CONSULTANCY SERVICES FOR ASSESSING WATER MANAGEMENT OPTIONS FOR TWO FEEDER ROADS UNDER REHABILITATION BY REACH PROJECT IN KWEEN AND KANUNGU DISTRICT AND TRAINING OF KEY STAKEHOLDERS ON TECHNIQUES THAT PROMOTE WATER MANAGEMENT AT FARMER LEVEL.

Subcontract No. **2017/REACH/UGA/208**

FIELD ASSESSMET REPORT ON WATER MANAGEMENT – REACH UGANDA PROJECT

Submitted by:

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LIST OF ABRREVIATIONS

IFDC	International Fertilizer Development Centre
REACH	Resilient Efficient Agribusiness Chains
PIO	Public International Organization
DLG	District Local Government
DE	District Engineer
SoW	Scope of Works
ToR	Terms of Reference
CAO	Chief Administrative Officer
RDC	Resident District Commissioner
GPS	Global Positioning System
MMR	MetaMeta Research
Dia	Diameter
CI	Culvert Intervention
DT	Diversion Trench (Mitre Drainage)
LHS	Left Hand Side
RHS	Right Hand Side

EXECUTIVE SUMMARY

International Fertilizer Development Centre IFDC is implementing the "Resilient Efficient Agribusiness Chains" (REACH – UGANDA) project, an innovative four – year agribusiness initiative. One of the objectives of the REACH – Uganda project is to improve availability and uptake of public and private support services related to core commodity value chains, infrastructure being one of the services.

As part of the program, IFDC realized that two of the access roads under rehabilitation located in Kween and Kanungu needed road water management and best practices applied to avoid damage to the roads by run off and protecting crops in farms/gardens adjacent to the roads. The roads link the established farmer to markets thereby contributing towards the objectives of the REACH – Uganda project. The roads are rehabilitated in partnership with the district local governments.

For IFDC to achieve its objective, it contracted METAMETA Research to:

1. To conduct a field assessment of opportunities for water management on roads in Kween and Kanungu Districts.
2. To train key stakeholders on roads for water measures in REACH (based on assessment) and guidance to implementation, including also process of community engagement.
3. Together with experts train project farmers in the field on specific water management interventions.

In this field assessment report, we indicate our findings from the field on the two roads and some of the proposed interventions that will ensure proper water management and having the water used to by farmer to enhance their farming.

The overall objective of this report is to outline the weak spots and issues of these roads related to water management. And based on this information propose solutions which cater for beneficial water management for landscapes and farms, and increase road durability and longevity at reduced maintenance costs. The roads under construction aim to be exemplary roads of how low-cost innovative road water management solutions, can make roads multi-functional, serving more than its transport functions solely.

Within the two site-studies it was noted that both roads run through sloping terrains, where the road induces high velocities and accumulation of road runoff. This requires a comprehensive approach which adequately halts water, slowing down its speed and being diverted at frequent and small intervals. Culverts and side drains are critical, though are not always sufficient in number and capacity to cater for this on their own. Among others, it needs structures of bio-engineering; i.e. to include vegetative measures with other local material to make the civil engineering structures stronger and last longer. Furthermore community engagement is crucial, so as to ensure the water will be used beneficially once it is drained from the road. This also allows greater involvement into road maintenance and commitment to manage roads and water.

For both areas a selection of practices is recommended explaining how this can be operationalized. As a conclusion this report shows how both roads would look like with integrated road water management. A separate report on the trainings is provided.

1. Background

1.1 Road construction in Uganda

The road sector in Uganda is managed by the Ministry of Works and transport (MoWT). This is a government institution that renders free services to the public. The Ministry gets its funding from Ministry of Finance, Planning and Economic Development in the consolidated fund. It also gets funds from donors. As of 2017 according to Uganda National Roads Authority (UNRA), Uganda had a total of 144,785km with only 5,100 km (4%) as paved and the rest are gravel and earthen roads. Roads are in four categories that is National Roads, Urban Roads, District Roads and Community Access Roads. The respective responsible entities are UNRA, Urban Authorities, District and Local Authorities. According to the Auditor General's "A value for money audit report on rehabilitation and maintenance of feeder roads in Uganda: a case study of Hoima, Kumi, Masindi, Mukono and Wakiso Districts", a total of Shs.18.8 billion was spent on the maintenance and rehabilitation of feeder roads in the five (5) districts selected for the study for four financial years covering the period from 2007/2008 to 2010/2011. Since water accounts for 80% of damage to unpaved roads, a lot of the money spent in rehabilitation can be saved by ensuring water along the road is well managed and put to beneficial use.

1.2 Project Background IFDC

The International Fertilization Development Center (IFDC) is a non-profit, Public International Organization (PIO) established on October 7, 1974, with its headquarters in Muscle Shoals, Alabama, United States of America. IFDC strives to improve the livelihood of people in developing countries throughout the world by facilitating the sustainable improvement of agricultural productivity through the development and transfer of effective and environmentally sound plant nutrient technology and agricultural marketing.

IFDC is implementing the "Resilient Efficient Agribusiness Chains" (REACH – UGANDA) project, an innovative four – year agribusiness initiative. The project will improve market engagement for 40,000 Market – oriented farmers, strengthen household resilience, and deepen availability of agriculture support services for farmers and businesses. The project is targeting two value chains, rice and Irish potato and is being implemented in Eastern and South Western Uganda.

The third objective of the REACH – Uganda project is to improve availability and uptake of public and private support services related to core commodity value chains. One of the services is infrastructure.

As part of the program, IFDC proposes the upgrading /rehabilitation of a total of 49 kilometers (10Kms in Kanungu, 10Kms in Butaleja and 29Kms in Kween districts). The access roads will link the established farmer to markets thereby contributing towards the objectives of the REACH – Uganda project.

It is proposed that the project will rehabilitate the roads in partnership with the district local governments. As part of the effort to achieve this, IFDC has contracted KKATT Consult Ltd to carry out a condition assessment of the roads for upgrading/rehabilitation and an assessment of the available equipment.

1.3 Project Locations

The project area is located in three districts which are Butaleja, Kween ad Kanungu. For this assignment the districts of Kween and Kanungu are considered as outlined and shown in Figure 1.

a. Kween district in Eastern Uganda where the project road comprises of five (5) links running in sequence from Cheminy to Atar, traversing Kwosir, Kitawoi and Benet sub-counties;
b. Kanungu district in South Western Uganda where the project road starts in Rutenga Trading Center and ends in Kirimbe Trading Center, traversing Rutenga and Kirimbe sub-counties.

1.4 Scope of Works

The SoW stipulates the following objectives for the assignment with MetaMeta:

1. To conduct a field assessment of opportunities for water management on roads in Kween and Kanungu Districts.
2. To train key stakeholders on roads for water measures in REACH (based on assessment) and guidance to implementation, including also process of community engagement.
3. Together with experts train project farmers in the field on specific water management interventions.

Overall, based on the assessments and trainings, the district and communities will provide a framework for collaboration to implement improved road water management in their respective areas.

1.5 Contract period/Duration of Assignment

The period of performance of this Subcontract/Assignment is from 26th September 2018 running up to 2nd November 2018.

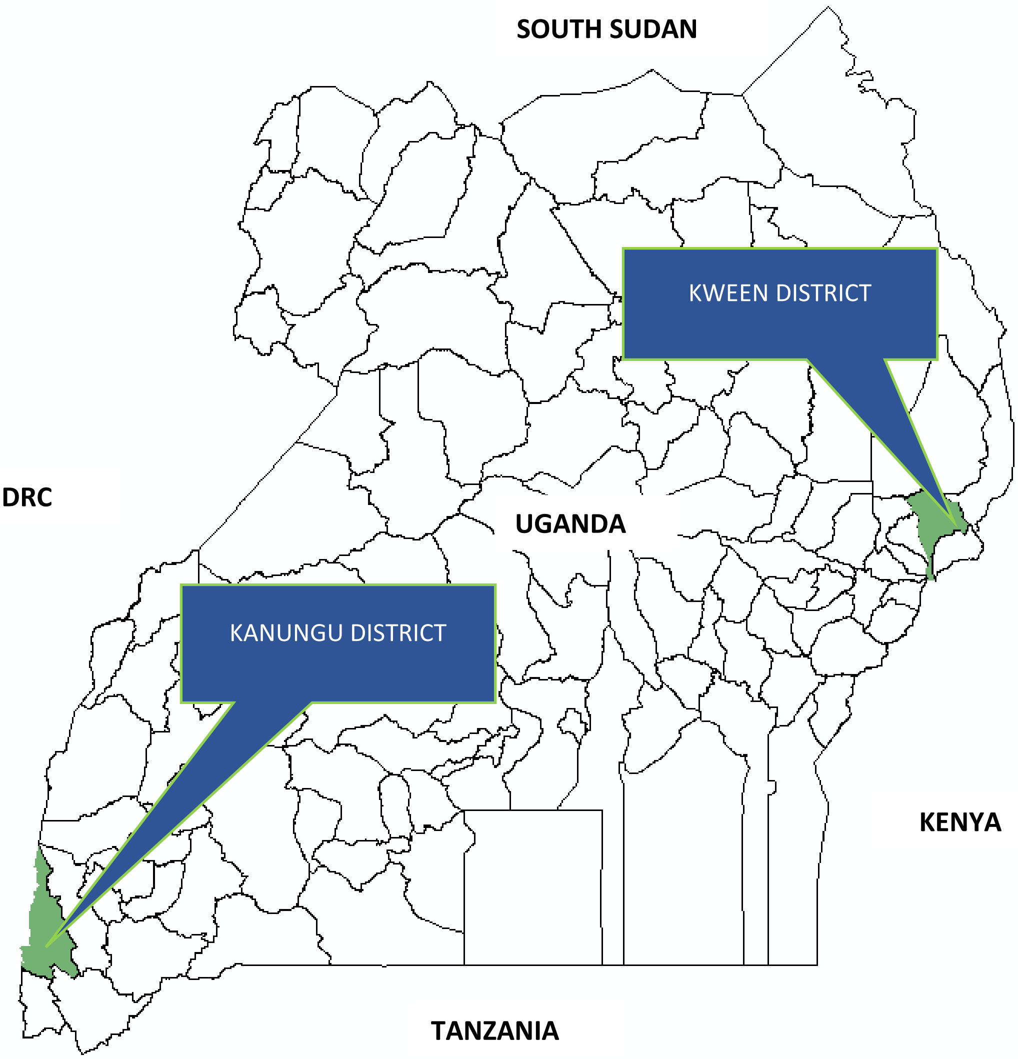


Figure 1 map showing project location districts

2 KWEEN DISTRICT

2.1 PROJECT ROAD LOCATION AND DESCRIPTION

The project road is in Kween district which is located in Eastern Uganda and is neighbored by Nakapiripirit, Amudat, Bukwo and Kapchorwa districts in the North, East, South and West respectively. The road, as mentioned in the final feasibility report starts in Cheminy trading center along Kapchorwa - Suam trunk road and ends in Atar along the same trunk road. The project road traverses the high agriculturally productive hills of Kwosir, Kitawoi and Benet sub-counties through a hilly topography. The area is bordered by Mount Elgon National Park.

Currently you can see agricultural production everywhere, with a large variety, the main crops cultivated are: Irish potatoes, barley, maize, cabbage, beans and matooke (banana).

Figure 2 agricultural production along Kween project road

From the interactions with the farmers in the area, they noted the importance of the road and how its condition plays a vital role in determining the prices of their produce. For example, the price of a 100 Kg sack of Irish potatoes can go as low as 25,000 Uganda shillings when the road condition worsens. But when the road is in good condition the price can rise up to 100,000 shillings for the same 100 Kg sack of Irish potatoes. This shows the great value farmers recognize as a result from the road conditions and how this impact their earnings.

The climate is warm and temperate in Kapchorwa[1]. There is significant rainfall throughout the year in Kapchorwa. Even the driest month still has a lot of rainfall. This location is classified as Cfb by Köppen and Geiger. The temperature here averages 18.5 °C. About 1576 mm of precipitation falls annually (https://en.climate-data.org/africa/uganda/kapchorwa/kapchorwa-780530/). Rainfall in the area is especially high in the months from April to August, though also in the other months there is normally some rain. However, farmers and technical officers indicated that the water is not enough to sustain agricultural production. In the area some farmers have already ventured into methods of irrigation, others practice water harvesting techniques in their farm. Though these practices are done by very few farmers. One of the challenges that farmers have is how to manage the peak flows of water and still be able to protect their farms, from e.g. soil erosion.

[1] Climate data from Kapchorwa, bordering Kween district, is obtained in order to provide information for Kween district, for which data is not available. Note that it intends to be comparable, not the same.

