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WATER SUPPLY & SANITATION

PICTURE BOOK
THE GOOD
&
THE BAD
INFRASTRUCTURE



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PICTURE BOOK
THE GOOD AND THE BAD INFRASTRUCTURE

Water Supply and Sanitation

by :
Ekart Hartmann
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Picture Book

The GOOD and The BAD Infrastructure Water Supply and Sanitation

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INTRODUCTION

Despite the fact that Indonesia has abundant rain, the availability of clean water supply and sanitation is very limited. In urban area only half of total population has access to clean water while in rural area it is only 30% (World Development Report 2004). The sources of water in the rural area is disappearing or declining in quality due to lack of environmental management.

Besides the above fact, Bappenas also mentioned that about 35% of Indonesia population has better access to sanitation while in rural area more than 80% of population does not have access to sanitation.

It can not be denied that providing the clean water supply and sanitation is a challenge in the development of Indonesia. A serious impact caused by the minimum access to clean water and sanitation in the future will decline the quality of life and increase the mortality.

Usually, women and children suffer from unavailability of clean water and sanitation. Therefore, it is understandable that women view that the clean water becomes the main priority in her village. However, it is quite often that their voices are undermined during the village meeting. Men, who prefer roads and bridges, usually are dominant in determining village development.

The biggest challenge in providing clean water in rural area is on the selection of proper technology by means of cheaper and easy to maintain. Generally, providing clean water is very expensive because it needs to be treated first before being utilized. It is often that not all water resources located higher than the service area, and usually it is quite far from settlement. During the dry season, villagers have to dig their wells deeper. Certainly this effort cost them a lot of money especially when they need water pump to extract the water.

Kecamatan Development Program (KDP) is one of the community-based development projects, where the community involved in every step of the process from planning, implementation and maintenance. Even though all the process of construction done by community, does not mean that the quality is low.

Many lessons have been learned from more than seven years of KDP implementation especially in infrastructures. In fact, some infrastructures have bad quality in design or construction such as uncovered pipe, unprotected spring water, latrines and deep well are too close, not good drainage around latrines that makes flooded area mix with garbage. Several factors which cause these problems are lack of technical knowledge of village technical cadre or even project facilitators, uncompleted field survey, limited of the existing materials, or lack of monitoring during the implementation.

The objective of this manual book is to assist people who involve in building small scale

infrastructure at village level, such as technical facilitator, technical cadre and villagers. So they will understand the minimum quality standard of infrastructure that influences the process of planning, implementation and maintenance. Besides, this book could be used as technical training manual.

The content of this book is easy to understand since it consists of many pictures that show the good and the bad examples of infrastructures, complemented with simple explanation. All pictures were collected from KDP locations.

There is an expectation that this book may benefit not only in KDP but also other agencies, NGOs and community themselves. In order to serve its purpose, critics, inputs and recommendations from the reader would be highly appreciated for better revision in the future.

Finally, we would like to thank to all parties who gave assistance in preparing this book. We wish that this book could give a benefit for better infrastructure development in the community-based development projects.

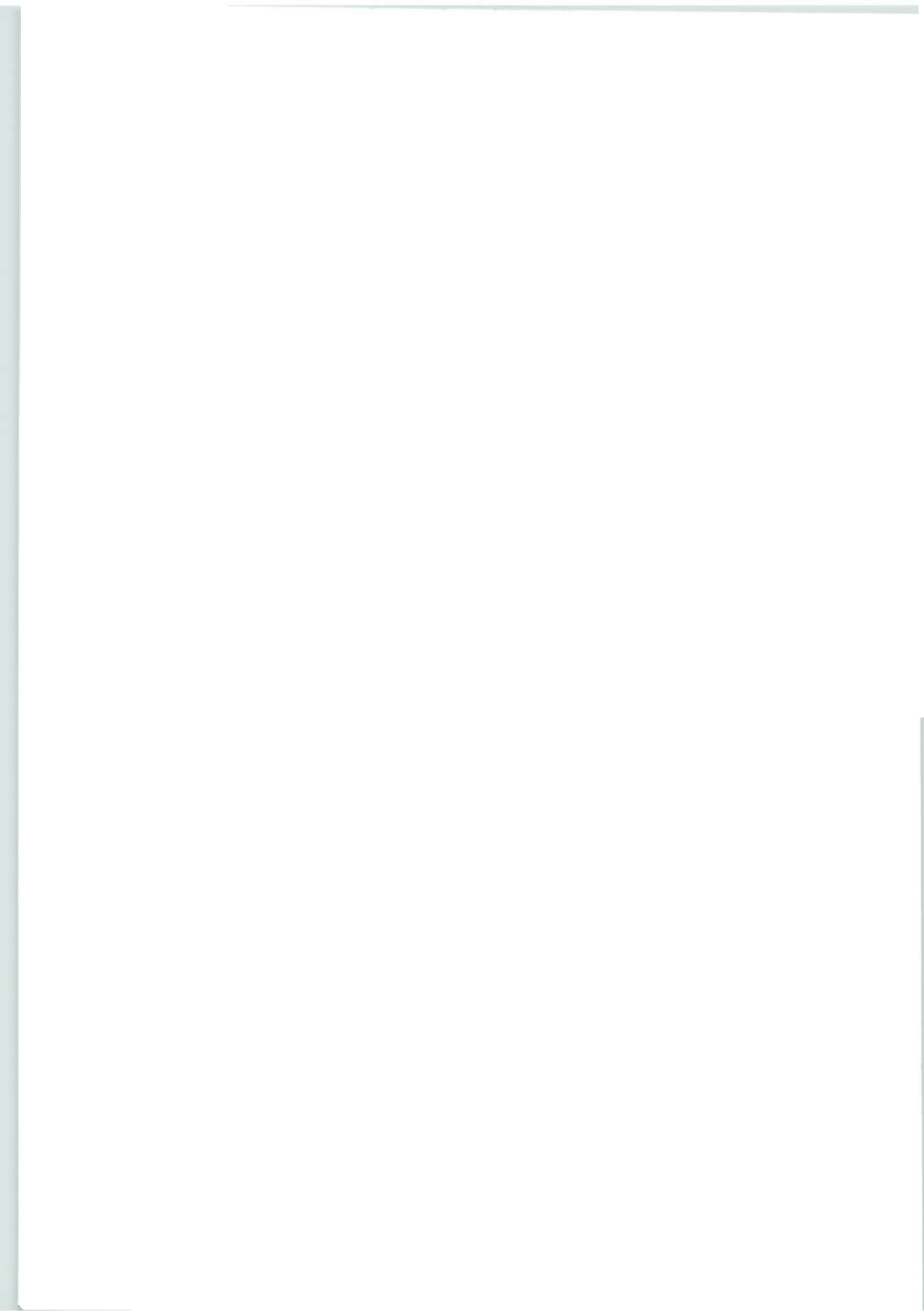
ACKNOWLEDGMENTS

All photographs and text were prepared by Ekart Hartmann and Heinz Unger based on the supervision missions conducted in several KDP locations; West Sumatra, South Sumatra, West Java, Central Java, South Sulawesi, South East Sulawesi, Bali and East Nusa Tenggara (NTT).

Octaviera Herawati oversaw the production of these texts from field survey to publication and provided Indonesian translation, with overall guidance from Victor Bottini. Sentot Satria provided invaluable assistance in selecting field locations.

Scott Guggenheim, Victor Bottini, Enurlaela Hasanah, Sentot Satria, Richard Gnagey and Suroso Yoso Oetomo also contributed comments and input. Field support was also provided by the National Management Consultant (NMC) in Jakarta and the Regional Management Unit (RMU) in the provinces listed above. Field staff facilitated visits to KDP sites.

Special thanks to Scott Guggenheim for his ongoing support.



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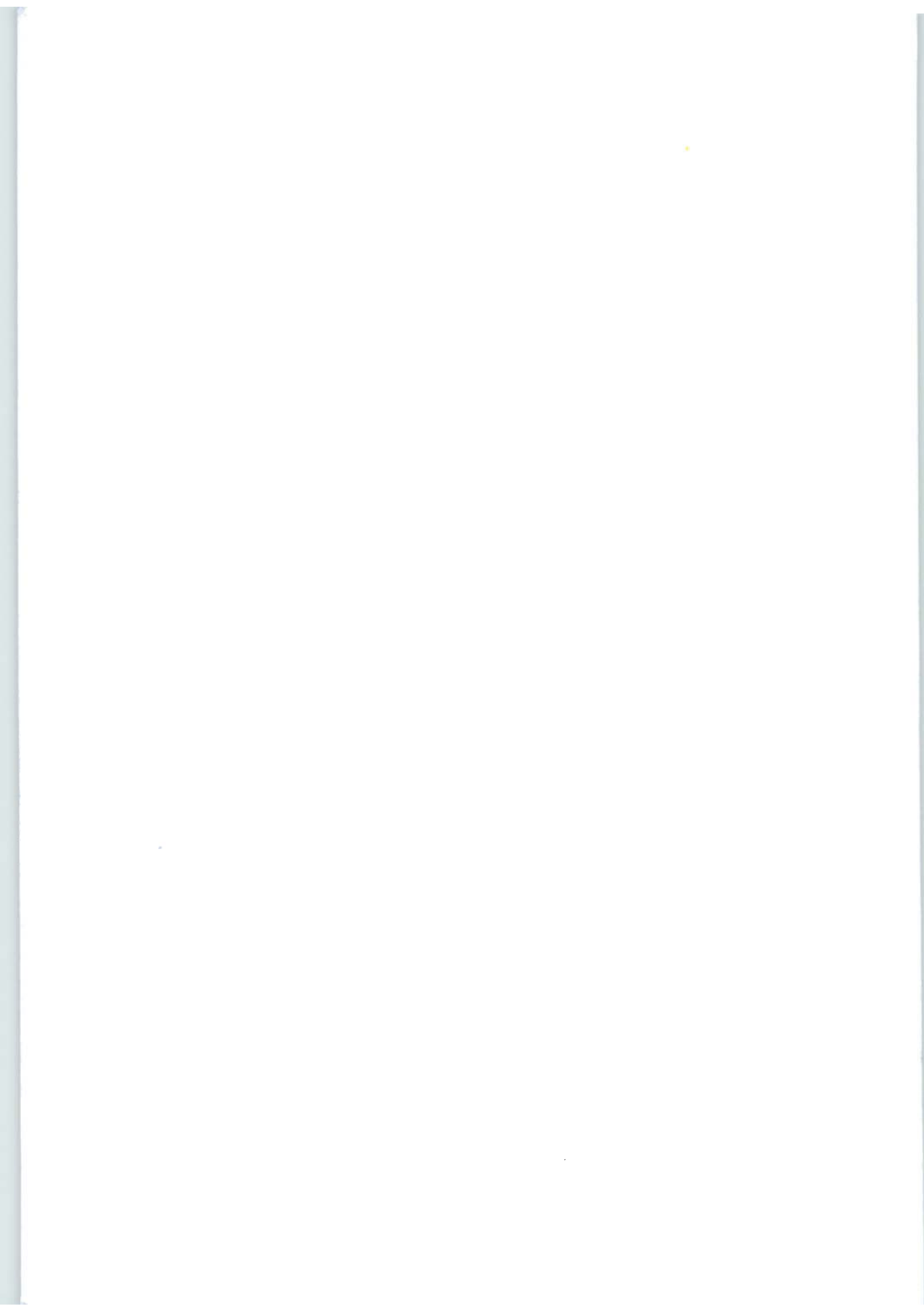
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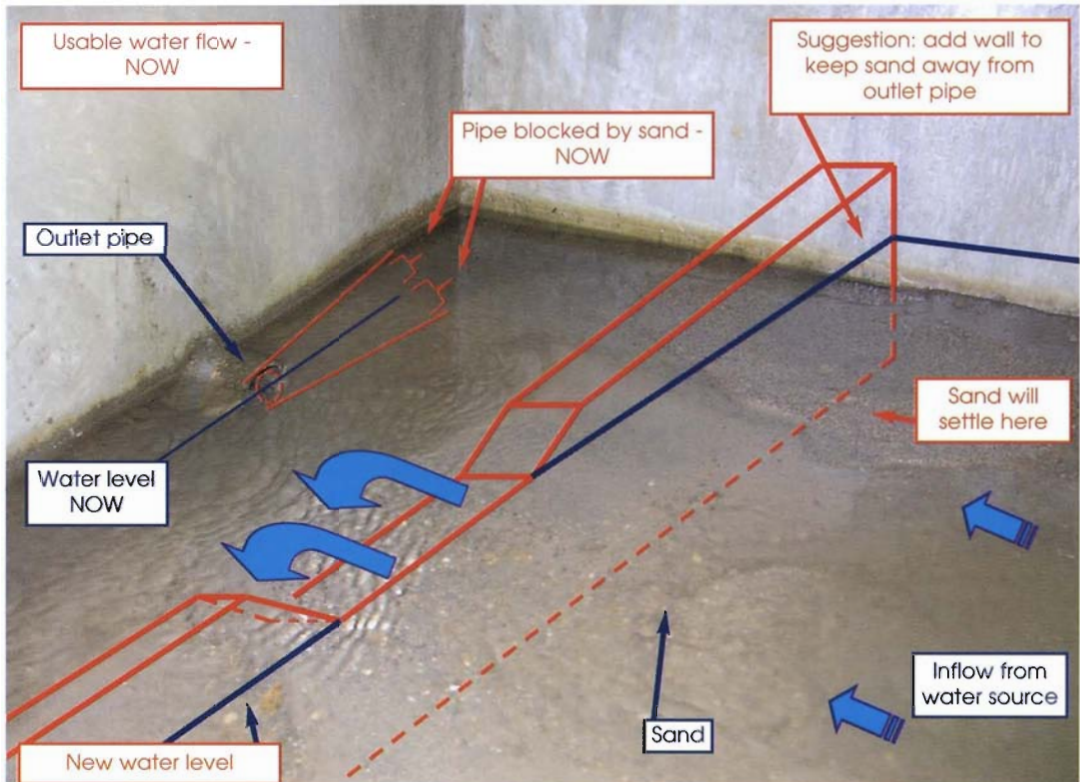
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WATER SUPPLY





Sand will block the pipe completely after some time

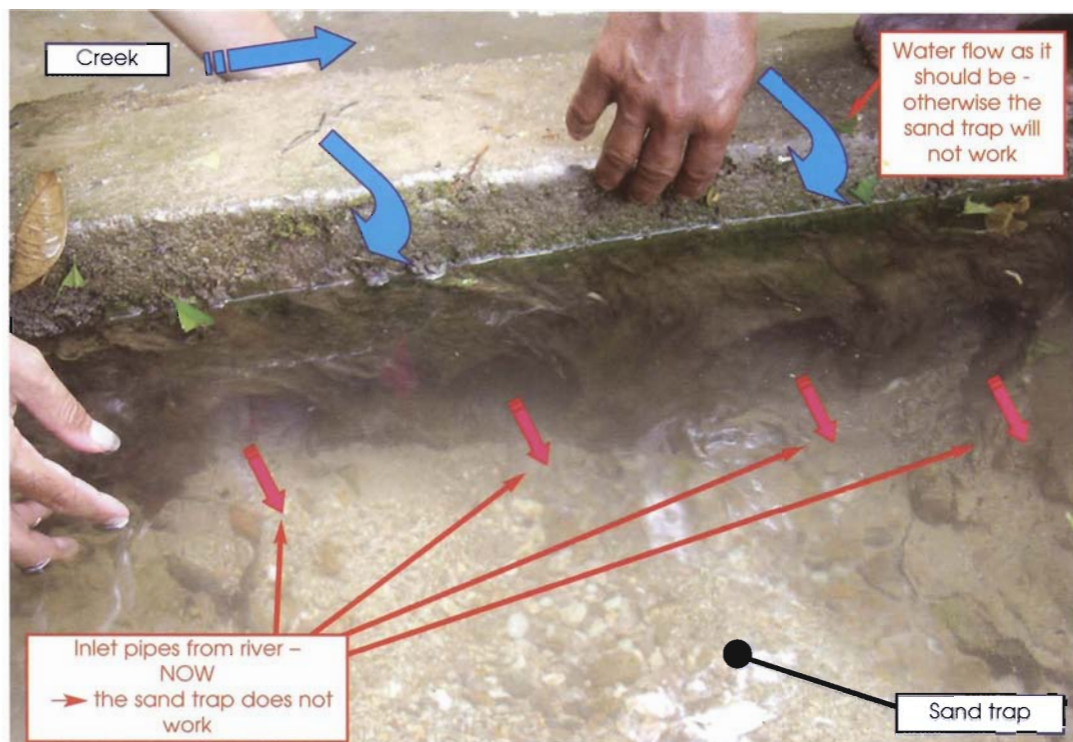
How can I do it better ?

SPRING – Sand Trap

- Add a wall between the inflow and the outlet pipe to create chamber for settling out sand.
- Build the wall with a notch (lowered section) for controlled flow.
- Sand must be cleaned out periodically → maintenance.

WHY ?

- The new inlet chamber slows down the flow and the sand will settle out.
- The dividing wall will contain the sand and clear water overflows the wall to the outlet chamber.



Sand will not settle in the flowing water of the river

How can I do it better ?

CREEK – Sand Trap

- Close off the existing pipes.
- Construct the inlet and the outlet wall of a sand trap in the same way as a weir crest, i.e. with a notch.
- The sand has to be cleaned out periodically → maintenance.

WHY ?

- Slowly flowing water is not able to carry sand or sediment along.
- A sand trap slows down the flow so that sand will settle out.



The outlet pipe crosses the flooding zone of the river

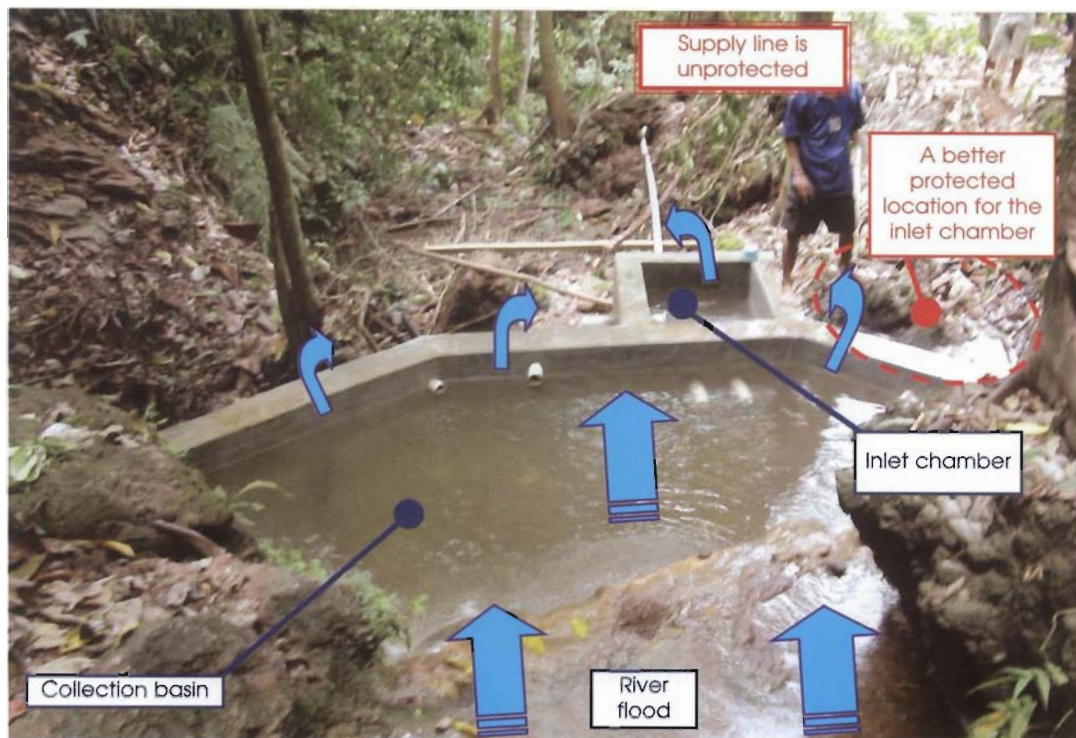
How can I do it better ?

RIVER – Collection Basin

- The pipe could be damaged when the river floods and overflows the weir.
- A drop (a lowered edge of the basin) for the overflow basin wall should be built to better control any overflowing water in case of flooding.

WHY ?

- It is best to place the inlet chamber away from the area of the overflow and where it could be flooded.



The outlet pipe and the inlet chamber are in the flooding zone of the river

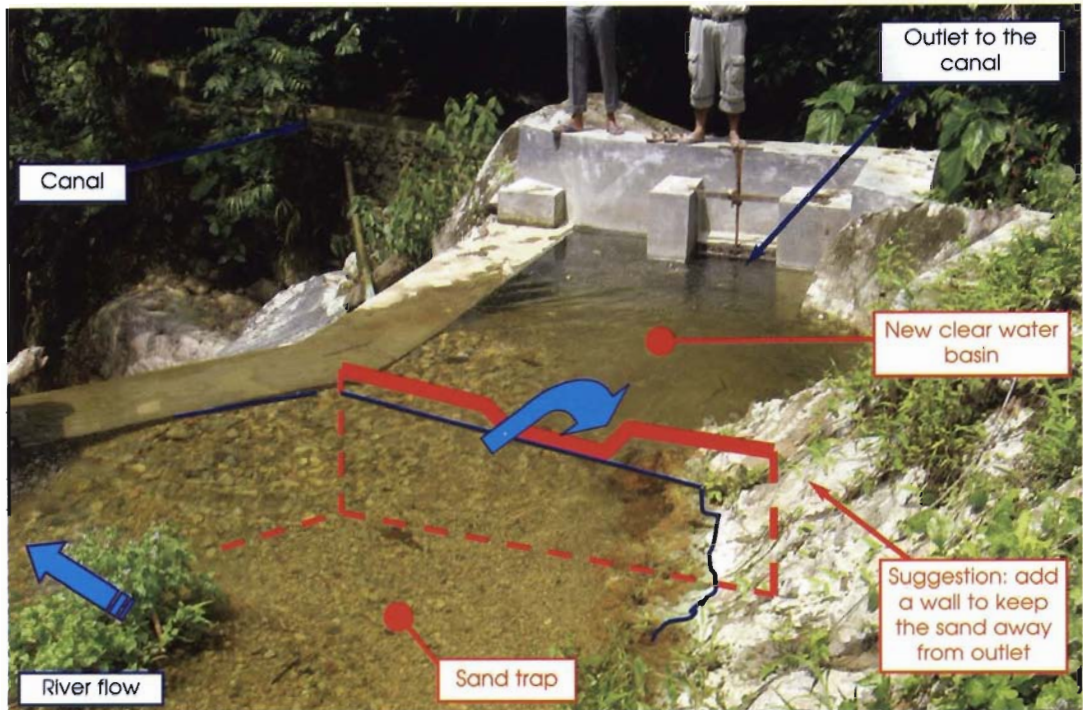
How can I do it better ?

RIVER – Collection Basin

- Cover the inlet chamber to prevent falling leaves and other debris from blocking the flow, or at least, place a wire mesh around the pipe inlet.
- The outlet pipe will be damaged or broken when the stream floods.
- A notch should be built into the basin wall to better channel any overflow water.

WHY ?

- It is safer and better to place the inlet chamber and the pipe line away from the area where the flood is expected, i.e. to the side of the stream.



Sand will settle out in a basin where flow is very slow

How can I do it better ?

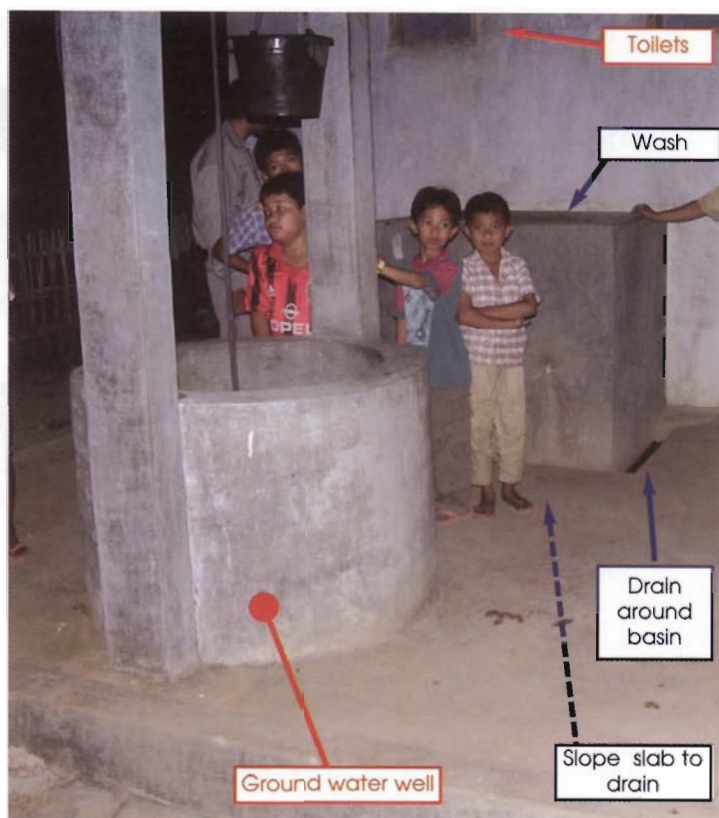
RIVER – Sand Trap

- Add a wall in front of the outlet to keep the sand in the river bed.
- Cut a notch in this wall for controlled water flow into the clear water basin.
- Accumulated sand has to be cleaned out periodically → O&M.

WHY ?

- The sand is held back by the wall and the surface water becomes clear and flows over the top of the wall into the clear water basin.
- In the canal the sand will settle out more easily due to the lower flow velocity of the water.

Design – Construction – O & M – Environmental Impact



Groundwater well is likely too close to the toilets
(depending on location of septic tank and effluent outlet)

How can I do it better ?

WELL – Location

- Try to check the direction of groundwater flow
– the well should always be upstream of the septic tank soakaway.
- Build the soakaway as far away as possible from the well (minimum 10 m).

WHY ?

- The soakaway can influence the quality of the drinking water well, when it is too close → **A SERIOUS HEALTH RISK.**



Collection basin for a spring capture

Why is it better ?

SPRING

- A PVC pipe, about 3m long, is used for the water intake.
- The pipe is perforated, i.e. holes (diam. 2mm) are drilled around the pipe.
- The clear water enters the perforated pipe which works like a screen.
- Closing the basin is essential to prevent leaves or other debris from entering in the basin.

Alternative:

- A short pipe with wire mesh (screen) around the open end.

Design – Construction – O & M



Collection basin for a spring capture

Why is it better ?

SPRING

- The fence protects the spring from public access and risk of contamination.
- Cover slab is very important to prevent falling leaves and fruits in the basin.
- The sand/gravel filter has to be changed periodically → maintenance.

Alternative:

- Build a structure with roof over the spring.



Collection chamber for a spring with sand/gravel filter

Why is it better ?

SPRING

- The sand/gravel filter traps sediment before the spring flow enters the collection chamber and has to be changed periodically → maintenance.
- In addition, a sand trap is recommended.
- The filter and the sand trap reduce sand and sediment which could settle out in the pipe or in the main tank at the end of the supply line (when and where flow and velocities are low).

Alternative:

- No, because every spring capture should be equipped with a filter and a sand trap.



Collection basin in a small stream

Why is it better ?

CREEK

- The collection basin functions like a sand trap, because the water to the inlet chamber flows through pipes.
- There are enough overflow pipes arranged.
- The inlet chamber should be covered in case to protect it from damage and debris caused by flooding of the stream.

Alternative:

- It is better to locate the inlet chamber to the side of the collection chamber, so the floods can pass without damaging the inlet chamber.



