

DESIGN, SIZING, CONSTRUCTION AND MAINTENANCE OF GRAVITY-FED SYSTEM IN RURAL AREAS

MODULE 5: MAINTENANCE OF THE INFRASTRUCTURES



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I. INTRODUCTION

I.1. Why maintaining the infrastructures?

Let's have a look at figure 1 which illustrates 3 distinct periods of a GFS for the beneficiaries:

- A: Before the GFS construction,
- B: During the GFS construction,
- C: After the GFS construction,

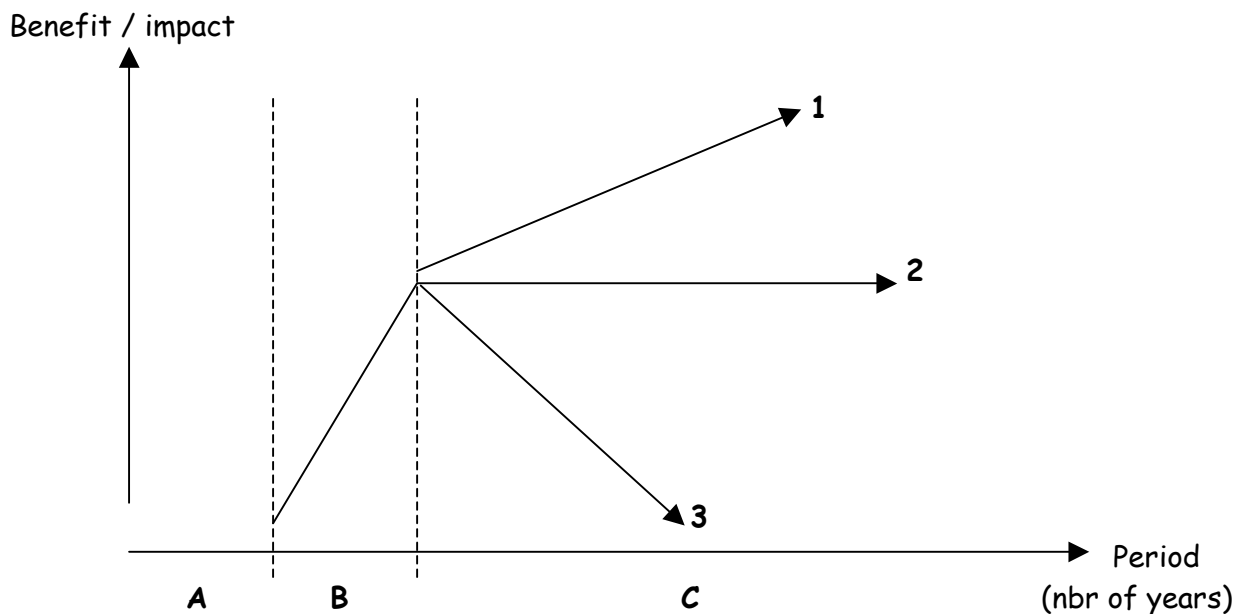


Fig.1: Impact of a long term project.

For each of these 3 periods, the benefit brought by the GFS to the beneficiaries is variable (see comments given in table 1). On the long term, benefits can be:

- Positive and always increasing (scenario 1),
- Positive and constant (scenario 2),
- Decreasing (scenario 3).




The objective of the construction of a GFS is to supply good quality water in sufficient quantity for a given population during several years (i.e. on a long term). The objective is thus to avoid scenario 3 and to obtain scenario 1 or 2.

The conditions to obtain scenarios 1 or 2 are as follows:

- A. Good quality of construction,
- B. Technology adapted to the local environment and technological level,
- C. Regular network maintenance

The point A and B were tackled in the previous booklets. Now we will see that in order to have a positive impact on GFS construction for the beneficiaries in the long term, it is also essential to ensure the regular maintenance of the network.

Table 1: The various impacts a GFS can have for the beneficiaries

	Moment	Period / benefit	Comments
A		Before / No impact	The population fetches drinking water far away from their village. Moreover, water has strong probabilities of being contaminated.
B		During / Positive increasing	The GFS is being built. Once finished, good quality water is available in sufficient quantity close to their houses.
C		After / Variable	<p>Three scenarios are possible:</p> <ol style="list-style-type: none"> 1: The network is regularly maintained and repaired. It was even extended by the beneficiaries to other parts of the village that were not covered initially. The standard of living of the villagers is constantly improving. 2: The network is regularly maintained and repaired. Several years after the network construction, the villagers still have good quality water in sufficient quantity close to their houses. 3: The network is badly maintained and gradually collapses. After a certain time, there is no more water at the taps and the villagers are obliged to fetch water at the water points that they used before the construction of network. The GFS construction was done for nothing.

I.2. What does “maintenance” mean?

Maintenance refers to all activities necessary to operate properly a GFS. It can be divided in two categories:

- Common works on small infrastructures which can be done even by people who are not specialists (for example, cleaning, additional concreting to eliminate a leak...)
- Technical work that needs to be done by specialized technicians (for example, regulating the network, replacing a broken PVC or GI pipe...)

I.3. Who can be involved in the maintenance of a GFS in rural area?

The various stakeholders that can be involved in the maintenance of GFS in rural area are as follows:

- Government of Indonesia, through Ministry of Public Work
- International NGO (ACF for example) or local NGO (for example Yayasan Pancaran Kasih, based in Soe implementing partner of ACF in 2007 for its Water and sanitation project in TTS District)
- Private sector
- The community using the GFS

→ **Government of Indonesia, through Ministry of Public Work,**

The Ministry of Public Work does have some financial and human resource capacity to build GFS, but they do not have enough means to be responsible for the operation and maintenance of GFS in rural communities. However, they can be involved in the following way:

- By making regular monitoring visit and giving a technical support when the village's Water Committees meet a technical difficulty that despite their training they do not know how to solve (replacement of pipes or taps, regulation of the network through the regulating valves...).
- By playing the role of community mobilizer/organizer and help Water Committees for the management of the GFS maintenance system (tri-month money collection, community mobilization, where to purchase the spare parts...) if the committee members are discouraged or not motivated.

