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LANKA JATHIKA SARVODAYA SHRAMADANA SANGAMAYA (Inc.)

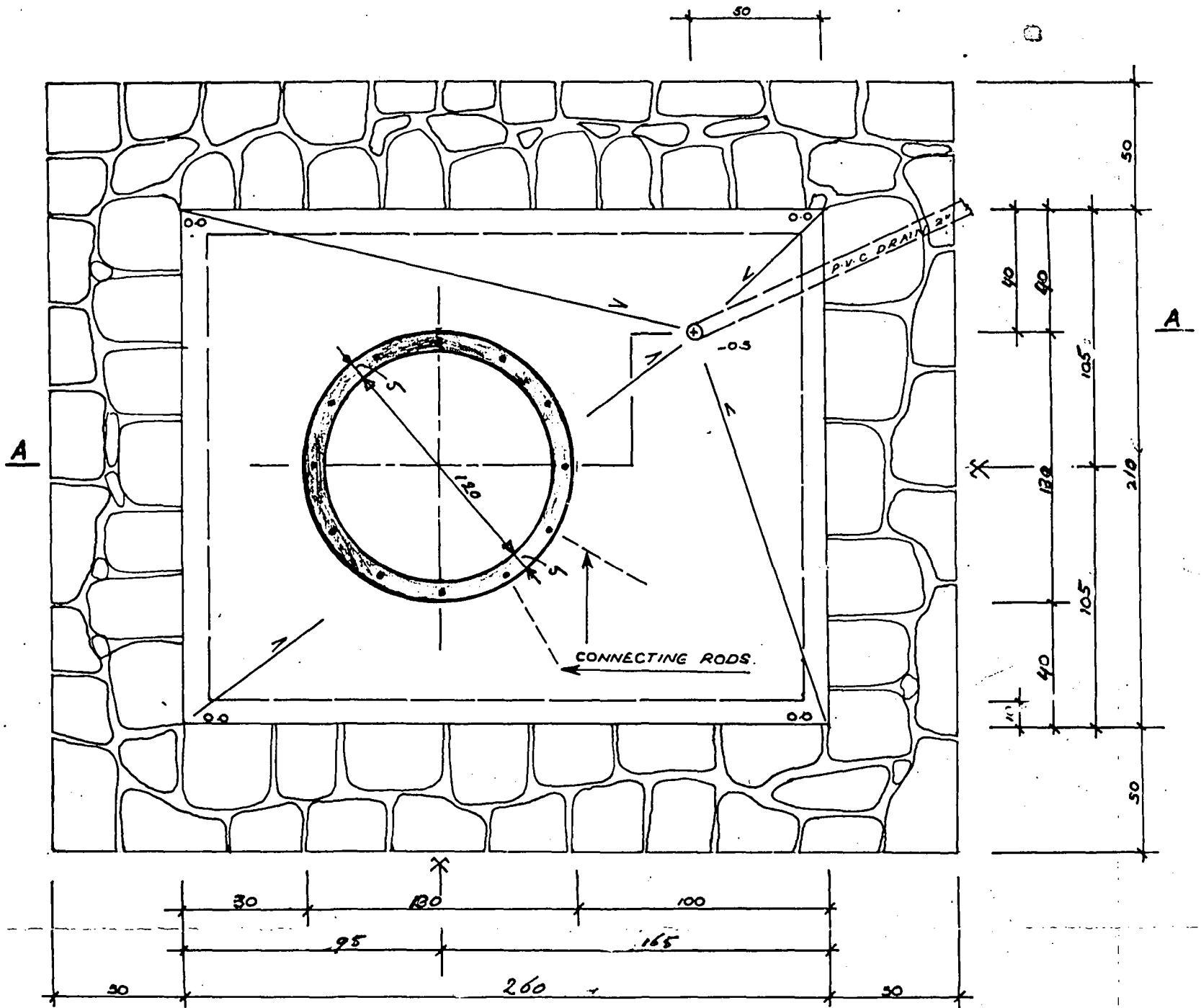
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Sarvodaya Rural Technical Services

