of basic principles of contour bunds that will be applied in many different ways.

Grass strips located within or at the edges of arable fields provide important cover and food for birds and small mammals, as well as flowers for pollinating insects. They can also help improve water quality by preventing soil erosion, intercepting surface water run-off and improving soil structure. Grass strips are also important for connecting habitats.

NURI WRM will support contour ploughing and contour beds which can be constructed manually using on-farm equipment like hoe, fork, spade and A-Frame.

Technical Deign

This kind of structure is sometimes called Fanya juu which literally means “throw it upwards’ in Kiswahili. Soil bunds must be used on cultivated lands up to 22^0. The design of the bund and its dimensions depend on climatic conditions and on the amount of water that will need to be intercepted by the bund.

Dimensions of the bunds should be in line with the maximum possible rainfall. Contour bunds are constructed in relatively low rainfall areas, having an annual rainfall or less than 600 mm, particularly in areas having light textured soils.

The volume of the ditch plus the volume of the section defined by the bund should be equal or bigger than the volume of the water to be stored – preferably with a safety margin for unusual years or intense rainfall events.

Dividing the field area by the length of the bunds gives the space to be maintained between the rows. Often a fixed vertical interval between bunds is followed as constant parameter.

Consequently, the horizontal distance varies with the slope. If the vertical interval is of 1 m, the horizontal distance will be 10 m and 100 m on slopes of 10% and 1% gradient respectively.

Dimensioning of bunds is often Carried out using rules of thumb and the experience of practitioners. There is a degree of flexibility but during the design a number of points needs to be kept in mind: The slope should be measured at several points along the hillside and areas with slopes smaller than 10% should be marked. On steeper slopes the runoff speed increases which poses a risk to the structure. For this reason, steeper areas are advised to be treated with trenches or terraces.

Always start constructing the bunds from the upper section of the slope and then work all the way down slope.

Once the interval between lines is decided, draw a straight line from the top of the field to the bottom.

- Mark the line intervals of this line.
- From each demarcation measure and mark the contour lines.
- Remove grass from areas where the bunds are to be built. This permits better adhesion to the ground.
- Construct the bunds on the marked contour lines.
- Reinforce the bunds and grow vegetation on it.
- Strengthen further contour beds by planting grass barriers along alternating beds of at least 30 to 40 feet (915 to 1 220 cm) between beds.

Tools

The standard set of tools that will be provided for preparing and constructing contour is:

Tool	No.	Price	Total
Measuring tape (100m)	1	45,000	45,000
Nylon strings 100 m	2	15,000	30,000
Jerry can	2	10,000	20,000
Drinking cup	10	1,000	100,000
Hoe incl. handle	10	13,000	130,000
Axe incl. handle	2	15,000	30,000
Panga	3	6,000	18,000
Slasher	4	6,000	24,000
Spade with metallic handle	5	20,000	100,000
Pick-axe	5	22,000	110,000
Rake incl. handle	4	8,000	32,000
Claw hammer. Metallic handle	3	15,000	45,000
Pliers	2	6,000	12,000
Pruning clippers	2	15,000	30,000
Watering can	4	6,000	24,000
Basin	6	6,000	36,000

A-frame materials	1	200,000	200,000
Total			**896,000**
VAT			161,280
Total tools			**1,057,280**

Special Tool	**No.**	**Price**	**Total**
Spray pump etc.	1	150,000	150,000
Total			**150,000**
VAT			27,000
Total special tool			**177,000**

Cash

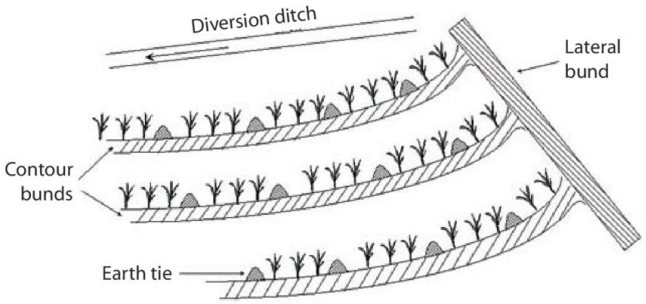
A person can dig 4m per day of conservation terrace (fanya juu and fanya chini) and infiltration pits. A person working for 20 days of 8 hours will have dig 80m. The table below shows the number of people required for different lengths to be dug.