Water intake in a river

Why is it better ?

RIVER

- A weir is built across the river bed.
- The inlet chamber is located to one side of the structure.
- The large rocks were left in place to dissipate the energy of the water after falling off the lowered edge of the wall.
- In case of flooding the water will flow over the entire length of the weir crest and will not damage or flood the inlet chamber.

Alternative:

- No.



Water intake in a larger river

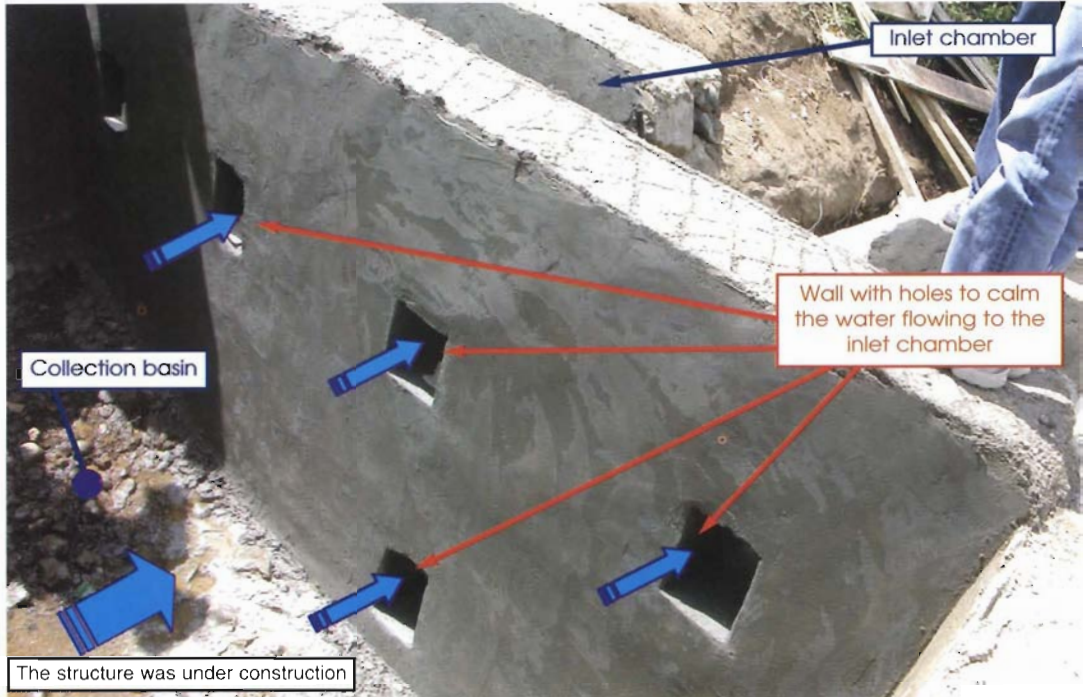
Why is it better ?

RIVER

- The collection basin is elongated in shape, so that water flow will slow down and sand and sediments will settle out.
- The large rock was left in place to dissipate the energy of the water before entering the inlet chamber.
- The sluice gate is flushing out sand and sediment from the collection basin.

Alternative:

- No, a large or elongated collection basin is good for achieving sedimentation.



Wall to calm the flow of water before it enters the inlet chamber

Why is it better ?

RIVER

- The perforations in the wall reduce the turbulence of the water before entering the inlet chamber.
- The water in the inlet chamber must be calm before entering the pipe to the hydro power turbine.

Alternative:

- No.

Design – Construction – O & M



Dug well with all necessary facilities

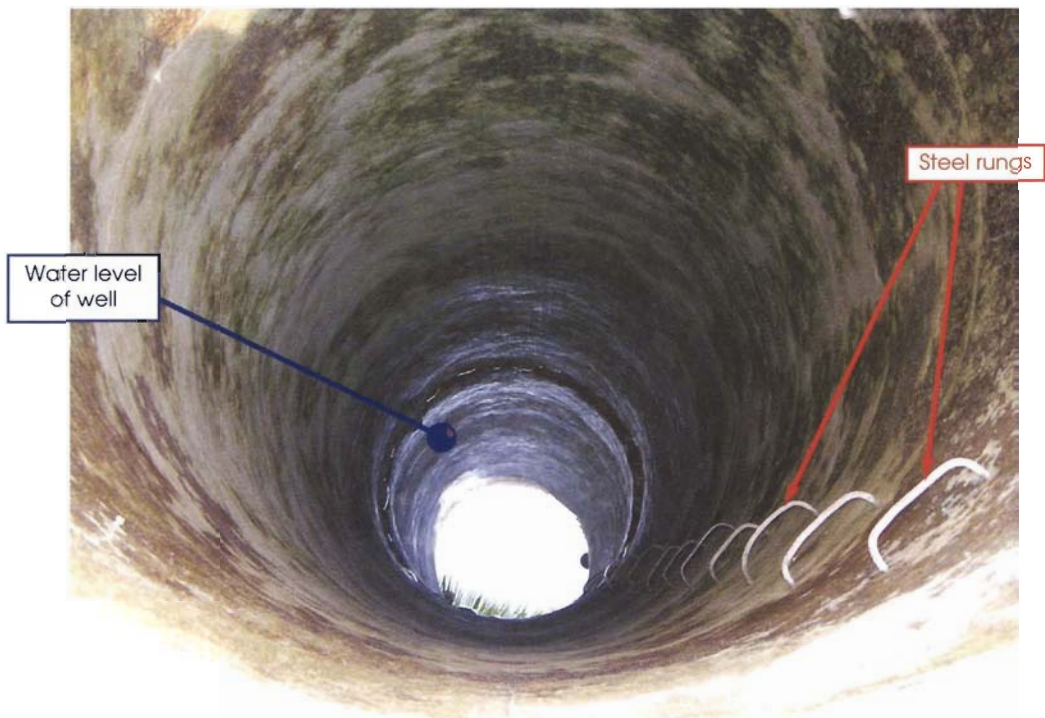
Why is it better ?

WELL

- It is equipped with everything that is needed.

Alternative:

- No.



Well equipped with steel rungs

Why is it better ?

WELL

- Steel rungs are essential for maintenance of a well or in case of an emergency.

Alternative:

- No.

Design – Construction – O & M



Wire mesh protection over a ground water well

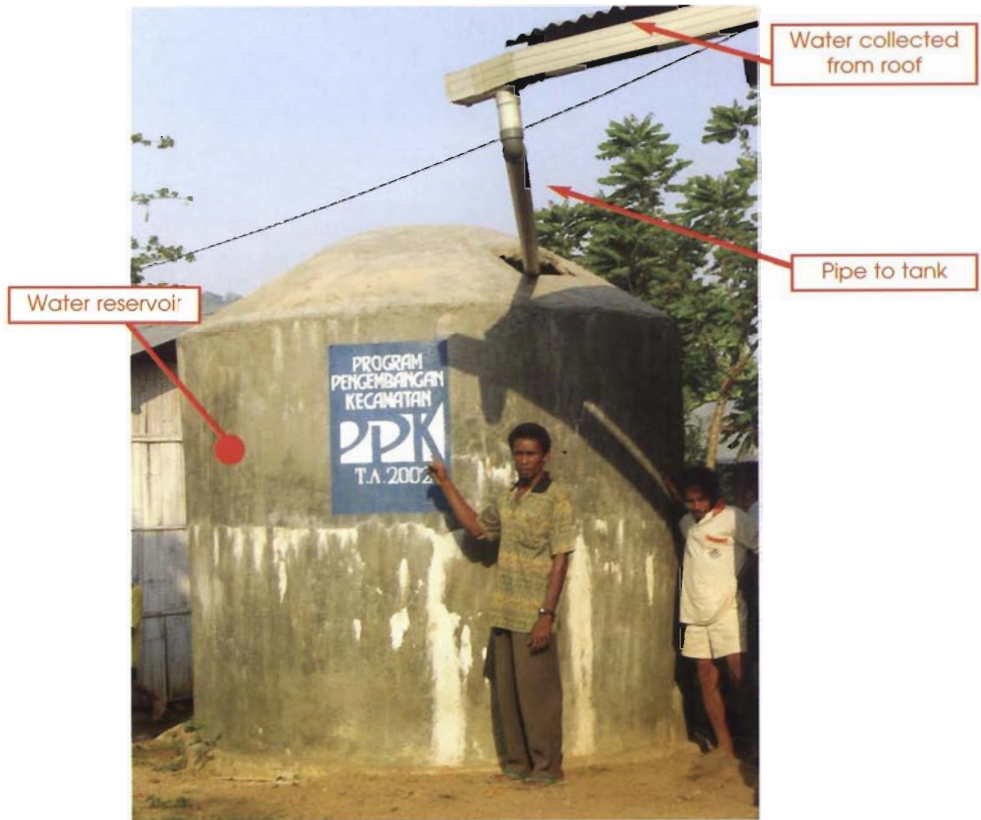
Why is it better ?

GROUNDWATER WELL

- A groundwater well usually has a wide open water area. To protect this area from falling leaves or debris it is good to cover it.
- A wire mesh, such as for fences, is cheap and reduces maintenance work.

Alternative:

- Any type of covering is an alternative, but it will be more costly.



Roof collection is a simple solution for water supply in dry areas
(it works during the rainy season – need refilling from tanker truck in dry season)

Why is it better ?

RAIN WATER

- There are no long pipes needed to get water.
- Metal roof is needed, or other type of smooth roofing material.
- A pipe from the nearby roof is only needed.

Alternative:

- To bring water from somewhere else, which is much more expensive.

Alternative: The size depends on the installed equipment and the design can vary.

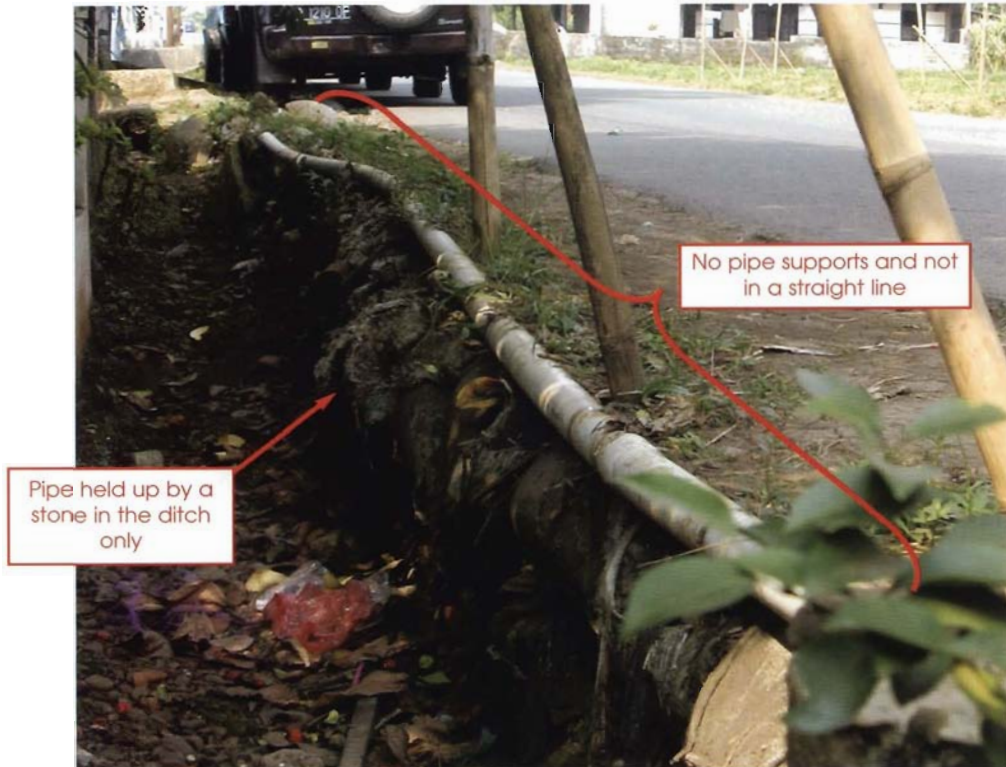
- The pumping station superstructure protects the equipment against unauthorized persons and inclement weather.
- Build an access path to the pumping station.

PUMP STATION

Why is it better ?

Pumping station for water supply





No pipe supports
Pipe is not even buried, covered or otherwise protected
Pipe is too close to the road and ditch

How can I do it better ?

PIPE LAYING

- Bury the pipe beside the ditch, or
- Lay the pipe in the ditch and cover it with concrete (coverage 10cm minimum)
- The pipe shall be laid in a straight line

WHY ?

- Pipe must be protected against external damage (eg. passing cars).
- PVC pipes must be protected against damaging UV-rays of the sun.
- Bending the pipe causes stress and loss of head.



No permanent pipe supports - Pipe is not even buried
No protection against sun

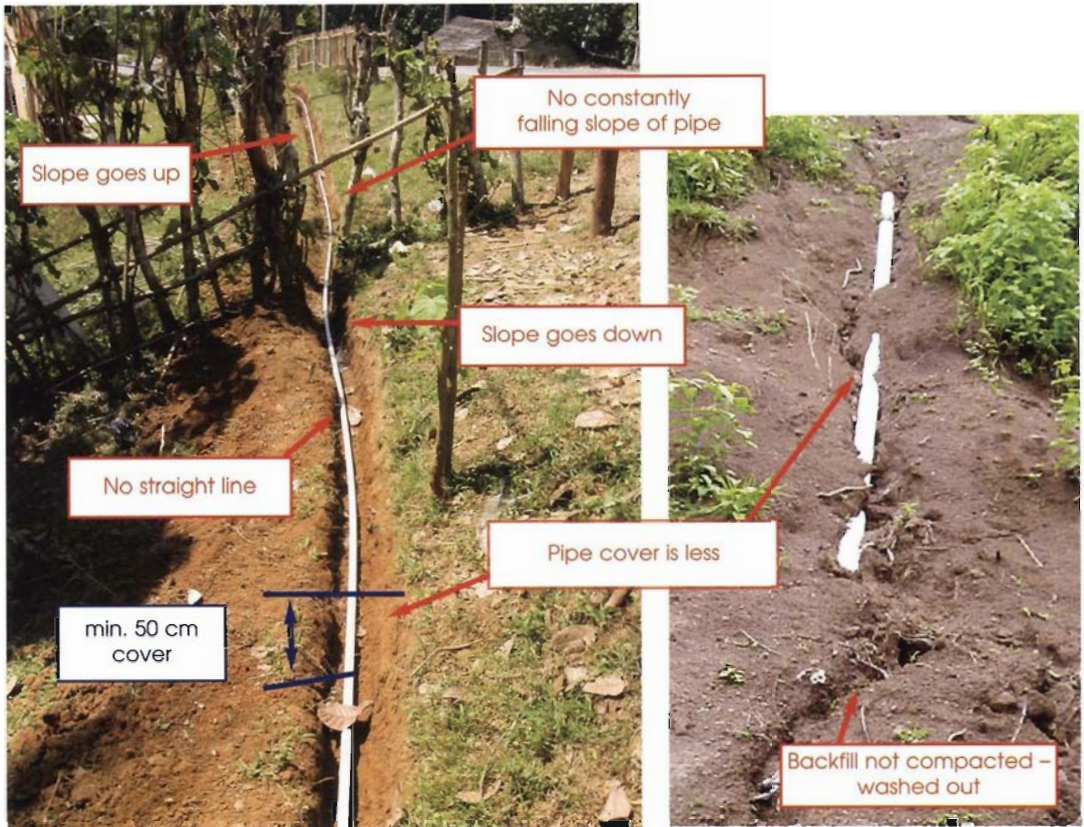
How can I do it better ?

PIPE LAYING

- Bury the pipe if at all possible.
- Build pipe supports, for example, with bamboo and tie the pipe on it. Support pipe every 5m on supports fixed into the ground. Pipe must not be bent between supports.
- Different types of supports possible, depends on ground conditions and availability of material.
- Provide sun protection by a slit bamboo, or use some other wrapping material.

WHY ?

- Pipe must be protected against external damages and it must be fixed to prevent movement by water hammer.
- Pipe shall be laid on a constantly falling slope.
- Sun influence destroys the PVC material.



No straight line - Not enough cover
No constantly falling slope of pipe

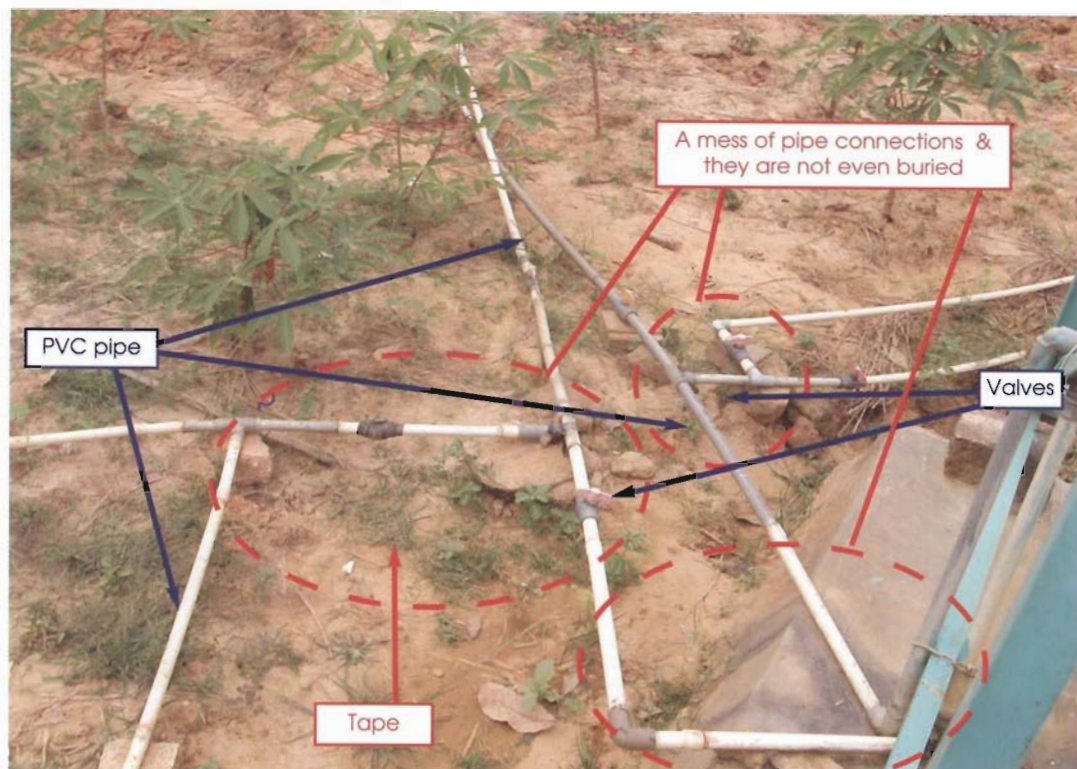
How can I do it better ?

PIPE LAYING

- Bury the pipe deep enough, making sure that the cover is at least 50 cm.
- The pipe shall be laid in a straight line.
- Avoid ups and downs – lay the pipe in a constantly falling slope.

WHY ?

- Every (horizontal and vertical) bend in the pipeline causes loss of head, which means the loss of water pressure and therefore flow.
- Deep enough cover protects the pipe against mechanical damage (eg. plow, vehicles).
- Water will be kept a cooler temperature, if there is enough cover.



Distribution pipes are not coordinated
Pipes are not buried Valves are not protected against damage

How can I do it better ?

PIPE LAYING

- Build a manhole and put all valves inside.
- Then all pipes can be buried.
- Describe all valves with the number of the different distribution lines.
- Straighten the lines as much as possible – find simple network connections.

WHY ?

- Unsupported pipes are at risk and can break if people step on them.
- Valves have to be protected from tampering with them, i.e. from other people operating them, from harsh weather, and other possible damage.
- Every bend (especially 90° bends) causes head loss which means less water pressure and therefore less flow.



Distribution pipes are not laid in common trench
Pipes are not protected against damage or UV-rays from sun

How can I do it better ?

PIPE LAYING

- Lay the pipes in a trench and cover them with earth (min. 50 cm).
- Protection against sun is NOT necessary when pipes are buried.

WHY ?

- Unburied pipes are at risk and can get damaged if people step on them.
- Lay the pipes in a straight line.
- Sunlight, i.e. UV-rays, make PVC material brittle, and it will break eventually.



Pipes are improperly installed and not protected against damage

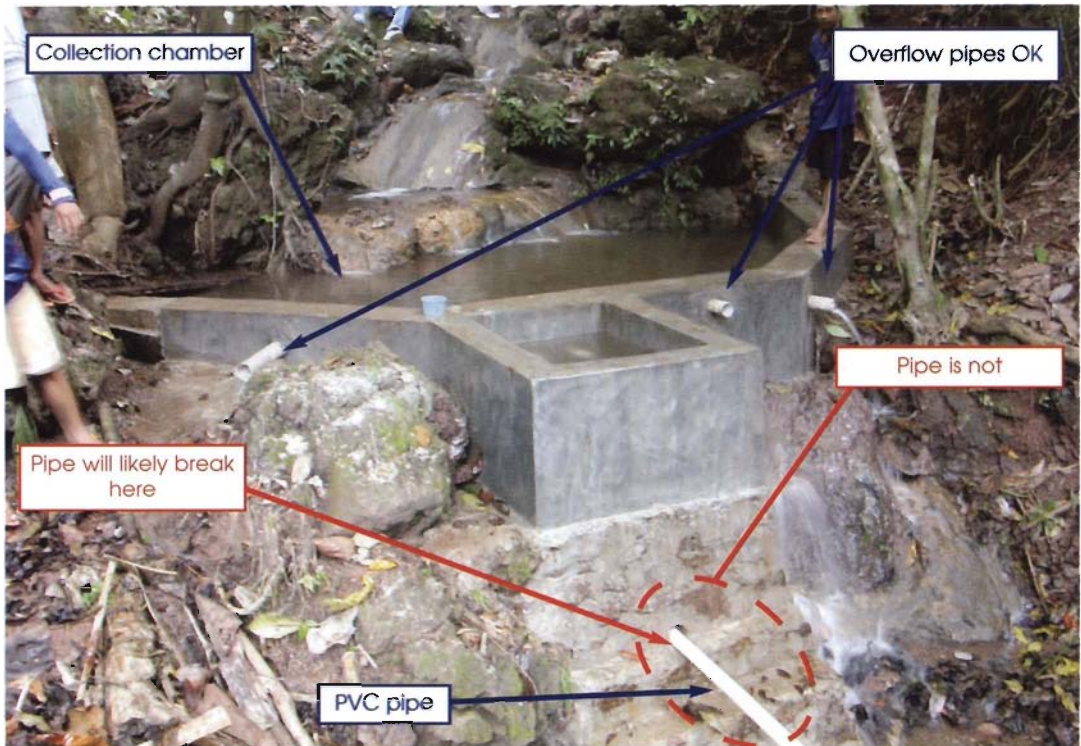
How can I do it better ?

PIPE LAYING

- Use fittings instead of bending the pipe → avoid tension stress which damages the pipes over time.
- Lay the pipes in a trench and cover them with earth (min. 50.cm).
- No sun protection is necessary when pipes are buried.

WHY ?

- To avoid tension stress - the pipes must be laid in straight line in a trench.
- Tension stress can damage the pipe material.
- Sunlight, i.e. UV-rays, makes PVC material brittle, and eventually it will break.



Outlet pipe is not supported

How can I do it better ?

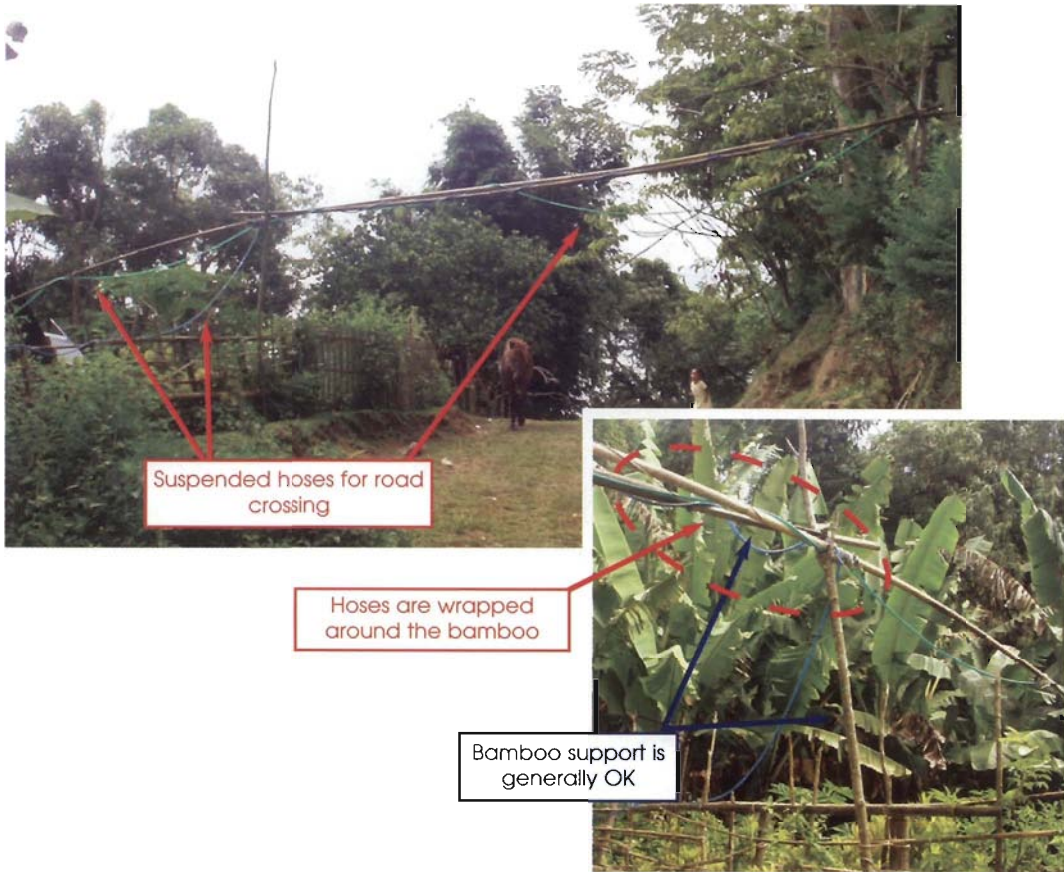
PIPE SUPPORT

- If not buried, pipe must be supported along its full length, at least with two pieces of bamboo under the pipe and taped together.

WHY ?

- Unsupported pipes can break easily.
- Pipe will sag (bend down) between supports and may eventually break, or joints will pull apart.

Design – Construction – O & M – Environmental Impact



Hoses are not fixed to the bamboo supports

How can I do it better ?

PIPE SUPPORT – Road Crossing

- Use two pieces of bamboo tied together as support (like a pipe bridge).
- Fasten the hoses to the bamboo supports with tape at about 1 meter intervals.
- O&M has to check the support system periodically.

WHY ?

- A supply line should be as straight as possible, even plastic hoses.
- For safety reasons also, the hoses should not hang loose from the bamboo support.