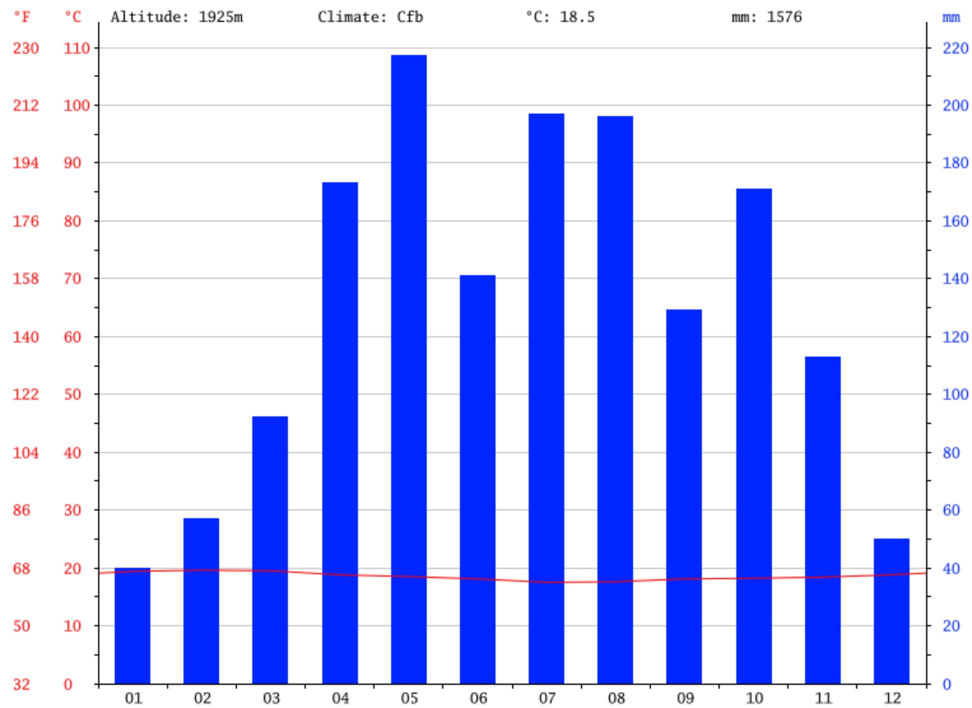


Figure 3 Graph showing monthly data on temperature and rainfall for Kapchorwa (Source: https://en.climate-data.org/africa/uganda/kapchorwa/kapchorwa-780530/).

2.2 METHODS OF ROAD ASSESSMENT

From the project progress meeting in which We were introduced to the team by the CAO during the project progress meeting in Kween on 28th September 2018 also in the presence of the RDC, MetaMeta team jointly visited the site with representatives from IFDC, Kween DLG (DE), COWI and KKATT consult Ltd on the same day to confirm the routes of the road and the borrow pit site for approved gravel.

On the morning of 29th September 2018, consultant then embarked on a detailed survey conducted through the project road in Kween and this was done using GPS machine for data capture and data recording sheets being some of the tools employed to note observations along the road. In some cases interviews of road side farmers were conducted to get a clear understanding about their current impression on road water runoff.

Figure 4 Pictures showing the various engagements with LC3 Chairmain Kwosir Sub County and several road side farmers

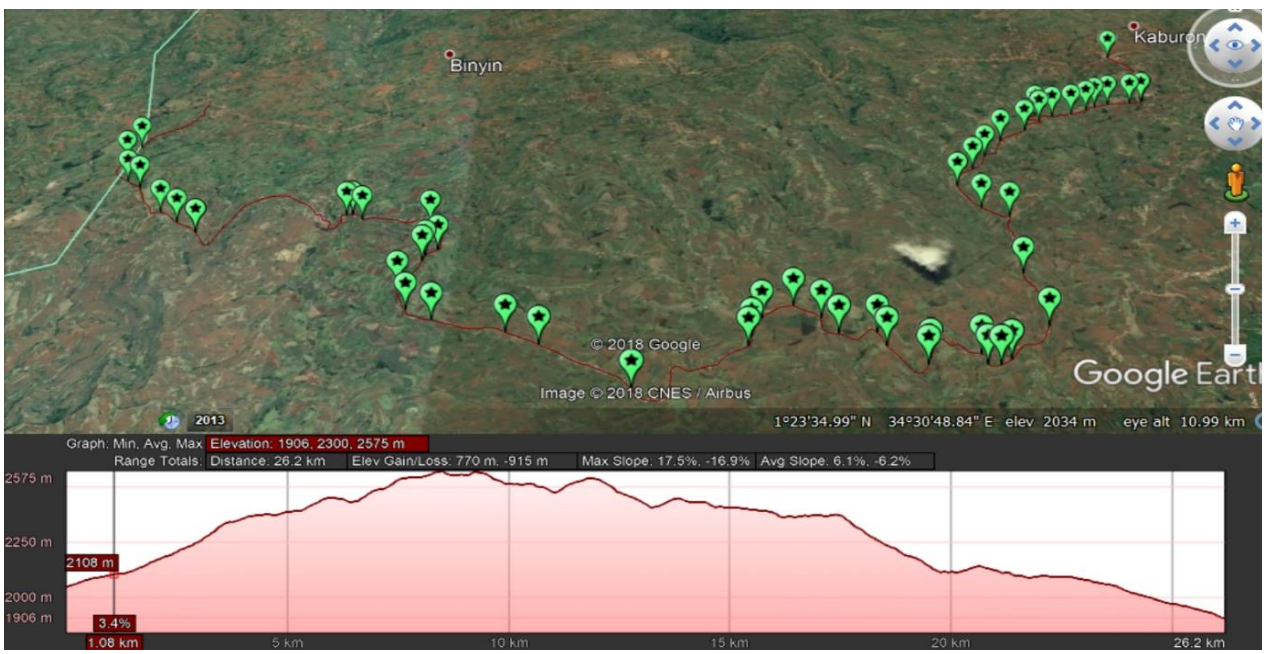
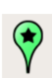


Figure 5 Road transect of Kween project road showing elevation profile and points for suggested interventions

Point along the road with suggested road water management intervention

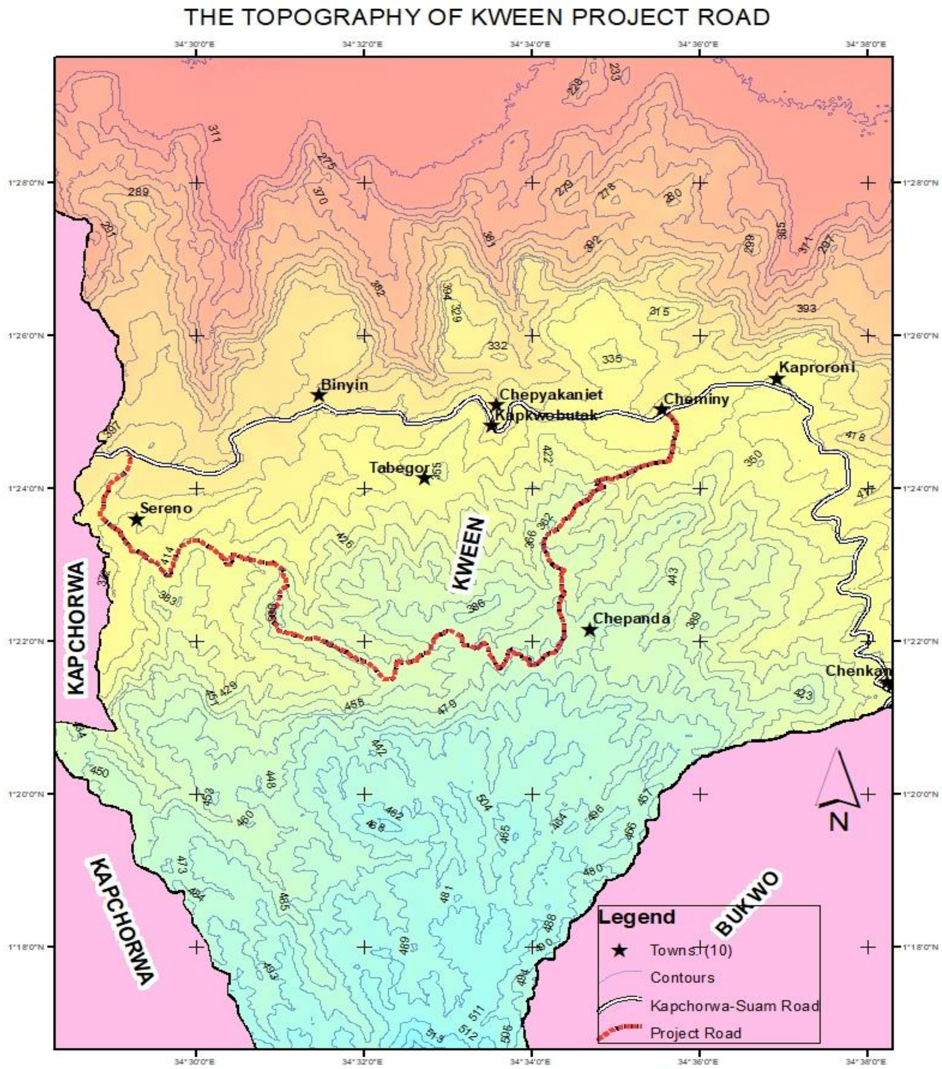


Figure 6 topograhpy of Kween project road

2.3 WATER RELATED ISSUES ON AND ALONG THE ROAD

The introduction of roads changes the hydrology of the area in a number of ways:

i. Changes surface runoff: The natural water flow system in the terrain is disturbed or interrupted while the road surface accelerates and concentrates the run-off.
ii. Changing sub-surface flows: Not only the surface runoff, the sub-surface water flow lines are also disturbed by roads development. Further the spring systems are also disturbed in the process.
iii. Can cause new water crossings i.e. streams and torrents

In general the issues all arise from water that flows with high velocity and which has accumulated to large amounts, because of a variety of reasons to be explained below. The flow velocity of the water in steep terrains has high inclination to erode the cut part and surface of the roads. In the area of Kween where the road is passing it is seen in many instances that water accumulates on the road itself.

Below a selection of identified challenges are discussed in more detail. In the next section recommended practices are suggested in order to provide solutions and ensure we can turn it around into opportunities.

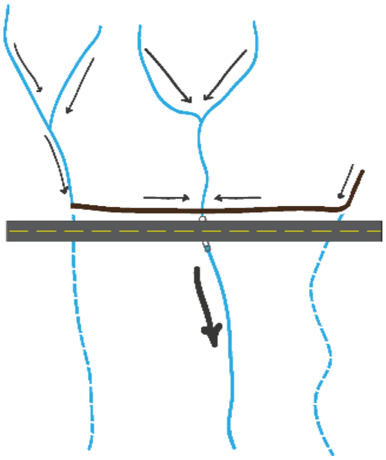


Figure 7 changed hydrology from road

2.3.1 Changing water flows

Looking at the topography in Kween, in many instances, water has to move from one side of the road to the other. The road is placed mostly following the contour of the hilly area at the middle section of the hill, and the road itself also has considerable gradients. Because of this road siting a lot of water from upstream is collected on the road, before it can move to the downstream areas. This greatly affects the road body, as per now the drains are insufficient and water is eroding much of the road body, causing bumpy rides and difficult passage to e.g. trucks which collect agricultural produce. The topography of the terrain requests for drainage structures which can transfer water downstream, without affecting the road body itself.

From the field observations it was noted that a lot of erosion, siltation, local flooding, and gully formation among other effects from road runoff were no exception for the feeder road under question. We captured some of the effects as observed at various points on the stretch of the road, as can be seen in Figure 8.

Figure 8 water logging and erosion problem spots

2.3.2 (Side) erosion due to blocking of structures

Water is being drained along the roads and can continue along the road on a long stretch or long slope. A big problem is that even where culverts and mitre drains are put in place, the community is often blocking these structures. Farmers see the water as a threat to their crops and farms, though they also see the problems they are creating for the road and the other farmers. Figure 9 shows examples of such issues along the project road.

Farmers have indicated these problems, if one farmer blocks the drain, automatically the next farmer will have accumulated run-off including debris which is carried with the flow. So it means one problem, creates many and bigger problems. Eventually it leads to the road ending up with all runoff water again, instead of draining it from the road, the water comes back to the road. This causes severe side erosion and in parts it is eating out the road body. It leaves gullies and rills on the road as well, making it difficult to pass.

Once this practice is taking place it is difficult for 1 or 2 farmers to change the practice, as it will have a small impact and is more likely to create problems for themselves. However, farmers indicated this should be a collective effort from all. Only in this way they can make it manageable for the farmers and can safeguard the road from damage due to water. The issue for the farmers is that they do not have the knowledge and skills on how to harvest this water.

Figure 9 pictures of mitre drains and culverts blocked by farmers or blocked by sedimentation

2.3.3 Erosion on steep slopes

There are a number of sections (Figure 10) on the project road which have severe erosion because they are on steep slopes and are partly rocky. These sections are most difficult to pass with a vehicle. On these parts the problems are combined: speedy flow of water, rocks guiding fast flow and easily scour out soils, and for farmers it is difficult to manage these waters coming in.

Figure 10 sites with erosion due to slope of the road and speedy flow of water

2.3.4 Current water management practices by farmers

From the field survey conducted on the project road, it was noted that the farmers use a number of good water management practices on their farms. A few farmers in the area indicated that they use trenches at the farm (Figure 11). However, they are very few and the water harvesting methods are also limited. Though it is something which is coming up in the area, coupled with irrigation methods. Farmers share the need for harvesting methods, mainly for the reasons of tapping into an alternative source of water and for preventing soil erosion on the farm. In this part of Kween District almost all the farms have contour bunds to control runoff and erosion. Within such a system trenches and infiltration pits can be integrated very well.