→ **International and local NGOs**

It is not possible for an international NGO such as ACF to be responsible for the operation and maintenance of GFS, because its presence in the country and the funding opportunities are very limited in time. The role of an NGO such as ACF is more to provide training, or an initial financial and technical input, while ensuring that its work will be sustainable in the future. Its role can be:

- Technical training for the technicians of Ministry of Public Work, or local NGOs.
- Provide the financial means to implement a few GFS
- Train and create a limited number of water committees
- Promote the local spare parts network.

However, local NGO, who usually stay operational in the area much longer than international NGO, could be theoretically involved in the maintenance of GFS in rural villages, using funds provided by the villagers, government, or donor. One can imagine for example a local NGO that is in charge, during two years, to monitor the activities of 10 water committees, and help them when they meet technical or management difficulties. The local NGO can be financed by small fees paid by the water committees, or by a funding from the Indonesian Government or an international donor.

→ **Private sector**

A private company, or a shop specialized in hydraulic system, can also be involved in the maintenance of GFS. The frequency of repair to be carried out is usually low, and the GFS are usually few and

scattered all over the District: It is not certain that their regular maintenance would be a profitable/sustainable activity for a private company. Nevertheless, water committees, using money collected monthly from the water users, can for example come to the nearest town to hire the service of a private company or a craftsman (plumber, mason...) to help them to repair their network.

→ **The community using the network**

The rural community using the GFS might be the most relevant actor to be involved in the maintenance of their GFS, provided that they received proper training to do so. Community-based management is the solution the most adapted to the current situation of the rural villages, and the one that is the most likely to obtain a positive impact on the long term. It is generally done through the creation and training of a village Water Committee, which has the following main responsibility:

- To ensure the maintenance of the network by implementing regular and occasional maintenance tasks (cleaning, concreting, repair pipes).
- To ensure the collection and the management of the funds necessary for maintenance (to purchase pipe, PVC glue, cement, taps...).
- To ensure a proper level of hygiene and sanitation in the village, especially at the water point level.

There is no "magic" formula to implement a good community-based management system. One must only try to take advantage of the available resources within a community, and maximize these resources through training, with the support of the Government, NGOs and the Private Sector. These three bodies can provide advices, financial inputs, technical support and other services, but all key-decisions have to be made by and for the sake of the community.

Warning!

For a community to be able to operate and maintain properly a GFS, it is essential to make them participate to the GFS design and implementation from the early stages of the project. It is necessary that the community develop a feeling of ownership of the GFS, and understands that the maintenance is an essential task, which will be entirely its responsibility. It is this aspect that will be developed in the following chapter.

II. INVOLVEMENT OF THE COMMUNITY IN THE VARIOUS STEPS OF THE CONSTRUCTION OF A GFS

II.1. What are the steps in which the community can be involved?

The communities can be involved in the following steps:

- Before the GFS construction: Community must take an active part in water resources identification (identification of the spring, population data collections, village mapping...).
- During the GFS construction: Communities must take an active part in network construction by providing casual labours (equipment and material transportation, excavation works for trenches and foundation, assist the specialized workers such as plumber or masons...).
- After the GFS construction: Communities must be entirely responsible for the operation and maintenance of the GFS.

II.2. How to involve the community?

➤ Before the GFS construction:

- Meetings with the community (in order to present and discuss the future GFS construction project).
- Make a written agreement with the community: Indeed, in order to avoid possible misunderstandings during and after the GFS construction, a written agreement with the community allows formalizing the responsibilities for each party. An example of a written MOU (Memorandum of Understanding) is given in Appendix 2.
- Creation of a Water Committee. This committee, whose members are chosen by the community, will ensure the proper operation and maintenance system of the GFS

➤ During the GFS construction:

- Training of the Water Committee (technical, administrative and sanitary training).
- Active free participation of the community in the work.

➤ After the GFS construction:

- Organization of a formal hand over ceremony including the signature of a "GFS hand over" document officially putting the community (through the Water Committee) in charge of the network. An example of hand over document is given in Appendix 3.
- Donation of an initial repair kits (tools and spare parts) and office equipment kit (cashbook, cashbox, pen, notebook etc...) to the Water Committee, which they will be able to replace in the future.
- Regular monitoring of the network functioning and activities of the Water Committee.

Table 2: Process of involvement of the communities

Regular meetings with the villagers:



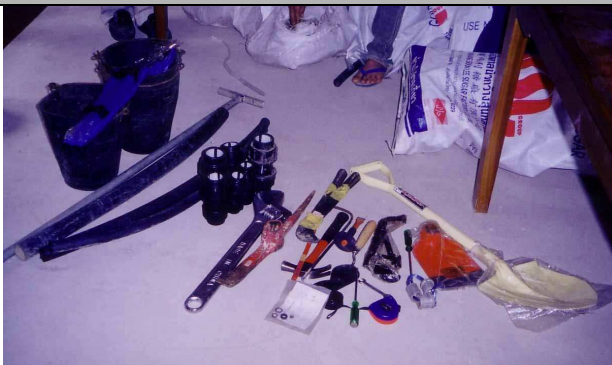
Villagers participation in the network construction:



Formation of the village committees:



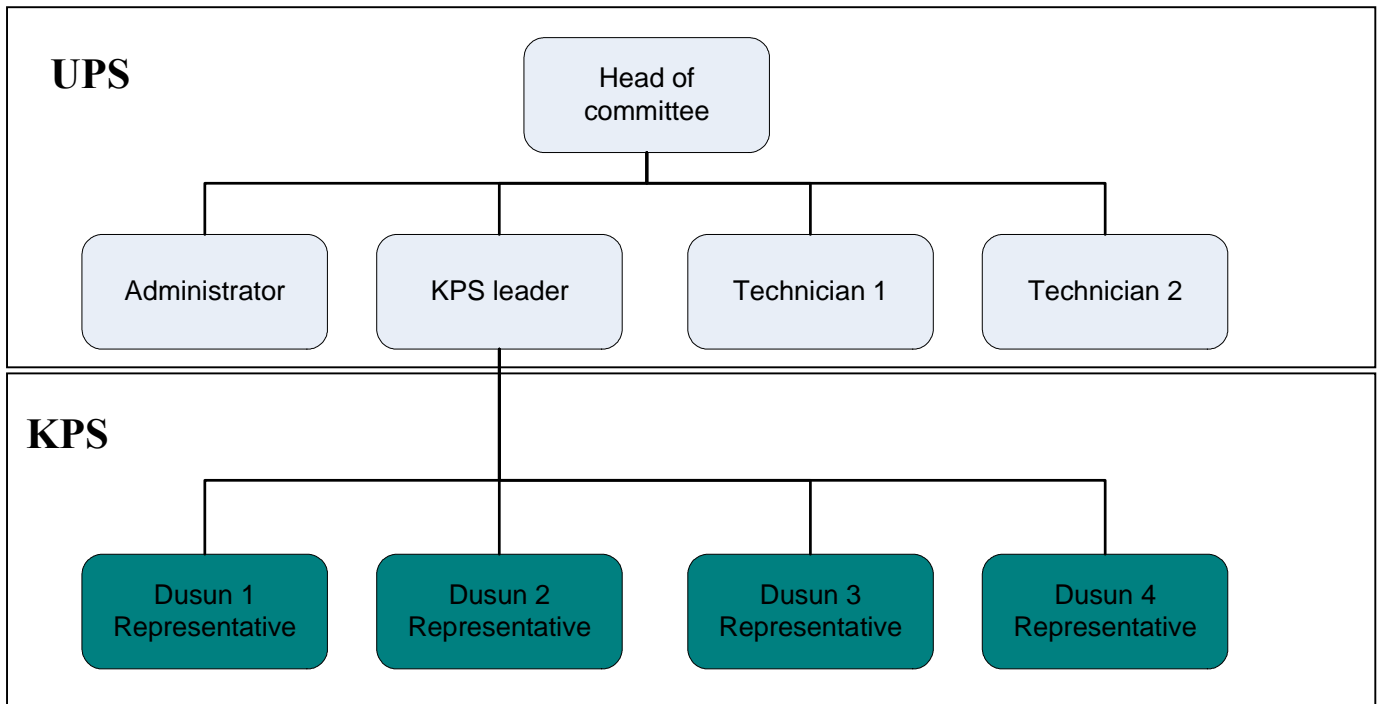
Tools and spare-parts distribution. Follow-up for the maintenance of infrastructures:



III. MAINTENANCE OF INFRASTRUCTURES

III.1. Water Committee

For the water committee in Indonesia, ACF use a water committee structure created by the government: the UPS/KPS committee. UPS/KPS committees are divided into 2 distinct bodies: UPS (Unit Pengelola Saran) and KPS (Kelompok Pemekain Sarana). The UPS is a management body at village level, while KPS is a committee representative of the water users.



LIST AND ROLE OF THE COMMITTEE MEMBERS

Head of committee: Because of his authority, he/she facilitates the decision making process and is responsible for the overall management of the UPS/KPS committee, financially and technically. If they are motivated and interested by the project, and if they have the time, influent people such as the religious leader or the chief of the village can be the head of committee. ACF saw the case of a functioning and efficient water committee in a village of Alor Island that was leaded by the priest. He should organize the meetings when necessary. However, to take financial decision (i.e. to use the money of the cash box), he needs the approval of the other members.

Secretary: He/she assists the head of committee, replacing him when necessary

Administrator: He/she can be in charge of the following tasks:

- Collect the money given by the villagers: from 500 IDR to 2000 IDR per month, according to the case (the amount should be calculated, discussed by the villagers, and can be increased if needed). This money is used to pay the costs related to the maintenance of network. It is

essential that the money collection is done regularly, and not only when needed. The money can be collected monthly, or tri-monthly (to be decided by the committee)

- Keep the money in a secure place, in a lock cash box.
- Keep a clear accountancy of the cash received and spent
- Buy the spare parts when the maintenance of network requires it.
- Remunerate the technicians or any other person that are working on the network

Technicians: They are the only ones allowed to operate and maintain the system. They can be in charge of the daily management of the water system if needed (opening of the valves for examples. Indeed, in some case, to save water, the network can be open only during the day) and its maintenance. Other tasks include:

- To clean the network each 6 months.
- To detect the problems.
- To carry out necessary repairs.
- To replace the worn or broken parts.
- To maintain the protection fences and the drainage ditches around the spring catchment.
- To keep the tools and the spare parts that were given to them or that they have purchased.
- To go to the shop of the nearest town to buy new spare parts or any other necessary material.

KPS leader: He is in charge of the coordination of the Dusun representatives. He is representing them (thus representing the community) in the UPS meetings and decision process. He is in charge of the work of the dusun representative (i.e. to maintain the water points clean, and to collect money in their respective Dusun)

Dusun Representatives: They are responsible for the proper use of the tapstands and the network in their Dusun. They have to report any problem to the KPS leader. They are in charge of the money collection in their Dusun, and make sure that the water points are kept cleaned and used in respect of the basic sanitation rules (not used as defecation place, no rubbish through near the water points etc...). They can be Head of Dusun, but it is not compulsory.

Several points have to be taken into consideration:

Remark 1:

The water committee members should not be chosen by somebody external to the village (NGO or government). They must be elected by all the community during a general village meeting during which the general organization, the objectives and the responsibility of the UPS/KPS committee are explained to the whole village. However, it can be the responsibility of an NGO or the government to make sure that the persons chosen are really suitable and motivated.

Remark 2:

The members of the committee have theoretically to be volunteers (working without receiving any payment). However, if the community agrees, and if the amount of the water fee allows it, it is possible to provide a minimum salary to them (especially the UPS members) in exchange of their work. In any case, some members of the committee have to receive some money from the committee's cash box to implement certain difficult tasks. For example, the committee should provide some money to the technicians when they implement the 6 months maintenance of the GFS, because it represent a tedious and long work, which nobody would accept to make for free.

Remark 3:

It is important to involve as much as possible women in the various phases of the project: they must take an active part in the meetings and at least one of them must be present in the Water Committee. Indeed, women are generally the most reliable sources of information on household water needs. Women are usually very meticulous, honest in their work, and concerned about clean water. They are often very motivated for the maintenance of the GFS, because they manage the water supply at household level, and are the direct beneficiaries of the GFS. It is difficult for them to be technicians, but they can certainly fill the rest of the responsibilities (head of committee or its secretary, administrator, Dusun Representatives...)

Remark 4:

The construction of a GFS should systematically include the technical and financial training of the UPS/KPS committee members. Training consist in

- On-the-job training during the GFS construction
- Two other formal training, where the details of their task should be explained to them, with practical examples.