The pipes sag if a river is crossed without any support
And they are exposed to flood water damage

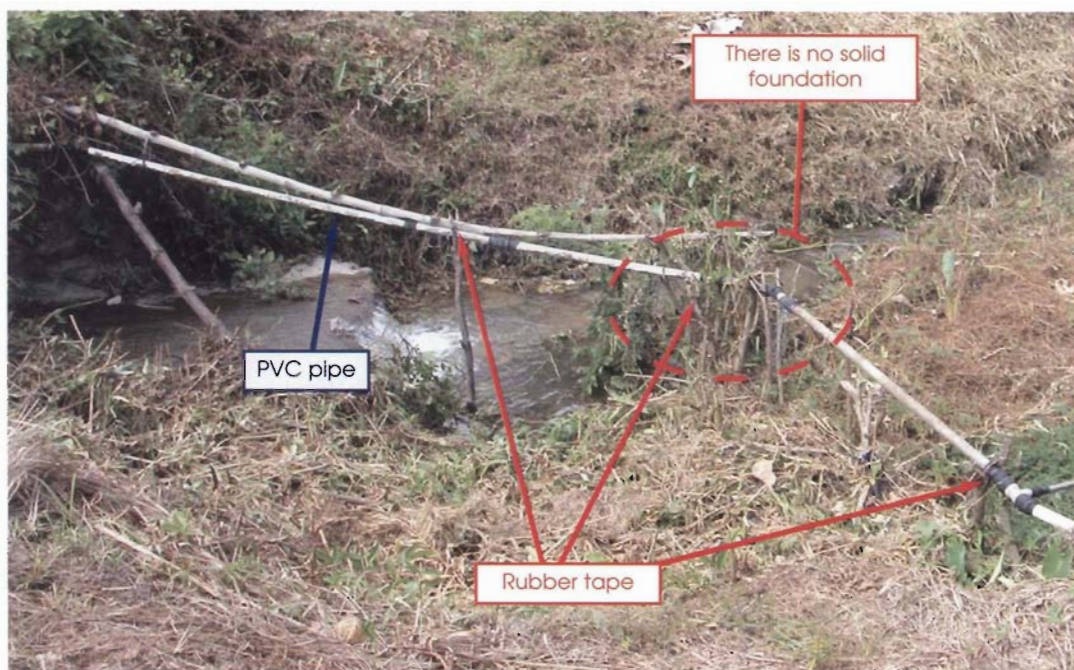
How can I do it better ?

PIPE SUPPORT – River Crossing

- Use two bamboo supports, fix them together and lay the pipe on top.
- Fasten the pipe on the bamboo supports with tape about every meter.
- Build a solid foundation for the supports on both sides of the crossing.
- Bamboo supports will have to inspected and replaced eventually.

WHY ?

- Unsupported pipes are at risk and can break easily.
- Every (horizontal and vertical) bend in the pipe causes loss of head, which means the loss of pressure and lower flow.



This pipe crossing is not adequate
Tape must not be used as a substitute for proper glued fittings

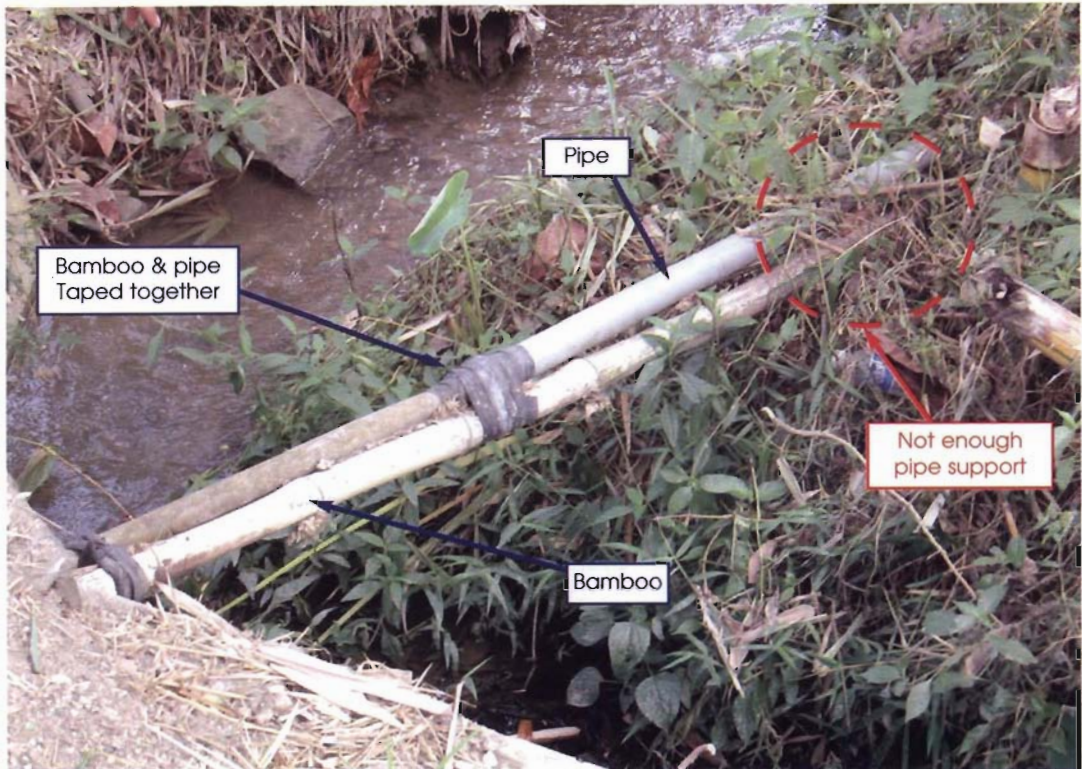
How can I do it better ?

PIPE SUPPORT – River Crossing

- Use two pieces bamboo, fix them together and lay the pipe on top.
- Fasten the pipe on the bamboo supports with tape every meter.
- Build a solid foundation for the bamboo supports on both sides of the crossing.
- Use proper glued fittings instead of tape to make a tight pipe connection.

WHY ?

- When two pieces of bamboo and the pipe are fastened together, they form a triangle which gives them the necessary rigidity and strength.
- Movements of the pipe will loosen the fittings, even glued fittings.



There is no solid pipe support

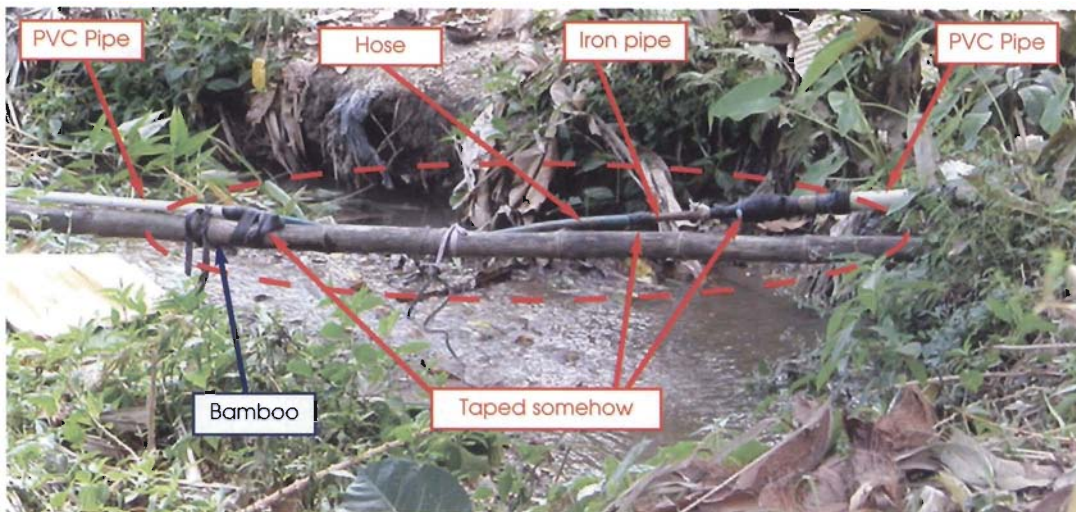
How can I do it better ?

PIPE SUPPORT – River Crossing

- Use two pieces of bamboo instead of one and lay pipe on top.
- The end of the bamboo support must be fixed to a solid foundation.

WHY ?

- Horizontal pipes have to be supported to avoid tension stress on the pipe.



Different pipe materials and diameters change and are just suspended loosely over the creek

How can I do it better ?

PIPE SUPPORT – River Crossing

- Replace the hose and the iron pipe with a PVC pipe of the same diameter.
- Use two bamboo supports and tape the PVC pipe to them.

WHY ?

- Reducing the pipe diameter will decrease the flow capacity.
- Horizontal pipes have to be supported to avoid tension stress on the pipe.

- Unsupported pipes will break easily.
- Pipe will sag (bend down) between supports and may eventually break.
- Sunlight, i.e. UV-rays, make PVC material brittle, and eventually it will break.

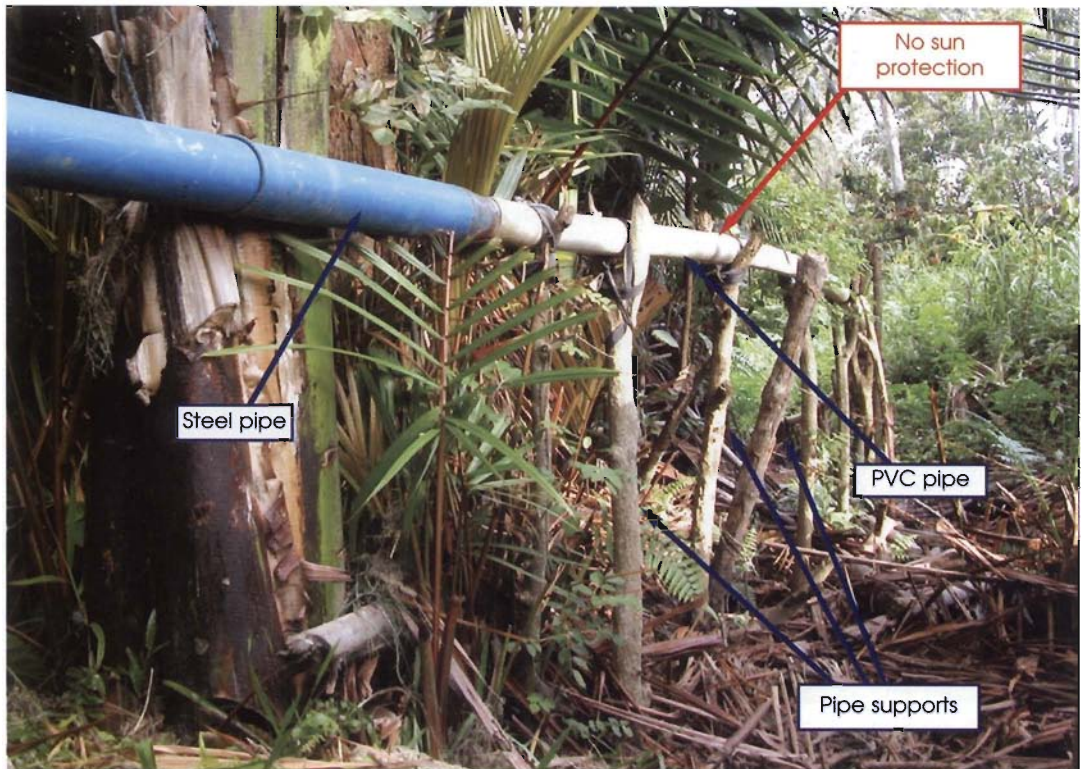
WHY ?

- If not buried, pipe must be supported along its full length, for example, with two pieces of bamboo (from support to support) under the pipe and taped together.
 - Use support posts of same material.
 - Protection against sunlight (UV-rays) is required.
- PIPE SUPPORT – River Crossing*

How can I do it better ?

The PVC pipe crossing sags over the creek because it is not properly supported





No protection from sunlight

How can I do it better ?

PIPE WORK - Protection

- Put suitable material over the PVC pipe as sun protection (old tires, sacking, other wrapping) – but only if pipe cannot be buried.

WHY ?

- Sunlight, i.e. UV-rays, make PVC material brittle, and eventually it will break.



Pipes can easily get damaged

How can I do it better ?

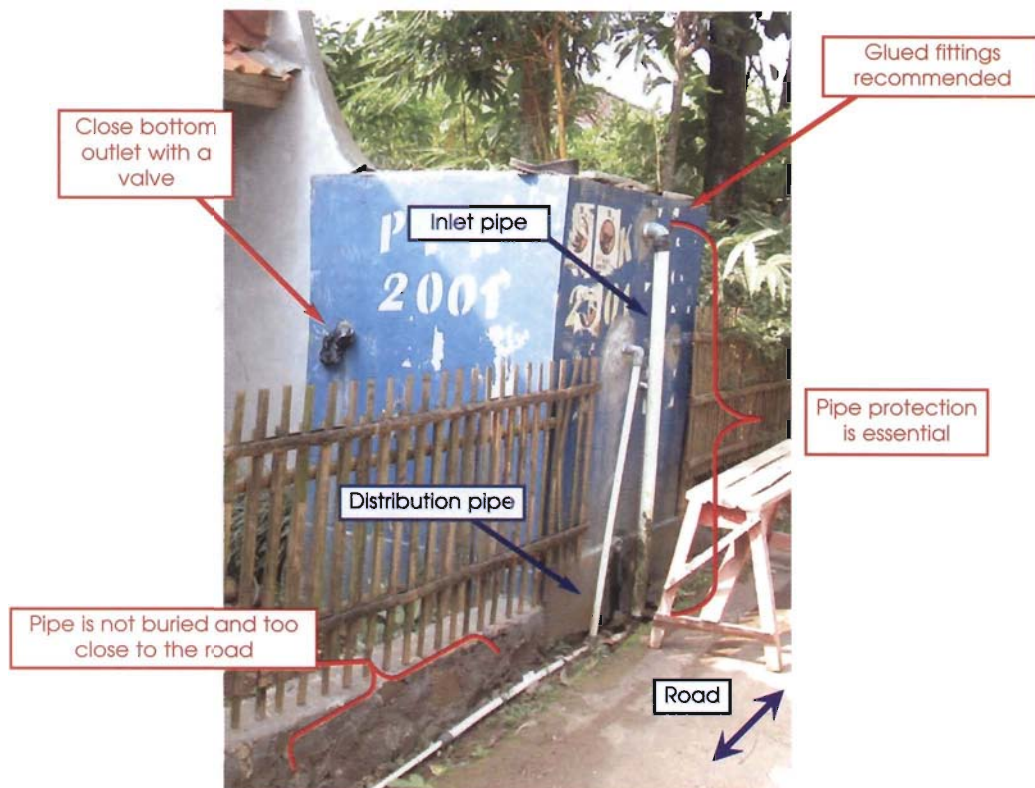
PIPE WORK – Around Tank

- Bury the pipes.
- Pipes on the ground should be covered with earth.

WHY ?

- Unburied pipes, even GI and steel pipes, are at risk and can get damaged easily if people step on them (these pipes are in a garden!).
- Uncovered pipes warm up easily.

Design – Construction – O & M – Environmental Impact



Inlet and distribution pipes are accessible to anybody
Distribution pipe is not buried

How can I do it better ?

PIPE WORK – Supply Pipes

- Protect the pipes by encasing them in concrete.
- Better still, bury the pipes, where possible.
- PVC fittings shall be glued together.
- Pipes have to be fixed to the tank with clamps.

WHY ?

- The pipes must be protected against the risk of damage and shall not be exposed to sunlight.
- There will be water leaks and losses when fittings are not watertight.



Pipe is under tension stress
No pipe support at the bend

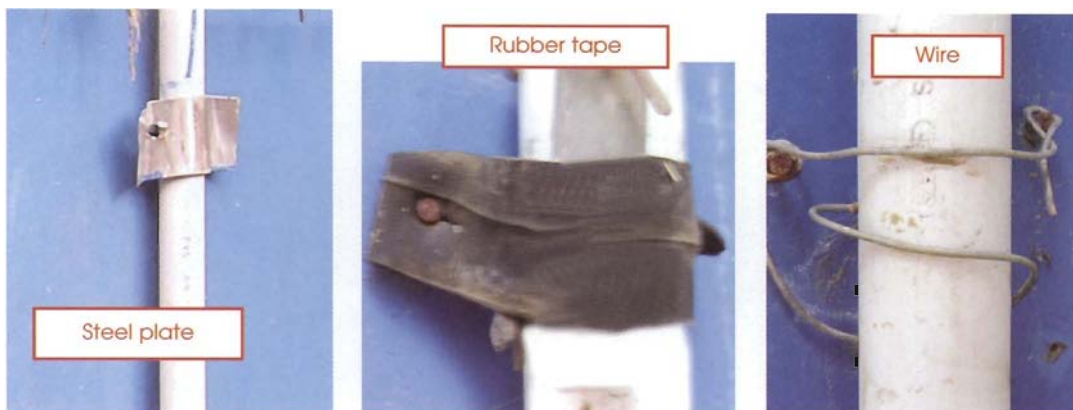
How can I do it better ?

PIPE WORK – Water Distribution

- Support outlet pipe, at least with a brick or clamp, and fix the bend.
- Lengthen the pipe between the tank outlet and the bend to prevent tension stress.

WHY ?

- Horizontal pipes must be supported to avoid tension stresses in the pipe.
- Pipes will not be under tension when they are laid in a straight line.
- Tension stress can damage the pipe or pull joints apart.



Three different types of clamps which shall NOT be used

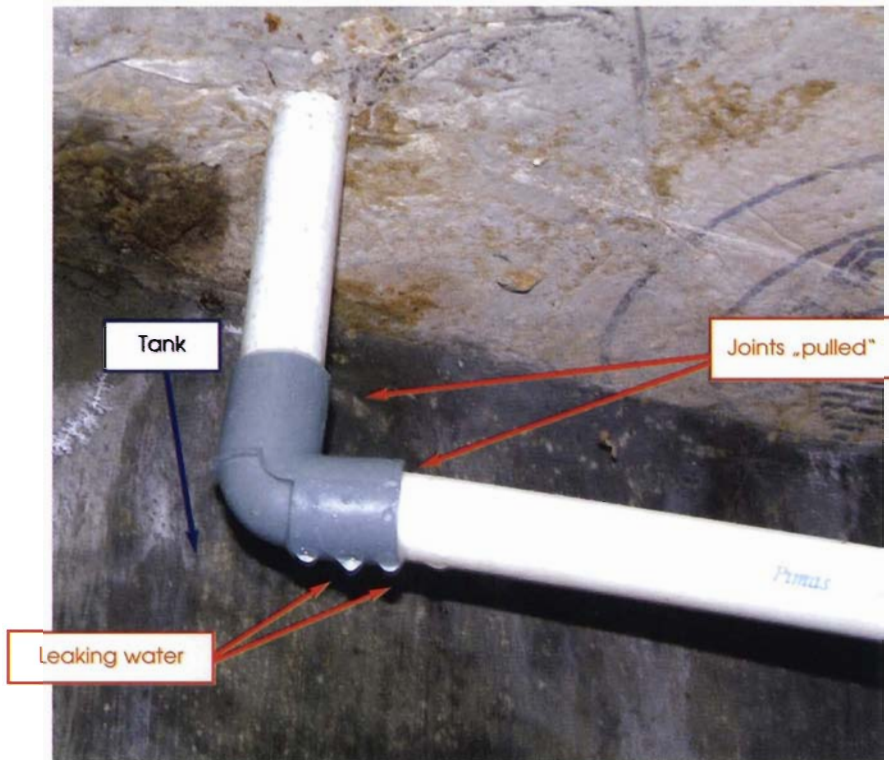
How can I do it better ?

PIPE WORK

- Use proper pipe clamps to fit the respective pipe diameter.
- Encase the pipe in concrete or plaster - in that case no clamps are needed and the pipe is protected from sunlight.

WHY ?

- The pipe must not be loose (but must be fixed) because the pipe connections (joints) could pull apart.
- PVC pipe becomes brittle when exposed to sunlight.



“Pulled” joints that leak caused by the weight of the pipe and because the joints are not glued

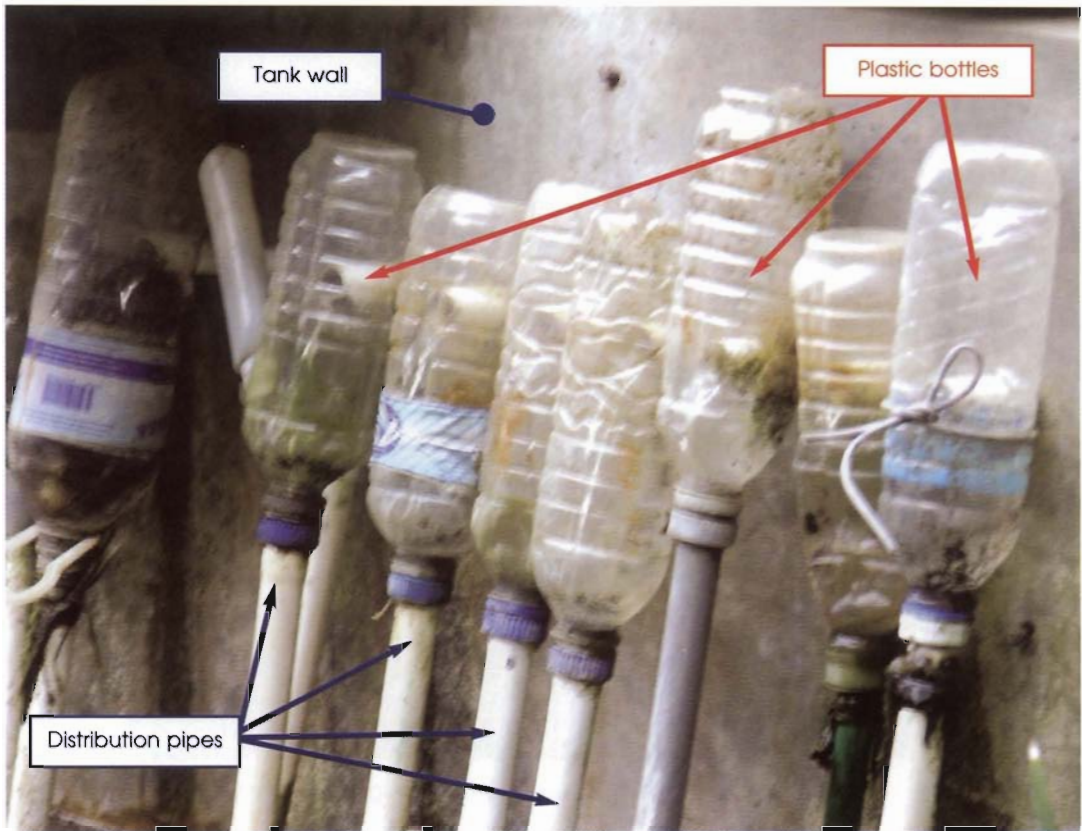
How can I do it better ?

PIPE WORK

- Provide enough support for the horizontal pipe.
- Glue the joints of pipes and the fitting together.
- Check fittings and pipe connections for watertightness.

WHY ?

- The seal of the joints will become defective after a while and the pipe connection leaks.



Plastic bottles are not suitable as fittings

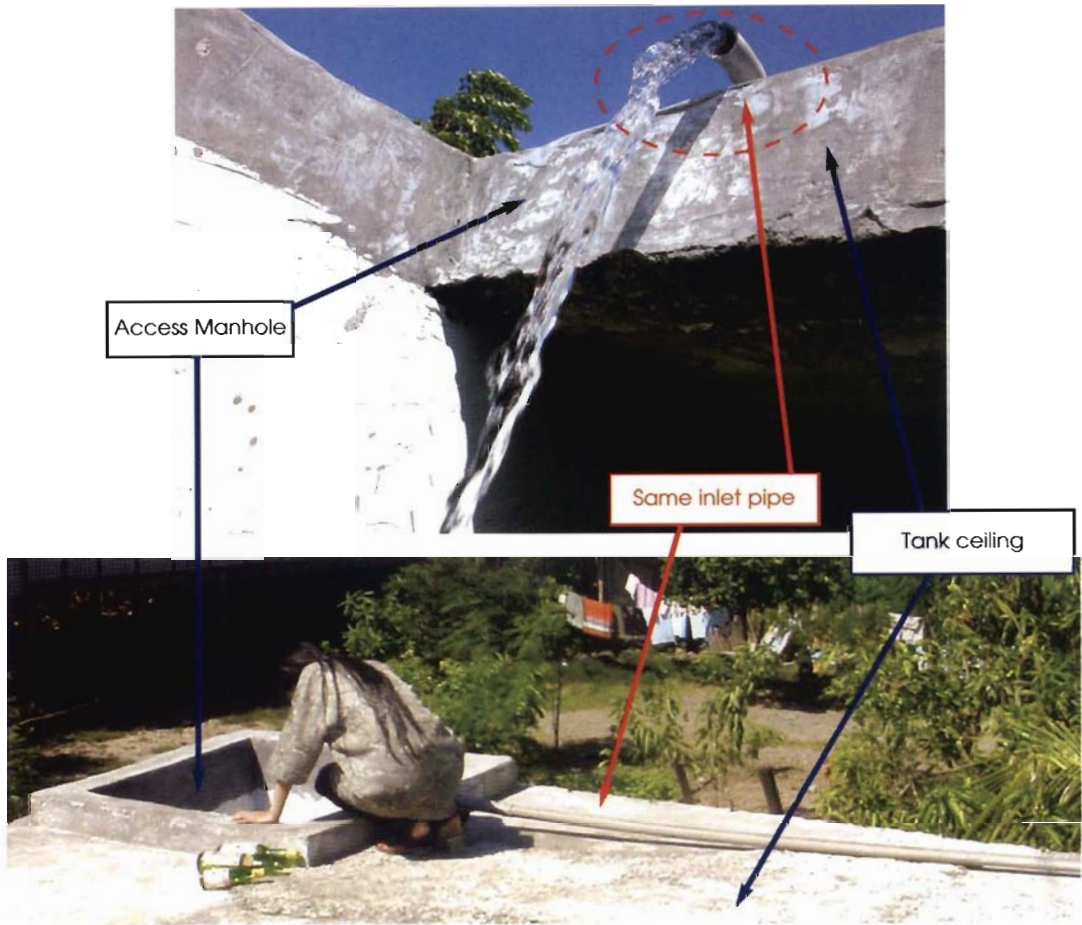
How can I do it better ?

PIPE WORK – Water Distribution

- Replace plastic bottles with proper fittings.

WHY ?

- Pipe connection must be solid to prevent movement which could cause leaking joints or broken pipes.



Inlet pipe is laid on the top of the tank only

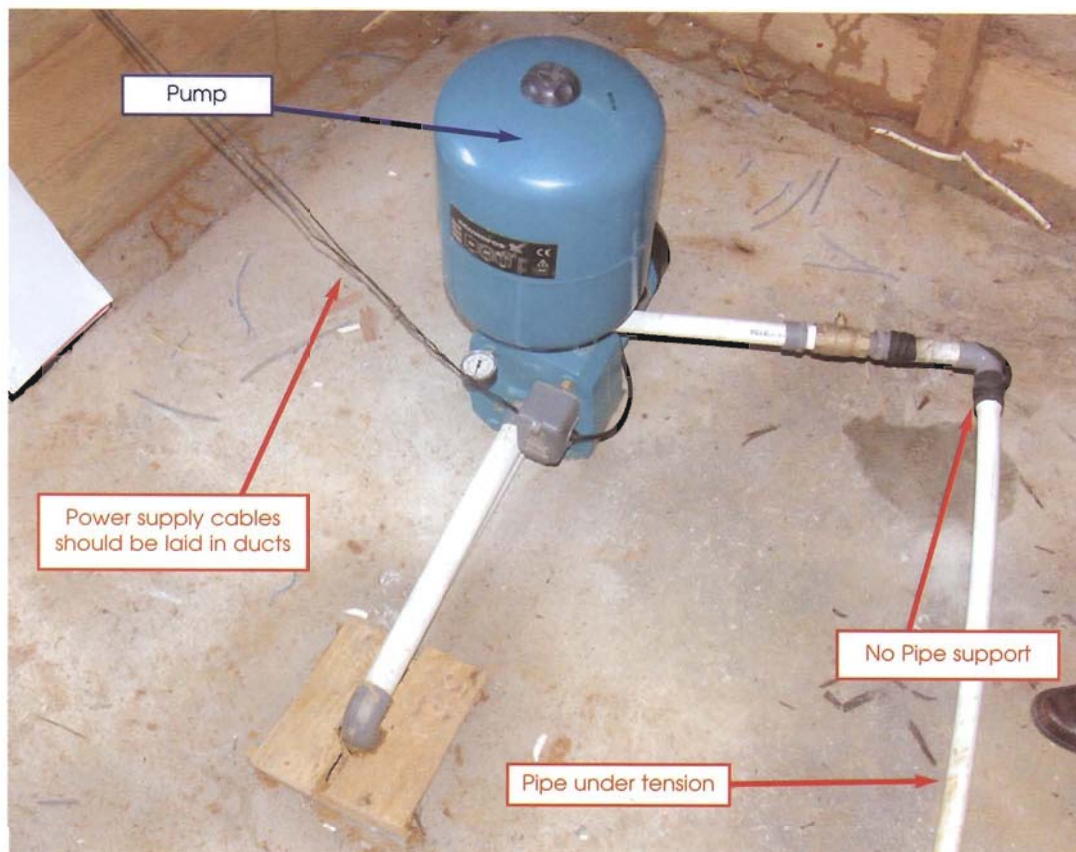
How can I do it better ?