Figure 11 example of mitre drain extended into the farm as a trench / pathway

2.4 RECOMMENDED PRACTICES KWEEN

In this section practices of road water management are selected which provide solutions for the issues for Kween as described above. It ranges from the placement and alignment of the road, to water harvesting practices that can be taken up by farmers. This in order to ensure the road to be respite from damage and the farmers to have water for beneficial use, without putting their crops at danger. The recommended practices include 1) catchment management, 2) cross-drainage design, 3) use of stones to stabilize and prevent erosion, and 4) road water harvesting techniques. The considerations on catchment management are included as provision, for reasons of future development of the road or new roads. For the project road under construction recommendations under 2), 3) and 4) are best applicable, they complement planned drainage structures and guide farm interventions.

2.4.1 Catchment management

Figure 12 and Table 1 sketch 4 situations and 4 different choices that inform you where to locate the road. One of the choices to make is based on the water catchment that you will be able to tap into with the road. If the road is almost at the top of the hill, there is not much water to be collected on the road from the upstream side. However, if the road is placed in the middle, it will gather a lot of water which then has to be distributed through road drainage systems. This can be a challenge, but also an opportunity. In Kween the road is rather at the middle of the hill, so this water from the upper catchment can be used downstream by the farmers. Therefore also the alignment and the gradients should be taken into account, so to help compartmentalize the water in small amounts for instance. Furthermore, the slopes of this road are steep at some sections, if this could be more windy and gentle, it would greatly help to reduce the speed of the runoff. The curves and bends can function as outlet points for the water. In these cases water does not move at speed and does not get the chance to damage the road. And farmers are more likely to be able to harvest the water, because it is already controlled for them.

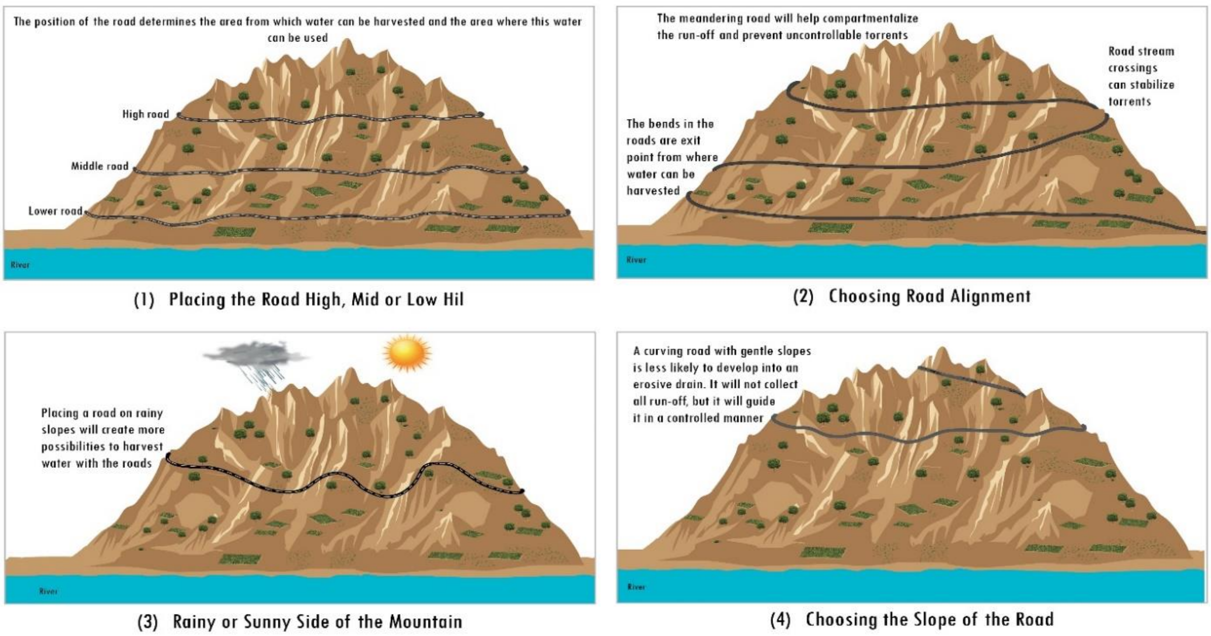


Figure 12 examples of options for road alignment and sloping in hilly areas

Table 1 options to weigh when designing and constructing roads in hilly areas

Catchment management	
Location on hill side	Consider placing the road uphill, mid-hill or downhill so as to balance the upstream road catchment and the downstream water use areas
Rain-slope	In semi-arid areas, having the road on hill sides with more rain so as to capture more run-off for productive use
Compartmentalize flood run-off	Use roads to compartmentalize and slow-down run-off, especially in areas that are highly susceptible to flooding and deep erosion.
Slopes, curves	Provide sufficient curves and breaks in the slope. A steeper road straight up a slope is likely to act as a drainage collector. In some cases such a new road may even impose a new drainage pattern on a landscape that was not there before, with many minor drains discharging into the road. This can happen particularly on the top of hills where the drainage pattern is usually not well defined. Care is required to provide an alternation of slopes and curves.

2.4.2 Cross drainage design

In order to get water across the road culverts are often a good option to allocate for the water to flow without affecting the road and its users. It normally allows for vehicle and foot passage at all times. Also, the provision of culverts including maintenance can be done primarily with local labour and local materials. However, regular maintenance for these culverts is required to prevent the culvert from silting up, or to remove debris blockage. Also they often act as a channel, forcing a concentrated water flow with greater potential downstream for erosion, they are not suited for occasional high volume flows.

There are consequently 2 things we look at:

1. Change culverts into an opportunity
2. Provide other options for cross drainage: rolling dips and water bars

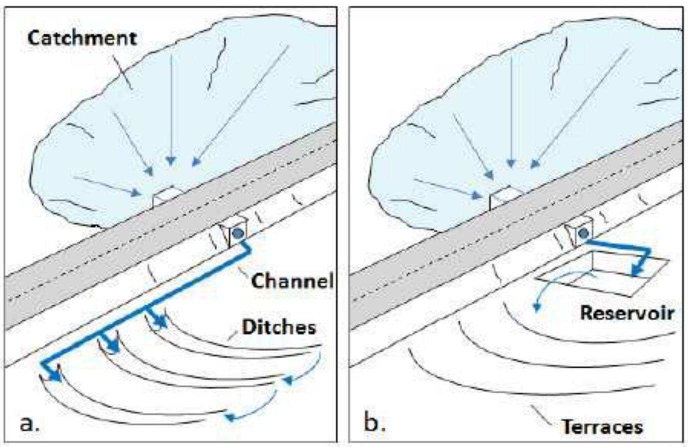


Figure 13 options for culvert diversions

1. Culverts can also be used for harvesting water, as the water is concentrated in one place it provides an opportunity to tap into this resource. The first key element is to spread the water from the culvert outlet. In this way it can be managed in small portions on the farm for infiltration and storage. The runoff from a cross-culvert can be directed to farms for immediate use, or for storage. Water is spread in smaller channels to reduce erosion and gully formation.

Steps on design and construction:

- Identify the flow direct of the water from the culvert and assess the quantity
- Construct cut-off drains with bunds. In order to direct the water flow.
- Ensure a gentle slope for the water to flow, but not to destruct.
- Identify the next use of the water
    - Construct ditches/trenches in the farm to collect the water from the culvert. Keep the gradient below 3%.
    - Construct a storage pond to collect the water from the culvert
    - Spread water over land, divide the field in terraces. Make a breach in the terrace-bund to let the water enter the terraces one by one.
    - Direct the water to planting pits (zai-pits)
- Diverting water from a culvert is key in preventing gully formation and erosion.
- Reinforce the bunds with stones when available
- Construct the culvert-diversions early, so that no gully will develop
- In grazing land water can be spread directly in a controlled manner. For instance using low earthen/stone bunds along contour or Vetiver/African fox tail grasses.

Figure 14 examples of existing culvert outlets which can be diverted into contour-trenches and example of on-farm trench (right-below)

2. ***Rolling dip*** (Figure 15) is the most reliable cross drain for low standard roads, because it does not concentrate the flow as much as culverts, risking erosion, and it is low in maintenance.

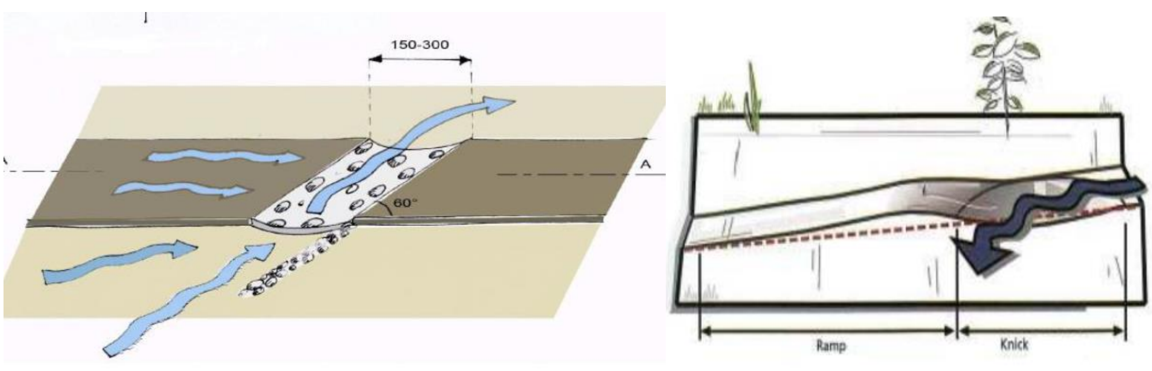


Figure 15 sketch on how rolling dips should look like

- Use when road profile is not maintained (is often)
- Used to drain roads having grades between 3 and 15%
- Function: collect surface runoff from the roadway and/or road ditch and direct the flow across and away from the roadway

- Broadly angled dip drain with a cross slope of 4-8%, steep enough to flush away accumulating sediments

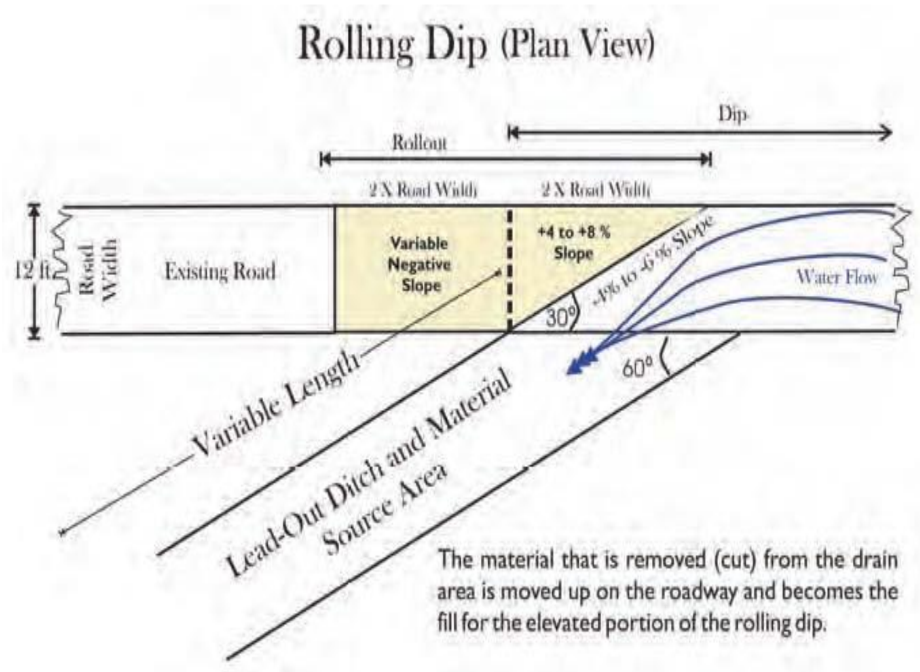


Figure 16 plan view of rolling dip

Construction of rolling dips:

- Part of the road and the adjacent areas is excavated so as to lead the road run-off to adjacent land
- The excavated material from the dip is used to create to a higher area in the dirt road, making the road to slightly undulate and so create different drainage segments
- The velocity of flow must be sustained through the dip to prevent puddling and to keep sediment moving through the dip drain.
- Can be channelled to land or ponds

A water bar is a pushed up mound of earth or hump on the roadway used to deflect runoff from the road surface:

- Quick, easy and cheap to build.
- More effective when built at an angle of 30% to the grade.
- Waterbars are normally built to a height of 15-40 cm above the road surface

2.4.3 Use of stones to stabilize and prevent erosion

Use of stones and local material in combination with vegetation will stabilize the water ways, especially important in areas with peak flows and steep slopes. Besides the often applied scour checks in side drains to slow down water flow and trap sediments, stones or types of check structures can also be used to protect water channels from eroding. This can be done for example with mitre drains, to support culvert outlets and in gully plugging. Furthermore for farmers this is an adequate and rather cheap method if combined with grasses and other vegetation to stabilize the water channels in their farms. It will also help them to ensure a safe cut-off from the road drainage into their farm.