The present booklets can be used to design and organize the training. Please also refer to the "UPS/KPS committee Guidelines", that ACF usually provide to each committee members.

III.2. Regular network maintenance

A GFS must be checked and cleaned regularly. In Indonesia it is recommended to carry out this maintenance at least once every six months: in October/November (before the rainy season), and in April/May (after the rainy season).

The maintenance of the GFS must be done from the bottom of the network to the top: cleaning always begins by the cleaning of the last tapstands, then each infrastructure while going up along the pipeline, and finishes by the spring catchment. The day before the maintenance, it is important to warn the villagers to store water because water will not be available during the cleaning day. The steps are as follows:

1. Clean the tapstands

- Clean the apron and the drainage channels.
- Repair the protection fence if necessary.

- Check that the taps function well and that there are no leaks at the valve and joints level. If a leak is detected, check that the joints are well tightened, and replace the broken part if necessary.
- Once the tapstand cleaning is finished, close the tapstand inlet valve.

2. Go up along the pipeline until the tank

- Clean the ground along the pipeline: cut grasses and shrubs so that any leak will be visible. Pay attention that no farmers planned to burn the field (slash-and-burn agriculture), because PVC pipes would melt.
- Check the ground along the pipeline, and especially on the level of the pipe joints, if there is anything unusual, such as water flowing, or moisture on the ground. If a problem is detected, it is necessary to dig in order to identify and repair it:
 - * If the problem is a joint that is improperly tightened, it must only be tightened again. If the problem continues, replace the faulty part.
 - * If the problem is a leak due to a broken part (hole made by an animal for example), it is necessary to cut the broken section and to replace it by a new pipe (by using socket, for example).
- Check that there is no leakage at the level of the wash-out valves, if they are present
- When wash-out valves are present, open the valves until air or sediments flows out.

3. Clean and check the storage tank

- Check that there is no leak on the various valves installed on the tank (wash-out, outlet).
- Clean inside the valve box.
- Check the water inflow (check that water flows normally).
- Check the valve box lid and tank's manhole lid water tightness.
- Check the mosquito nets installed on the ventilations pipe (they must be clean and in good condition).
- Open the wash-out valve.
- Clean the inside of the tank with a brush and chlorine/cleaning product.
- Once the cleaning is finished, close the washout valve and wait until the tank is filled again.
- Once the tank is full, re-open the wash-out valve and wait until tank is empty and that all the dirtiness has gone.
- Close the wash-out valve
- Close the tank's water inlet valve, to stop the water from arriving to the tank, and continue to do the maintenance on the upstream infrastructures.

4. Go up along the pipeline until the break pressure tank (if there is one).

- Repeat the operations described at step 2.

5. Clean and check the break pressure tank (if there is one)

- Check that there is no leak on the valves,
- Clean the inside of the valve box.
- Check the water inlet (check if water flows normally).
- Check the valve box and tank manhole's lids water tightness.
- Check the mosquito net installed on the ventilations pipe (must be clean and in good condition).

- Open the wash-out valve. (For the break pressure tanks equipped with a sill, there are two compartments inside the tank, so two wash-out valves should be opened)
- Clean the inside of the tank with a brush and chlorine/cleaning product.
- Once the cleaning is finished, close the wash-out valve and wait until the tank is filled again.
- Once the tank is full, re-open the wash-out valve and wait until tank is emptied and all the dirtiness has gone.
- Close the wash-out valve (for the break pressure tanks equipped with a sill, there are two compartments inside the tank, so two wash-out valves that should be closed).
- Close the tank's water inlet valve, to stop the water from arriving to the tank, and continue the maintenance for the infrastructure located upstream.

6. Go up along the pipeline until the header tank

- Repeat the operations described at step 2.

7. Clean and check the header tank

- Check that there is no leak on the valves,
- Clean the inside of the valve box.
- Check the water inlet (check if water flows normally).
- Check the valve box and tank manhole's lids water tightness.
- Check the mosquito net installed on the ventilations pipe (must be clean and in good condition).
- Open the wash-out valve.
- Clean the inside of the tank with a brush and chlorine/cleaning product.
- Once the cleaning is finished, close the wash-out valve and wait until the tank is filled again.
- Once the tank is full, re-open the wash-out valve and wait until tank is emptied and all the dirtiness gone.
- Observe the flow entering in the tank (this flow corresponds to the outlet flow of the spring catchment).

8. Check the pipeline from header tank to the spring catchment (remark: sometime the header tank is attached to the catchment, so there is no pipeline between them)

- Repeat the operations described at step 2.

9. Clean the spring catchment

- Clean the protection zone around the spring; make sure that there is no upstream source of contamination (animals grazing, defecation place etc...)
- Repair if necessary the protection fence and the surface water drainage ditch that have been dug around and above the spring.
- Look at the overflow of the catchment: if there is a lot of water flowing through the overflow, and if the flow entering in the header tank (that you have checked before) is lower than usual, it means that there is a problem with the catchment box (probably blockage) and it is necessary to open it for cleaning it up. If necessary, remove the stone/gravel, clean them, clean the outlet filter pipe, and put everything back
- Put some chlorine in the catchment to disinfect it.

10. Go back to the header tank

- Check that all dirtiness is gone from the tank through the wash-out valve.
- Close the wash-out valve and wait until the basin is filled again.

11. Go back to the break pressure tank (if exists).

- Open the inlet valve.
- Wait until the basin is filled.

12. To go down to the storage tank

- Open the inlet valve.

13. To go down to the tapstand

- Open the inlet valve and check that water runs from the taps with normal pressure and normal flow.

III.3. Occasional network maintenance

Occasional maintenance tasks have to be made following an unforeseen breakdown or malfunction of the GFS. They require the occasional intervention of water committee technicians. The most frequent problems encountered on a GFS in rural area are listed in this paragraph. For each problem, a brief description of the method to be applied to try to solve the problem is given.

The most common problems are as follows:

- Water does not flow from the tapstand, or the flow is very low.
- Water flowing from tapstand is turbid (especially during or after the rain).
- Leakage from reinforced concrete infrastructures.
- A tap or valve leaks.
- Landslides.