PIPE WORK – Water Inlet

- Inlet pipe should be fixed in the wall and should be 10 cm below the tank ceiling.
- Open the access manhole for inspection and maintenance only.

WHY ?

- If the pipe is fixed in the wall, it cannot move and the pipe connections will not come loose or be broken.
- On the other hand, the access manhole of the tank must be kept closed with a tight-fitting, lockable cover to protect the water quality.



No pipe support at the bend
Pipe is under tension stress

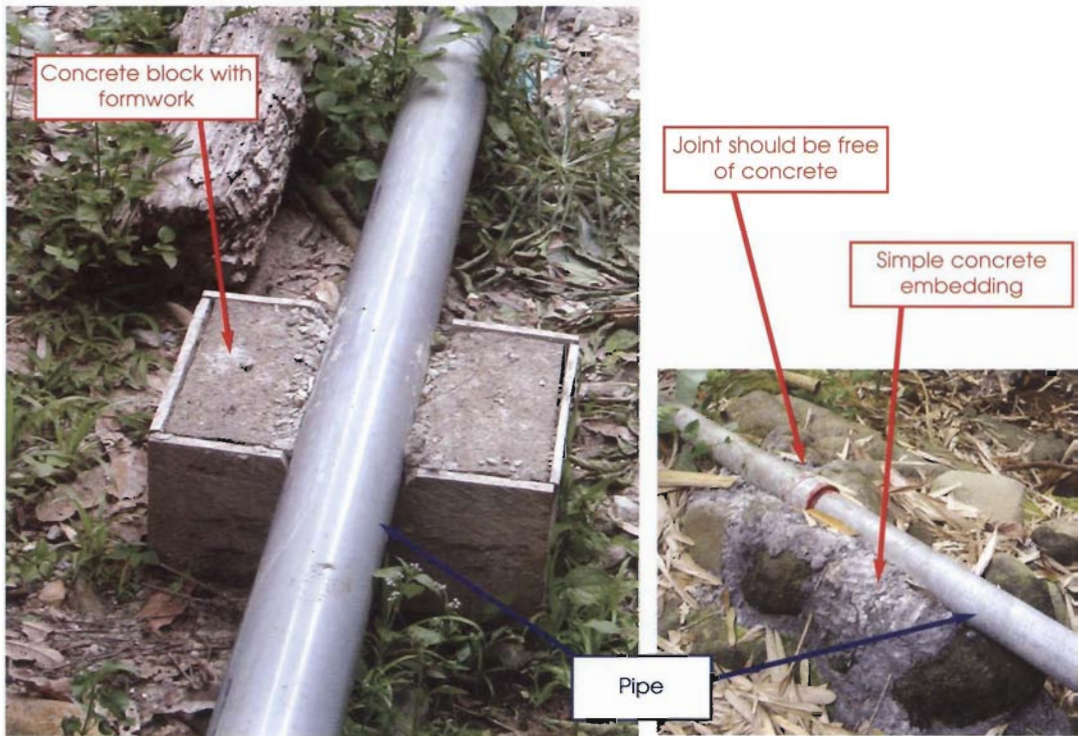
How can I do it better ?

PIPE WORK

- Support, with a brick or clamp, and fix the bend.
- Lengthen the pipe between the pump and the bend to prevent tension.

WHY ?

- Horizontal pipes must be supported to avoid tension stresses in the pipe.
- Pipes will not be under tension when they are laid in a straight line.
- Tension stress can damage the pipe material.



Concrete pipe supports

Why is it better ?

PIPE SUPPORT

- This type of support stabilizes the pipe, especially for longer spans. Make sure the pipe material is suitable for it, such as GI (galvanized steel pipe). Not suitable for PVC pipes.
- Pipe has to be laid straight and free of tension and should be fixed to the support, but joints should be kept free.

Alternative:

- See the following pages.

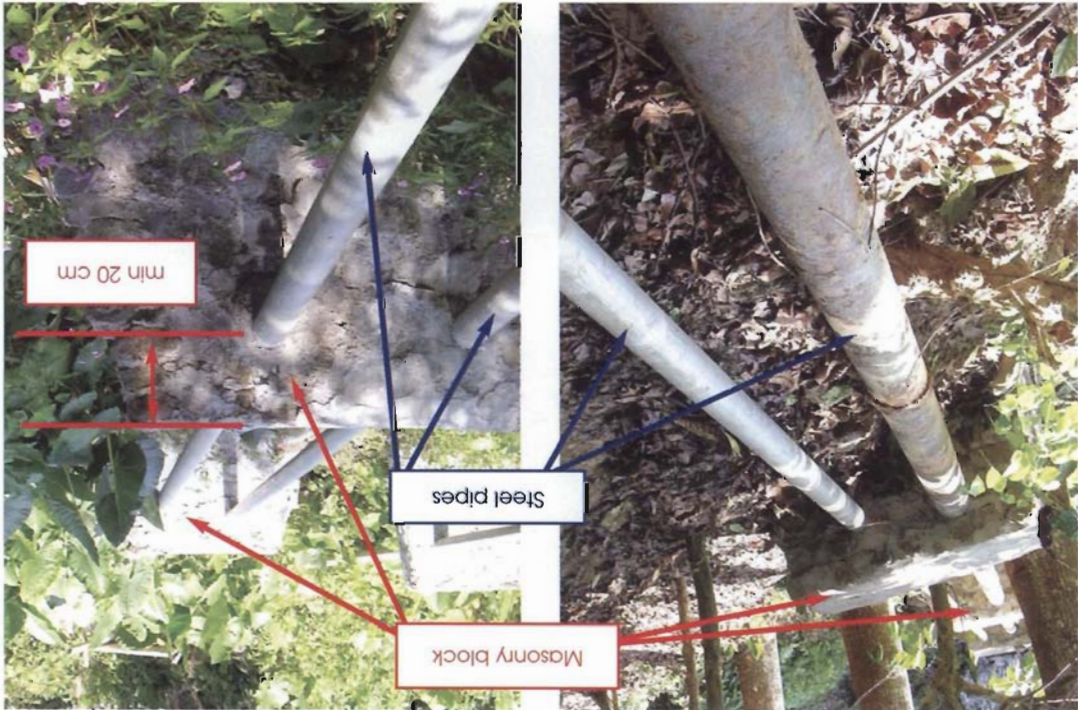
Alternative:
• See relevant pages.

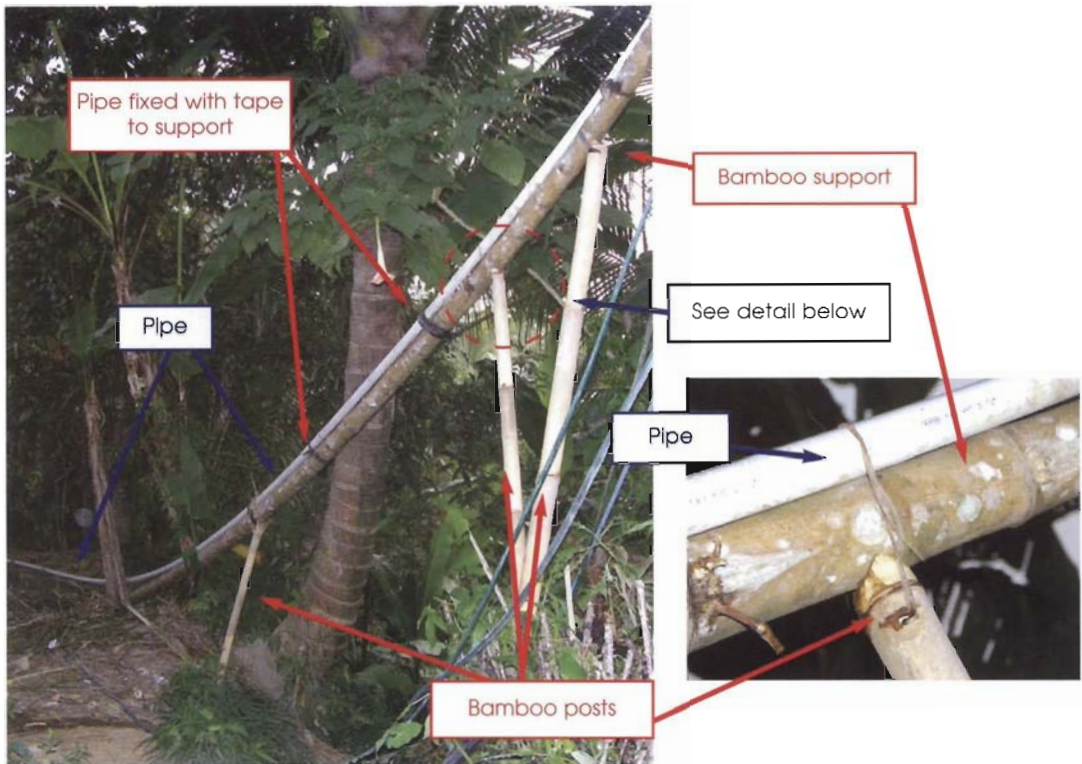
- This type of support stabilize the pipe, especially for longer spans. Make sure the pipe material is suitable for it, such as GI (galvanized steel pipe). Not suitable for PVC pipes.
- Pipe has to be laid straight and free of tension and should be fixed to the support, but joints should be kept free.

PIPE SUPPORT

Why is it better ?

Pipe supports made of masonry





Bamboo support for PVC pipes

Why is it better ?

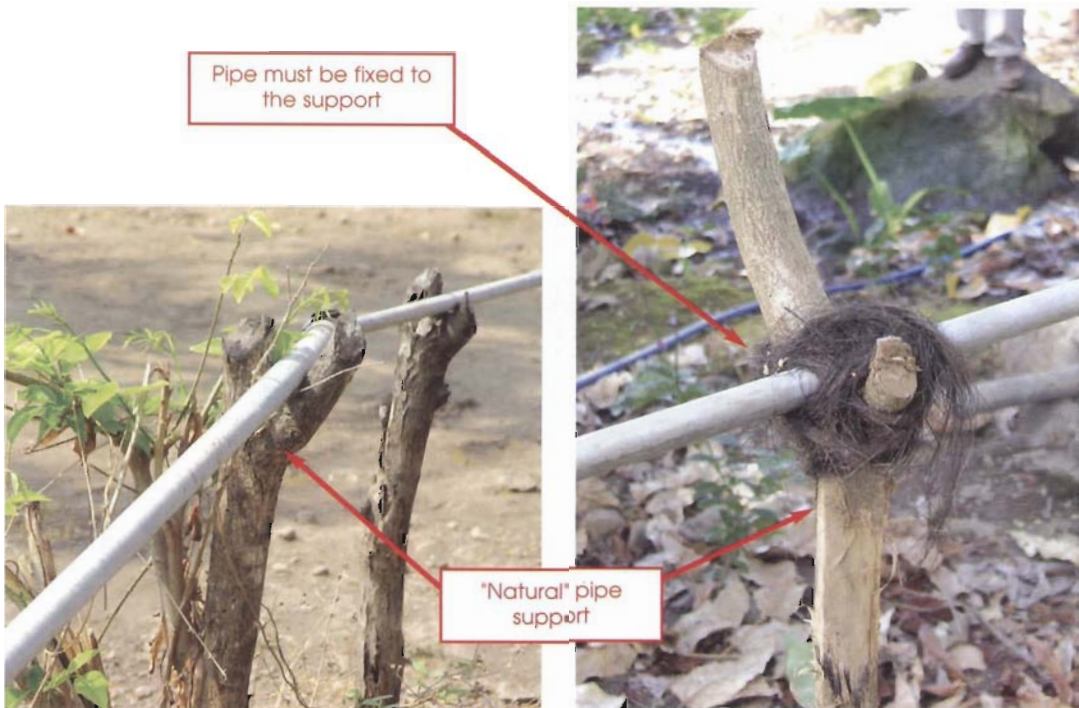
PIPE SUPPORT

- A support should fix the pipe, to prevent movements (two bamboo supports are much better than one).
- Pipe has to be laid free of tension and must be fixed to the support.

Alternative:

- See relevant pages.

Design – Construction – O & M



"Natural" pipe support

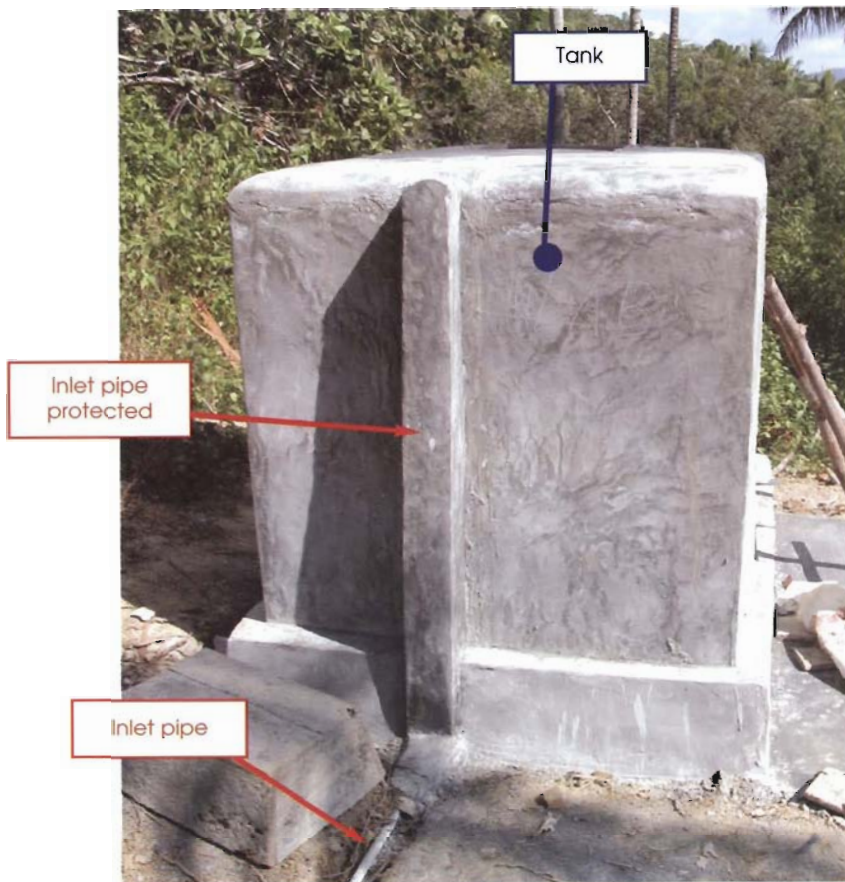
Why is it better ?

PIPE SUPPORT

- A support has to stabilize the pipe, to prevent movements which could stress and damage the pipe.
- Pipe has to be laid free of tension and must be fixed to the support.
- "Dead" wood is preferred for natural supports.
- The joint should be kept free.

Alternative:

- See relevant pages.



Protection of a PVC inlet pipe

Why is it better ?

PIPE PROTECTION

- A pipe fixed to the wall of a tank cannot move and the joints cannot come apart.
- Reduce O&M control.

Alternative:

- Use proper pipe clamps to fit the respective pipe diameter.



Pipe sleeve used for a river crossing

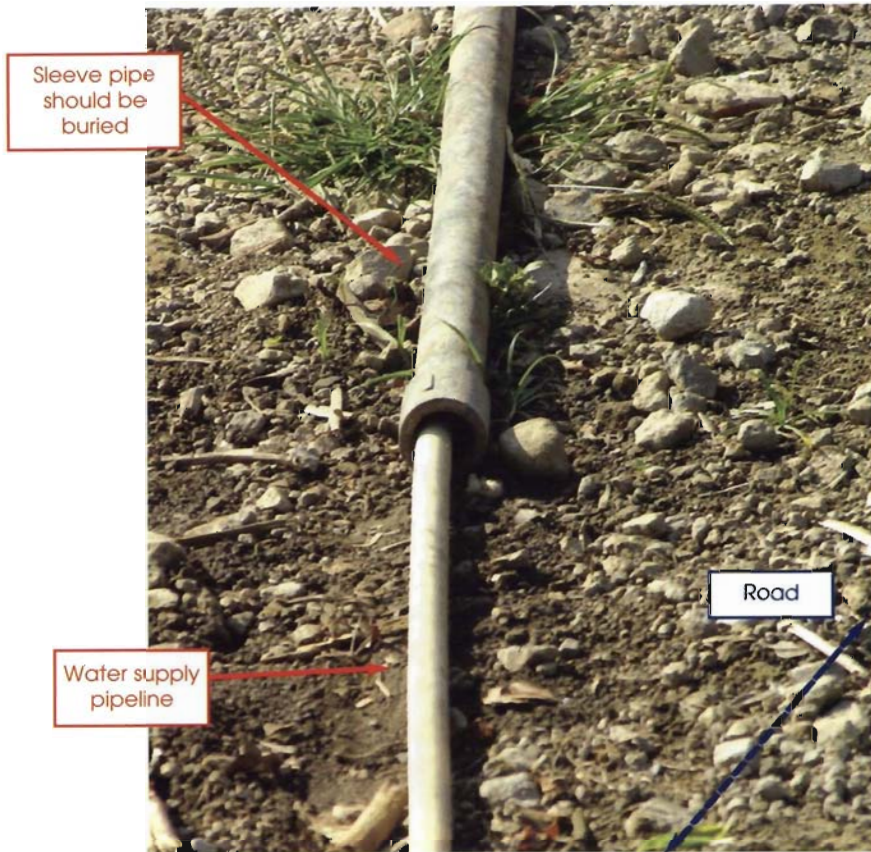
Why is it better ?

PIPE PROTECTION

- A steel pipe protects the supply line, crossing rough terrain, such as a river.
- The sleeve pipe has to be fastened to the ground using pipe supports.
- Diameter of sleeve pipe shall be 1,5 times the diameter of the supply line.

Alternative:

- A pipe bridge, but it would be much more expensive.



Using a pipe sleeve to protect supply line

Why is it better ?

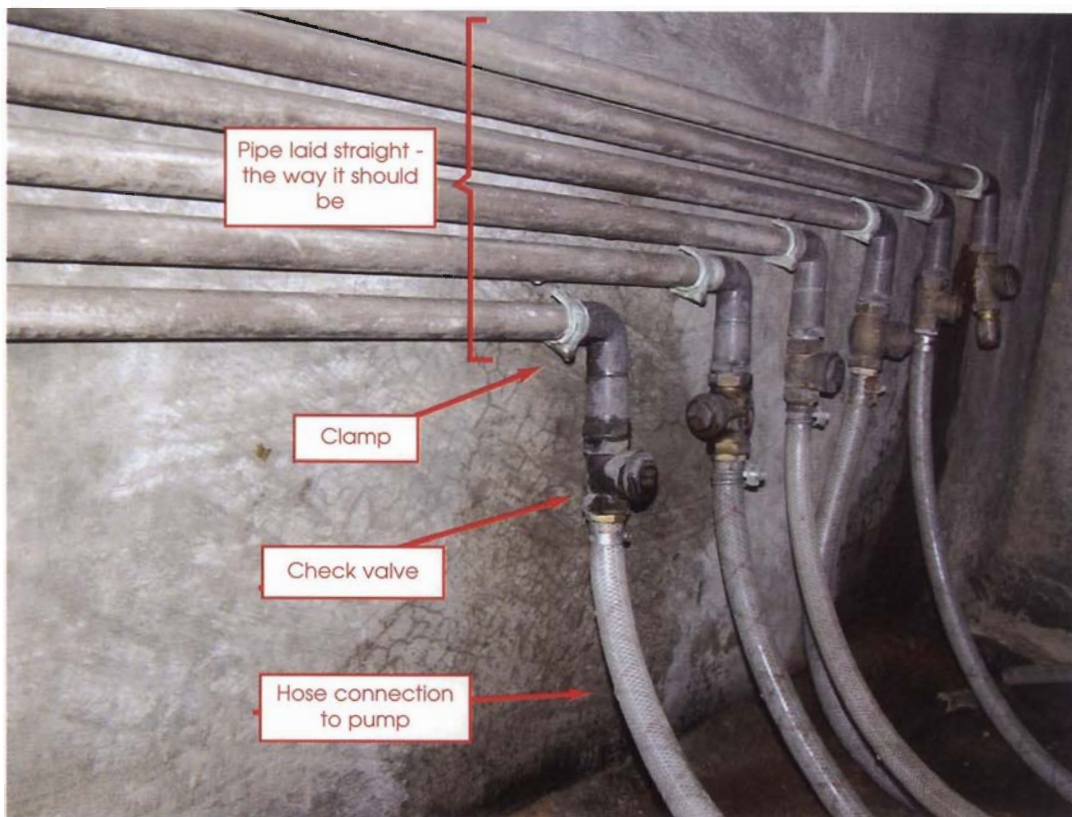
PIPE PROTECTION

- A steel pipe protects the supply line crossing rough terrain, such as a road.
- The sleeve pipe should be buried (coverage at least 50 cm).
- Diameter of sleeve pipe shall be 1,5 times the diameter of the supply line.

Alternative:

- Unprotected pipe will be damaged sooner, needing repair or replacement

Design – Construction – O & M



Pipe installation in a pumping station

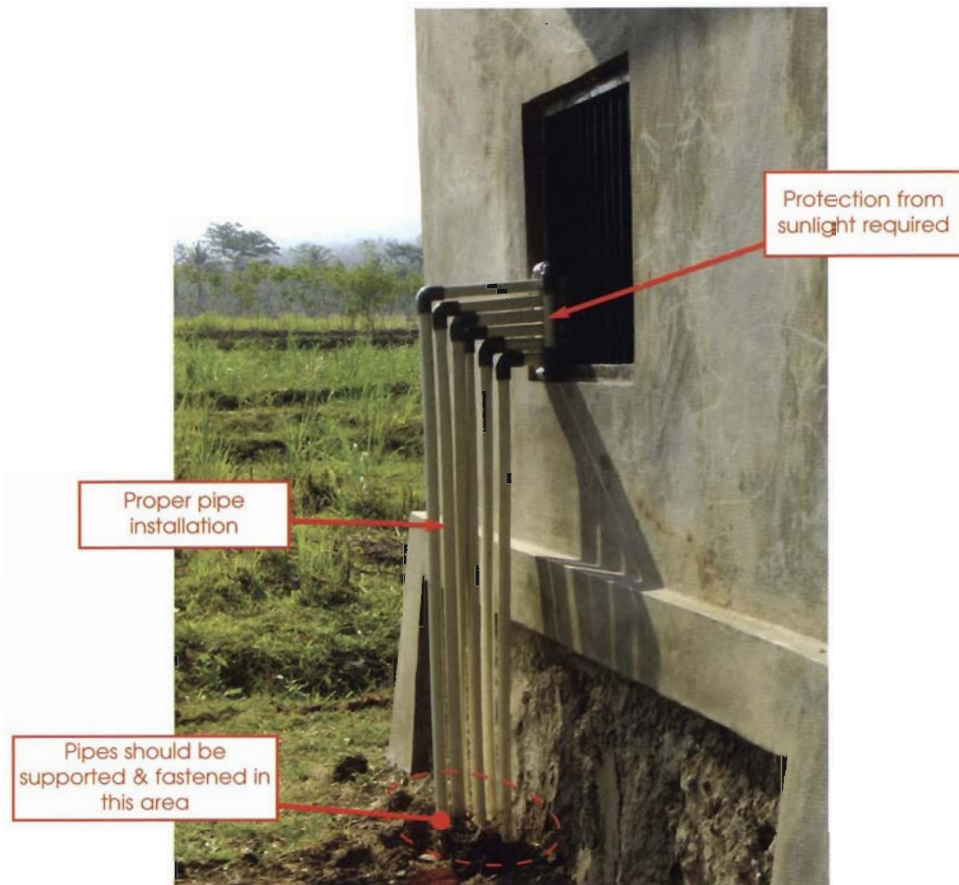
Why is it better ?

PIPE WORK – Pipe Laying

- The pipes cannot move because they are fastened to the wall.
- Clear and simple layout – pipes are accessible for inspection.

Alternative:

- No.



Pipe installation outside a pumping station

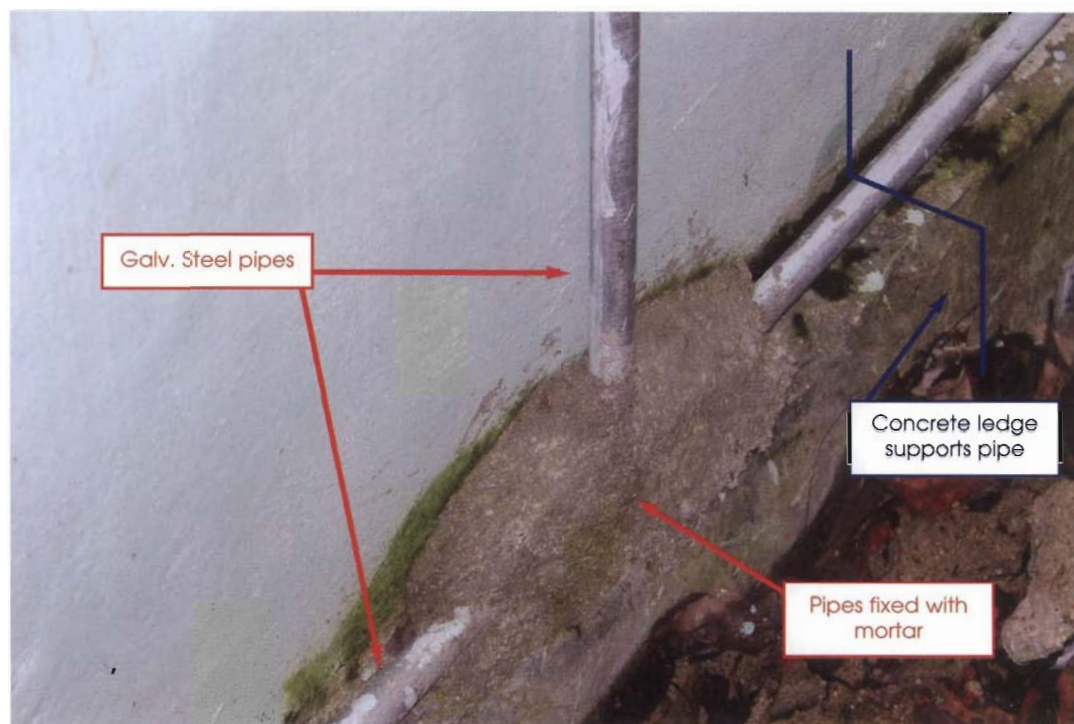
Why is it better ?