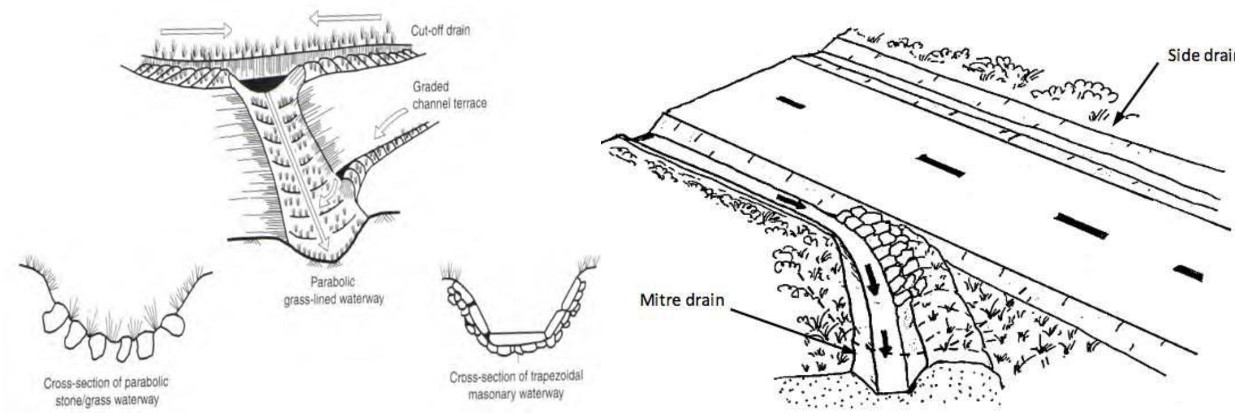


Figure 17 examplel of how to use stones to support culvert outlets, side drains and mitre drains

Characteristics and design considerations:

- Cause some water to infiltrate
- Used to conduct run-off from cut-off drains to storage structures
- Grass waterways for slopes up to 25%
- Steeper slopes, channel lined with stones, masonry or reinforced concrete
- Dimension depends on the expected discharge
- Diagonally across de slope not recommended, if they break or overtop can cause serious damage
- The preliminary position should be determined from a reconnaissance field survey
- Where possible, it should be located in a natural depression or drainage way.
- Should be inspected after every heavy storm

Figure 18 stone chutes in practice - reducing soil erosion and slowing down water flow

2.4.4 Road water harvesting techniques

The following techniques will be trained to technical people and road side farmers and jointly decide which ones they would prefer to apply; cut-off from side drains, diversion from culverts, deep trenches and infiltration ditches. Below design steps are noted for the different structures.

1. Cut-off from side drains

- Identify the location to enter the farm
- Put a block-off (scour check) to ensure water will flow into the diversion
- The angle between the diversions and the side drain should be 30 degrees, but not greater than 45 degrees
- The desirable slope of the diversion is 2%, no larger than 5%
- Drain should lead gradually across the land. Best to follow the contour, so it gets shallower and shallower
- In case of need, lay stones at the end of the diversion to prevent erosion

Remarks:

- A sequence of diversions improves the water collection and safeguards the side drains from eroding
- *In mountainous terrain,* accept steeper slopes. Provide soil erosion measures. For example use stones and vegetation in the diversion ditch.
- *In flat terrain*, gradients of <1% may be necessary. Make the slope continuous with no high or low spots.
- In case of siltation, apply a silt trap before it enters the farm. Grasses, like Vetiver, can help to filter the water and trap sediments.
- This diversion can be combined with deep trenches or an on-farm pond.

2. Deep Trenches/infiltration ditch

Trenches are made to keep the water in the farm to increase soil moisture. This makes water available in the root zone of the plants. Trenches can be closed off every 2m to become pits. These pits improve the water infiltration, so to recharge groundwater. Trenches are made to directly harvest run-off from the road into the field and protect the field from erosion by road run-off. The following steps can be used in the construction of deep trenches.

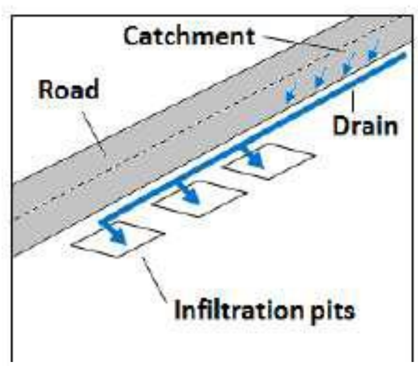
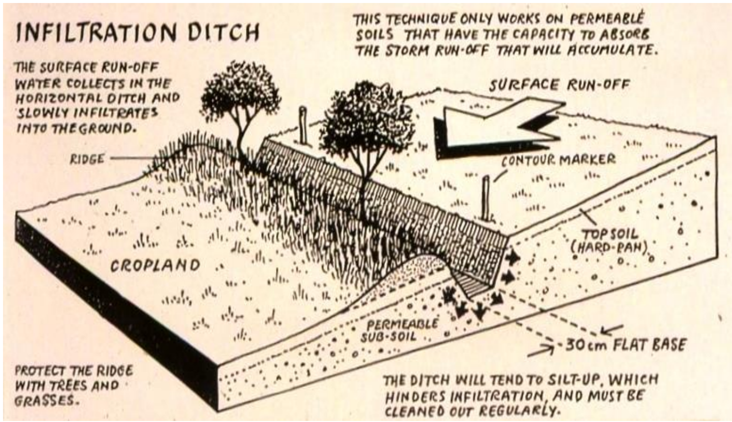


Figure 19 Sketch of infiltration pits along the road

- Identify the location on the farm
  - On the upper part of the farm
  - Along the contour
  - In case of steep terrain, combine with terraces. Lead the trench down along the terraces.
- Dig the trench in the farm
  - Use the soil that you dig to make the bund/ridge.
  - Protect the bund/ridge with trees/ tree-crops / grasses
- The trench should have a depth and width of 60-90cm (about 2-3 feet). The length can be as long ad needed.
- Ensure the water in the trench to flow along the contour. You want the water to stay, so it should have minimal flow, slope should be below 1%.


INFILTRATION DITCH
THIS TECHNIQUE ONLY WORKS ON PERMEABLE SOILS THAT HAVE THE CAPACITY TO ABSORB THE STORM RUN-OFF THAT WILL ACCUMULATE.
THE SURFACE RUN-OFF WATER COLLECTS IN THE HORIZONTAL DITCH AND SLOWLY INFILTRATES INTO THE GROUND.
SURFACE RUN-OFF
RIDGE
CONTOUR MARKER
TOP SOIL (HARD-PAN)
CROPLAND
PERMEABLE SUB-SOIL
30cm FLAT BASE
PROTECT THE RIDGE WITH TREES AND GRASSES.
THE DITCH WILL TEND TO SILT-UP, WHICH HINDERS INFILTRATION, AND MUST BE CLEANED OUT REGULARLY.


3 KANUNGU DISTRICT

3.1 PROJECT ROAD LOCATION AND DESCRIPTION

The project road in Kanungu district in western Uganda begins at about 0+000 km from the UNRA main road (Kanungu - Kabale) at Rutenga Trading Centre and ends at Kirimbe T/C a total distance of 7.85km as mentioned in the feasibility report. The road lies within a hilly undulating terrain where the main economic activity is lumbering, and potato cultivation with cabbage and Irish potato growing on a small scale.

The main activities along the road are farming activities. The greatest portion of the road, agro-forestry is being practiced. A large part of land is used for lumbering and tree planting. To a lesser extent bananas, maize, tea, Irish potatoes, cabbage and more vegetables are being grown.

Figure 20 tea, bananas, Irish potatoes are mainly grown in the project area, also much lumbering is taking place

The climate here is tropical. In winter, there is much less rainfall than in summer. This location is classified as Aw by Köppen and Geiger. In Kanungu, the average annual temperature is 18.9 °C. The rainfall here averages 1222 mm (https://en.climate-data.org/africa/uganda/western-region/kanungu-50845/).

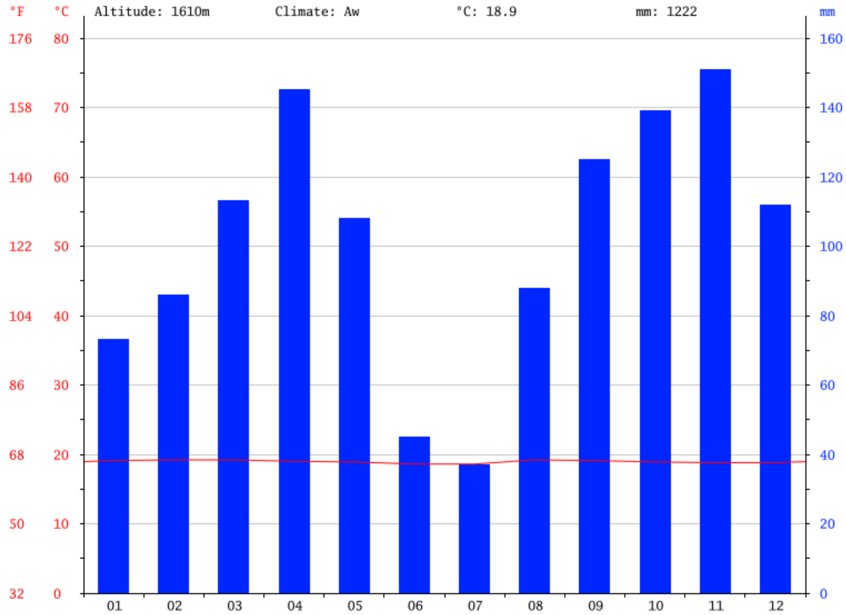


Figure 21 Climate graph showing the monthly temperature and rainfall conditions for Kanungu, Uganda. (Source: https://en.climate-data.org/africa/uganda/western-region/kanungu-50845/

3.2 Methods of Road Assessment

The field work started after an introduction meeting with the Chief Administrative Officer of Kanungu District where the consultant (MetaMeta Research) introduced themselves and the role of their engagement on the REACH project to him on 3rd October 2018. Thereafter, we jointly visited the site with representatives of KKATT Consult Ltd on the same day to understand the extent of the project road.

On the morning of 4th October 2018, we were led by a representative of KATT consultant to the site carry out a road assessment to ascertain the various road water harvesting interventions that can benefit the roadside farmers as per the ToRs. With the use of a Global Positioning System (GPS) Equipment, suitable locations were recorded where various roadside water harvesting systems can be positioned to improve the agricultural yields of the roadside farmers.

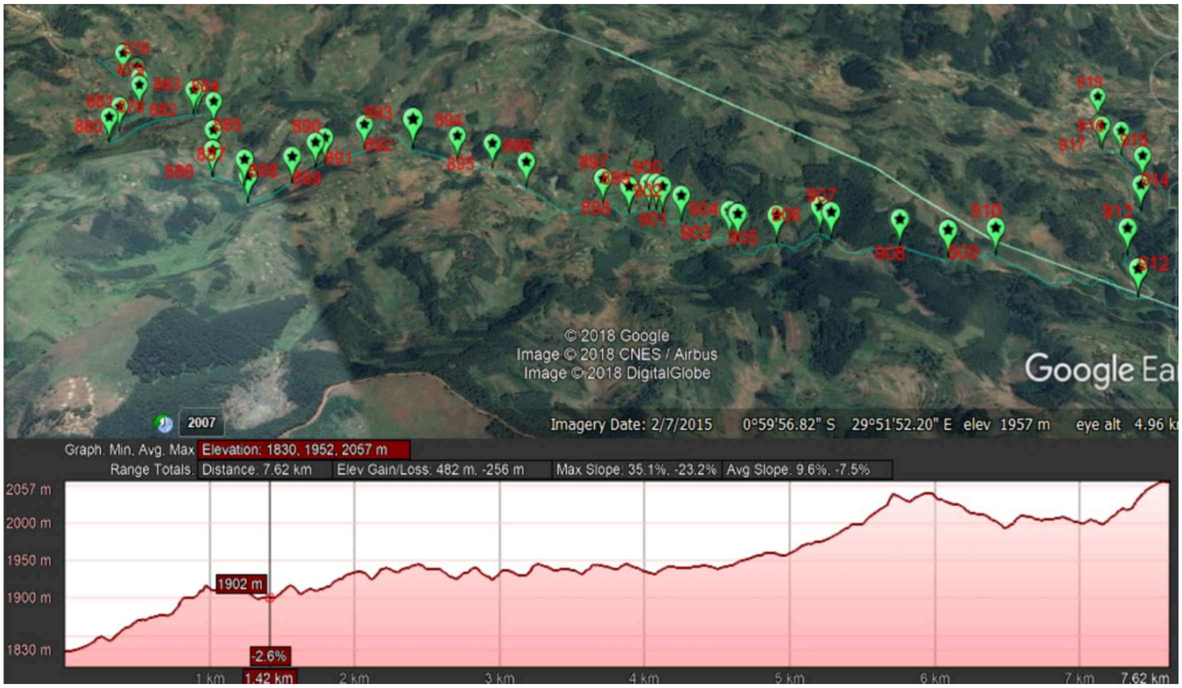
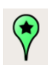


Figure 23 road transect showing the elevation profile and the points for suggested interventions