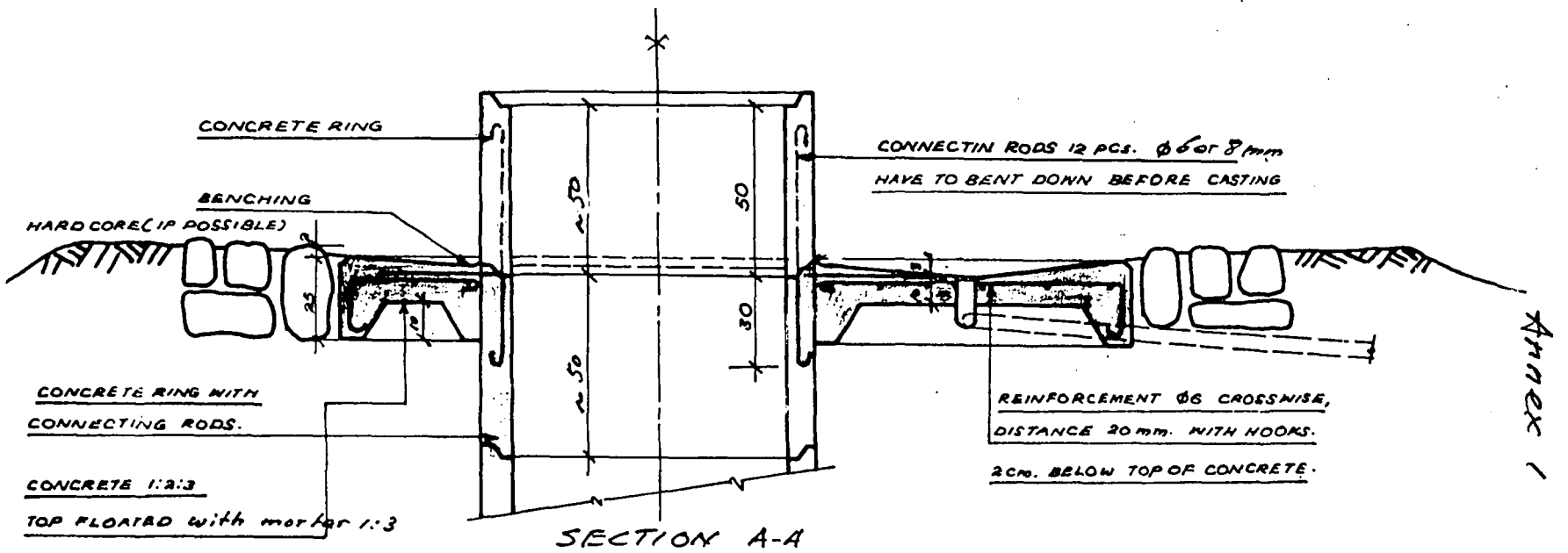
WELL CONSTRUCTION MANUAL



LO: 212-588 WE
SN: 7229



GROUND PLAN



Annex 1

WELL CONSTRUCTION MANUAL

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Rudolf Stark
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1. INTRODUCTION

The construction of wells for village water supplies is very common in Sri Lanka. The Sarvodaya Rural Technical Service is supporting efforts of villages to construct wells, especially in areas where the construction of gravity water supplies is not possible.

Well projects -like any other project supported by SRTS- are planned and executed with the optimal involvement of the local population. The projects are set up in such a way that not only a small group, but a whole village or area can benefit.

This manual will not deal with the theoretical part of well construction, but will give guidelines for the villagers and the workers who are actually doing the job. It reflects the experiences gained within the SRTS projects during the last years.