PIPE WORK – Pipe Laying

- Tidy pipe layout will ease inspection and maintenance.

Alternative:

- No.



Pipe installation outside a MCK

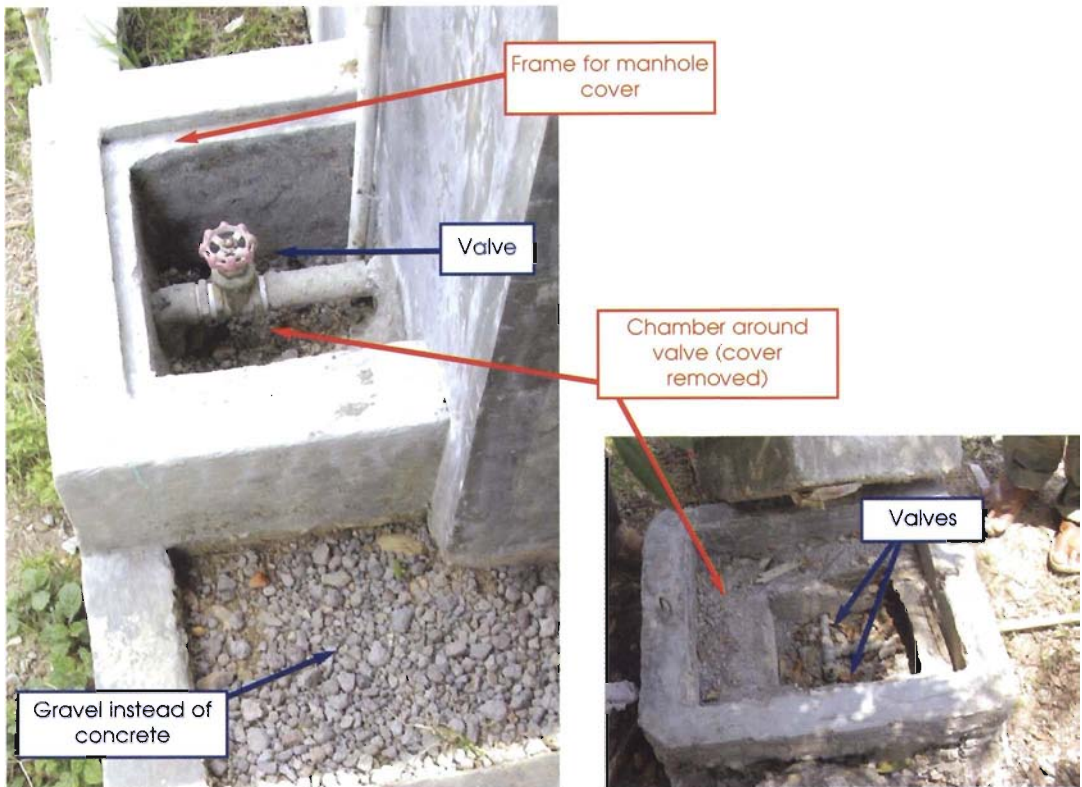
Why is it better ?

PIPE WORK – Pipe Laying

- The pipe is protected and supported by the concrete ledge of the tank and fixed to the wall with mortar, so the pipes cannot move.
- A proper pipe layout will ease inspection and maintenance.

Alternative:

- To fix the pipes with clamps to the wall.



Valve protection

Why is it better ?

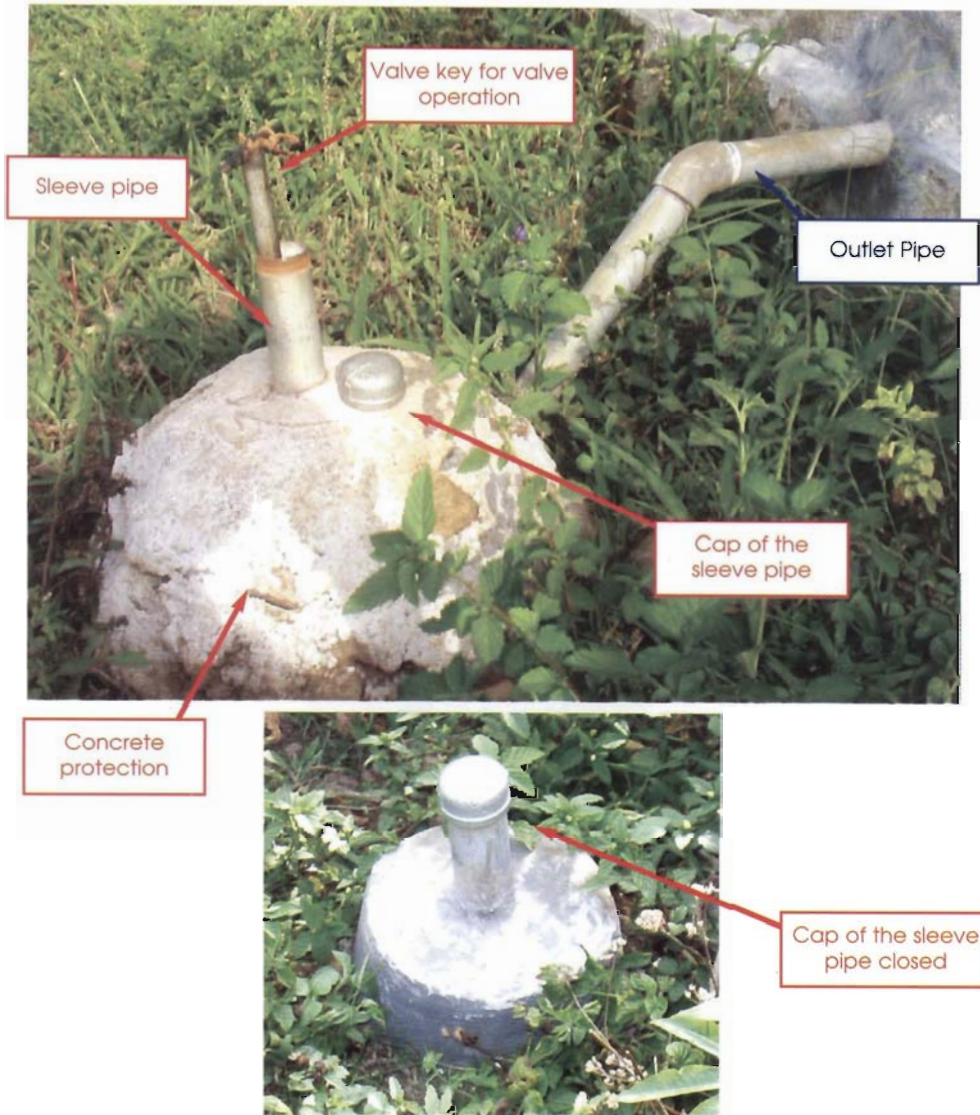
PIPE WORK - Equipment

- Valves are protected against mechanical damage and operation or tampering by unauthorized persons.

Alternative:

- No.

Design - Construction - O & M



Valve protection

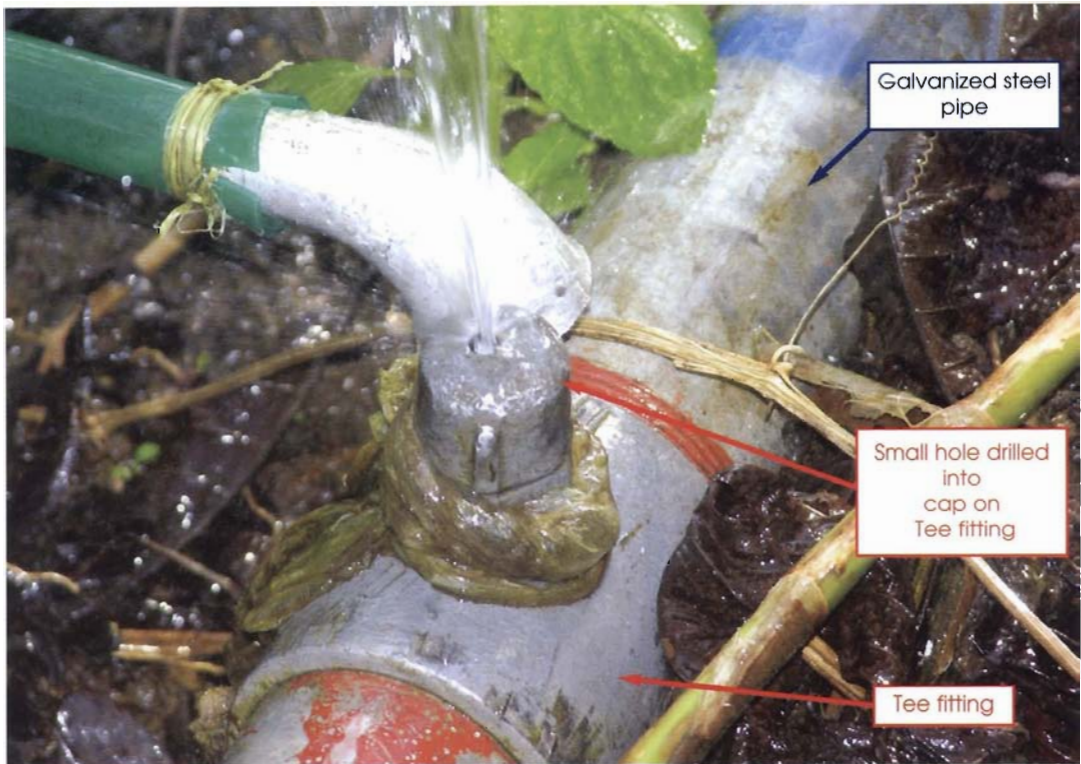
Why is it better ?

PIPE WORK - Equipment

- The valve is protected against mechanical damage as well as tampering or operation by unauthorized persons.

Alternative:

- No.



A simple air valve (note air and water escaping through hole)

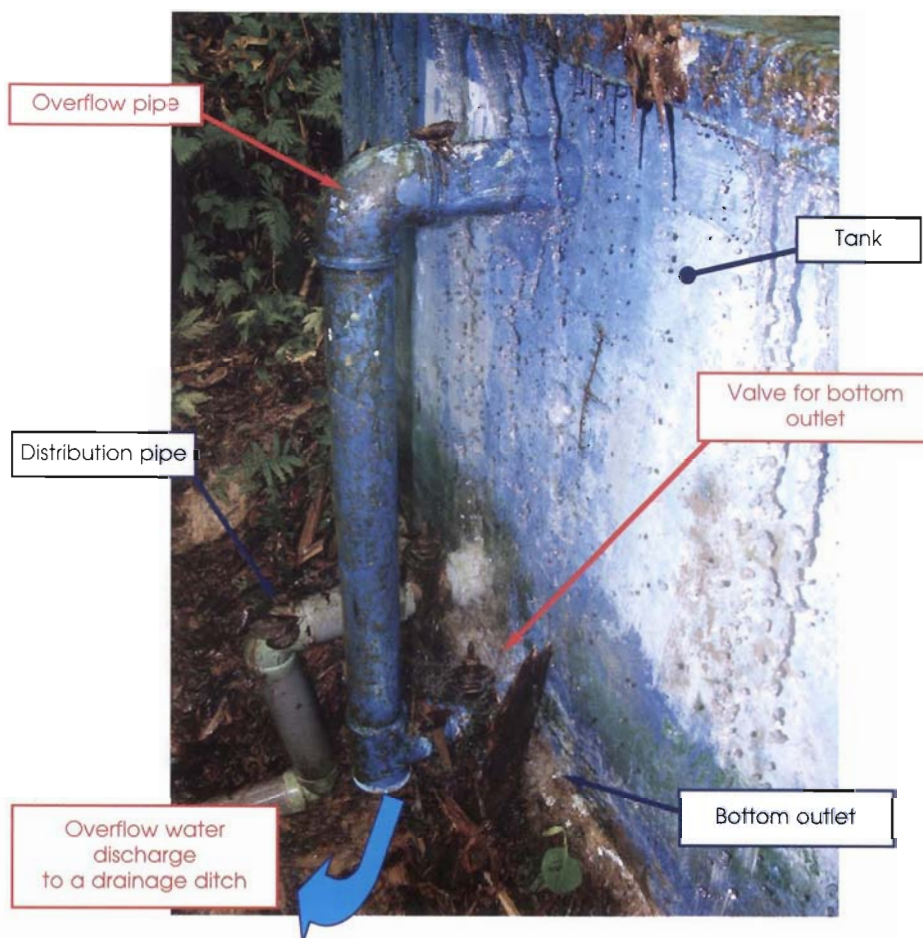
Why is it better ?

PIPE WORK - Equipment

- This is a simple air valve: air drawn into the pipeline gathers at high points and needs to be vented (otherwise it will restrict the flow).
- This installation has the disadvantage, that some water is ejected with the air (it could be used for something else, such as a nearby garden).
- Air valves should be installed at high points in long pipelines, preferably in a small valve box (chamber) for protection against damage.

Alternative:

- Air valve from supplier but much more expensive.



Overflow water discharge combined with bottom outlet

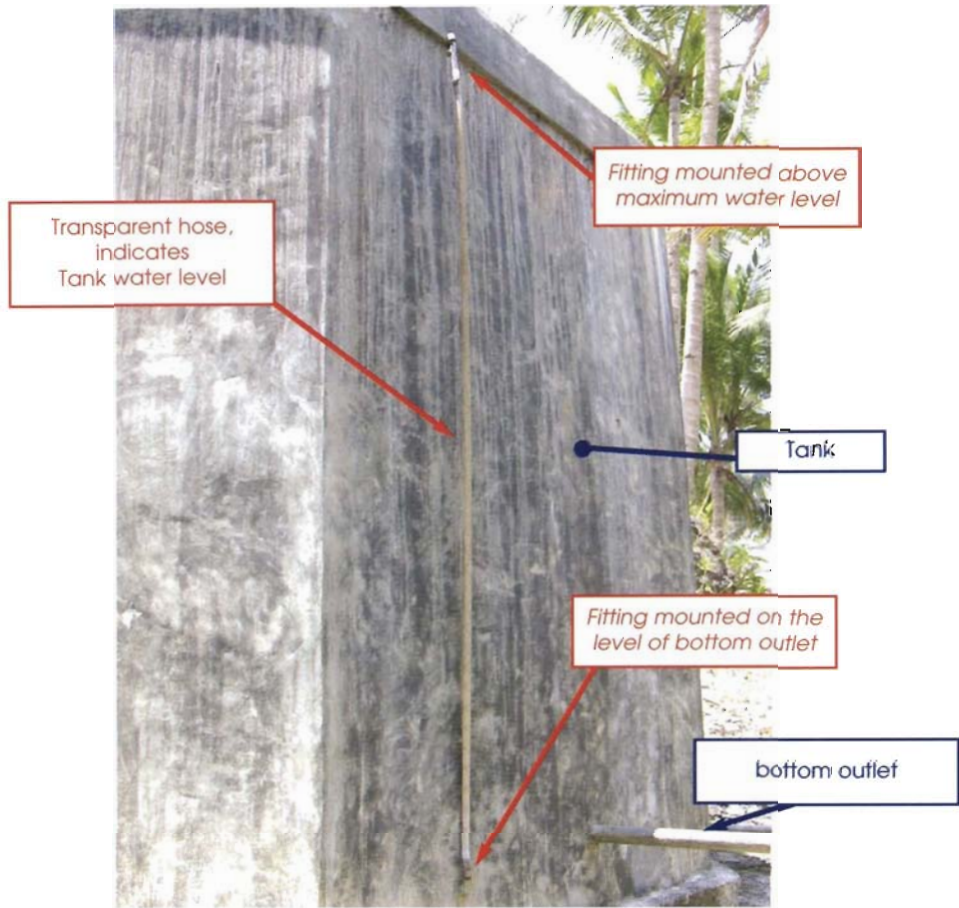
Why is it better ?

PIPE WORK – Overflow + Bottom Outlet

- The overflow water can flow directly into a drainage ditch and avoid a drainage problem around tank (health risk).
- Overflow pipe can be connected to the bottom outlet – water from both outlets can be controlled better.
- Diameter of overflow pipe shall be twice the size of the inlet.

Alternative:

- Same pipe assembly but without the connection to bottom outlet.



Simple indicator for tank water level

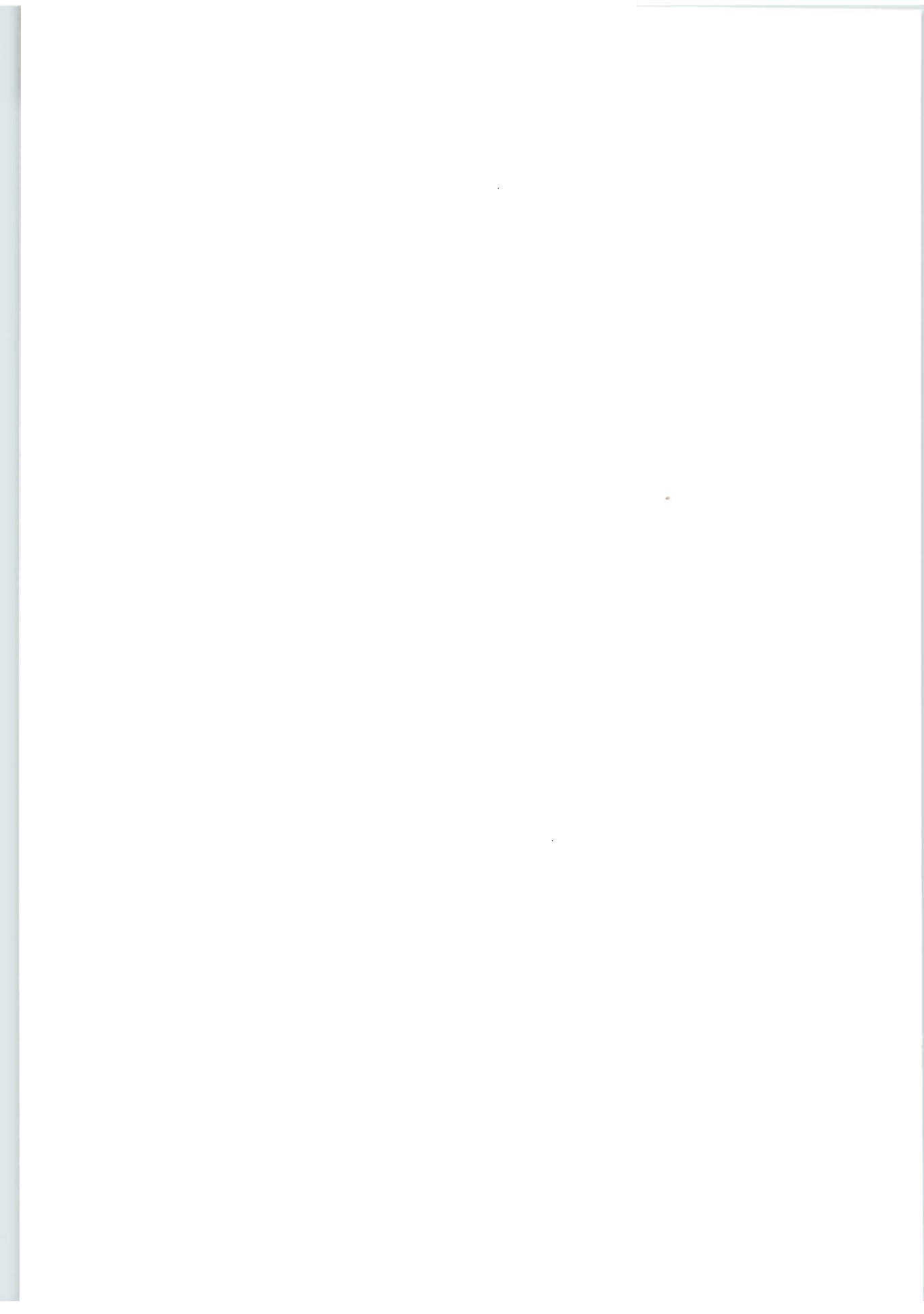
Why is it better ?

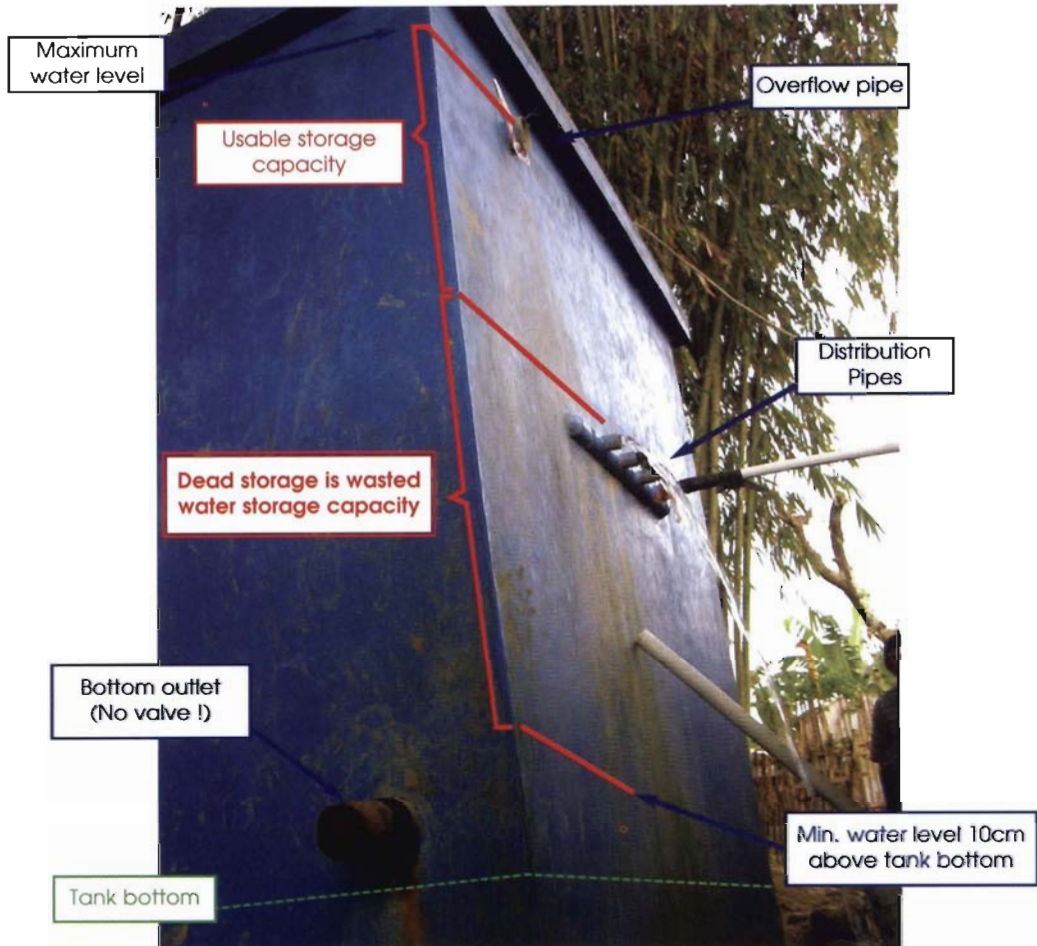
PIPE WORK – Water Level Indicator

- The transparent hose (diam. $\frac{3}{4}$ ") shows the actual water level in the tank.

Alternative:

- A pole with a scale.





Distribution pipes are connected at the upper part of the tank

How can I do it better ?

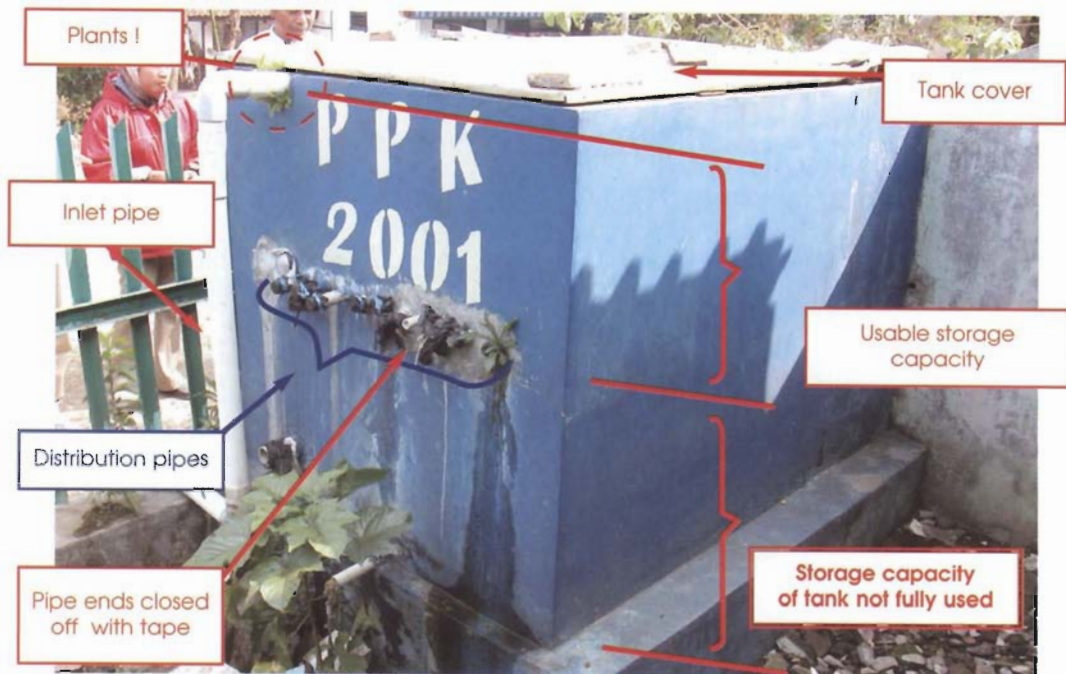
TANK – Water Capacity

- Install the distribution pipes 10cm above the tank bottom.

WHY ?

- The level of the water in the tank determines water pressure and flow volume (not the level at which the distribution pipes are connected).
- All water in the tank should be used, if not it could become stale.
- The maximum volume of the tank shall be used as water reservoir.

Design – Construction – O & M - Environmental Impact



Distribution pipes are placed in the middle of the tank
Overflow pipe is too close to the top edge of the tank
Tank cover is not tight and not fixed

How can I do better ?

TANK – Water Capacity

- Distribution (outlet) pipes should be connected 10 cm above the bottom of the tank and on the opposite side of water inlet.
- Overflow pipe should be 15 cm below tank ceiling.
- Close off any pipes not in use with a proper cap.

WHY ?

- For best use the tank's storage capacity, the inlet pipe and the outlet pipes shall be placed apart in the height as much as possible.

TANK – Tank Cover

- The cover must be fitted tightly to the top of tank.
- A ventilation pipe with fly screen should be placed in the cover.

WHY ?

- A tight tank cover prevents water pollution by dust and dirt.
- A ventilation pipe (with fly screen) helps to aerate the tank, which is necessary for good water quality.



Inlet pipe and distribution pipes are on the same level and in the same wall
Everything is exposed and anybody can tamper with the pipes & valves

How can I do it better ?