 Point along the road with suggested road water management intervention

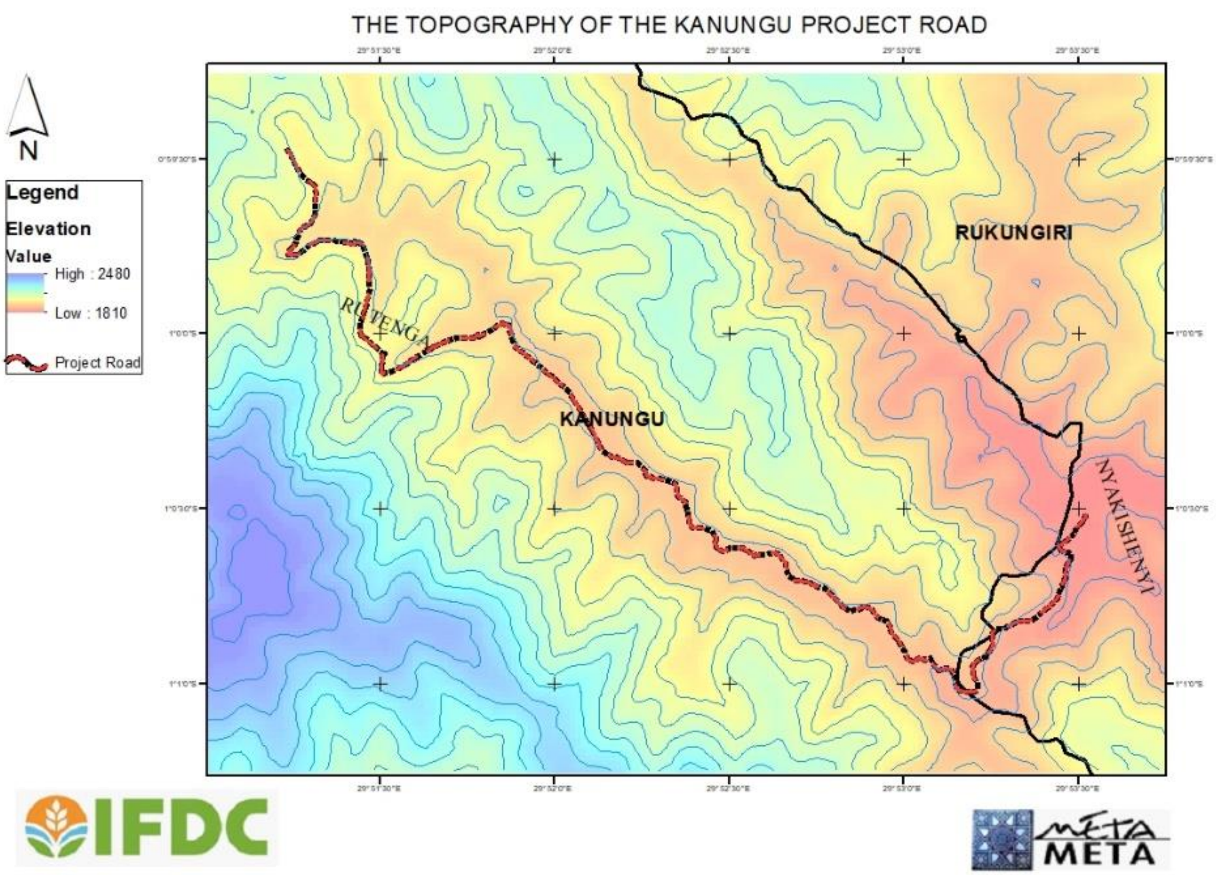


Figure 22 topography of Kanungu project road

3.3 Water related issues on and along the road

The project road is located in a very steep terrain bordered by a great hill on the right-hand side as shown in the map below which rises over 2,500m asl. This puts the infrastructure at a great risk of being destroyed by the speedily running water from uphill.

Especially during road construction the slopes on the side of the road have become unstable. The cut and fill sections of the road and road surfaces itself are very vulnerable during the construction phase. Erosion may be inevitable phenomena during and after the road construction, from the less stable slopes. The reason roads are a huge source of sediments, this comes from erosion, landslides and from the unpaved road surface itself. Many of these sediments are washed away from the land and end up into streams and rivers.

Due to road construction there is also a change in hydrology in this area, with this type of topography it is especially important to cater for changed water flows. For instance, new road water crossings can evolve in terms of streams and torrents which now have to cross the road. On the road it was identified that surface runoff and springs are interrupted by the road. This has an effect to the road, and also to the downstream area.

The main issues for the project road are: Water logging on the road, erosion, flooding and sedimentation.

3.3.1 Road sections with water logging

The existing drainage system being insufficient for accommodating the gross amount of water collected by the road catchments in the project area, development of pot holes and iterative flooding of the roads has are some of the signs noted. There is a number of waterways from the upstream side and also springs that come from the rocks and pass the road before they enter the downstream area. This is causing severe waterlogging at these crossing points. Additionally, also the road surface itself is not properly

Figure 24 examples of water logging on the road, mostly because of spring water crossing the road aligned at this moment, allowing water to stay at the road and making the road body soft. This now causes many difficulties for vehicles to pass the road during rains, because of the slippery and soft soil, cars cannot get grip and either 'dance' through the mud or get stuck too deep.

3.3.2 Erosion

Erosional problems were also recorded along the road, some were rills while others were gullies (Figure 25). Due to erosion, many road structures like bridges have been eroded, drains have been silted, culverts have been carried away and this has become a big threat to road safety.

- Erosion during/ just after road construction
- Erosion from less stable slopes
- Sedimentation from road surface

Figure 25 erosion along the road leading to a gully downstream

3.3.3 Flooding of farms

Figure 26 banana farm adjacent to road deals with flooding issues

In this situation (Figure 26) a garden with Matooke (bananas) at the end of the road flooded with uncontrolled water from the road. The banana plantation is directly adjacent to the road and the water collected on the road spills at this point to the garden downstream. The farmer has not put in place soil and water conservation measures. There is a need for farmers to put structures in the farm which can spread and control flood water and enable retention on the farm.

3.3.4 Sedimentation /siltation from unstable slopes

Various sedimentation/siltation problems were recorded from the field work. Mostly the problems appeared downstream of various culverts. Sedimentation/siltation is caused by the debris carried by the running water along the roads. This blocks the culverts that are designed to convey the water from one side of the road to another to avoid flooding.

The main reason for sedimentation in the old situation was erosion of soil from the upstream hill. During road construction this has aggravated due to the loose soils caused by machinery doing cut and fill of road sections. The widening of the road often happens by taking soil from upstream slopes and depositing this on the downstream slope. The slopes on both sides would need to settle and be supported with vegetation in order to stabilize. As the contractor will do back-sloping the main activities required would deal with providing bio-engineering with vegetation, stones and other locally available material. This will be discussed in a next session on the recommended practices.

Increased sedimentation and siltation from unstable slopes typically leads to:

- Damage to road surface
- More sediment in streams and water bodies

- More sediment washed in fields (the more so in early years)

Figure 27 Unstable embankments leading to soil collapse

Figure 28 other examples of very loose soil and other debris material on the slopes - cause of increased sedimentation

From the field survey conducted on the project road in Kanungu, there were no existing water management practices along the road. Large part of the area is used for lumbering, while in other parts they grow vegetables, especially potatoes and cabbages. These fields are on the slopes and are separated with grass bunds with planting along the contour lines, in order to prevent erosion on the farm. There are no specific water management practices in place on the farms that are made to harvest and store water. The area has a lot of rainfall with an almost annual distribution, however farmers indicate that the water is not always enough, in the dry months they have shortage for their farms.

Lumbering is widely practiced along the project road, especially in the section of towards Kirimbe market center. Cutting the trees also induces sedimentation due to slopes left bare, normally the slopes are reforested again, though it will always take some time to settle. During these times also more sedimentation is expected. Furthermore farmers indicate that the people who are cutting the trees into pieces leave a lot of debris, which is taken with the water and is blocking the culverts. This leads to mal functioning of the drainage systems in place. Additionally wood is often left on the road, occupying space for vehicles. And heavy loaded vehicles cause damage to the road, as can be seen in Figure 29.

Figure 29 lumbering activities s along and challenges on the road

3.4 Recommended practices Kanungu

This section provides a selection of recommended practices for Kanungu. Taking into account the effects of water on road structures and its environment, and how these can be solved with road water management practices. The recommendations should go hand in hand with the drainage structures that will be placed. A number of recommendations suggested for Kween are also applicable for Kanungu: a) catchment management and choosing the placement of the road within the hilly topography, b) the techniques of providing stones and vegetation measures for stabilizing water channels, and c) the techniques for harvesting runoff in farms through deep trenches and infiltration pits. For Kanungu the focus will be on 1) road alignment and sloping, 2) bio-engineering, 3) spring protection, and 4) road water crossings. In addition, suggestions are given for 5) protection structures for the culverts that are planned for the project road. As for Kween, also options for road design are included being provisionary and for future development (1). For this project the focus would be on interventions recommended under 2), 3), 4) and 5) which are mainly additional measures to the project road.

3.4.1 On road alignment, sloping and more

i. Gradual road slopes that avoids road developing into drains
ii. Gradual outward slope of road – no run-off accumulation
iii. Mass balance method – using the spoil that becomes available by cutting a road in the mountainside to make the downward toe of the road – thus reusing the spoil and requiring less pronounced road cuts
iv. For example a multi-year approach can be taken – in Nepal they are developing the road over three years typically – fist aiming at 2.5 meter width, then allowing the road to settle and then widen it to 3.5 and 4.5 meter respectively in year 2 and 3.
v. Labour-based approach – attention for detail. Care for springs and careful use of spoils.
vi. Breast walls/ toe walls for slope control and spoil control
vii. Use of Bio-engineering

3.4.2 Bio-engineering for reduced sedimentation

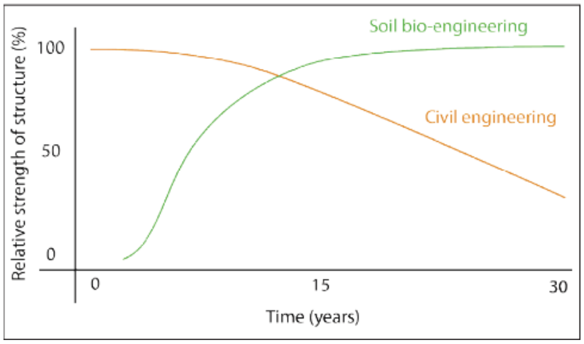


Figure 30 civil and bio-engineering complement and strengthen each other

Currently roads requires much periodic maintenance and is less cost-effective.

Compared to road constructed with proper drainage and low-cost vegetative stabilization, or bio-engineering

Civil engineering and bio-engineering should go hand in hand. Both cannot stand alone.

For small failures, appropriately-scaled civil engineering structures may be required as reinforcement to vegetative stabilization to anchor the soil (e.g. stone walls for reinforcing slope toes with vegetation on slopes). Furthermore, community based bio-engineering for eco-safe roadsides will greatly reduce maintenance costs for the entire life-span of a road. With limited extra budget at initial construction the annual maintenance costs will be reduced, eventually resulting in a better and cheaper road in 20 years' time.

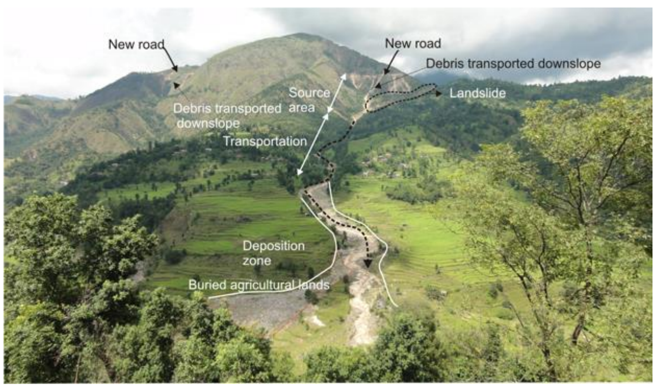


Figure 31 road drainage catchment overview

At first it is key to identify the problems related to road construction on the slopes. Looking at the entire road-catchment to find the changing hydrology patterns and how this should be buffered. Issues that arise after road construction may be landslides, earthflows, rock falls, debris flows, water induced erosion, and sedimentation impacts to waterways. Once the problems are identified you move into a techniques assessment. A diagram for making choices on what techniques provide best solutions and what species of grasses and trees to select is provided in Figure 32.