Total length of terrace	**Number of participants required for work**	**Number of groups needed**
200	3	0
500	6	0
1000	13	0
1500	19	1
2000	25	1
3000	38	1
4000	50	2
6000	75	3
8000	100	3
8500	106	4
9000	113	4
10000	125	4

Cash for work

Project	**No. of participants**	**Days per participant**	**Total no. of work days**	**Amount per day**	**Amount total**
Construction	60	20	1200	6,000	**7,200,000**

Drawings and Pictures



Grass strips located within or at the edges of arable fields provide important cover and food for birds and small mammals, as well as flowers for pollinating insects.

They can also help improve water quality by preventing soil erosion, intercepting surface water run-off and improving soil structure. Grass strips are also important for connecting habitats.

Gully plugging (Check dams)

Temporary and permanent gully plugs are used to rehabilitate gullies and retain sediments that would be otherwise washed away. Gully plugs are structural barriers that obstruct the concentrated runoff inside gullies and ravines. They are often temporary structures built to favor the establishment of a permanent soil cover to effectively conserve soil and water.

Requirements

The gully should preferably not be steeper than 10% or deeper than 2 m. When stones are readily available stone check dams can be constructed to restore small gullies. The trapped sediments can be used as arable land, which can provide additional income to the farmers. Preferably flat stones are to be used as they add more strength.

Plant materials are stacked behind a series of wooden posts that are driven deep into the soil. Brushwood from species that propagate vegetatively from cuttings is ideal to use as the roots encourage consolidation of the structure and the soil. After few years the established stems-plants can be pruned providing fodder and fuel. Once the check dam structure is in place, gully reshaping is required to ease plant establishment.

Technical Design

When constructing a check dam, wooden poles should be planted across the gully at 50-60 cm intervals. The poles, should not rise more than 1 m from the ground level. The posts should have a slight upslope inclination so they can withstand more pressure. Finally, branches are inter-woven around the post-poles. On the sides, the branches should be driven 30-50 cm into the gully banks to improve the stability. Optionally some litter mixed with soil can be placed behind the barrier. The water should be able to slowly percolate through the barrier.

Stone check dams are constructed with local available stones. The structure should be keyed on the side and on the bottom.

- A foundation should be dug 50 cm into the banks.
- Flat stones are preferred as they add greater strength and are not easily dislocated. The bigger stones must be used for the crest and the middle section of the dam.

- Wing-walls should protect the wings of the dam. Wing-walls depart from the main dam wall and are directed upslope at a 30-45% angle.
- An apron should be constructed downstream to protect the toe of the dam
- The distance between dams is a critical factor.
- For rock dams, it is suggested to place subsequent dams in a way that a hypothetical line drawn from the top of one dam to the foot of the dam immediately upslope has a back-slope angle of 30-45°
- Each stone check dam should either be seeded with hardy grasses or a water tolerant seedling

Drawings and Pictures


Figure 10:4 Gully plugging (Check dams)

Cash for work

Project	No. of participants	Days per participant	Total no. of work days	Amount per day	Amount total
Construction	30	20	600	6,000	**3,600,000**

Treatment design and placement of SWC structures

Treatment design begins after a thorough site analysis and inventory of problems and opportunities in a given reach. Stream reaches should be walked several times as it is easy to miss things on the first pass. Reading the landscape and thinking like water are key aspects of the process. Pay GR4Weful attention to landform, grades and changing elevations, vegetation types that may inform site conditions, areas where water moves faster and becomes concentrated, or where it slows down and spreads out. All of these site details inform effective treatment design. Learn to identify resource problems, such as, headcuts, channel incision, and areas that are drying out due to de-watering. Also, look for opportunities to reconnect the channel with its floodplain, areas of deep soils that can hold water in the system for longer periods when saturated, and landforms where water could be spread out further on the land surface.
Multiple structures are often installed together to achieve desired objectives within a reach

NB: Working with rock can be dangerous, so safety and proper handling techniques are always critical to emphasize during training. Some safety aspects to keep in mind are instructing field crews on proper lifting position to avoid injury, being aware of your surroundings and other people, wearing protective clothing and being aware of unstable footing while working on the rock pile or transporting material.