TANK – Water Inlet

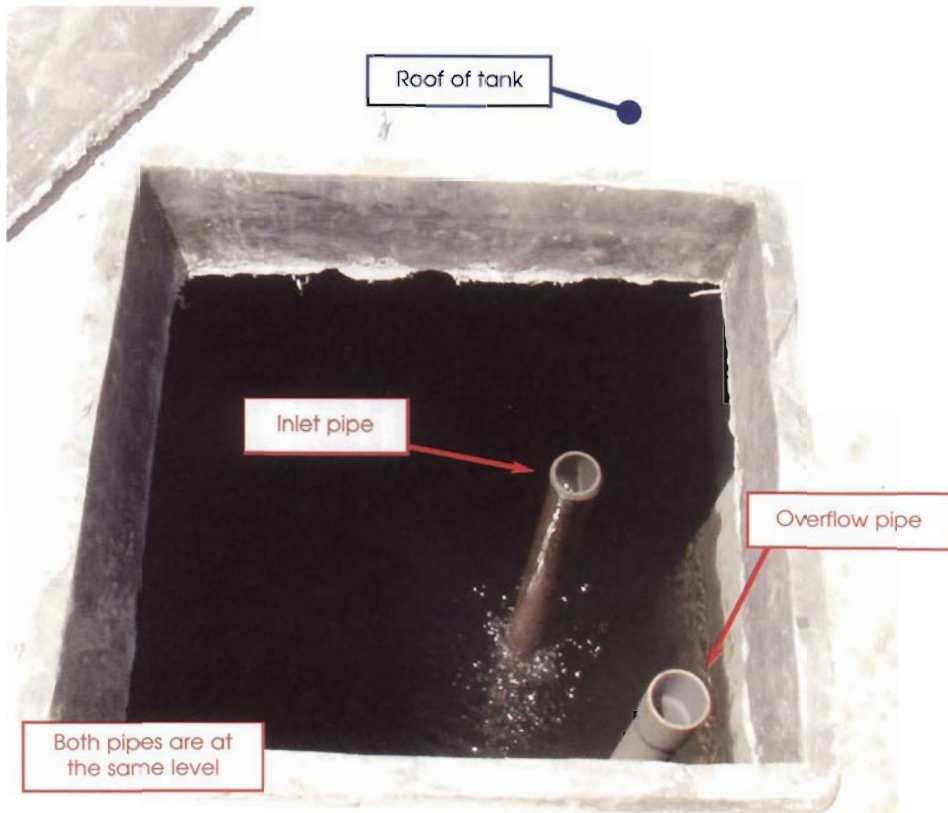
- Inlet pipe should be 10 cm below the tank ceiling.
- Prevent access to pipes & valves by non-authorized persons.

TANK – Water Distribution

- Distribution pipes should be 10 cm above tank bottom and on the opposite side of water inlet.
- Overflow pipes should be 15 cm below the roof of the tank.
- Prevent access by non-authorized persons.

WHY ?

- For better use of the tank storage capacity, the inlet pipe and the distribution (outlet) pipes shall be apart in height as much as possible.
- Locate the distribution pipes on the opposite wall of the inlet pipe (if possible) for better flow of water in the tank.
- Access by non-authorized person can cause damage to the pipes.



Vertically installed inlet and overflow pipes are not a good solution

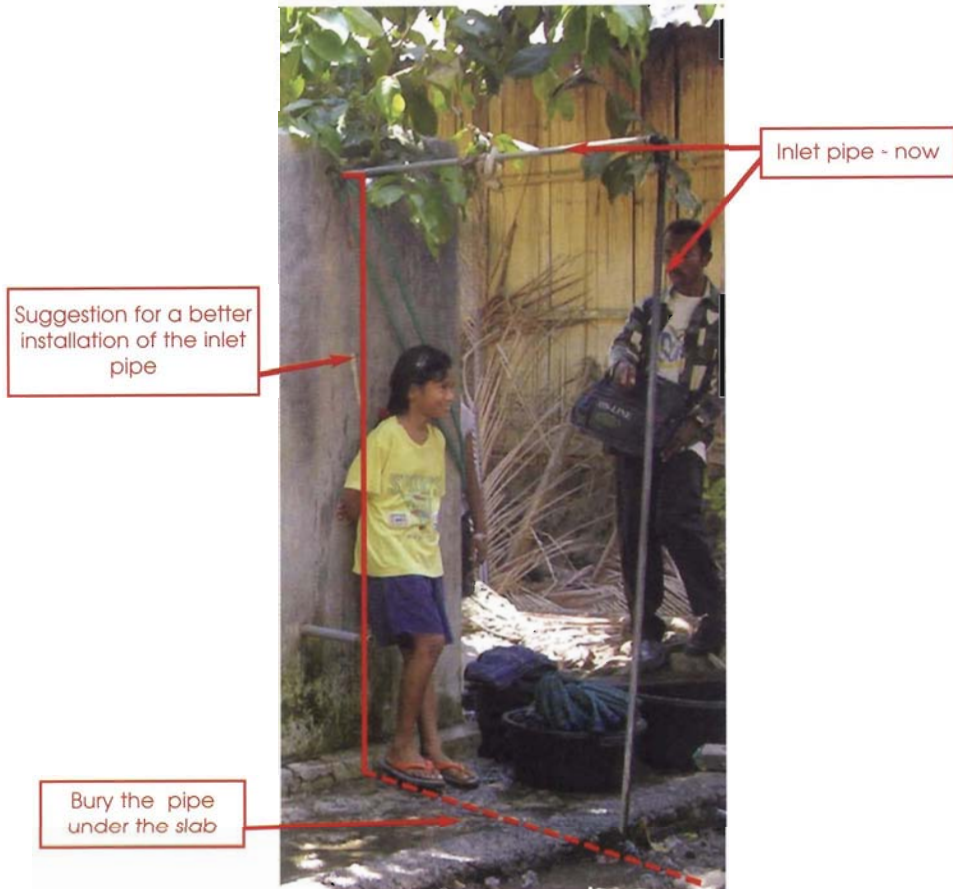
How can I do it better ?

TANK – Water Inlet

- The overflow pipe should be twice the diameter of the inlet pipe.
- Both pipes are too long ? shorten them for at least 10cm below the top of the tank, but the overflow must be well above the inlet.

WHY ?

- Vertically installed inlet and outlet pipes are not very common, because O&M would more difficult in case of damage.



The unprotected, loose inlet pipe could get damaged easily

How can I do it better ?

TANK – Water Inlet

- Protect the vertical part of the pipe with a concrete or steel post and fasten the pipe to it with clamps.
- It be much better though, to install the inlet pipe close to the tank wall and fasten it with clamps as suggested.

WHY ?

- A pipe shall never move, because the joints will loosen and leak.



.Too many pipes & hoses need too many holes in the tank

How can I do it better ?

TANK – Water Distribution

- Install a collector pipe (see Good Example) outside the tank from which the distribution hoses are tapped.
- Bury or at least protect the hoses.
- Describe all distribution hoses with the number of the different houses so you can find them easier.

WHY ?

- Each perforation through the tank wall is a possible site for a leak.



It was not planned to put the hoses through the overflow pipe
The inlet pipe has to be fixed in the tank wall

How can I do it better ?

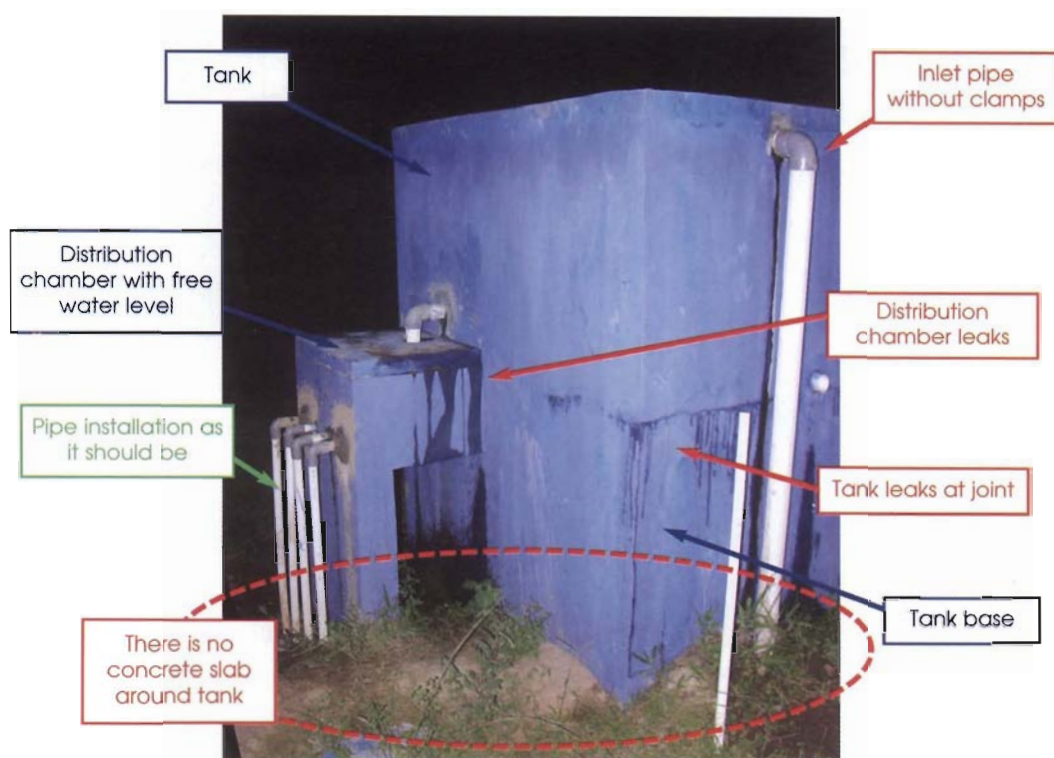
TANK – Water Distribution

- The hoses for the house connections must be connected to the planned proper outlet pipes NOT through the overflow pipes.
- If there are more house connections than outlet pipes, install a distribution pipe (manifold) outside the tank to which all house connections can be connected.
- Mark all valves with the number of the different connection lines.

WHY ?

- The overflow will not work if the pipe is blocked with the hoses.

Design – Construction – O & M - Environmental Impact



Too much water in the distribution chamber and no overflow is installed
There is no concrete slab around the tank
Tank is not watertight between base and tank bottom

How can I do it better ?

TANK – Water Distribution

- Install an overflow pipe in the distribution chamber .
- Distribution chamber is not really necessary.
- Build a sloped concrete slab around tank with discharge to a drainage ditch. Such a slab will also give support for the pipes.
- To seal the leak, cut a groove (3cm deep, 1cm wide) at joint between tank bottom and top of base and fill it up with rubber and silicon.

WHY ?

- Overflowing water will damage the plaster and cause standing water.
- A slab helps to control the flow of water so it can be discharged to a drainage ditch to reduce the health risk.
- A leaking tank will slowly destroy the base and foundation of the tank.



The valves of distribution pipes must not be accessible to everybody

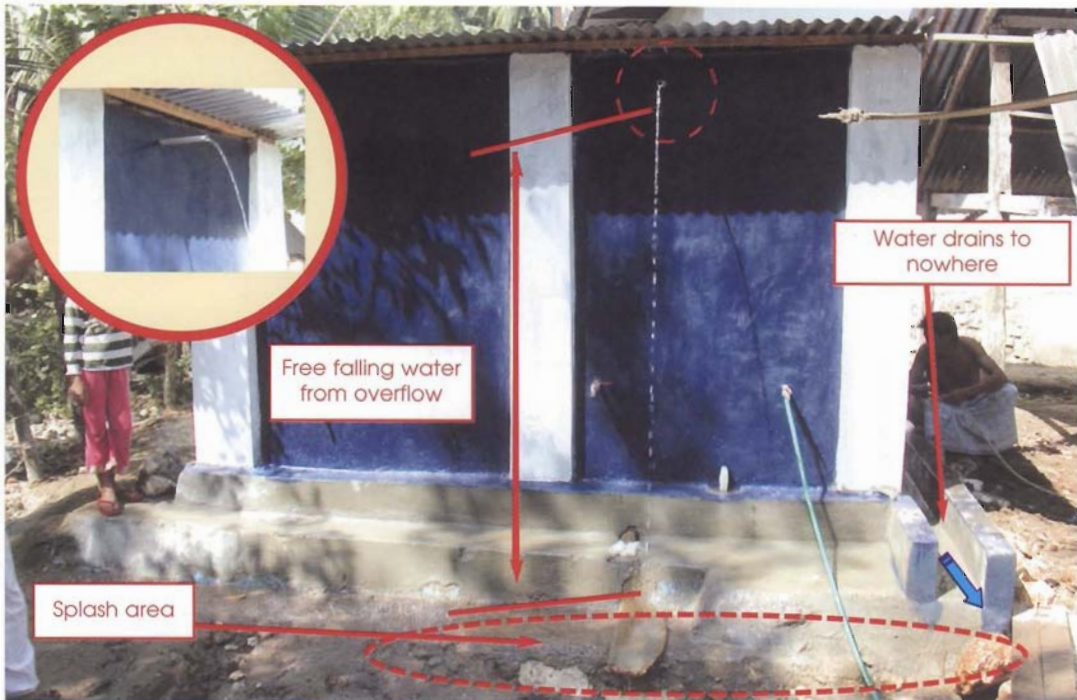
How can I do it better ?

TANK – Water Distribution

- The valves of distribution pipes shall be mounted in a lockable box or chamber or the faucets shall be lockable.

WHY ?

- Access by unauthorized persons must be prevented.



Water from overflow pipe drops all the way from top of tank
Diameter of overflow pipe is too small

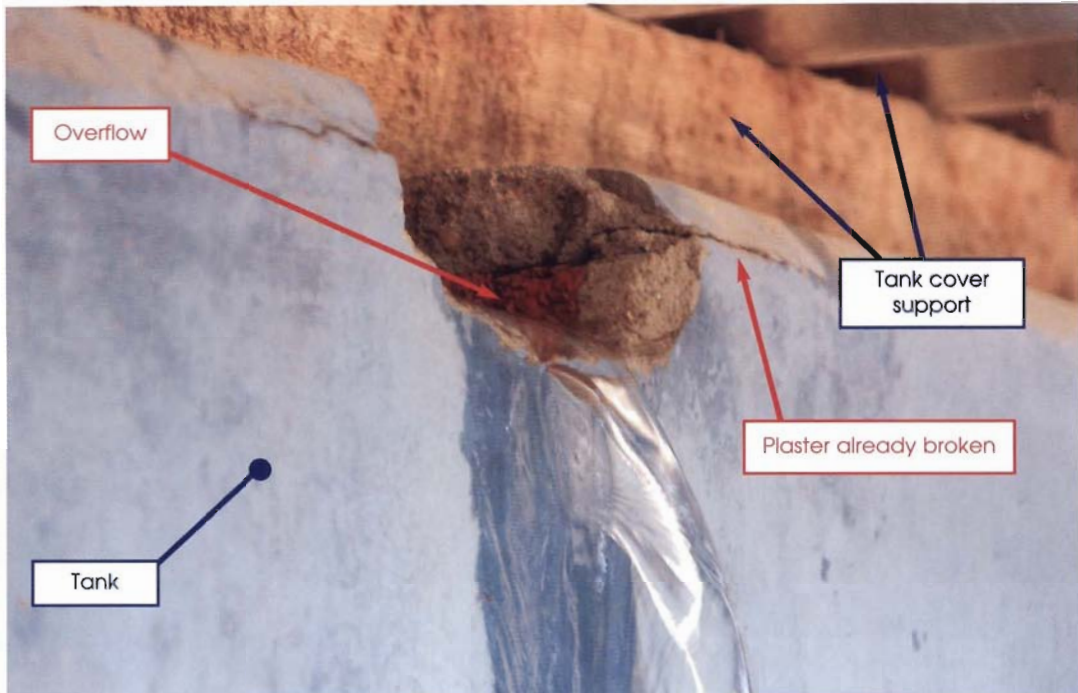
How can I do it better ?

TANK – Overflow Pipe

- Run the overflow pipe all the way to a drainage ditch.
- Diameter of the overflow pipe shall be the double the size of the inlet.
- Discharge water always to a drainage ditch.

WHY ?

- To avoid a mess around the tank which could be a health risk.
- The overflow pipe shall be taken to a ditch for a controlled discharge.



Overflow is a cut into the tank wall

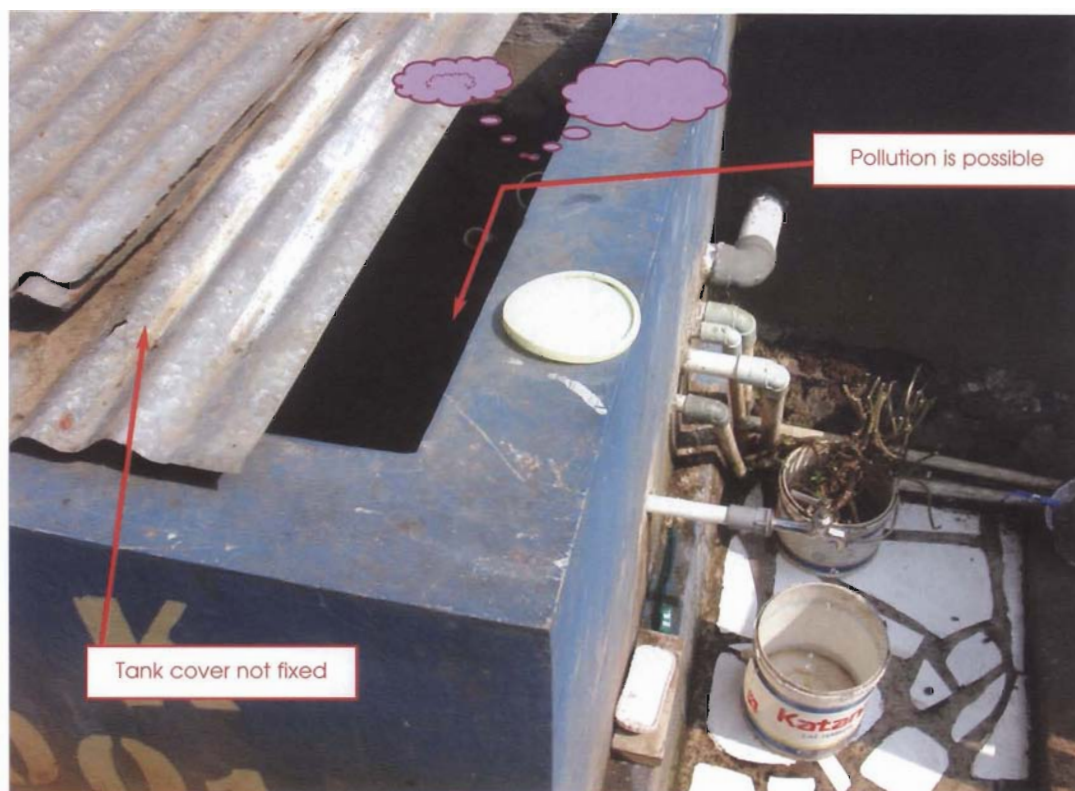
How can I do it better ?

TANK – Overflow Pipe

- Install an overflow pipe which should run to a drainage ditch.
- Diameter of the overflow pipe shall be double the size of the inlet.
- Discharge water always to a drainage ditch.

WHY ?

- To avoid a mess around the tank which could be a health risk.
- The overflow pipe shall be taken to a ditch for a controlled discharge.



Tank cover is not fixed and locked to the top of the tank

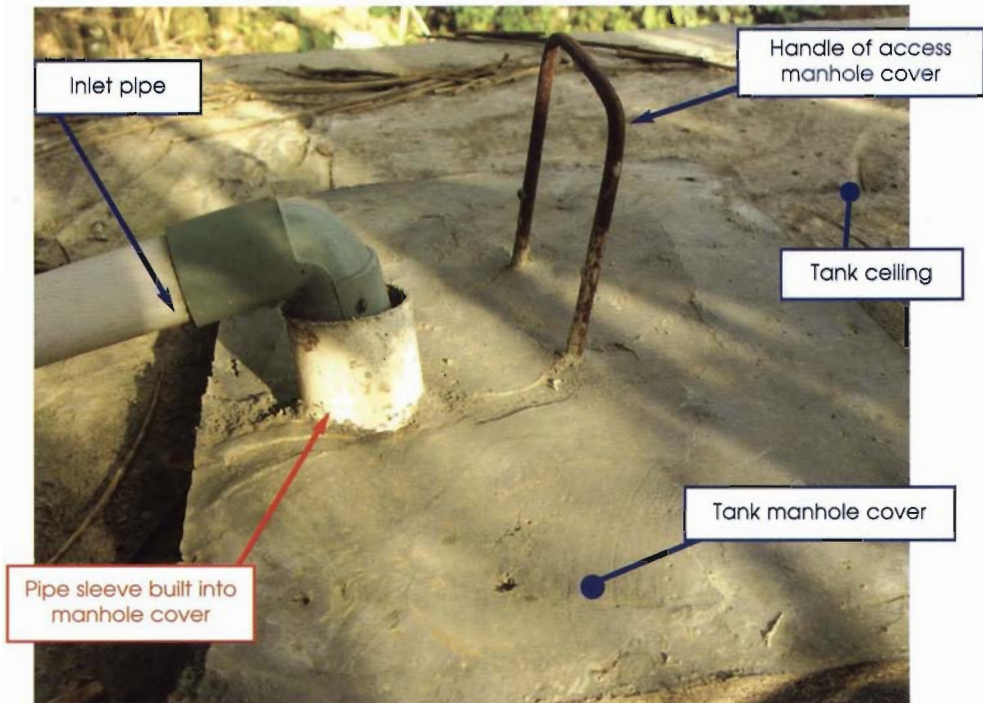
How can I do it better ?

TANK – Tank Cover

- Fix the tank cover with bolts and a rubber seal on the tank top.
- Make a lockable access manhole in the cover for maintenance.
- Install a ventilation pipe equipped with fly screen in the cover.

WHY ?

- The tank cover shall prevent dirt and dust pollution of the water in the tank, therefore the seal between tank and cover must be tight.
- For small tanks (less than 2 x 2m) the complete cover should be removable for maintenance work.
- Larger tanks (more than 2 x 2m) shall be provided with a lockable access manhole.
- The ventilation pipe aerates the water in the tank and improves the water quality.



Every time the manhole cover is moved, the inlet pipe has to be moved too

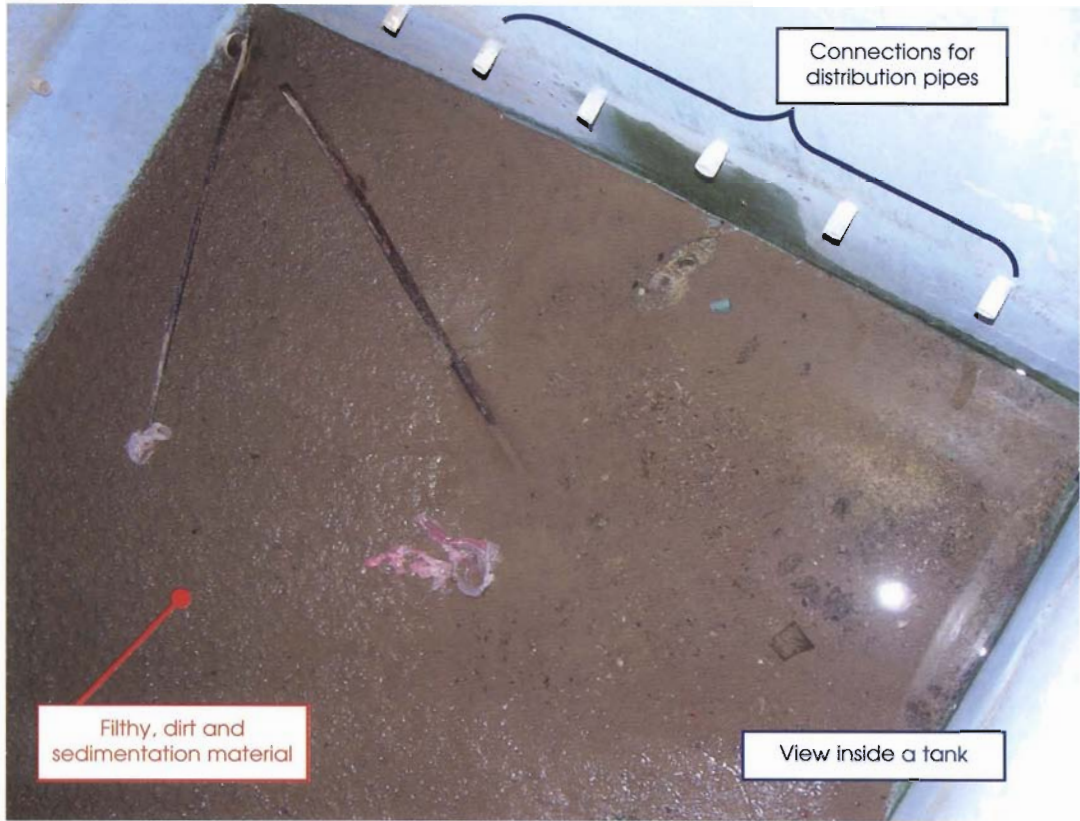
How can I do it better ?

TANK – Tank Cover

- Install the inlet pipe through the tank wall or roof.
- Insert a ventilation pipe in the pipe sleeve of the manhole cover.

WHY ?

- If the pipe is installed through the wall or roof, it cannot move and the pipe and joints can not be damaged so easily.
- The access manhole of the tank must be kept closed with a tight-fitting and lockable cover.



Sedimentation and debris in a tank

How can I do it better ?

TANK – Tank Cleaning

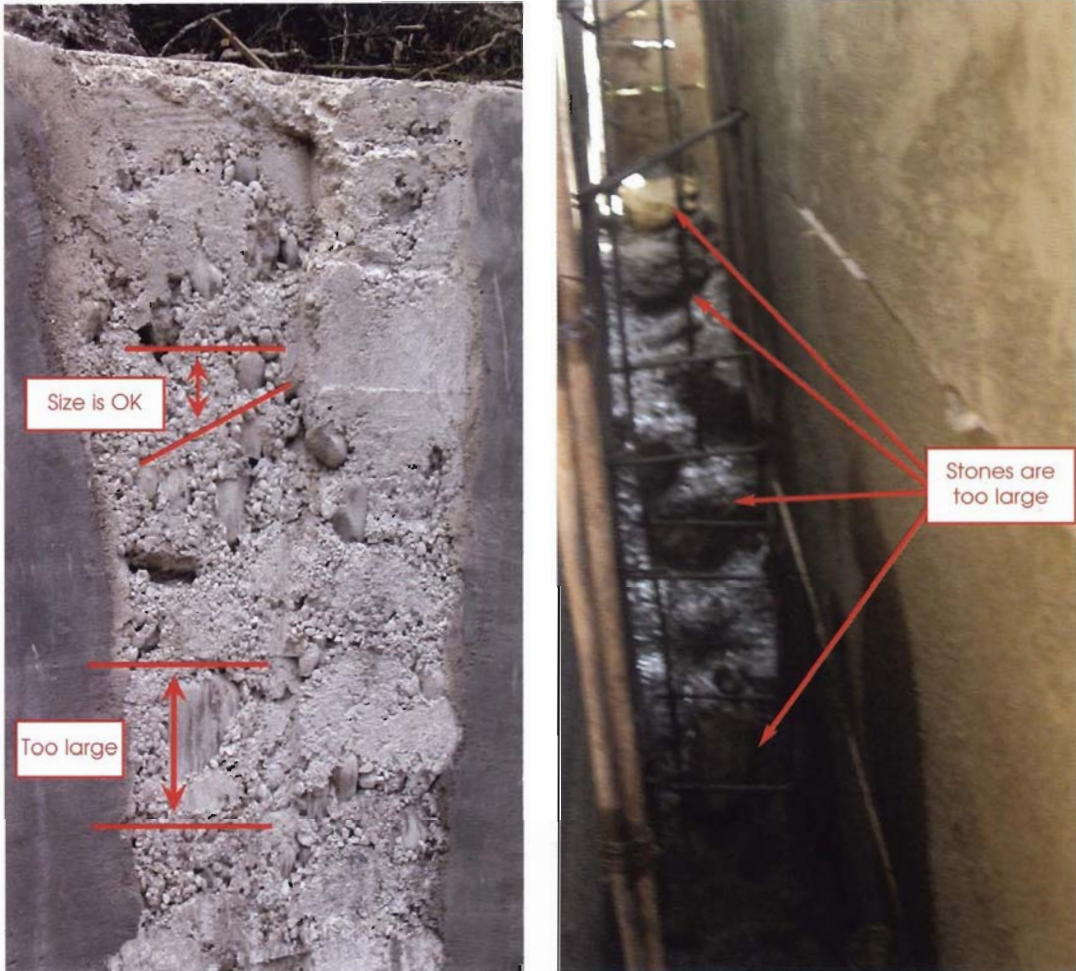
- Inspect and clean the tank periodically.