Problems	Solutions	
1. Surface erosion Control of run-off		Method 1.1. Turfing
		Method 1.2. Jute netting along with seedlings
		Method 1.3. Grass plantations
		Method 1.4. Facines
2. Gullies		Method 2.1. Live check dams
		Method 2.2. Vegetative stone pitching
3. Shallow landslides	DRAINAGE techniques +	Method 3.1. Palisades
		Method 3.2. Brush layering
		Method 3.3. Gabion walls combined with vegetation
		Method 3.4. Dry stone walls combined with vegetation
4. Secondary impacts on waterways from road construction		Method 4.1. Live check dams combined with vegetation and boulders
5. River bank protection		Method 5.1. Sandbags, bamboo vans & vegetation, if the problem is bigger gabion or stone / boulder retaining wall might be good

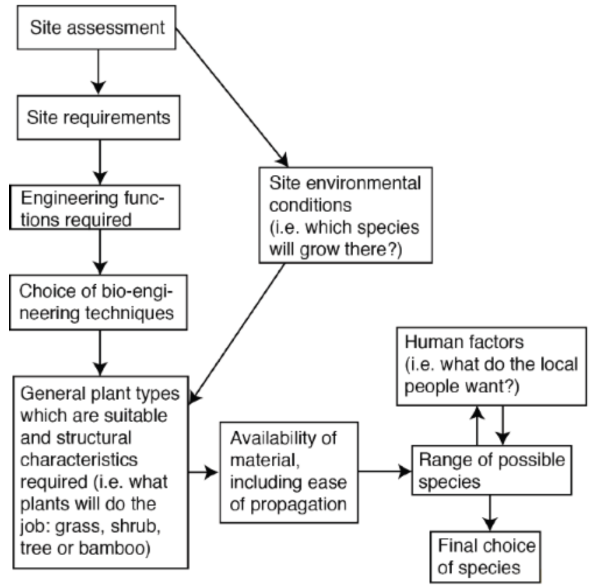


Figure 32 diagram to select adequate solutions to the problems identified

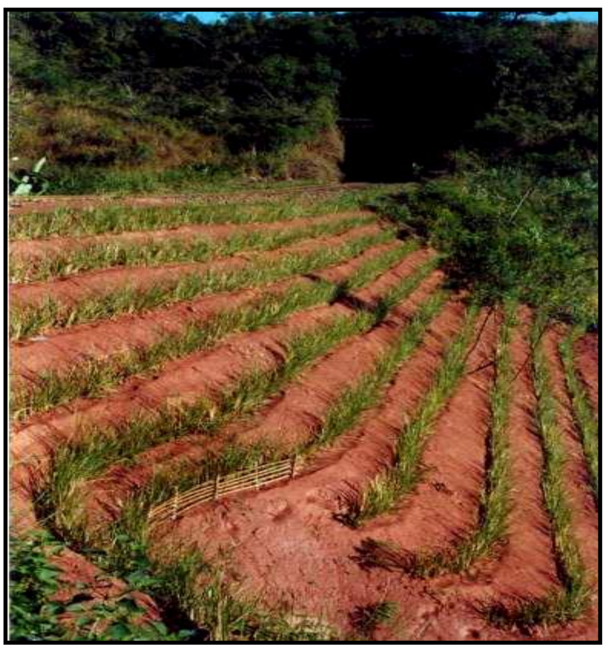


Figure 33 example of vetiver planting on a slope

The main methods include types of vegetation, combined with stones, woodwork, branches and other material which is locally available. In the project area there are few section where stones are available which can be used. Stones can be put inside drainage channels to strengthen these, reduce water flow and prevent erosion. Coupled with vegetation they will also keep more sediments from flowing to downstream areas. Regular maintenance is key for removal of sediments. Furthermore grasses such as vetiver, but also e.g. elephant grass can be planted along ridges on the slopes to stabilize and prevent soil erosion (Figure 33). Grasses can also be used for livestock, or by selling it for additional income.

Bio-engineering techniques recommended for Kanungu project road include the following, Figure 34:

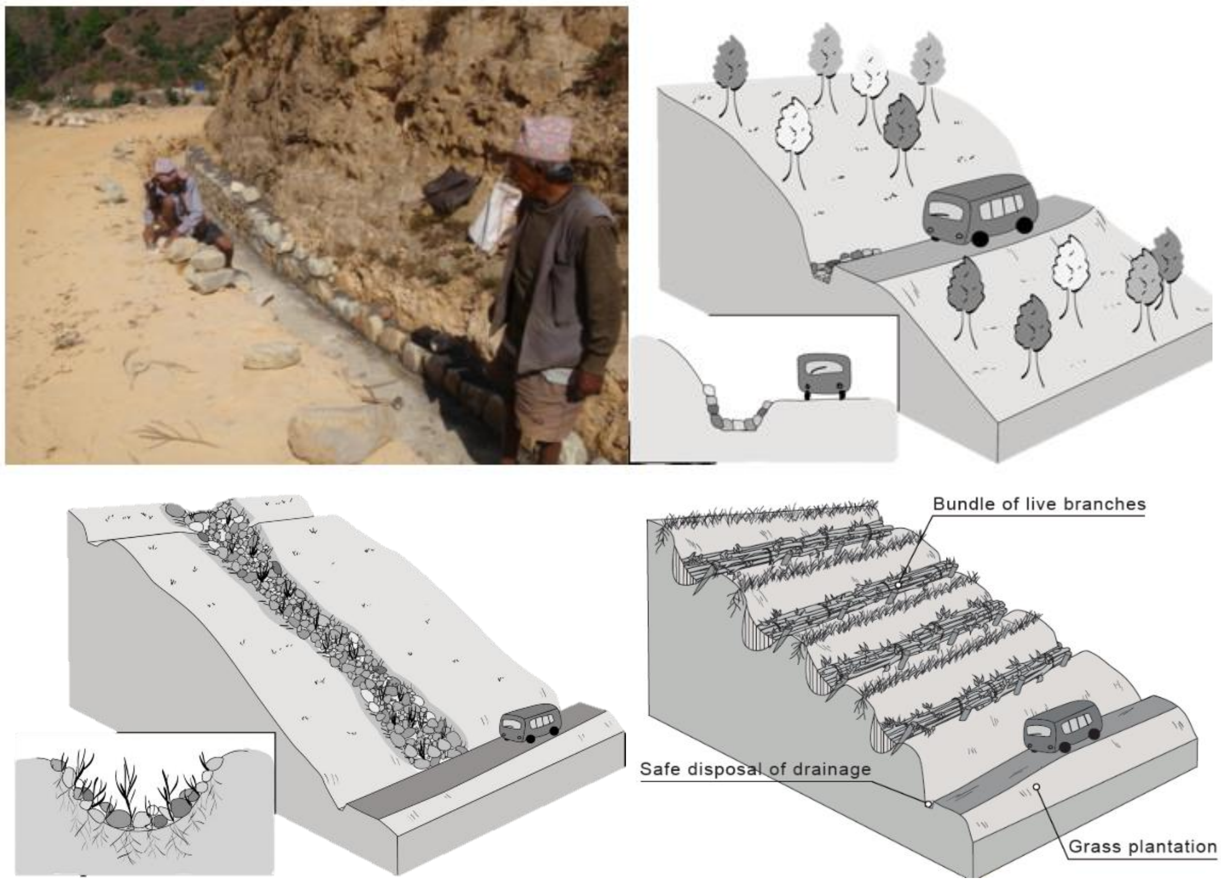


Figure 34 picture and schematic examples of how to use bio-engineering along roads and slopes in hilly areas

3.4.3 Springs management

Protecting and managing existing springs and opened by road construction can provide a safe and reliable source of water for the local community and agriculture. Springs can be managed in two ways

i. Controlling springs: By controlling outflow of the springs, water can be better retained in the area. Having the spring equipped with a gated outlet, make it possible to store spring water in the aquifer. In the controlled spring the outflow is regulated and retained – creating storage in the aquifer and prolonging the time during which water is available
ii. Water from springs is collected and stored for agriculture use by constructing small storage tanks or plastic ponds nearby the agricultural land.

3.4.4 Road water crossings

Below a few options for road crossing coupled with sketches on how this looks are provided. These additional structures can be designed and placed by using local material and without changing the road design. Their main function is to cater for (new) streams of water that need to cross the road without affecting the road body itself or causing erosion/sedimentation downstream. Table 2 gives options for road water crossings based on the type of water flow. Figure 35 gives examples of how this would look like.

Table 2 summary of road water crossings options

Rain torrents	Dissipation blocks Stream armouring Check dams
Minor stream	Reinforced causeways - Lower middle section

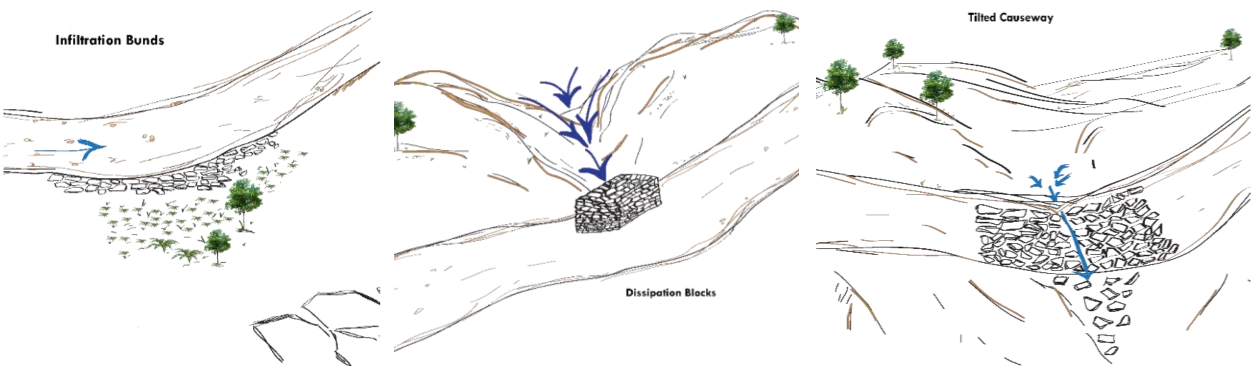


Figure 35 examples of ways to cater for, dissipate or support road water crossings

3.4.5 Culvert protection measures

With the planned drainage system of the road, the spacing between the culverts leaves little space for additional structures. However, protection of culvert inlets and outlets, plus diversion structures are critical in ensuring proper drainage without washing away of structures or flooding downstream farms. (For cases of overflow of culverts due to being blocked by debris from wood cutting, farmers and road engineers decided the community has to set good practices and rules to ensure this will be managed in a good way along the road.) For the new culverts to be placed, interventions were decided on all the

culvert locations where there is a roadside farm. Such culvert interventions shall include:

- ✓ Water will be spread gently away from the drains to avoid erosion.
- ✓ Culvert water spreaders shall be constructed early enough so that gullies shall not develop from culvert tail water.
- ✓ Water will be guided gently to agricultural land to be used as flood irrigation using cascading spillways and chutes with stones (use local material in the area)
- ✓ Bunds will be reinforced with stones.
- ✓ Gully plugging at culvert outlets
- ✓ Infiltrating bunds at the downside road shoulder – using stones that are locally available
- ✓ Install water bars and depressions to guide water across the road. Do this to evacuate the water to specific points in the bends – reinforce these evacuation points with spoil from the road and other stones available.
    - o In dry years, lead the water from water bars to infiltration bunds – in order to add water for recharge of groundwater and soil moisture.

4 GOVERNANCE AND COMMUNITY ENGAGEMENT

Last but not least. Implementing road water management can only happen in a sustainable way if there is cross-sectoral integration and intensive community collaboration. Especially for these type of feeder-roads which can unleash an enormous potential when it is integrated with other sectors. You make use of the enormous development potential of roads in boosting local economy, skill development, local business generation and climate resilience. In such a setting roads truly become multi-functional and become resilience corridors.

Within this chapter two aspects will be discussed, on integrated road water management at district level and community engagement within districts. In annex 6.1 an example of road maintenance groups is provided as a good practice which has potential for both Kween and Kanungu districts.

4.1 INTEGRATED ROAD WATER MANAGEMENT

The focus is on how road water management can be integrated into existing programs, rather by improving coordination and collaboration instead of moving away from the systems in place. Roads do not stand alone, so the cross-sectoral collaboration is vital for its success. Through: cross-sectoral integration, low-cost and high impact interventions and close involvement of farmers in road maintenance and water harvesting; costs of operation and maintenance can be greatly reduced. Saving on recurrent costs and ensuring that in e.g. five years' time the road is still in optimal condition without additional costs for maintenance.

In Table 3 a short summary of the district committee members for both Kween and Kanungu is provided, more information on this can be found in the training report.

Table 3 district committee members for Kween and Kanungu

Kween District Committee	**Kanungu District Committee**
District engineer	District engineer
District Community Development officer	District Community Development officer
District Natural resource officer	District natural resource officer
District production officer	District production officer
Rep. Local Council	Rep. Local Council
Secretary works	Coordinator from the office of the CAO
District Planner	
Coordinator from the office of the CAO	

The main tasks for the committee are to:

- Supervise and monitor ongoing road water management in ongoing construction
- Mobilize communities and engage them in the work – through sub-county road committees
- Guide the process at sub-county level to make by-laws against practices that damage the road
- Integrate road water management in existing programmes and mobilize resources
- Ensure implementation
- Advocacy and sensitization
- Address cross-cutting issues
- Report and share lessons with communities, other districts, IFDC and MetaMeta

The overall objective is that now that key stakeholders are trained on the technical opportunities and have developed a framework of collaboration, improved water management is implemented in the project area without much additional cost. Through intensive collaboration between district technical officers, road engineers and community, and through the use of local materials and skills, this can be mainstreamed in the work. The operational plan is shown in Table 4.

