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Rehabilitation of water system of Ambohitrolomahitsy village - Madagascar

BACKGROUND INFORMATION

The village of AMBOHITROLOMAHITSY is located in the highlands of Central Madagascar approximately 40 kilometers north of the capital city TANANARIVE. The village has a population of approximately 2500 persons, of which the largest percentage earns their living by rice production.

The village is perched on a hilltop surrounded by 3 valleys which are used for irrigated rice production. Since the irrigation canals follow the periphery of the valley it was necessary for the villagers to descend to the edge of the rice fields to obtain water for household use.

Because of the inconvenience encountered in obtaining water for domestic uses, a water supply system was constructed for the village in the late 1960's. This water system utilized the "capping" of a spring, about 500 metres from the village, as its source. A small water distribution system was installed however after a period of time the water from the one small spring was not enough to supply the needs of the villagers. The villagers attempted for a period of a few years to obtain financial assistance to rehabilitate the water system. In 1982 they received financial assistance from the Miororealisation Projects Division of the Presidency (Malagasy Govt) together with the French Corporation (French Govt) to rehabilitate the water system. FIKRIFAMA (a non profit Malagasy PVO), through the channel of the Malagasy Ministry of Population, was requested to do the work of the water supply rehabilitation.

PROJECT DESIGN CONCEPT

After a brief preliminary review of the Project, FIKRIFAMA decided to undertake its design and construction, however it was evident that it would be necessary to implement the following guidelines:

1) To obtain a sufficient quantity of water to meet the future domestic needs of the villagers.
2) To take the necessary measures to provide potable water for the users.
3) To ensure that the maintenance and security of the water system would be provided after the completion of the project.

Quantity of water: various means are used for calculating the quantity of water for village consumption, however the following guidelines have been used by FIKRIFAMA technicians for a period of 10 years and these have generally proved to be satisfactory:

a) Consumption: 20 litres/person/day.
b) Village growth factor for 15 year period:
   i) for villages less than 1000 population multiply by 2
   ii) for villages more than 1000 population multiply by 1.5.

It should be mentioned that the results obtained in using the village growth factor depend entirely upon the accuracy achieved in getting the correct existing village population. One method often used by FIKRIFAMA is to count the number of the houses. This technique tends to avoid underestimating the number of the existing population. By using the above techniques it was determined that the 15 year design population of AMBOHITROLOMAHITSY Village was 2500 x 1.5 or 3750 people. The quantity of water required would be 3750 x 20 litres/day or 75 cubic metres per day. The required continuous water flow rate would be a minimum of 52 litres/minute.

Water quality: a satisfactory tool used in evaluating water quality for rural communities is the WHO guidelines. It should be remembered that the guidelines pertaining to the total coliform limit of 1/100 ml (MPN) in 90% of the samples will be difficult to obtain if there is no chlorination or disinfection as a final treatment stage.

Maintenance and Security of the Water Supply: It should be emphasized that the most positive factor regarding maintenance and security is the involvement of the villagers in the planning, construction and follow-up phases of their water supply system. Self-help village participation projects are ideal because the villagers become involved and feel that the project belongs to them. This strengthens the village ownership concept and thereby the people feel responsible to maintain and take measures to ensure the security of the project. It has been noted that if the villagers work on the construction phase of the project, they become knowledgeable in the skills required for minor repairs and maintenance in the future.

AMBOHITROLOMAHITSY Water Supply System

A reconnaissance of the area showed that a sufficient quantity of surface water could be obtained to supply the needs of the design population of the village. This supply of water is held in a retention dam about 2 kilometres from the village. The retention dam is fed by a number of small springs located in the valley above the dam. Some repairs on the water retention dam were to be required. It was also required that water laboratory anayses be completed.

Since the dam was located at an elevation of more than 30 metres higher than that of the village gravity flow could be utilised. To improve and ensure the security of the water quality, a filtration system would be required.

In reviewing the water filtration techniques, both the slow sand and rapid sand filtration techniques are accepted as standard techniques in water purification, however maintenance consideration for both need to be evaluated.

Rapid sand filtration units are compact and are successful only if clean water is available for the backwash process. In standard design practices, the filtered water is pumped to a reservoir to be stored and used for periodique backwashing. This requires a pump and is a maintenance consideration. Should the pump be out of use for a brief period of time, then the filter can become overloaded, which can result in very little or no filtered water passing through it, thereby, making it difficult to obtain a sufficient supply of water for the backwashing process. Since the filter media would have to be removed to cleaned to solve the problem, it is quite likely that by-passing the filter, at least for a time, would result. Slow-sand filtration does not require backwashing however it requires a sizeable surface area. Maintenance of the units, such as "skimming", and sand replacement, need to be considered.