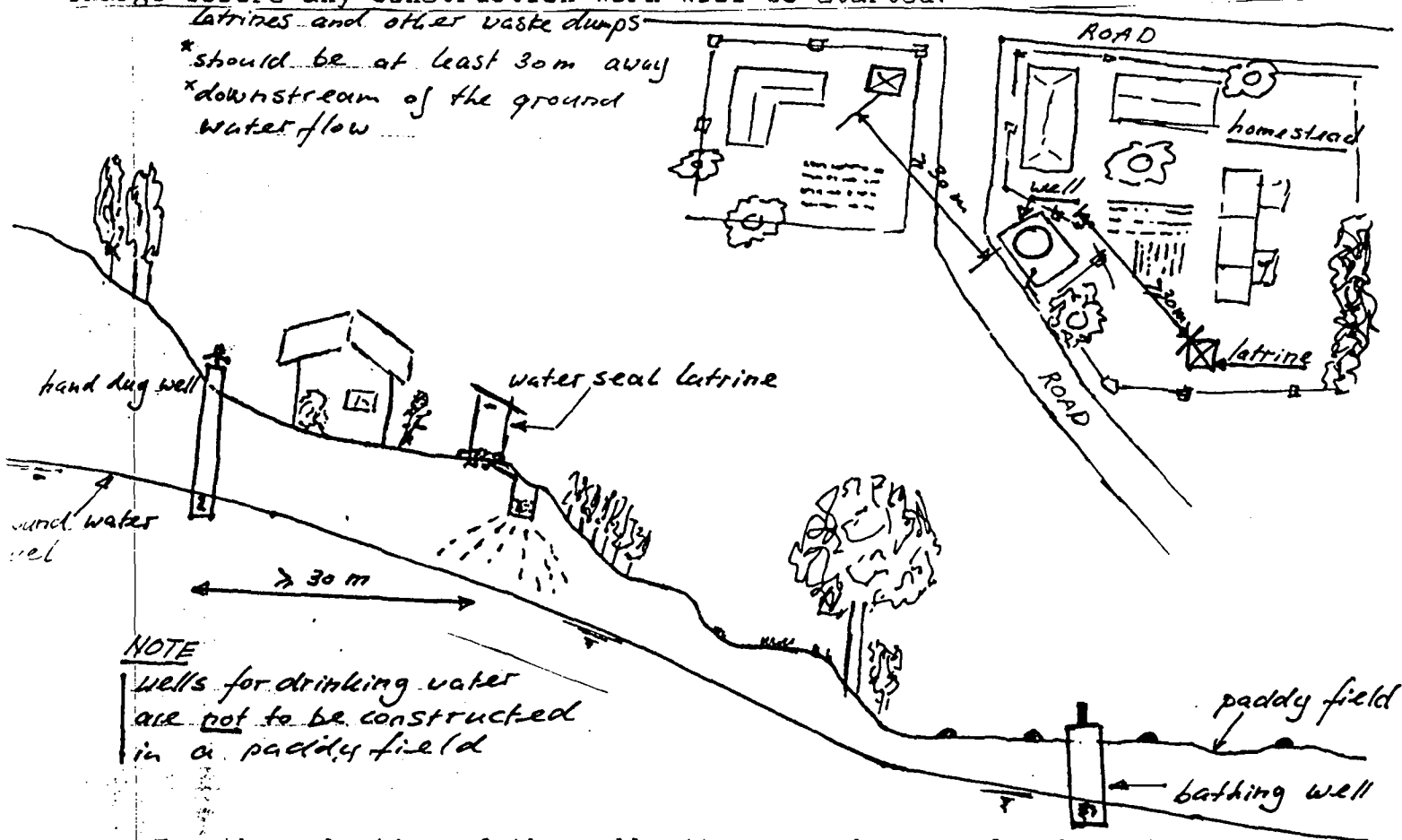


Shallow dug well and SL 15 handpump
installed at the outskirts of
Anamaduwa/Puttalam district, February 1988

2. DESIGN AND PLANNING

2.1. WELL SITE SELECTION

The selection of well sites as well as the number of wells to be constructed is usually done by the villagers themselves together with the shramadana society or the water committee. If necessary they can be assisted by the gramadana worker or the SRTS officer in-charge of the area. In any case, the well sites and the number of wells will be checked by the SRTS Officer in-charge before any construction work will be started.