→ **No water flow at the tapstand.**

Go to the upstream tank and look if flow ok

← No or low flow in tank

Go to the header tank and look if flow ok

1. No flow or low flow:

Go the spring catchments and look the overflow

→ *water overflows from catchment blocking problem):*

→ Flow in tank ok

It is necessary to differentiate the 2 following cases:

1. No flow at all at the tapstand:

→ *water overflows from catchment (=blocking problem):*

Clean inside of the catchment box and remove all the dirtiness

If the catchment box is buried and difficult to open (gabion-like catchments), an alternative would be to remove the outlet pipe on the GI/PE joint then to clean the inside pipe using a cloth or a stick

→ *nothing flows from the overflow (= leakage problem)*

Check that the spring water flows in the catchment and that water do not flow below or beside the catchment.

If all is OK, go down along the pipeline until the header tank and look for leak (especially on the joints)

2. Water flows normally:

Look the overflow of the header tank

→ *water flows from the overflow (= blocking problem):*

Check that outlet valve of the header tank is open. If valve is open, go down along the pipeline until the tank, go at the high points of the pipeline and open the nearest joint (or air bleeding valve if any) to try to remove potential air plug.

→ *nothing flows from the overflow (=leakage problem):*

Check that wash-out valve of the header tank is closed. If it is the case, go down along the pipeline to the tank and look for leaks (especially at the level of joints)

Check that the tank outlet valve is open

If the valve is open, go the tapstand and remove the inlet valve (there can be an air plug at this level) If water still not flow, go up along the pipeline to the tank, check the pipeline high points and remove the nearest joints to try to remove potential air plug

→ *nothing flows by the overflow (=leak problem)*

Check that the wash-out valve of tank is closed If the valve is closed, go down along the pipeline to tapstands and look for leaks (especially on the joints)

2. Water flow at the tapstand only sometimes during the day

(= in a rush hour, water demand higher than the available flow)

See whether there is no leakage problem (on tank or along the pipeline).

See whether the village consumption did not increase (for example increase in population by the arrival of new families).

Check the water use of the villagers (it is maybe necessary to impose limitations).

→ **Water flowing from the tapstand is turbid (especially after or during rains)**

It is important to check the GFS when the water that flows out of the tapstand is dirty. Generally, water is dirty during heavy rain. Take a transparent bottle or a tube to estimate water turbidity.

Go to the tank and look if the water that arrives is dirty

←
Water is dirty

Go to the header tank and look if water is dirty

1. Water that flows inside tank is dirty

Go the spring catchments and open the catchment box:

- Check that there is no place upstream where surface water can infiltrate (for example roots or crack in a rocky ground, etc).
- Clean the inside of the catchment.

2. Water that flows inside tank is clean

Check water turbidity in header tank

→ *water is dirty*:

At the level of the header tank, check:

- Water tightness of inspection manhole,
- Water tightness of joints,
- There are no infiltrations, tank not broken

→ *water is clean*

Check that there are no infiltrations along the pipeline from header tank to the tank.

→
Water is clean

Look the water turbidity in the tank

→ *water is dirty*:

Check on tank the following:

- Water tightness of inspection manhole,
- Water tightness of joints,
- No infiltrations, for example on ventilation pipe (for large tanks),
- Tank is not broken/cracked

→ *water is clean*:

Check that there is no infiltrations along the pipeline from tank to the tapstands.

→ **Leaks in the reinforced concrete infrastructures**

If it is the spring catchments that leaks:

- If water leaks from the bottom, it is necessary to build a vertical reinforced concrete wall inside the box (see picture 3).
- If water leaks from the corner of the box, it is necessary to build a concrete wall inside the box at the level of the leak.

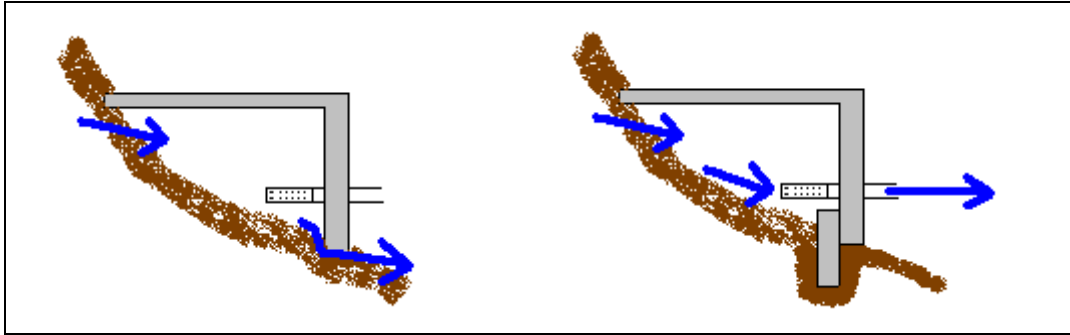


Fig.3: Construction of reinforced-concrete wall at the bottom of the catchment that leaks

If it is the storage tank, the header tank or a break pressure tank that leaks:

Re-apply a layer of mortar at the level of the leak outside the tank (make a watertight plastering).

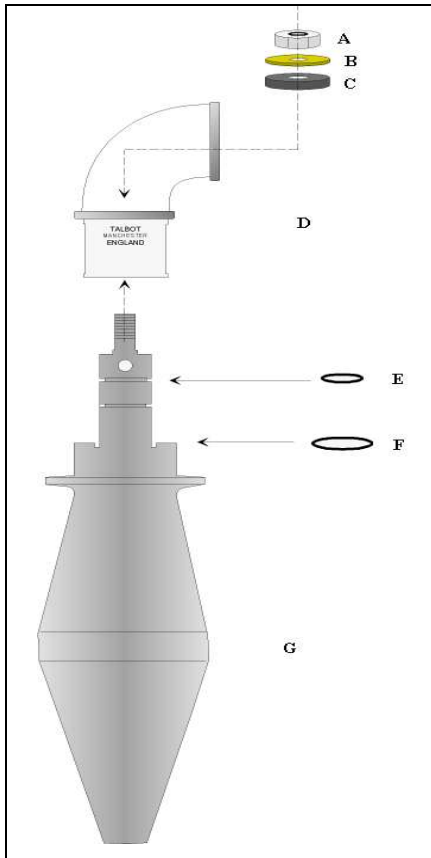
→ **A tap or a valve leaks:**

If the leak is on the GI pipe joints, it is necessary to re-make the joint by using new Teflon tape.