Further reconnaissance of the AMBOHITROLOMAHITSY area revealed that it was possible to cap springs of the "point source" nature in the valley above the retention dam. Because the springs were located at a higher elevation than the retention dam it was determined that the pure water from the springs could be stored at a sufficient elevation and that it could be used for filter backwash water by gravity flow in a water filtration-backwash scheme. The flow-schematique on Page 3 outlines the water purification process. Some technical characteristics are as follows:-

1. Retention dam ... 4000 square metres surface
   ... 3000 cubic metres volume.

Note: Dam Construction of Stone masonry reinforced by concrete on lower section of dam. Siphon inlet installed.

2. Sedimentation basin: 5 metre particle path length 3 hour detention period 60 litres/min-rate of flow.

Note: Path flow in vertical direction to utilise "contact zone" - See Basin Section on Page 3.

3. Rapid Sand Filter:
   76 l/min/m^2 - loading rate
   450 l/min/m^2 - backwash rate
   0.7 stm - backwash pressure.

Note: For filter media see Sand Filter Section on Page 3.

4. Water Storage Reservoir: 50 m^3.

5. Pure water backwash reservoir:
   7.8 m^3
   15 litres/min - rate of flow from springs.

PROJECT CONSTRUCTION

FIKRIFAMA was responsible for the design and construction of the project. During the construction phase, one technician was on the job-site to implement the day-to-day work activities. The villagers provided the labour for the construction of the water purification plant as well as the digging of the trenches for the pipelines. They also provided food and housing for the FIKRIFAMA technician.

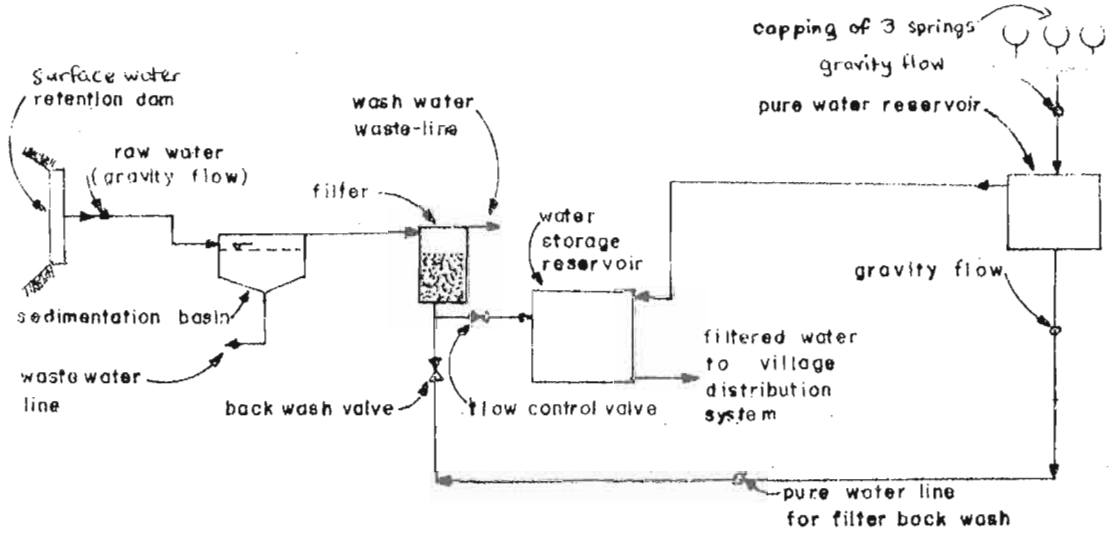
Reinforced concrete was used in all areas of the construction. Concrete rings were used in the capping of the springs and circular steel "slip" forms for reinforced concrete were used in the reservoirs, filter and sedimentation basin construction.

Flexible polyethylene pipe was used for the majority of the pipelines, however galvanised steel pipe was used for road crossings and in rocky terrain.

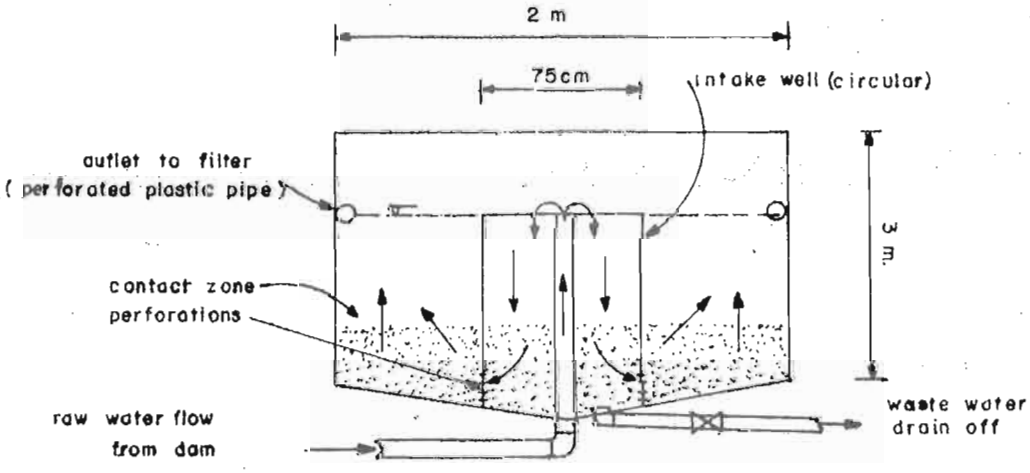
The total cost of the project was approximately U.S. $ 27,500 out of which an amount of $ 2500 was evaluated as the contribution (in-kind) from the villagers. These are 1983 construction costs.