11 APPENDICES

11.1 Appendix 1: Format for Project Description

PROJECT DESCRIPTION - WRM INFRASTRUCTURE					
Project Name	XXXXXX				
Project number	P000X-XXXX			Micro catchment/ District	XXXXX
Project type	New Construction			Sub-county	XXXX
Infrastructure Type	Multipurpose storage			Parish	XXXX
Capacity('000m^3)	10			Village	XXXX
Number of Groups	1			Location	XXXX
Number of participants	30				
Number of work days	600				
DESCRIPTION					
When this valley tank is constructed it will provide the community water to irrigate XXXX acres of XXXXX crop for XXXXX months of the dry period and XXXXX livestock will be watered. Over XXXX people will directly benefit from the facility.					
PROJECT COSTS					
Specification	**Unit**	**Quantity**	**Unit Cost**	**Amount**	**Comment**
Participants from local communities	Day	3,600	6,000	21,600,000	
Fee for payment to participants	Part.	180	6,500	1,170,000	
Training of PMC	PMC	6	260,000	1,560,000	
General Tools	Set	6	1,723,980	10,343,880	
Materials	Set	6	236,000	1,416,000	
Clearing of site access road	Km	5.6	1,750,000	9,800,000	
Clearing the site	Day	2.00	350,000	700,000	
Tree seedlings	No.	1,201	1,000	1,201,000	
On-farm infrastructure					
Construction/installation of cattle drinking trough	Nr.	6	7,375,000	44,250,000	
Installation of irrigation system	Acres	1	9,693,225	9,693,225	
Maintenance training	Lump	1	1,000,000	1,000,000	
Total				**184,453,265**	
Estimate prepared by:					
Title					
Estimate Reviewed by: 1					
Title					
Estimate Reviewed by: 2					
Title					

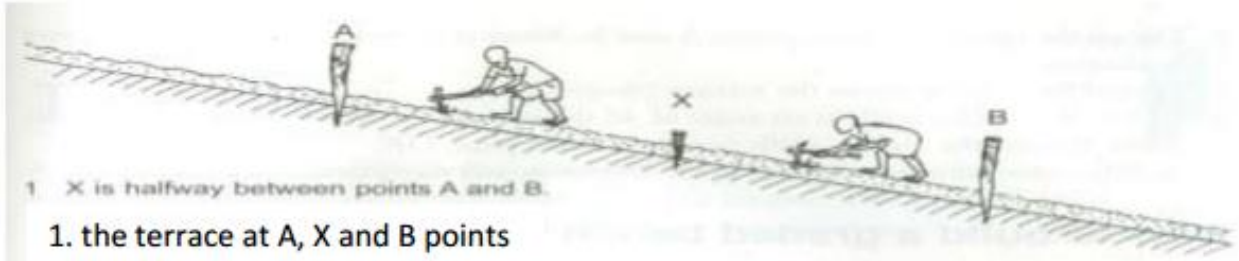
11.2 Appendix 2: Format for Investment Plan Overview

	NURI- RURAL INFRASTRUCTURE INVESTMENT PLAN FOR XXX DISTRICT-20XX/20XX									
P-no.	**I-type**	**Project Name**	**Size**	**P-type**	**Budget**	**Part.**	**No. of Projects**	**Work Days**	**Parish**	**Location (Comment)**
	XXXXX micro-catchment (1)									
Valley tank										
	……	XXX	1.0	XXX	XXX	XXX	xx	XXX	XXX	XXX
Irrigation System										
	…….	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
Afforestation										
	…….	XXX	XXX	XX	XXX	XXX	xx	XXX	XXX	XXX
Protected spring										
	…….	XXX	XXX	XX	XXX	XXX	xx	XXX	XXX	XXX
Soil and Water Conservation	**Bench terrace**	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
	Contour Planting	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
	Gulley plugging	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
Total for XXX micro catchment			**XX**		**XXXX**	**xxx**	**xxx**	**XXX**		
	XXXXX micro-catchment (2)									
Valley tank										
	……	XXX	1.0	XXX	XXX	XXX	xx	XXX	XXX	XXX
Irrigation System										
	…….	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
Afforestation										
	…….	XXX	XXX	XX	XXX	XXX	xx	XXX	XXX	XXX
Soil and Water Conservation	**Bench terrace**	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
	Contour Planting	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
	Gulley plugging	XXX	1.0	XX	XXX	XXX	xx	XXX	XXX	XXX
Total for XXX micro catchment			**XX**		**XXXX**	**xxx**	**xxx**	**XXX**		
SUBTOTAL - ALL MICRO CATCHMNETS	**XXX**	**XXX**	**XX**	**XX**	**XXX**	**XXX**	**xxx**	**XXX**	**XXX**	**XXX**
	Contingency should be……..									
Total for xxx Sub catchments - 2020					**XXX**	**XXX**	**xxx**	**XXX**		