WHY ?

- Clean water and heat is a potential breeding ground for mosquitoes
→ **HEALTH RISK.**

Note:

If you use a collector pipe for distribution you have to install only two pipes through the wall



Diameter of some stones is too large for a narrow reinforced concrete wall

How can I do it better ?

TANK – Concrete Work

- Do not put large stones (more than 40 mm diameter) into reinforced concrete walls (only use in mass concrete).

WHY ?

- Large diameter stones may affect the quality of reinforced concrete, i.e. water tightness and strength.



Well built drains lead to nowhere

How can I do it better ?

SLAB DRAINAGE

- Connect the slab drainage outlet to a ditch or soakaway to avoid stagnant water next to the slab → **HEALTH RISK.**

Alternative:

- No.



Surplus water is not discharged to a ditch

How can I do better ?

SLAB DRAINAGE – Water Discharge

- The water can run off the slab in any direction.
- The surplus water must be channelled to a ditch or soakaway.
- Connect the slab to a drainage ditch (see sample → Good examples).

WHY ?

- Standing water and heat are breeding grounds for mosquitoes
→ **HEALTH RISK.**

Design – Construction – O & M - Environmental Impact



Spilled water is not drained to a ditch

How can I do better ?

SLAB DRAINAGE – Water Discharge

- Any spilled water must be drained to a ditch.
- Build a drain around the slab and connect it to a ditch (see sample → Good examples).

WHY ?

- Standing water and heat are breeding grounds for mosquitoes
→ **HEALTH RISK.**



Spilled water is not drained to a ditch
Slab washed out because of uncontrolled water discharge

How can I do better ?

SLAB DRAINAGE – Water Discharge

- Any spilled water must be drained to a ditch.
- Build a drain around the slab and connect it to a ditch (see sample → Good examples).
- Use the water for something else (eg. Vegetable gardens, irrigation).

WHY ?

- Standing water and heat are breeding ground for mosquitoes
→ **HEALTH RISK.**



Spilled water flows to a garbage disposal area

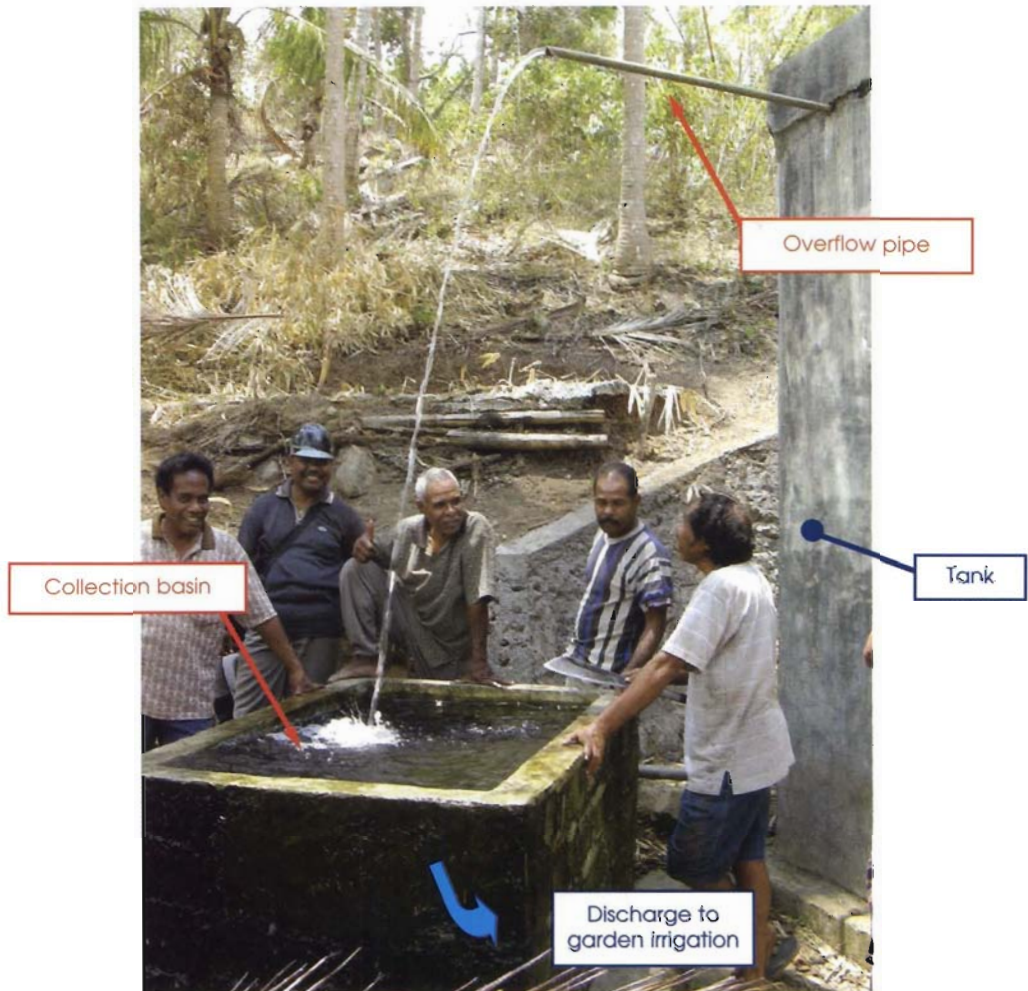
How can I do better ?

SLAB DRAINAGE – Water Discharge

- Build a drain around the slab to collect water.
- Connect the drain to a ditch or soakaway (see sample → Good examples).
- Put solid waste into garbage containers far from hydrants.

WHY ?

- Water, waste and heat are breeding ground for mosquitoes
→ **HEALTH RISK.**



Overflow water discharges to a basin

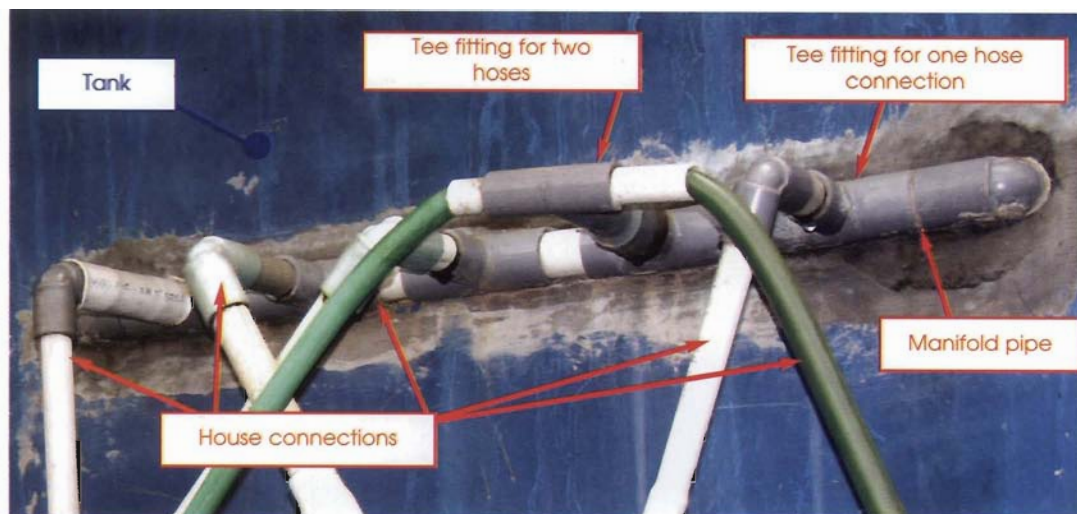
Why is it better ?

TANK - Overflow

- The overflowing water is not wasted, it will be collected and used for other purposes - eg. irrigation of gardens.

Alternative:

- No, because water is a valuable resource and should not be wasted.



A manifold pipe requires only two holes through the tank

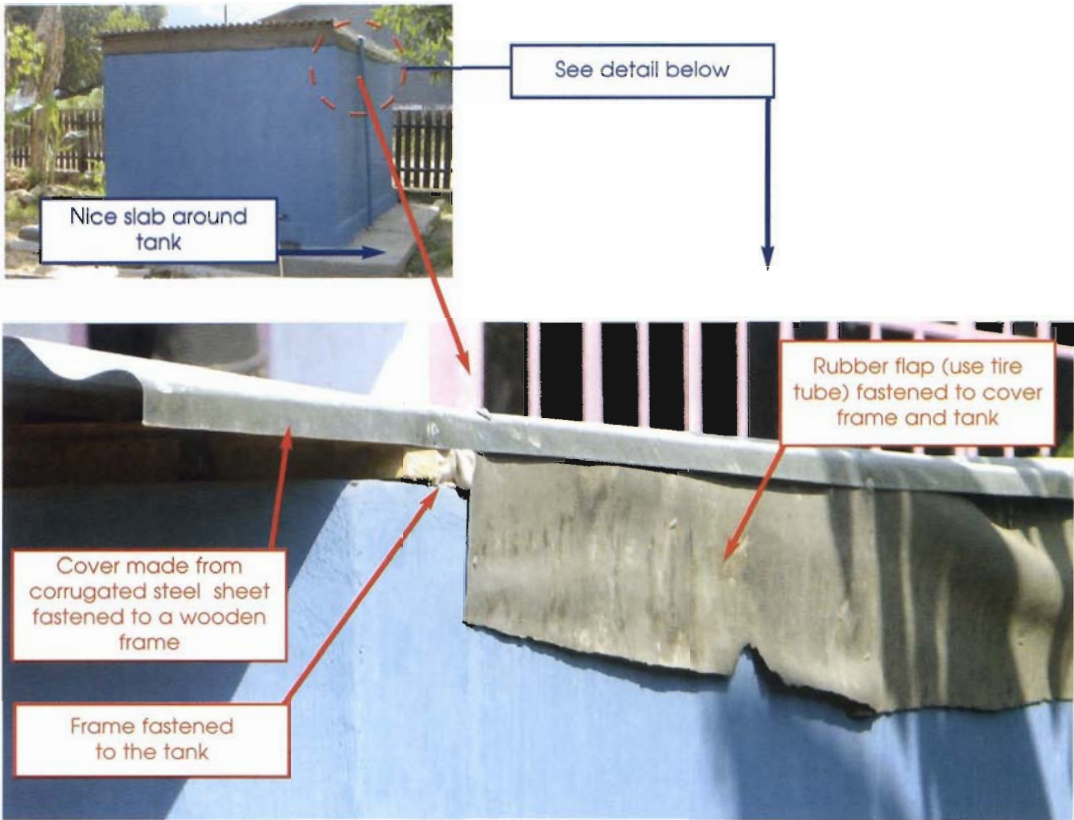
Why is it better ?

TANK - Distribution

- Additional house connections can easily be connected to the manifold pipe after long after the construction of the tank.
- Preferably, the house connection lines should run straight down.

Alternative:

- Each individual connections made through the tank wall can be the cause for leaks.



Simple tank cover to prevent dust pollution and contamination

Why is it better ?

TANK - Cover

- The cover is quite tight and prevents pollution and contamination of the water.

Alternative:

- Concrete tank ceiling with manhole access and vent pipe.

Design – Construction – O & M

W = welded
T = threaded
G = glued



A variety of simple vent pipes

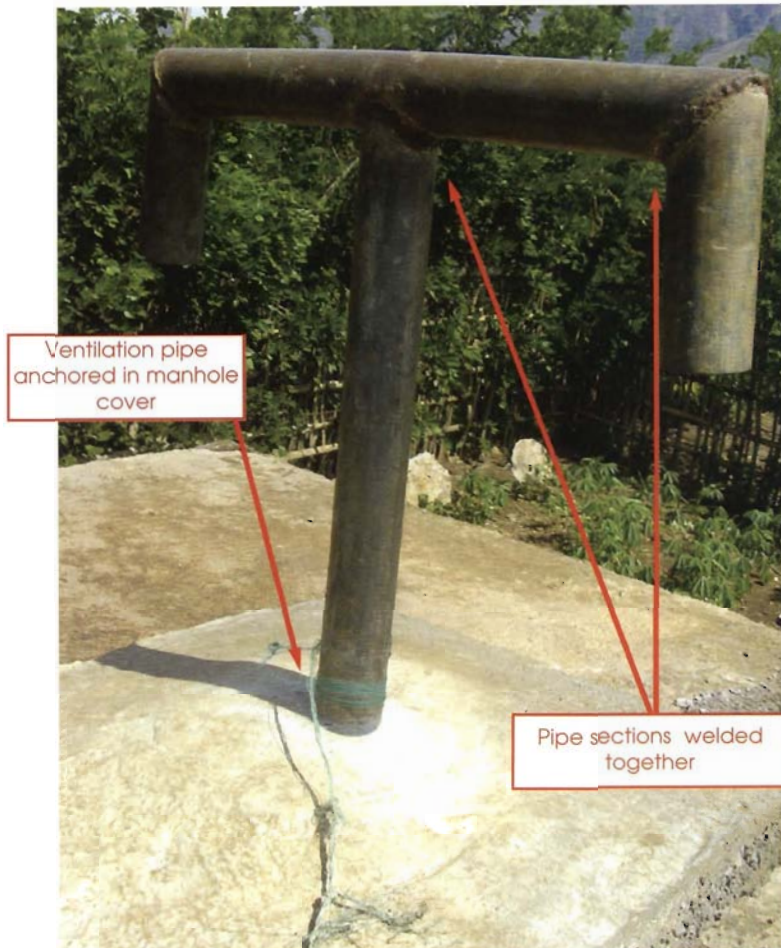
Why is it better ?

TANK - Ventilation

- A ventilation pipe is necessary to aerate the water in the tank – otherwise stored water will get stale.
- The vent pipe should be PVC or GI.
- Fittings can be threaded, welded or glued.
- A fly screen at the open ends of the pipe is strongly recommended.

Alternative:

- No, except other variations in design.



Ventilation pipe built into the manhole cover

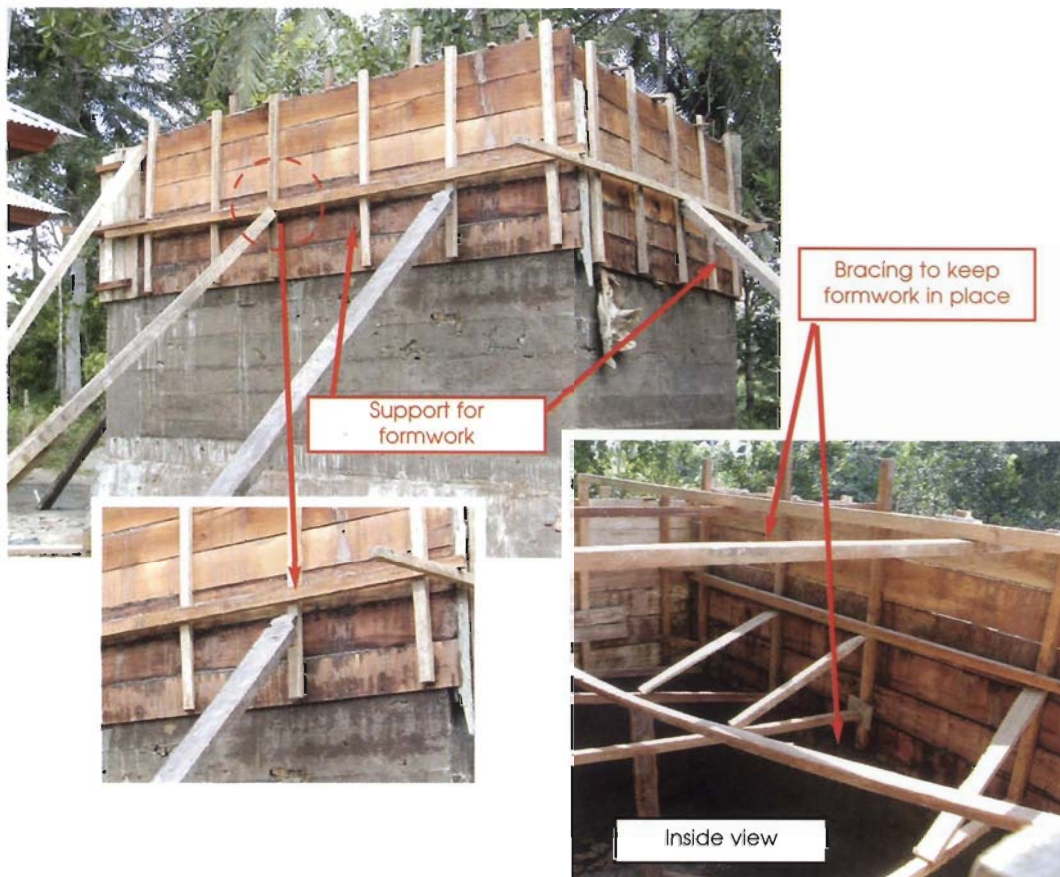
Why is it better ?

TANK - Ventilation

- The ventilation pipe is also the handle of the manhole cover.
- The connection between vent pipe and manhole cover must be strong.

Alternative:

- Handles of manhole cover and ventilation pipe should be separate.



Formwork for construction of a tank

Why is it better ?

TANK - Formwork

- Solid formwork support and bracing is essential for quality concrete work.

Alternative:

- No.



Tank with public hydrant and public washing / laundry place (2 basins)

Why is it better ?

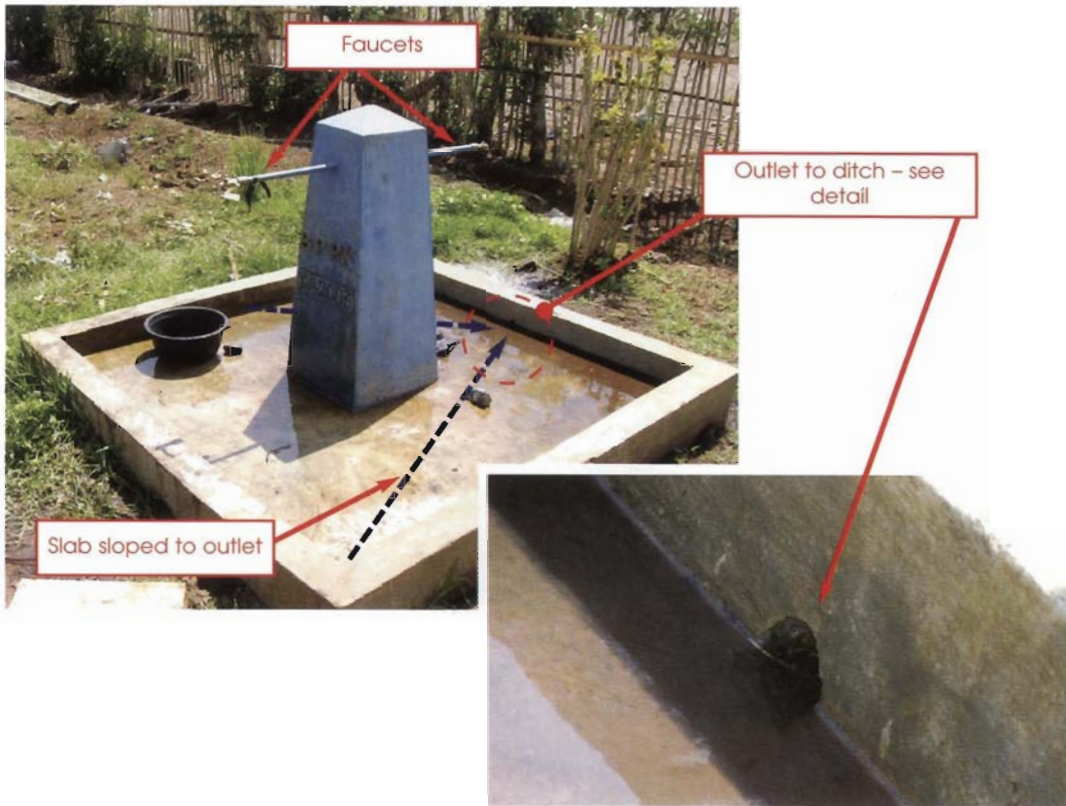
TANK and HYDRANT

- Combining a tank with a washing laundry place can work very well.
- The slab is sloped to the drainage grooves around the slab and any spilled water is channelled to the drainage ditch.
- The water runs quickly straight to the drains ? keeps the slab dry.
- Regular maintenance must keep the drains clean.

Alternative:

- There are other some possible ways to combine tank, hydrant and washing / laundry place.

Design – Construction – O & M



Hydrant

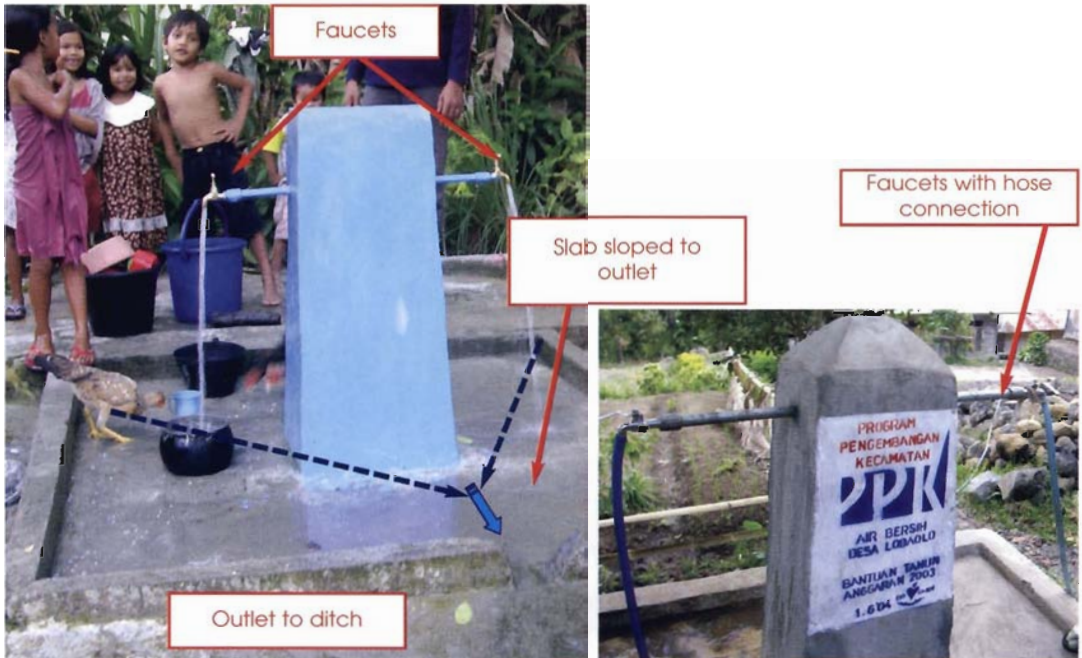
Why is it better ?

HYDRANT

- The public hydrant has two faucets with facility for a hose connection.
- The slab around is sloped to the drainage outlet.
- Water flows off to a drainage ditch.

Alternative:

- No, except that simple design variations are possible.



Hydrant

Why is it better ?

HYDRANT

- The hydrant has two faucets with hose connections.
- The slab around the hydrant is sloped to the outlet.
- Water is discharged to a drainage ditch.

Alternative:

- No.

Design – Construction – O & M



Hydrant and details

Why is it better ?

HYDRANT

- The hydrant has two faucets with hose connections.
- The slab is sloped to the outlet.
- Any spilled water and overflow from the basin are discharged to the drainage ditch.

Alternative:

- No, except some details could be modified.



Other examples of a basin

Why is it better ?

HYDRANT

- The basins have nicely rounded smooth edges.
- The blue colour of PPK and the brass faucets are very attractive.

Alternative:

- There are other possible ways to combine a hydrant and basin.



Sloped slab around tank (under construction)

Why is it better ?

SLAB DRAINAGE

- A sloped slab makes the water flow to the lowest point from where it can be discharged to a drainage ditch.

Alternative:

- Small size gravel could be used instead of a concrete slab if the subsoil is permeable, but it is more difficult to maintain.



Notch for water discharge to a drainage ditch from a sloped slab around tank

Why is it better ?

SLAB DRAINAGE

- The water is channelled into the ditch and cannot discharge somewhere else in an uncontrolled manner.

Alternative:

- Use a pipe instead of the notch at the lowest point of the slab.

Design – Construction – O & M



Water discharge to a drainage ditch

Why is it better ?

SLAB DRAINAGE

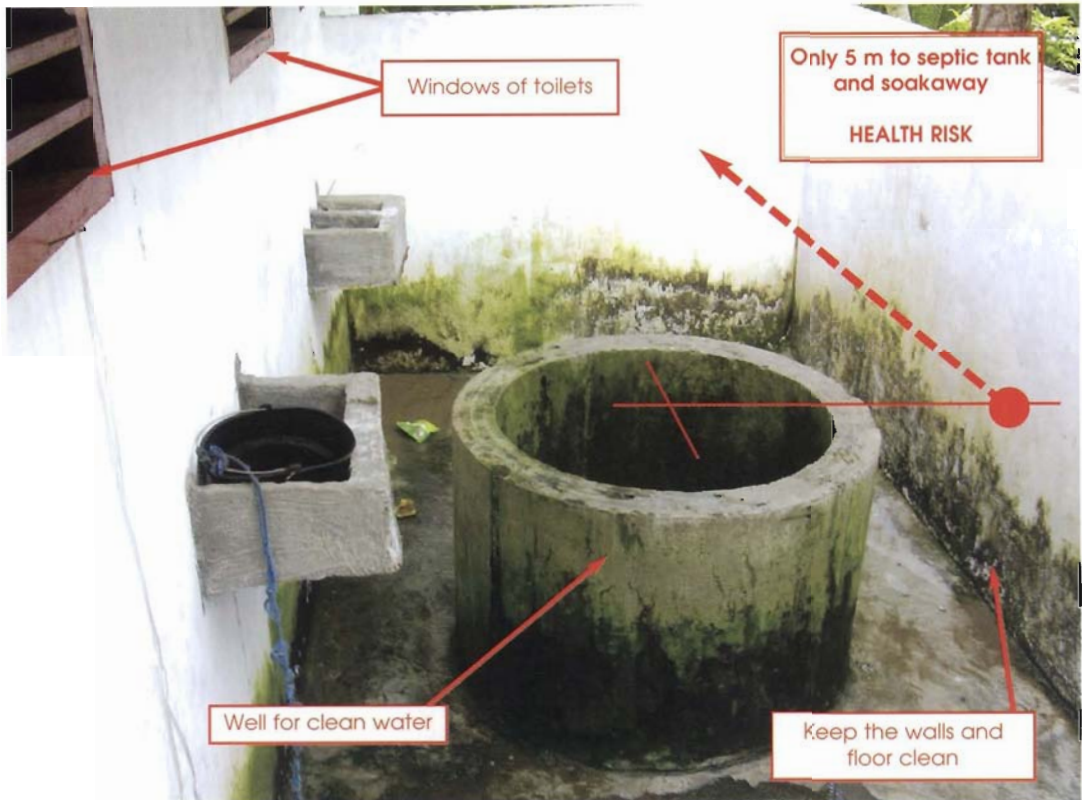
- The water is forced to flow into the ditch and cannot discharge in an uncontrolled manner somewhere else.
- Regular maintenance must keep the drains clean.