If the leak is on the PVC pipe joints, it is necessary to cut the pipe and install a new joint with a new piece of pipe and a socket.

If the leak is on the valve, the valve should be changed.

If the leak is on the tap, try to dismantle the tap and change the faulty part. Faulty part is generally one of the 3 rubber seals: see example of Talbot tap (push-type tap) in picture 4. If not possible, change the tap.



A: nut

B: iron ring

C, E and F: rubber gasket

D: 45° elbow

G: tap's body

Fig.4: Parts of Talbot tap ("push type" taps)

→ **Landslide**

The best of course is to identify the area of the network that are sensitive to landslide, and to install gabions before landslide happens. If a part of the pipeline was uncovered, it is necessary to protect the plastic pipe by putting them inside GI pipe. If the GFS was damaged by a landslide, it is necessary to clean the affected area and protect the network from further landslide, if necessary, through the installation of gabions installation.

III.4. Maintenance tasks calendar and necessary tools and spare parts

The summary of the tasks to be carried out for the maintenance of a GFS in rural area is given in table 3, including the tasks' frequency and the stakeholders to be involved.

Table 3: Tasks calendar

Activity	Frequency	Person responsible
Clean the spring and the drainage ditches. Check the spring flow and absence of contamination upstream	6 months (before and after rainy seasons)	Technician
Clean the header tank	6 months	Technician/ community
Clean the break pressure tank	6 months	Technician/ community
Clean the storage tank	6 months	Technician/ community
Clean the tapstands	3 months	Dusun Representative (KPS committee) / community
Clean the tapstands' drainages	6 months	Dusun Representative (KPS committee) / community
Repair the fences	6 months	Dusun Representative (KPS committee) / community
Cut the grasses and shrubs along the pipeline. Control the air bleeding valves, wash-out valve and leaks	6 months	Technician/ community
Carry out repair the on cement infrastructures (cracks, leaks...)	Occasional	Technician
Collect the money (500 to 2500 IDR /month/family)	Every 3 months	Dusun Representative + Administrator
Pay the technicians (5'000 to 10,000 IDR/person/day)	6 months	Administrator

In order to carry out the maintenance of network, the water committee will need:

1. A large amount of tools, which are often expensive and/or difficult to find. It is hence relevant to donate all the tools to the water committee during the GFS handover. The most relevant is to give the tools that have been used on the GFS construction, so people know how to use them. Do not forget to replace before the donation the tools that have been damaged or heavily worn during the work.
2. Spare parts. When there is a faulty or a damaged part in the GFS, the water committee must buy the necessary spare parts with the money collected. However, when a breakdown occurs, it can take a lot of time for the water committee to go to the nearest town, to buy the spare parts and to replace it, and in the meantime, the GFS is not working, the users are unsatisfied

and can stop paying the water fee. So it is relevant to provide the water committee with an initial amount of spare parts at the beginning, which they can use while purchasing new ones. According to the experience of ACF, in a lot of cases, the water committee just uses the parts that are donated, without purchasing new ones: a special attention to this issue should hence be given during the water committee training.

3. A certain amount of office equipment and other material, in order for the committee to keep accountancy, organize meetings between them and with the water users. This material may appear unnecessary, but are actually very important for the motivation of the committee members.

A list of the 3 kits (tools, spare part and office equipment) usually given by ACF to the water committees during the GFS hand-over is provided in Appendix 1. Please note that the spare parts are specific to PVC network: in case of PE pipe network, the list will change.

To organize the GFS maintenance, it is also essential to provide the committee with a map of the network, indicating the location of all the infrastructures, and all the pipes' diameter. The UPS/KPS committee should be provided with such large map of their network, laminated, or painted on a wooden board, so it will not get easily damaged. A lot of rural people having a lot of difficulties to read a two dimensions map, the provision of a 3 model map using papier-mâché or any other material (like paper used to make cribs, for example), to be located in the head of village house, is a must.

III.5. Most frequent problems encountered by ACF regarding the maintenance of the infrastructures

Most frequent problems encountered by ACF concerning the maintenance of the infrastructures are as follows:

- Formation of a water pond and/or gully at the level of the tapstand drainage.
- Maintenance of the fences around the infrastructure is not always ensured.
- Formation of air plugs in pipelines.
- The PVC filters installed on the outlet of the tanks get easily blocked.
- Pipes broken or cut by villagers, moles or landslide.

→ Wastewater drainage at the level of tapstands

As shown in the picture 6, a pond and/or gully can quickly appear at the level of tapstand's drainage. This situation generally attracts animals such as cows, dogs etc...which makes the surrounding of the water point even more dirty. The following advices should hence be followed to limit the problem:

- The choice of the tapstand location is important: avoid the centre of the village and prefer a peripheral area presenting a good slope.
- The construction of a soakage pit is useless because it usually get clogged quickly.
- To plant plants (banana trees for example) at the extremity of drainage channel do improve the situation.
- Make a large drainage channel leading to a slope where water can flow without problems.

- If it is necessary to burry a part of the drainage channel, do not use pipes because they will get clogged quickly. Construct a culvert using four wooden planks, which can be easily opened if it needs cleaning.



Fig.6: Pond and gully and formed at the level of a tapstand drainage.

→ **Maintenance of the protection fences around the infrastructures**

The villagers do not always repair the protection fence around the infrastructures. A solution can be to plant shrubs which form a live fence, and needs almost no maintenance. It is important to plant inedible shrubs (that pigs or cows do not eat) and plant them at the proper period of the year.

→ **Formation of air plug in the pipeline**

The easiest solution to avoid the formation of air plug is the installation of air-bleeding valves at the high points of the pipeline. If the spring flow allows it, it is preferable to install an adjustable stock cock valve at the entry of tanks and adjust the maximal opening of the valve on the flow obtained in dry season: by doing so, you avoid having a flow more important than the required one flowing in the pipe, and thus avoid the formation of air plug.

→ **Outlet filter pipe get easily blocked**

Filter pipes are often installed on the outlet of the tanks, to avoid having dirt, leaves or gravel entering in the pipe. However, they get easily clogged. It is important to avoid using a hacksaw to make the slits of filter pipes: if the slits are too small, they will get clogged quickly. It is necessary to make holes of significant size (from approximately 1 cm of diameter) using heated steel bar for example (see picture 7).