11.3 Appendix 3: Summary of Projects

Summary								
Micro-catchments	Valley tanks ('000m^3)	Irrigation Systems (ha)	Protected Sprigs	Reforestation (ha)	Bench terraces (ha)	Contour planting (ha)	Gulley plugging (No)	**No of Projects**
Ora	1	1						
Yelulu	1	1						
Nyarwodho	1	1						
xxxx	1	1						
xxxx	1	1						
xxxx	1	1						
xxxx	1	1						
xxxx	1	1						
Total	**8**	**8**						**>= 40**

11.4 Appendix 4: Construction steps for a bench terrace

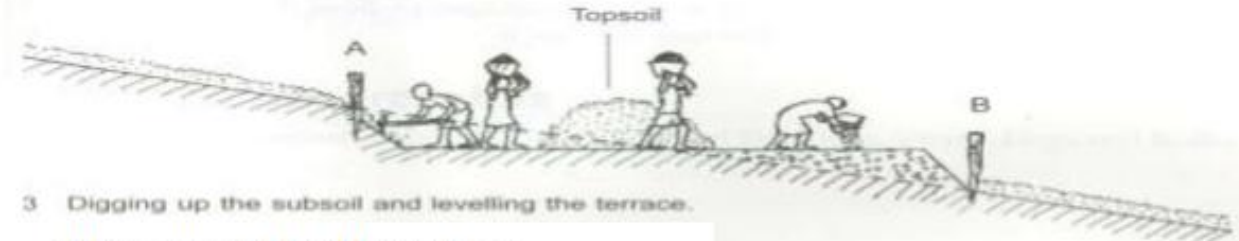


1 X is halfway between points A and B.

1. the terrace at A, X and B points

2 Removing the topsoil and putting it to one side.

2. Excavate the top soil and collect it to the centre



3 Digging up the subsoil and levelling the terrace.

3. Excavate and level the sub-soil

4 Spreading the topsoil over the terrace.

4. Spread the top soil uniformly

11.5 Appendix 6: Site dialogue meeting template

Date: ……

SUB COUNTY: …… PARISH: ……

PROJECT No. ……

NAME OF PROJECT: ……

REASON FOR SITE MEETING: ……

……

Key discussion points (informative bullet points)
Action points from meeting and recommendations.
Any other matters of concern.

Please add more sheets if need be.

NB: Ensure attendance list is attached.

Meeting chaired by: ……..

Title: ……..

Recorded by: ……

Title: ……

Aggrieved Parties

Sign: ……..

Name: ……

Sign: ……

Name: ……

Endorsed by:

LC I Chairperson

Sign: ……

Name: ……

LC II Chairperson

Sign: ……

Name: ……

LC III Chairperson

Sign: ……

Name: ……

Sub County Chief

Sign: ……

Name: ……..

Follow up Template

This template should be used to report conflicts in DRC Uganda's areas of intervention. All emerging conflicts, whether related to covid-19 or not, should be recorded using this template.

Incident recorded by (Name)	
Date of reported incident	
Location of incident	
Summary of incident (150 words max) – - ***What was the type and cause of conflict?*** - ***What were the main consequences of the conflict?*** - ***Who were the main parties to the conflict (identify by community if verifiable, livelihood if applicable and gender)?***	

Were the conflict resolved/did parties to the conflict seek resolution or mediation?	☐YES ☐NO
Did one or more parties to the conflict seek resolution through a local, customary or other authority?	☐YES ☐NO
If yes, who?	
Any further action or other points, if relevant	