Alternative:

- Set a gully in the slab around tank and join it with a pipe to a drainage ditch.

SANITATION





Water level of the well almost the same as the soakaway
Well too close to the toilets and septic tank

How can I do it better ?

GENERAL – Water Source

- Try to check the direction of groundwater flow – the well should be placed upstream.
- Built the soak away as far as possible away from the well (minimum 10 m).

WHY ?

- The soakaway for the septic tank effluent can impact the quality of the drinking water well, when they are too close → **HEALTH RISK.**



A well in the toilet is not acceptable at all

How can I do it better ?

GENERAL – Water Source

- Build a basin in each toilet room and fill them from the well by pipe, channel or container.
- Keep the toilets clean and separate from the well.

WHY ?

- A toilet is not a suitable place for a well because of the high risk of contamination → **HEALTH RISK.**



Traditional toilet

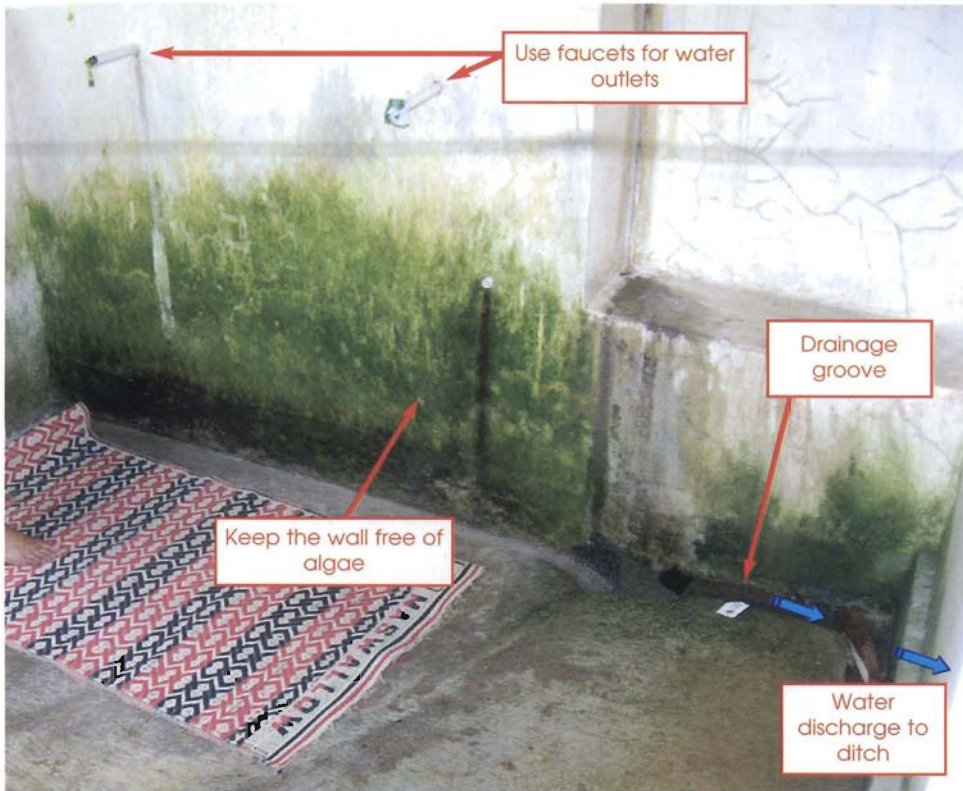
How can I do it better ?

GENERAL - Toilet

- Install faucets on water supply and bottom outlets.
- Install an overflow pipe leading to drain on the outside.
- Keep the toilet clean (firstly the responsibility of users).
- Also keep the walls and floor clean.

WHY ?

- Water, spreading excrements can be serious a **HEALTH RISK**.



Public washing place in a MCK

How can I do it better ?

GENERAL – Washing Place

- Keep the washing place clean, including walls and floor.
- Install faucets on all water supply outlets.

WHY ?

- Algae growth is an indicator for lacking O&M .

- The pipe laid on the ground surface may become brittle from the sun's UV-rays and could also be damaged by people stepping on it or other impact.

WHY ?

- Bury the sewer pipe all the way to the septic tank.
- Install a ventilation pipe and a manhole access in the septic tank.

SEPTIC TANK - Inlet Pipe

How can I do it better ?

Sewer pipe not buried



Design – Construction – O & M – Environmental Impact



There is NO access to this septic tank !

How can I do it better ?

SEPTIC TANK

- There must be an access manhole in the septic tank so that the tank could be inspected periodically and cleaned as needed.
- For variation of ventilation pipes see "Water Supply – Good Examples".

WHY ?

- An access manhole is required in the septic tank to control the filling level.
- At least a lockable opening is necessary large enough for insertion of the pumpout equipment (hose).

Note: *Minimum equipment of a septic tank consists of:*

- **Access manhole with a lockable cover.**
- **Inlet pipe.**
- **Dividing wall of baffle.**
- **Overflow pipe.**
- **Ventilation pipe.**



MCK with separate entrances for women and men

Why is it better ?

GENERAL

- A MCK consist of toilets (women's and men's separated) and of a public washing place with a basin.

Alternative:

- Layout can vary.

Design – Construction – O & M



A typical, well designed and built, small MCK

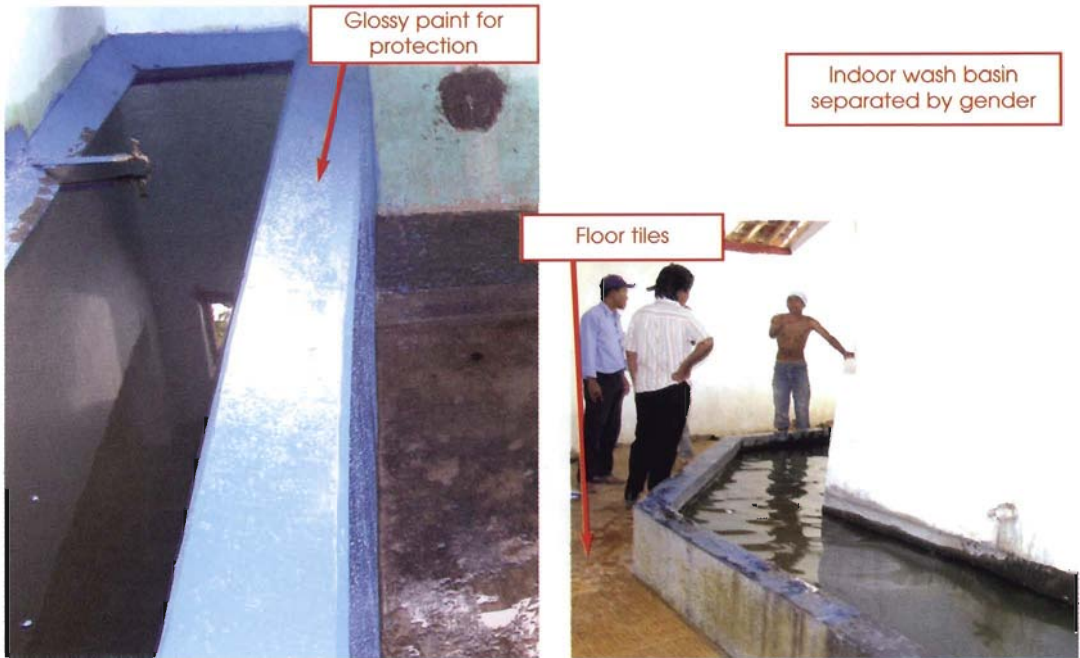
Why is it better ?

GENERAL

- All essential elements of a MCK have been included as shown.

Alternative:

- Layout can vary.



Public wash basins inside the MCK

Why is it better ?

GENERAL – Washing Place

- Preferable in bigger MCKs the washing places can be arranged inside the building, and separate for women and men.

Alternative:

- A single public washing place in small facilities.

Design – Construction – O & M



Discharge of surplus water

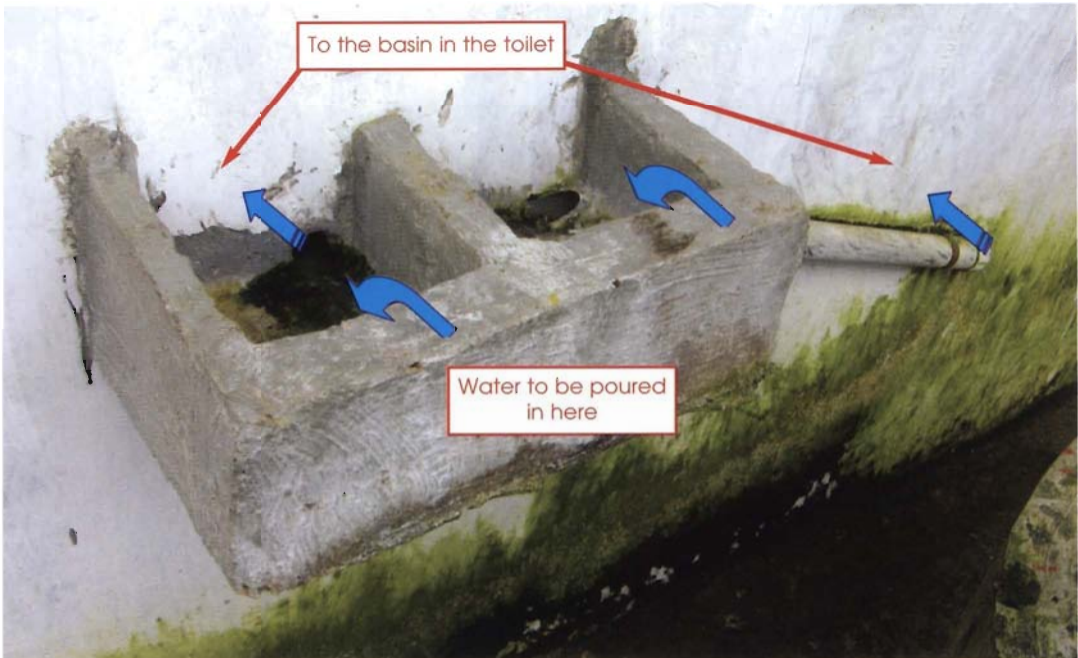
Why is it better ?

DETAIL – Discharge Grooves

- Any spilled water must be discharged properly.
- The drains in the concrete slab collect this water and discharge it directly to the ditch.

Alternative:

- Layout can vary.
- See also chapter Good Examples – Tank & Hydrant.



Filling station for the basins inside the toilets

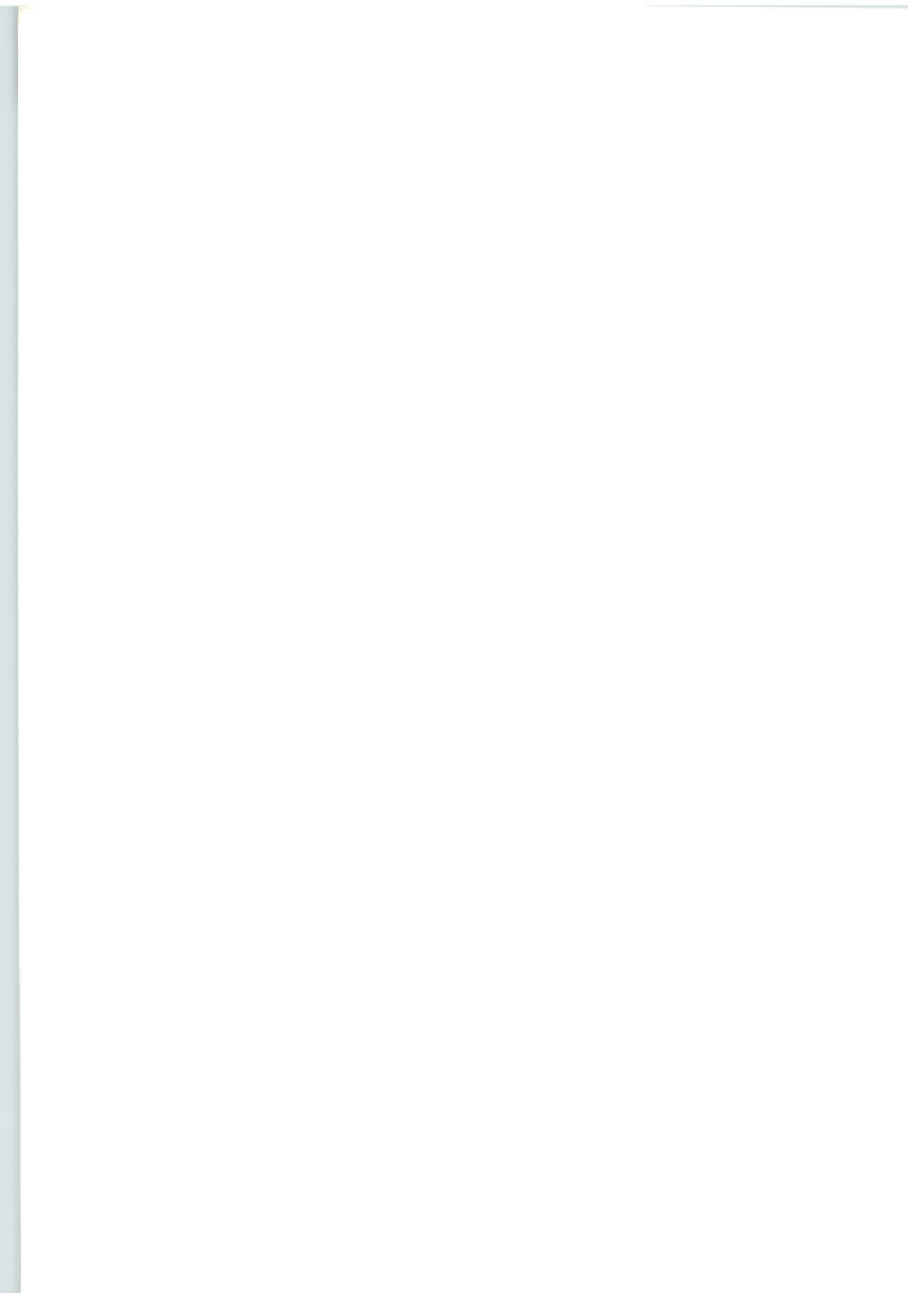
Why is it better ?

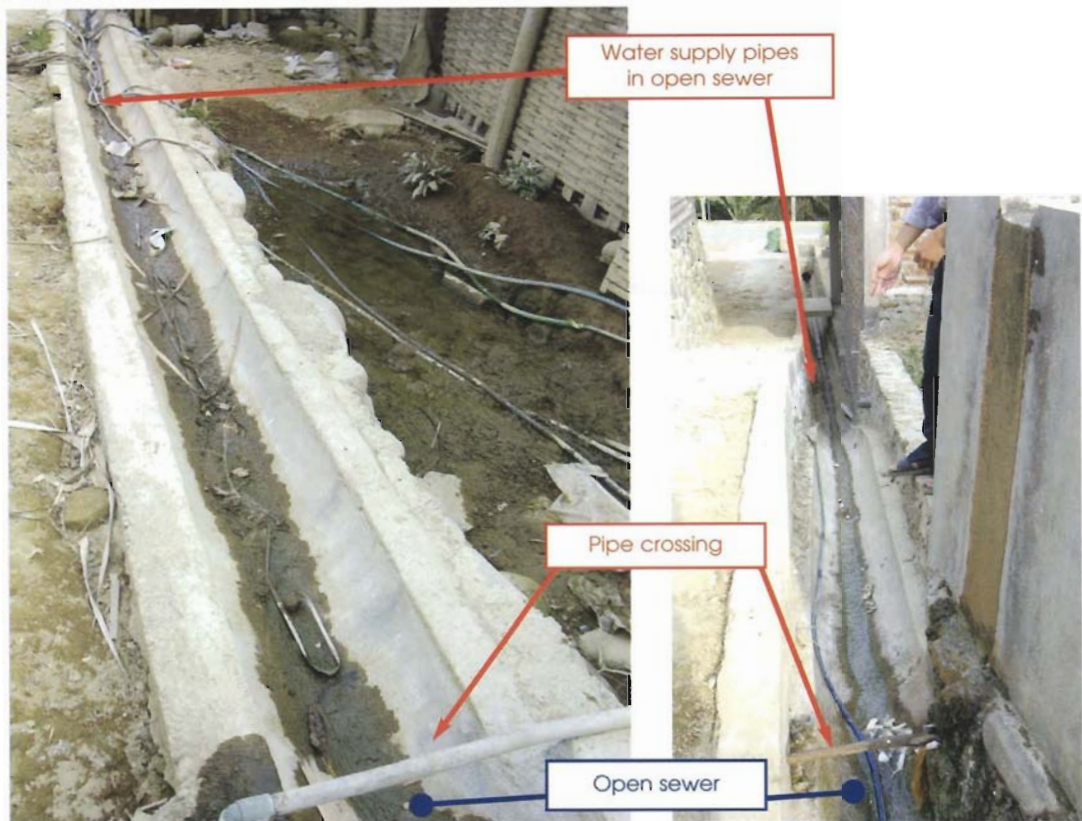
DETAIL – Refill of Water Basin

- Basins in the toilets can be filled up from a central point (such next to the groundwater well) outside the building.

Alternative:

- A central supply line from the washing place to the basins.





A sewer should be for sewage only

How can I do it better ?

CANAL - Open

- Lay water supply lines away from open sewers and bury them.
- Keep the open sewer clean → O&M.
- Avoid exposed pipe crossings of the sewer.

WHY ?

- Water supply lines in open sewer could be cross contaminated.
- Open sewers should not be blocked so as not to cause flooding.



The pipe can easily get damaged

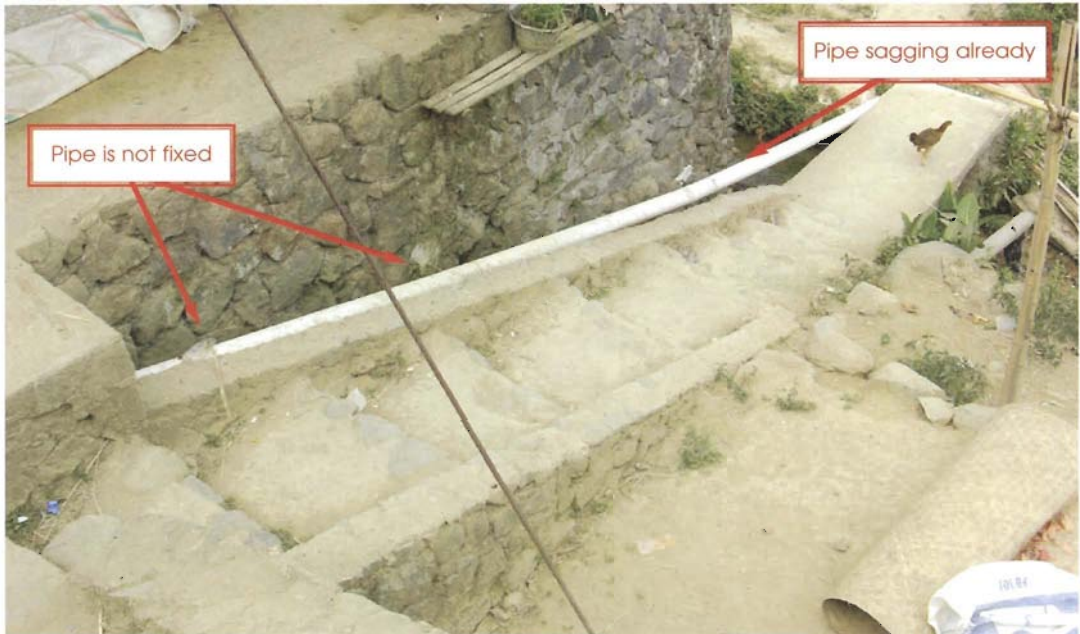
How can I do it better ?

CANAL - Pipe

- If it is not possible to bury the pipe fasten it with clamps to the wall.
- It would be better to use 2 x 45° bends instead of 1x90° bend or lay the pipe as shown in the picture (Alternative way of installation).
- Maintenance should inspect the watertightness of the fittings periodically.
- Protect the PVC pipe from sunlight.

WHY ?

- The sewage flows easier when it passes bends with larger radius.
- The fittings will come apart, when pipe is not fixed somewhere.



The pipe can easily get damaged

How can I do it better ?

CANAL - Pipe

- Fix the pipe with clamps to the staircase.
- Maintenance inspection must check the watertightness of the fittings periodically.
- Protect the PVC pipe from sunlight.

WHY ?

- The joints will pull apart when the pipe sags.
- Every length of pipe and fitting must be fastened somewhere.



This is not an acceptable way to discharge a sewer!

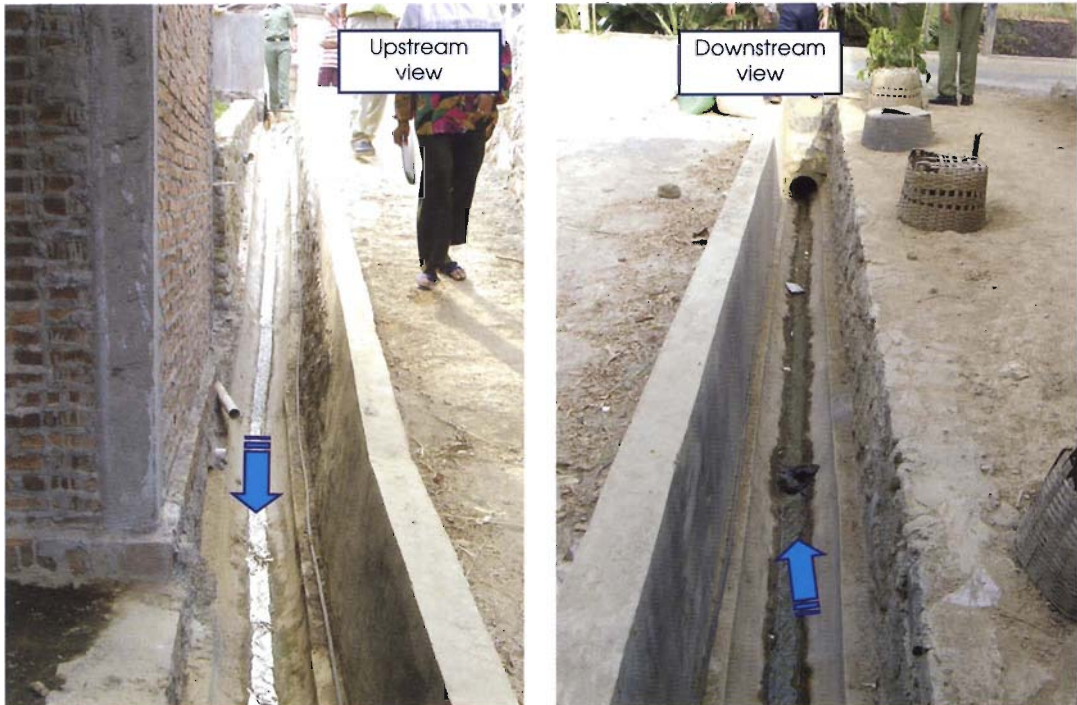
How can I do it better ?

CANAL - End

- A sewer carrying human waste should be discharged to a treatment plant or a septic tank.
- A septic tank or other type of settling tank will also partially treat sewage (human waste) and improve effluent quality for underground discharge to a soakaway.
- Remove the wastewater from the creek.

WHY ?

- Sewage which contains human waste carries pathogens and must be treated before discharge into the ground or an open water course
→ **HEALTH RISK.**



A well built and clean open sewer canal

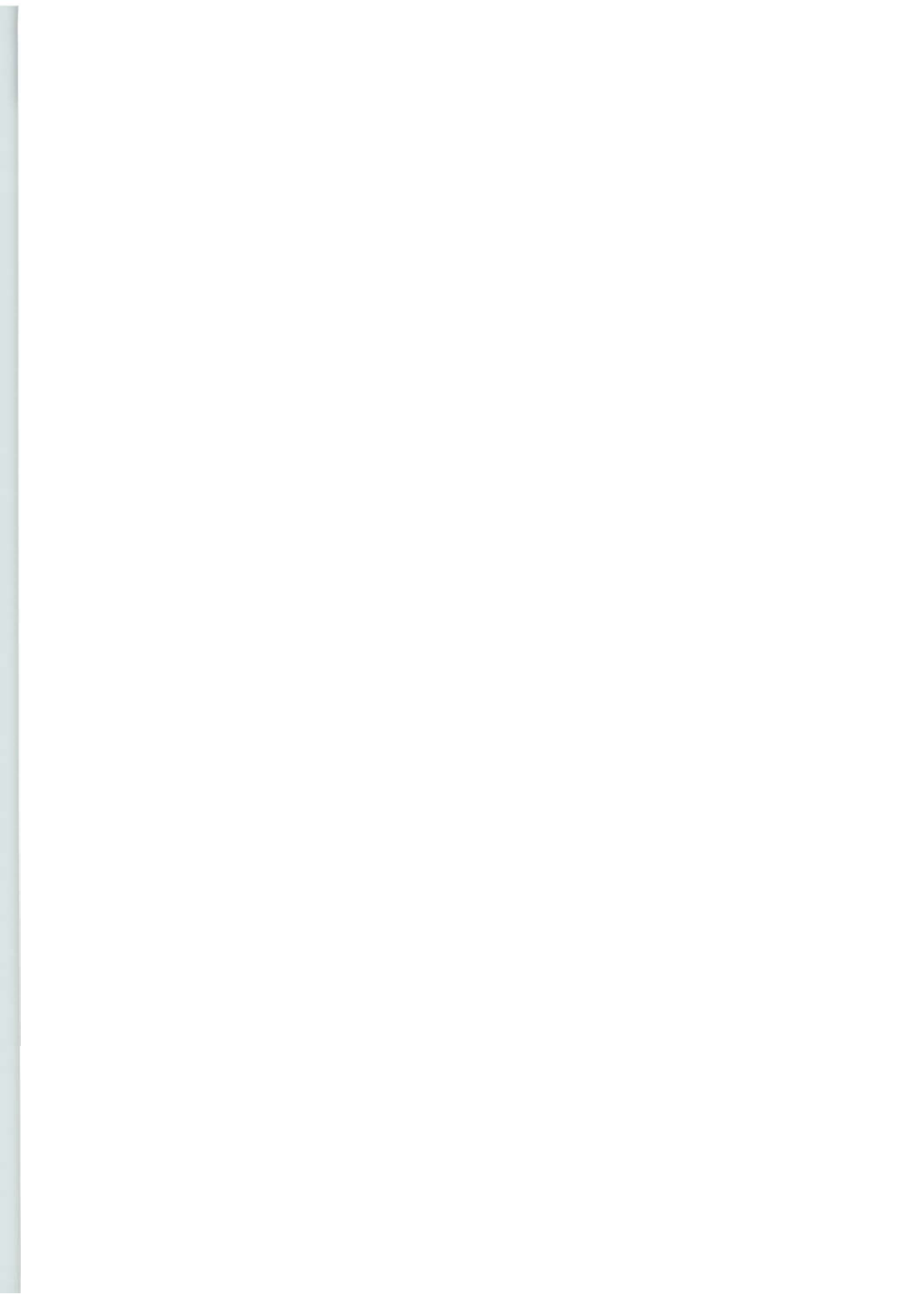
Why is it better ?

CANAL - Open

- The bottom is rounded and smooth for good flow characteristics.
- The depth is sufficient for the expected waste water.

Alternative:

- Pipe sewer instead of an open sewer.





PROGRAM PENGEMBANGAN KECAMATAN (PPK)

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