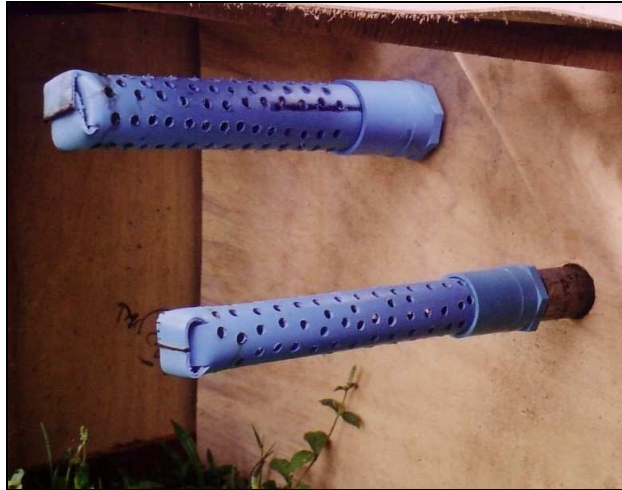


Fig.7: Filter pipes installed on outlet of the tanks

→ **Broken/cut pipe**

To avoid this type of incident it is essential to burry the pipes deep in the ground (0.8 meters minimum). In the locations where landslides may occur, the installation of gabions as retaining walls can protect the network.

IV. APPENDIXES

Appendix 1: Water committee kits

Appendix 2: Example of MOU with the community prior to the GFS construction

Appendix 3: Hand-over document of a GFS to the community

APPENDIX 1:

Water committee kits: tools, spare parts and office equipment kit

A. Tools

Nb	Item	Unit	Quantity
1	adjustable wrench 24"	Pces	1
2	Chain pipe wrench 2"	Pces	1
3	Chain pipe wrench 3"	Pces	1
4	Hoe	Pces	4
5	Shovel	Pces	4
6	Crowbar (long metallic stick)	Pces	2
7	wheel barrow	Pces	2
8	Pickaxe	Pces	2
9	Hammer 2,5 kg	Pces	1
10	Hammer 5 kg	Pces	1
11	Hammer carpenter	Pces	2
12	Nylon rope for level (roll 50 m)	Pces	1
13	Pipe cutter 2" (from 1/2" to 2") and 3"	Pces	1
14	Pipe threader 2"(from 1/2" to 2") and 3"	Pces	1
15	Pipe vices	Pces	2
16	Pipe wrench 12"	Pces	1
17	Pipe wrench 24"	Pces	1
18	Carpentry square	Pces	2
19	Rubber bucket	Pces	5
20	Tape measuring 5m	Pces	2
21	Tape measuring 25m	Pces	1
22	Trowel for plastering	Pces	4
23	Trowel medium size for construction	Pces	4
24	Trowel small size for construction	Pces	4
25	Wood chisel 1/4"	Pces	2
26	Wood chisel 3/4"	Pces	2
27	Wood chisel 3/8"	Pces	2
28	Hacksaw for metal	Pces	2
29	Hacksaw blade for metal	set	2
30	Hacksaw for wood	Pces	2
31	Hacksaw blade for wood	set	2
32	Screwdriver	Pces	2
33	Cross-head screwdriver	Pces	2
34	Metallic brush for cleaning the infrastructure	Pces	4
35	Plastic brush for cleaning the tanks	Pces	4

B. Spare parts (PVC network)

#	Item	Unit	Quantity
1	Adjustable stop cock valve	2 pieces for each diameter used on the network before each tank/tap stand	
2	Ball Tap 3/4 "	Pces	10
3	Gate Valve 3/4 " (for tapstand)	Pces	10
4	Gate valve	2 pieces of each diameter used on the network	
5	Teflon Tape	Pces	20
6	PVC glue	Tube or can	20
7	PVC pipe (10 bar of nominal pressure)	5 pipes of each diameter used on the network	
8	Set of <u>5 of each</u> of these PVC fitting: socket, union, elbows 45°, elbow 90°, tee, GI-PVC adapters male, GI-PVC adapter female, caps	1 set for each diameter used on the network	
9	Set of <u>5 of each</u> of these GI fittings: socket, nipple, union, elbows 45°, elbow 90°, tee, reducer, cap male, cap female	1 set for each diameter used on the network	

C. Other material

#	Item	Quantity
1	Wooden Table	1
2	Cash box with lock	1
3	Plastic Chair	6
4	Accounting book A3	2
5	Notebook A2	6
6	Pen	6
7	Pencil	6
8	Rubber eraser	6
9	Ruler	6
10	Black board	1
11	Chalk stick for black board	1
12	Large map of the GFS	1

APPENDIX 2

Example of agreement with community prior to the GFS construction

MEMORANDUM OF UNDERSTANDING (MOU)

Between:

Dinas Kimpraswil

And

Community of the village:_____.

Date:

This MOU between Dinas Kimpraswil and the community of _____ establishes general rules of cooperation between the two parties during the construction of a Gravity Fed System in the village

Dinas Kimpraswil and the target community agree on the following articles:

Article 1.

Object of MoU

DINAS KIMPRASWIL plans to implement the following activities in the village:

1. Excavation and construction of a spring catchment on the spring named: _____.
2. Trench digging and pipe laying on : _____km.
3. Gravel, sand and stone transportation:.
4. Construction of header tank.
5. Construction of _____break pressure tanks
6. Construction of a _____m³ storage tank.
7. Construction of _____tapstands:
8. Construction of protection fence around _____infrastructures
9. Materials transportation from _____ to the concerned village
10. Etc...

Article 2.
Obligation of the parties

2.1. DINAS KIMPRASWIL obligations

- Purchase all materials necessary to the construction of the infrastructures, except locally materials such as gravel, stone, sand and wood, and manage their transportation up to the construction site.
- Provide transportation means to the villagers to transport the locally available materials around the village until the working site,
- Provide to the community all necessary tools to perform the construction works. The list of tools is attached in appendix. A part of these tools will be donated to the community after the work
- Provide to the community all necessary safety equipments during the construction to ensure the safety of the workers during the working hours (helmet, boots, gloves...).
- Provide technical designs for each infrastructure of the GFS. The list of designs is attached in Appendix
- Monitor the different steps of the construction to ensure that the community workers will follow the technical specifications.
- To organize and supervise the free community participation and provision of locally available materials
- Assist the community to identify and provide the locally material (sand, gravel, stone, wood) with a proper quality, to use in construction works.
- Supervise daily and give technical guidance to the community workers to construct the infrastructure respecting the original design.
- To assist the community for the creation of the UPS/KPS committee, who will be responsible of the maintenance of the infrastructures implemented, and provide the committee members technical and financial training.