Table 4 operational plan district committees

Activity	Strategy/ objective	Responsible actors	Communication means	Time Frame
Meet with committee members	Set-out plan for Road water mgt. in district.	District committee	Meetings /	November 2018
Training extension workers + Sub-county road water mgt. committee	Knowledge transfer + plan for implementation	District committee + technical staff	Meeting/ training	December 2018
Awareness creation	Community awareness + out-reach	District committee	Radio shows, local/regional media, social media	January / March 2018
Implementation	Put road water mgt. into practice	District committee, sub-county committee	Posters/letters on the ground visits	From January onwards
Monitoring implementation	Update on status, quality supervision, sharing lessons	District committee	Field visits, reporting, radio, social media	Continuous throughout

4.2 Community Engagement

As much as road constructors indicate that people should not block their structures, the position of farmers currently is also understandable. Farmers are seeing the danger of this runoff water to their farms, and without the collaboration with road engineers and the knowledge on how to utilize this water, they are not able to make beneficial use of the water and thereby contribute to maintaining their roads. Given the velocity and volume of water this would be too risky for their farm. The crucial part is that road engineers and other technical officers, should involve farmers and discuss together on the best locations of culverts, their frequency and also advise farmers on how they can harvest and control this water in their farms. It takes two to tango. In this case an engineer and a farmer. Additionally farmers will not be committed to help in road construction and maintenance when they feel duped when a culvert outlet is at their farm. Rather they should be included in the process to share their local knowledge and also be supported on what they need in order to harvest the water and maintain the road. The large potential of the community, together with the potential of the water, should be unlocked together. People need to own the road, for this road is by and for them. Also the work that farmers do in the farm, will greatly benefit the road. Farmers need to see both the importance, and the benefits it has to them in terms of increased production, safeguarding of their property and improved market prices for their crops.

Often it is mentioned that there is a ‘lack of awareness’ among farmers, it is posed here that this lack of awareness is also present with technical officers. This last one reverts to not being aware of the farmers’ needs, their opinions and the reasons behind their actions. This results in not being on the same page and lack of resourceful collaboration, although both road constructors and farmers aim for the same goal: have a reliable and long-lasting road.

Within the trainings with the communities and the technical staff at district level, these aspects received great attention. A separate document is shared on the trainings provided, their content and the main outcomes. A start is made on community engagement and collaboration by the road engineers and the communities. Now this has to continue, specifically through the road user committees in place, who can greatly contribute to spurring good practices among all community members. The committee at district level also has the important task to regularly communicate, support and monitor the ongoing activities at community level, through the road user committees at sub-county level.

5 CONCLUSION

5.1 EXEMPLARY ROAD

As a conclusion the old and new roads for Kween and Kanungu are presented in a summarized overview. This gives an idea of what can be done. The specific locations of the points recorded as problem spots with corresponding interventions are provided in the annexes. Together with the recommendations on improved practices and the framework for integration and collaboration, this should inform the process of implementation and make the project roads exemplary roads for improved road water management.

The exemplary roads are shown in the following 2 pages in Figure 36 and Figure 37.

5.2 FOLLOW-UP AND NEXT STEPS

- Do close monitoring and follow-up with and between districts, IFDC and MetaMeta – ensure operationalization through the road water management committees at district level. Re-visiting of the project areas is recommended in order to monitor implementation and enable to take stock of good practices and learning points.
- Share lessons and work out the good practices that are implemented on the selected roads.
- It is recommended to include soil and water conservation practices in other project areas by IFDC under REACH-UGANDA. Existing farming practices can be greatly complemented with 3R (Recharge, Retention, Re-use) water harvesting measures.
- Videos were recorded by MetaMeta during the activities. Video clips capturing the roads assessment, trainings and proposed interventions will be produced. In order to increase knowledge sharing and out-reach to other channels.

Kween old and exemplary road overview:

EXISTING ROAD

A

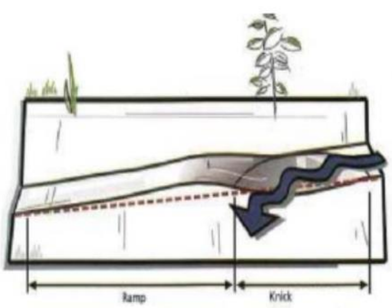
Road section prone to erosion due to high runoff as the road has an ongoing steep slope. The speedy flow of the water causes road body to be 'eaten away' by water flowing along the drain.

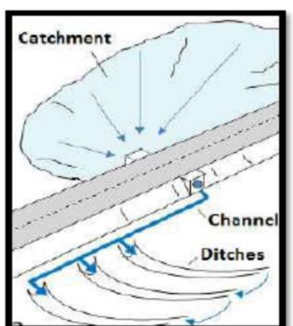
B

This inlet from the cross-culvert is blocked by a farmer who is on the receiving end of this culvert. this causes water to stay on the road and the farmer is not tapping into the road-runoff resource.

C

Another case of blocking, in this scenario a mitre drain is blocked. FOrcing the water back onto the road and also causing sedimentation to fill up the side-drain. Untapped potential





NEW ROAD

A

Rolling dip to be introduce in order to safely guide the water across the road. Complementing existing culverts as a low-cost intervention. It will reduce eroding of road body and allows farmers to harvest water slowly in small amounts.

B

Water from a culvert outlet to be diverted into multipe trenches/infiltration pits (along contour lines). These will distribute the water in small amounts and make the water infiltrate into the soil, to increase soil moisture. While keeping the soils in place.

C

Existing example in the area where a mitre drain is extended into a trench. This water the water that comes is put to beneficial use and recharging water levels. While this water cannot damage the road.

Figure 36 old and new road situations of project road in Kween

Kanungu old and exemplary road overview:

Figure 37 old and new road situations for Kanungu project road

6 APPENDIX

6.1 Road Maintenance Groups – experience from Nepal

Road implementation by Rural Access Programme (RAP) is centered around a labour based approach. The project has involved construction of tracks, trails and roads using labour-intensive, environmentally sound and climate resilient method; alongside complementary socio-economic intervention. The labour based approach has given an attention for details, take care of springs and careful use of spoils. RAP engages number of RBGs each of 20 people who are also the beneficiaries of roads too. They are responsible for constructing a certain stretch of the road section.

Figure 38 road maintenance works done by local communities in Nepal

Road Building Groups (RBGs): The road construction in RAP involves labours from local community groups and use of hand tools, small machines and equipment for road construction. RBGs are formed representing households from amongst the poorest of the poor and excluded groups from the community, disadvantaged group/community and seriously project affected families (SPAFs) living within the porject zone of influence (ZoI[2]).

Another approach of RAP to protect road for long run is the formation of Road Maintenance Groups (RMGs). For rural road network a length worker system is applied where the workers engaged for a road are grouped together for maintenance for the entire road. The RMGs can reallocate their members according to need that allows them to allocate additional time to the more problematic road sections. In this case, an administrative burden is reduced on contracting, supervision, planning and inspection. This is important in the rural road set up, which is majorly earthen or gravelled and have very locational problems that requires more attention. The system of RMGs is very good in different maintenance types especially with all the routine maintenance activities. And it is also good in the case where recurrent and specific maintenance do not required skilled labour, equipment or significant materials. RMGs can also cover emergency maintenance where the required intervention is small in nature whereas periodic maintenance activities are not included due to the scope of the work demand.

RMG size

Size of RMG depends on the length of road, required work input, and approx number of person-days to be worked by by EMG members each year. The input of person-days depends on the characteristics of the road (condition, topography, and road surface type, traffic levels and existing road protection structures.

[2] Within one and half hours of walk from either side of the road

Road Type	Approx Input level
A. Blacktop Road	
Road in good/fair condition in dry season i.e. road is passable by normal car at min. road design speed (20 & 40 km/hr for hill and Terai respectively)	65 person-days/km/year
Road in poor condition in dry season i.e. road is passable by normal car in below road design speed (20 & 40 km/hr for hill and Terai respectively)	104 person-days/km/year
B. Earthern/Gravel Roads	
Road in good/fair condition in dry season i.e. road is passable by normal car at min. road design speed (20 & 40 km/hr for hill and Terai respectively)	80 person-days/km/year
Road in poor condition in dry season i.e. road is passable by 4*4 Bus, Truck or tractor or normal car in below road design speed (less than 20 & 40 km/hr for hill and Terai respectively)	104 person-days/km/year
Road in poor condition in dry season i.e. road is only passable by 4*4 Bus, Truck or tractor and required heavy maintenance	156 person-days/km/year

RMG members selection

Members are selected from communities along the road (sections) to be maintained or from those communities nearest to the road. Before the start of the selection process, the district development committee (DDC) body conducts a meeting and approve selection criteria and modality. It is suggested to use following technical and social criteria for RMG member selection

Technical Criteria

- The workers must be above 18 years of age
- They must be physically and mentally able to do road maintenance
- They live near the road to be maintained. This reduces travel time
-

Social Criteria

- The candidates must be unemployed or employed less than 25% of their time.
- The priority need to be given to poorest ad marginalized people of the VDC.
- Preference to female candidates. Women participation should not be less than 33% but can go to 100% too.
- At least 40% of the group must be from disadvantaged groups (Dalits, Janajati, other excluded and deprived groups)

Two methods are used for selection of RMGs, i. Interview or ii. Mass meeting. The applicants must fill the application. In case of Interview methods the applicant required to provide information related to the technical and social selection criteria which decide the candidate for RMGs. In case of mass meeting method, VDC representative will call and organizes a mass gathering making sure that it has representation of at least 33% households of nominated wards adjacent to both sides of the road.

RMG Training

The training encompass the technical issues involved in the maintenance contract (how, when, and where to implement the different maintenance activities), as well as the managerial aspects of the maintenence contract (how are the payment made, what documents need to be presented, etc). Generally, these trainings is carried out in two days. First day covers the theoretical introduction to maintenance and group management and the second day on the practical implementation of the different maintenance activities, most preferably on the road RMG is responsible for.

Once they get RMG training, the group can sign maintenance contract. The payment for the maintenance activities is made according to performance, based on the resulting conditions of the different road elements. As it is no possible to maintain whole section of raod in one time, they need to prepare work plan on monthly basis to determine for which road elements and on which sections of the road the performance based system is applied. The frequent inspection of the work plan and work at the road is needed to ensure the condition of road elements and road section included in the plan is appropriate. Inspection forms a basis of the payment made to the RMGs. Inspection, supervision and monitoring work is carried out by technicians or engineers in DDC/DTO from project/programme on weekly basis.

6.2 Road chainage links Kween

	CD	Land Owner	Crops Grown	Terrain	Inventory Details
LINK 1	L1001				
	L2001			Sloping	Crossing Culvert
	L2002				DT
	L2003		Maize, Barley, Potatoes	Sloping	DT, LHS, RHS Matooke
	L2004		Barley	Slightly Sloping	DT LHS
	L2005	Mr. Labu Simotwa	Maize	Gently Sloping	DT LHS (Red roof)
	L2006		maize, Eucalyptus	Sloping	DT, LHS
	L2008	Mr. Satia Sam Alafu	Maize	Flat after slope	C (RHS) 600m
	L2009		Irish Potato		CI RHS
	L2010		Barley, Matooke, Irish Potato	Sloping	CI RHS
	L2011		Maize	Gently Sloping	CI
	L2012	Kyerwang Violet, Kyemtai Fred	Maize, Barley, Cabbage	Sloping	DT RHS
	L2013	Mosobo Moses, 0787070264	Cabbage, Irish Potato	Gently Sloping	DT, RHS
	L2014		Cabbage, Beans, Maize	Sloping	CI LHS
	L2015		Sukumawiki, Barley		CI LHS
	L2016	Culvert at Hut	Pumpkin, Maize		CI LHS
	L2017			Sloping	2DT RHS 200m downstream
	L2018	Stone Out crop covering great extent of land		Sloping	
	L2019	Good Culvert Design			CI RHS
	L2020			Flat after slope	CI LHS
	L2021				CI RHS
	L2022		Water Melon, Irish Potato	Sloping	Water sipping out of rock 2 Culverts 900mm Dia
	L2023				2 Culverts 900mm Dia
LINK 2	L2024				DT (Before Corner)

	L2025			Sloping	CI RHS
	L2026			Flat	CI RHS
	L2027				DT 100m downstream RHS
	L2028				DT LHS
	L2029		Maize, Cabbage	Sloping corner	DT RHS
	L2030		Grass, Maize, Tree	Sloping corner	DT RHS
	L2031	End of Link 2	Maize	Sloping	DT RHS (T. Juction)
	L3032		Barley		
	L3033	Busindiche Joan	Maize	Sloping	CI and DT RHS
LINK 3	L3034			Sloping	DT LHS
	L3035		Irish Potato	Flat/Corner	DT LHS 2 and 1 RHS
	L3036		Barley, Maize		CI LHS
	L3037		Cabbage, Maize	Slanting	CI RHS
	L3038		Maize	Flat after slope	CI LHS
	L3039		Maize	Flat after slope	DT LHS
	L3040		Maize		DT LHS
	L3041		Trees		DT LHS
	L3042		Maize		DT LHS
	L3043		Maize		DT LHS
	L3044		Barley		DT RHS
	L3045				DT LHS (New Culvert)
	L3046				DT LHS
	L3047				DT LHS
LINK 4	L4048		Maize		CI RHS
	L4049		Maize		CI RHS
	L4050	Mr. Banan Banyoko	Onions, Maize		DT LHS
LINK 5	M005	Mr. Jarop	Banana, Cabbage		CI LHS
	L5051		Maize		DT LHS
	L5052		Matooke, Maize		DT RHS
	L5053		Eucalyptus, Matooke		DT LHS
	L5054		Coffee, Matooke		DT RHS