PROJECT MAINTENANCE

The village employs 2 part-time workers for the maintenance of the water supply system. These workers were trained by the FIKRIFAMA technicians and are now familiar with the water purification process as well as the backwashing of the filters, spring protection reservoir cleanliness etc. These workers are paid by the village governing committee which is responsible for assessing each household

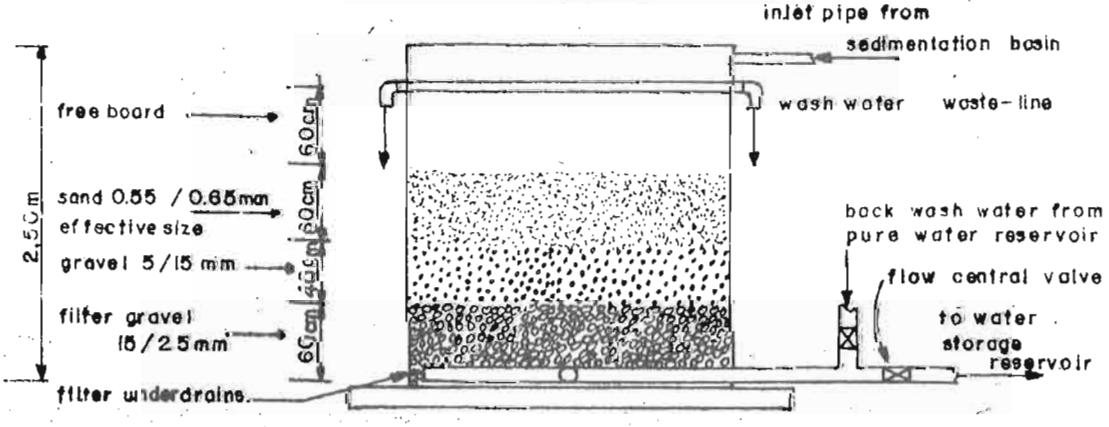


FLOW SCHEMATIQUE



CIRCULAR SEDIMENTATION BASIN

SECTION



RAPID SAND FILTER

SECTION

with a water-charge. There are no private household hook-ups however the hospital complex and school science laboratory are supplied with water. There are 24 public taps in the village and the use of each of these is under the supervision of someone living nearby.

PROJECT EVALUATION

The water supply system has been in operation for approximately 18 months and FIKRIFAMA has continued to assist in the maintenance training of the 2 water supply workers. The workers are familiar with the filter backwash process however they have encountered some difficulty in the regulation of the flow control valve. This is manually operated and has to be regulated daily as the head loss in the filter increases. It has been noted that an increase in the freeboard to allow more fluctuation of the waterlevel above the sand layer would make the flow control operation easier.

The sedimentation basin has proved to be quite efficient for its short detention time. It should be noted that the retention lake greatly assists in the reduction of turbidity. Some erosion around the lake has produced significant water turbidity during heavy rains. It is felt that to assist the turbidity removal process after heavy rains, it would be useful if the detention time were increased by 50% and the particle path length increased by an amount of 1 to 2 metres.

It has been noted that continued efforts are needed to properly protect the watershed surrounding the retention lake. The villagers have begun such a program however additional regulations limiting the planting of crops upstream from the retention lake need to be implemented.

APPLICATION FOR FUTURE PROJECTS

The rehabilitation of the AMBOHITROLOMAHITSY Water Supply System has proved to be a positive factor for future development projects in the surrounding area. Because the village people have been able to complete this project they have confidence in their own ability to organise and implement projects. They are now beginning projects in the fields of health sanitation and nutrition and are showing an interest in agriculture and afforestation projects for the future.

The technical knowledge gained from the project has also been of assistance to the FIKRIFAMA staff. Similar projects are now being planned, however it should be noted that characteristics of the terrain make this type of project feasible, and these characteristics do not normally exist for a broad range of project sites. Certain design modifications using rapid-sand filters with solar powered or wind driven pumps for pumping the backwash water to the storage reservoir, are now being considered for other construction sites.