2.2. Community obligations

- Provide all necessary free participation in term of labour (loading and unloading, site clearance, all construction labor work, foundation and trench digging etc...) and provision of locally available materials such as stone, gravel, sand and wood.
- Provide safe place to store material and tools and look after it. In case of loss or theft of material or tools by the community, the project will be cancelled.
- Follow the design of the infrastructure, following the daily guidance of DINAS KIMPRASWIL supervisor. If because the instruction given are not followed by the community workers, and a mistake is done in the design, DINAS KIMPRASWIL will possibly be able to correct the mistake, but DINAS KIMPRASWIL will not provide additional materials and it will be the responsibility of the community to provide it, or provide the financial means to DINAS KIMPRASWIL to buy it again.
- Use all safety equipment provided and follow the safety procedures during the construction.

Article 3.

Acceptance of the project by the community

By the present documents, the beneficiaries ensure that the program was presented clearly to them by DINAS KIMPRASWIL, discussed and accepted by all the inhabitants of the village and that the population made an agreement on the location of the infrastructures.

Article 4.

Safety procedure and accident

Community commits to follow the safety procedure provided by DINAS KIMPRASWIL. DINAS KIMPRASWIL is not responsible for any accident happening to the workers during the construction

Article 5.

Land Ownership.

After the hand over, the infrastructures will belong to the whole village, and should not be used for private purpose. In case an infrastructure has to be built on a private land, a separate MOU will be signed between DINAS KIMPRASWIL, the community and the owner of the land. This document will stipulate that "the land owner (and descendants) agrees to let his land to build the infrastructure and will never ask for any financial compensation to DINAS KIMPRASWIL or the community. He will let free access to the infrastructure to the community."

Article 6.

UPS/KPS Committee

Before implementation, the community will have to organize itself to create a committee called UPS/KPS, who will ensure the maintenance of the water supply infrastructures. According to the guideline of the Government of Indonesia, the creation of UPS/KPS committee is the responsibility of the head of village. However, this one will be assisted by DINAS KIMPRASWIL. Moreover, the UPS/KPS committee will receive financial and technical training by DINAS KIMPRASWIL before and during the work implementation. The members of committee are also responsible to organize the free community participation (provision of labour and material)

The committee will be in charge of collecting water fees from the water users, and use this money to operate and maintain the system. The money collection must be started at the signature of the MoU, which will be monitored by DINAS KIMPRASWIL. A first round of money collection should be done by the committee before the infrastructure is handed over by DINAS KIMPRASWIL to the community, in order for the committee to have reserve money right after the hand over. In addition to the training, a UPS/KPS committee written guideline will be provided by DINAS KIMPRASWIL to each member of the committee.

After completion of the work, a hand over will be done to the community stipulating that UPS/KPS committee will own and be fully responsible of the infrastructures built. In the meantime DINAS KIMPRASWIL will support the UPS/KPS committee with a material and tool kit to enable them to implement properly their activities

Article 7.
Termination of MOU

DINAS KIMPRASWIL commits to implement the planned program in the selected village. However, in case of major problem, DINAS KIMPRASWIL reserves the right to cancel the project, and chose another village. Major problem could be as follows: non respect of the terms of this agreement by the community, security problem, serious internal conflict among the villagers etc...

Signature and date:

Land Owner	Head Of Dusun	Head of Village

Dinas Kimpraswil	Camat	

APPENDIX 3

Government of Indonesia
Ministry of Public Work, Department of Kimpraswil

Province of NTT, District of TTS
Village of

Hand-over document of GFS to the community

In order to bring clean water to the village of _____ The Ministry of Public Work has implemented the construction of a GFS

The GFS construction was implemented by the villagers, under the technical supervision of Dinas Kimpraswil

Physical works began on.....and were completed on

The following works were realized:

1. Excavation and construction of a spring catchment on the spring named: _____.
2. Trench digging and pipe laying on : _____ km.
3. Gravel, sand and stone transportation: _____.
4. Construction of header tank.
5. Construction of _____ break pressure tank
6. Construction of a m³ storage tank.
7. Construction of _____ tapstands:
8. Construction of protection fence around _____ infrastructures
9. Materials transportation from _____ to the concerned village
10. etc...

The total cost of the work is _____, divided as follows:

- Construction materials : _____
- Transportation: _____
- Supervision : _____
- Organization of training: _____
- Spare parts and material provided to water committee: _____

By the present documents, the Department of Dinas Kimpraswil hands over the GFS to the villagers, represented by its UPS/KPS committee, who become the owner of the infrastructures and should ensure its operation and maintenance system. The two parties also commit to be responsible for the following issues:

Responsibilities of the Dinas Kimpraswil:

1. Visit every year the village, and inspect the GFS.

2. In case of technical problem that can not be solved by the villagers, the Dinas Kimpraswil will provide necessary technical assistance.

Responsibilities of the community:

1. The UPS/KPS committee must implement the maintenance of the network every 6 months. They should realize all the tasks that they were taught to them during their training, including the following:
 - To repair and change the GFS faulty parts (taps, valve, pipe).
 - To keep clean the various water points (apron and drainage).
 - To maintain and repair the protection fences built around the infrastructures.
 - To clean and clear regularly all the ground along the pipelines.
 - To wash regularly the tank and the pipeline with chlorine using the washout valves installed on the pipeline and the tanks. The chlorine can be provided by the local Puskesmas.
3. Each family must pay _____IDR every 3 months to the UPS/KPS committee. This money is kept in the cashbox and used to finance the expenses for the maintenance of the GFS (purchase of materials, spare parts, payment of the technicians for the 6 months maintenance of the GFS...).
4. The UPS/KPS commits to manage meticulously and honestly the money paid by the families, and to use it only for the maintenance of the network.

Village of, Sub- District of,

This present contract was made and signed by the following people:

<u>Chief of village</u> Date:

<u>Chief of the Dinas Kimpraswil</u> Date:

<u>Chief of the UPS/KPS committee</u> Date