6.3 COORDINATES ASSESSMENT POINTS PROJECT ROADS

Table 5 coordinates assessment points Kween project road

FID	Shape *	Code	Point	Elevation (m asl.)	longitude	latitude
0	Point ZM	1014	L1 000	2040.189	34° 35' 36.265" E	1° 24' 59.674" N
1	Point ZM	1016	L2 001	2099.249	34° 35' 38.634" E	1° 24' 22.194" N
2	Point ZM	1017	L2 002	2101.203	34° 35' 38.004" E	1° 24' 21.834" N
3	Point ZM	1018	L2 004	2115.793	34° 35' 32.791" E	1° 24' 20.369" N
4	Point ZM	1019	L2 005	2140.031	34° 35' 23.226" E	1° 24' 18.770" N
5	Point ZM	1020	L2 006	2158.796	34° 35' 17.279" E	1° 24' 16.848" N
6	Point ZM	1021	L2 007	2172.587	34° 35' 12.973" E	1° 24' 14.123" N
7	Point ZM	1022	L2 008	2187.996	34° 35' 5.708" E	1° 24' 10.177" N
8	Point ZM	1023	L2 009	2215.252	34° 34' 57.050" E	1° 24' 7.204" N
9	Point ZM	1024	L2 010	2235.218	34° 34' 50.164" E	1° 24' 7.376" N
11	Point ZM	1026	L2 011	2335.098	34° 34' 42.312" E	1° 23' 53.934" N
12	Point ZM	1027	L2 012	2337.006	34° 34' 41.779" E	1° 23' 53.131" N
13	Point ZM	1028	L2 013	2352.993	34° 34' 30.590" E	1° 23' 45.442" N
14	Point ZM	1029	L2 014	2360.143	34° 34' 22.080" E	1° 23' 34.332" N
15	Point ZM	1030	L2 015	2366.933	34° 34' 15.895" E	1° 23' 26.426" N
16	Point ZM	1031	L2 016	2384.132	34° 34' 8.184" E	1° 23' 16.062" N
17	Point ZM	1032	L2 017	2431.987	34° 34' 13.508" E	1° 23' 1.666" N
18	Point ZM	1033	L2 018	2432.478	34° 34' 22.163" E	1° 22' 56.413" N
19	Point ZM	1034	L2 019	2473.314	34° 34' 19.452" E	1° 22' 25.777" N
20	Point ZM	1035	L2 020	2544.504	34° 34' 20.737" E	1° 21' 59.184" N
21	Point ZM	1036	L2 021	2548.047	34° 34' 5.239" E	1° 21' 43.909" N
22	Point ZM	1037	L2 022	2547.723	34° 34' 1.571" E	1° 21' 41.533" N
23	Point ZM	1038	L2 023	2541.844	34° 33' 57.640" E	1° 21' 41.828" N
24	Point ZM	1039	L2 024	2560.177	34° 33' 56.686" E	1° 21' 46.238" N
25	Point ZM	1040	L2 025	2517.524	34° 33' 41.353" E	1° 21' 45.432" N
26	Point ZM	1041	L2 026	2516.382	34° 33' 40.266" E	1° 21' 42.682" N
27	Point ZM	1042	L2 027	2519.745	34° 33' 29.063" E	1° 21' 50.994" N
28	Point ZM	1043	L2 028	2510.982	34° 33' 27.032" E	1° 21' 57.067" N
29	Point ZM	1044	L2 029	2502.529	34° 33' 15.102" E	1° 21' 56.790" N
30	Point ZM	1045	L2 030	2534.274	34° 33' 10.282" E	1° 22' 3.025" N
31	Point ZM	1046	L2 031	2549.415	34° 33' 1.908" E	1° 22' 8.206" N
32	Point ZM	1047	L3 032	2519.207	34° 32' 51.680" E	1° 22' 3.133" N
33	Point ZM	1048	L3 033	2503.349	34° 32' 48.041" E	1° 21' 55.926" N
34	Point ZM	1049	L3 034	2492.923	34° 32' 46.860" E	1° 21' 52.146" N
35	Point ZM	1050	L3 035	2463.605	34° 32' 10.950" E	1° 21' 34.560" N
36	Point ZM	1051	L3 036	2431.629	34° 31' 42.013" E	1° 21' 54.320" N
37	Point ZM	1052	L3 037	2422.454	34° 31' 31.076" E	1° 22' 0.023" N
38	Point ZM	1053	L3 038	2395.758	34° 31' 6.881" E	1° 22' 6.233" N
39	Point ZM	1054	L3 039	2398.835	34° 30' 57.989" E	1° 22' 10.787" N

40	Point ZM	1055	L3 040	2395.918	34° 30' 53.651" E	1° 22' 21.666" N
41	Point ZM	1056	L3 041	2368.373	34° 30' 59.652" E	1° 22' 35.940" N
42	Point ZM	1057	L3 042	2351.109	34° 31' 0.224" E	1° 22' 39.227" N
43	Point ZM	1058	L3 043	2333.358	34° 31' 3.972" E	1° 22' 42.593" N
44	Point ZM	1059	L3 044	2265.775	34° 30' 58.781" E	1° 22' 59.074" N
45	Point ZM	1060	L3 045	2179.109	34° 30' 33.257" E	1° 23' 4.229" N
46	Point ZM	1061	L3 046	2159.018	34° 30' 29.117" E	1° 23' 7.692" N
47	Point ZM	1062	L3 047	2152.729	34° 30' 26.816" E	1° 23' 7.609" N
48	Point ZM	1063	L4 048	2118.404	34° 29' 34.314" E	1° 22' 58.505" N
49	Point ZM	1064	L4 049	2108.006	34° 29' 25.764" E	1° 23' 4.668" N
50	Point ZM	1065	L4 050	2102.294	34° 29' 17.819" E	1° 23' 10.892" N
51	Point ZM	1066	L5 051	2061.27	34° 29' 4.931" E	1° 23' 26.750" N
52	Point ZM	1067	L5 052	2043.976	34° 28' 58.696" E	1° 23' 31.297" N
53	Point ZM	1068	L5 053	2016.717	34° 28' 53.609" E	1° 23' 45.089" N
54	Point ZM	1069	L5 054	1996.792	34° 28' 55.715" E	1° 23' 55.468" N

Table 6 coordinates assessment points Kanungu project road

FID	Shape *	Code	Point	Elevation (m asl.)	Latitude	Longitude
0	Point ZM	876	M1 CI LHS	2008.938	0° 59' 33.382" S	29° 51' 17.176" E
1	Point ZM	877	M2 CI LHS	2001.81	0° 59' 36.618" S	29° 51' 18.727" E
2	Point ZM	878	M3 CI LHS	1996.094	0° 59' 38.785" S	29° 51' 18.799" E
3	Point ZM	879	M4 CI LHS	1993.212	0° 59' 40.240" S	29° 51' 18.616" E
4	Point ZM	880	M5 CI LHS	1978.109	0° 59' 44.048" S	29° 51' 15.624" E
5	Point ZM	881	M6 CI LHS	1976.063	0° 59' 46.273" S	29° 51' 14.209" E
6	Point ZM	882	M7 CI LHS	1996.158	0° 59' 44.545" S	29° 51' 25.729" E
7	Point ZM	883	M8 CI LHS	2000.459	0° 59' 44.351" S	29° 51' 26.255" E
8	Point ZM	884	M9	2002.802	0° 59' 48.372" S	29° 51' 28.073" E
9	Point ZM	885	M10	2013.708	0° 59' 55.662" S	29° 51' 27.331" E
10	Point ZM	886	M11	2016.6	1° 0' 0.565" S	29° 51' 26.766" E
11	Point ZM	887	M12	2017.165	1° 0' 3.377" S	29° 51' 30.391" E
12	Point ZM	888	M13	2005.296	1° 0' 7.070" S	29° 51' 30.373" E
13	Point ZM	889	M14	1988.183	1° 0' 4.000" S	29° 51' 36.331" E
14	Point ZM	890	M15	1980.462	1° 0' 2.052" S	29° 51' 39.769" E
15	Point ZM	891	M16	1976.683	1° 0' 1.318" S	29° 51' 41.144" E
16	Point ZM	892	M17	1962.835	1° 0' 0.094" S	29° 51' 46.843" E
17	Point ZM	893	M18	1958.875	1° 0' 2.376" S	29° 51' 53.183" E
18	Point ZM	894	M19	1945.389	1° 0' 6.437" S	29° 51' 58.392" E
19	Point ZM	Katojo Town	Katojo Town	1940.851	1° 0' 9.752" S	29° 52' 2.446" E
20	Point ZM	896	M20	1938.49	1° 0' 15.066" S	29° 52' 5.574" E
21	Point ZM	897	M21	1930.392	1° 0' 22.079" S	29° 52' 13.976" E
22	Point ZM	898	M22	1934.083	1° 0' 24.718" S	29° 52' 16.662" E

23	Point ZM	899	M23	1933.113	1° 0' 25.276" S	29° 52' 19.268" E
24	Point ZM	900	M24	1933.126	1° 0' 25.675" S	29° 52' 20.179" E
25	Point ZM	901	M25	1932.633	1° 0' 26.356" S	29° 52' 20.798" E
26	Point ZM	902	M26	1929.516	1° 0' 28.847" S	29° 52' 22.368" E
27	Point ZM	903	M27	1930.474	1° 0' 34.002" S	29° 52' 26.825" E
28	Point ZM	904	M28	1930.704	1° 0' 34.823" S	29° 52' 27.617" E
29	Point ZM	905	M29	1925.111	1° 0' 36.814" S	29° 52' 32.261" E
30	Point ZM	906	M30	1922.087	1° 0' 37.696" S	29° 52' 38.165" E
31	Point ZM	907	M31	1922.964	1° 0' 38.952" S	29° 52' 39.148" E
32	Point ZM	908	M32	1930.152	1° 0' 43.830" S	29° 52' 46.319" E
33	Point ZM	909	M33	1934.282	1° 0' 47.502" S	29° 52' 51.208" E
34	Point ZM	910	M34	1914.822	1° 0' 49.518" S	29° 52' 57.094" E
35	Point ZM	912	M35	1910.872	1° 1' 1.243" S	29° 53' 10.061" E
36	Point ZM	913	M36	1908.398	1° 0' 55.750" S	29° 53' 13.157" E
37	Point ZM	914	M37	1884.115	1° 0' 49.241" S	29° 53' 21.991" E
38	Point ZM	915	M38	1866.213	1° 0' 44.698" S	29° 53' 26.585" E
39	Point ZM	916	M39	1852.135	1° 0' 38.826" S	29° 53' 28.392" E
40	Point ZM	917	M40	1843.259	1° 0' 36.889" S	29° 53' 26.596" E
41	Point ZM	918	M41	1842.138	1° 0' 36.389" S	29° 53' 26.664" E
42	Point ZM	919	END	1826.599	1° 0' 30.924" S	29° 53' 31.276" E

6.4 WORKPLAN FOR "REACH – UGANDA"

Table 7 workplan MetaMeta under REACH-UGANDA

ACTIVITY	DATES
1. Contract Signing	26th September 2018
2. Desk studies > Developing the Work-plan > Drafting Data Collection sheets > Reviewing the information and ToR, Final Feasibility Report	26th September 2018
3. Field Meeting and Data Collection – KWEEN DISTRICT	28th September 2018
4. Field Meeting and Data Collection – KANUNGU DISTRICT	3rd October 2018
5. Field Assessment Report Writing	8th October 2018
6. Field Assessment Report Submission	12th October 2018
7. Training Kween - Technical People - Farmers and Local Leaders	22nd to 23rd October 2018 24th to 25th October 2018
8. Training Kanungu - Technical People - Farmers and Local Leaders	29th to 30th October 2018 31st October to 1st November 2018
9. Report Submission – assessment and training	2nd November 2018

6.5 Signed Copy of Letter of Introducing Consultant to CAO – Kanungu

IFDC

To: D/Engineer
Could you please link them to the Project Site & [illegible] help them accomplish their research.
3/10/18

27th September, 2018

The Chief Administrative Officer
Kanungu District,
Uganda.

Dear Sir / Madam,

CHIEF ADMINISTRATIVE OFFICER
KANUNGU DISTRICT

RE: INTRODUCTION OF IFDC CONSULTANT TO ASSESS AND BUILD CAPACITY ON OPPORTUNITIES FOR WATER MANAGEMENT

Greetings from the International Fertilizer Development Center (IFDC) Uganda Office.
I make reference to the subject line.

I would like to introduce to you META META, a consulting engineering company that has been contracted by IFDC to assess and build capacity on opportunities for water management at the Rutenga-Kirimbe Road in Kanungu.

META META has assigned its staff to commence field assessments starting 4th October, 2018 in the various project locations.

Please accord them all the necessary support.

Sincerely;

27/9/18.

David Slane

Chief of Party, IFDC-REACH Uganda Project

IFDC Uganda, Plot 5, Bandali Rise, Studio House, Bugolobi, Kampala, PO. Box 75391 - Clock Tower, Kampala, Uganda
Phone: +256 312 518 549/599. www.ifdc.org • Email: ifdcuganda@ifdc.org