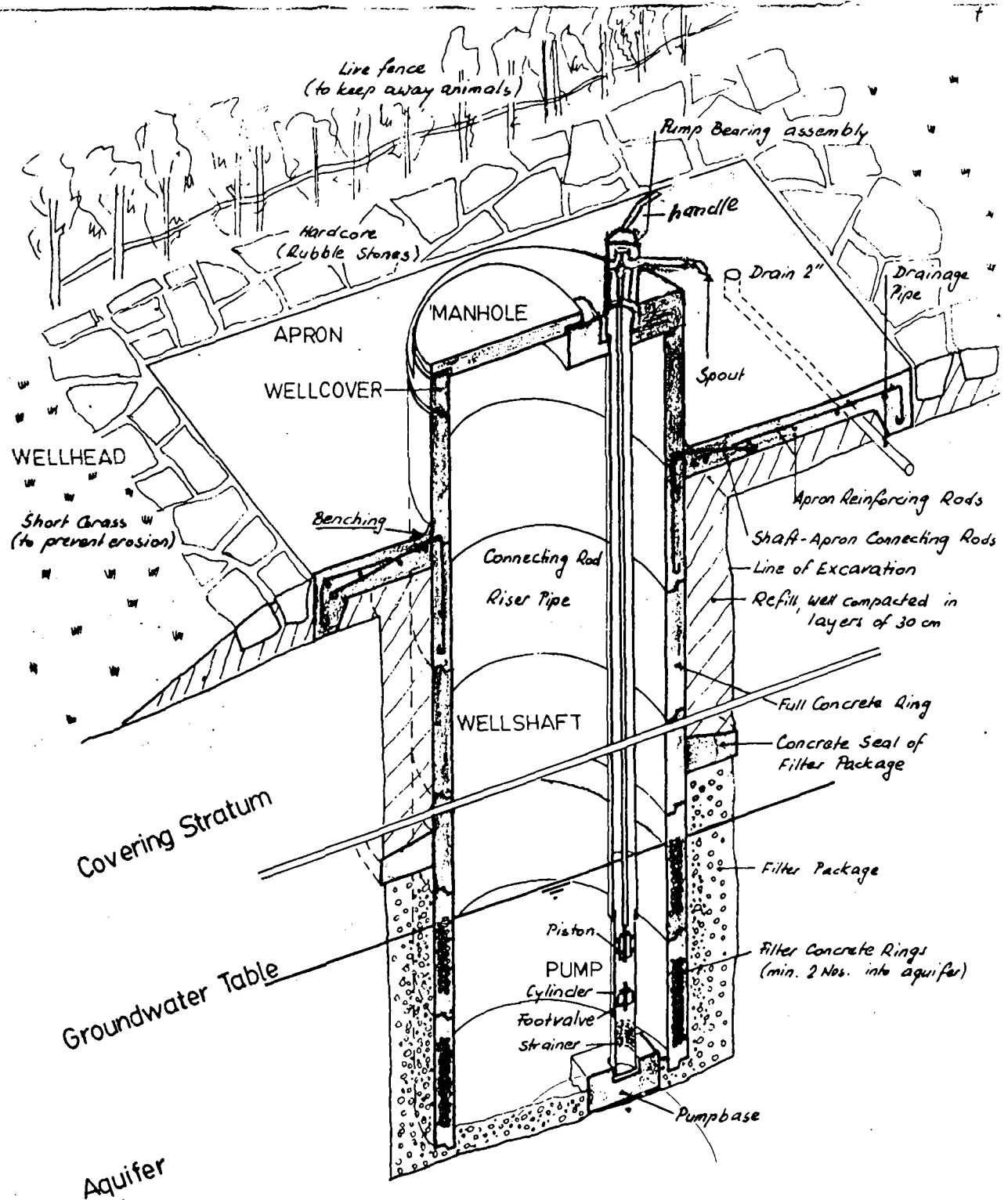
For the selection of the well sites some basic rules have to be observed:

- Wells must be outside the flood level of rivers and tanks.
- The distance to any source of pollution must be at least 30m (or 100 feet). Possible sources of pollution one has to check are for instance latrine pits, cattle sheds, irrigation channels, polluted drains, etc.
- No well should be built inside a paddy field because of the danger of pollution by agro-chemicals.
- Everybody must have free access to the well, i.e. all wells must be public wells! In case the well is situated in private land, the owner has to give his permission for the public use of the well in writing. This letter should be confirmed by the Grama Sevaka or a Justice of Peace.

* downstream of the well
in the direction of
the ground water flow

For the number of wells the following rules will be basic guide lines:

- In any village there should be at least two wells.
- One well should serve at least 6-8 families, with a maximum of 40-50 families.
- none of the families served should have to walk more than 250 m to the nearest well.



2.2 DESIGN OF THE WELL SHAFT

The well shaft consists of a non-reinforced concrete ring, cast in-situ, with an inside diameter of 120 cm (4 feet). In some cases the diameter may be 90 cm (3 feet). The wall thickness is 6 cm.

The first one or two meter of the well shaft is made of wellrings using lean concrete (filter rings), and backfilled with rubble or metal. This filter packing will be sealed with concrete or clay between the concrete shaft and the soil.

2.3 APRON DESIGN AND LIFTING DEVICE

How the wells will be used depends of course on the available water during the average dry period and on the ideas and suggestions of the villagers.

The design of the apron will be adapted accordingly to suit the needs of the villagers, while at the same time maintaining technical standards and ensuring proper drainage of the waste water.

The issues, which have to be discussed with the people and which have to be resolved before the apron can be made, are:

- Will or can the well be used only for drinking water, or also for bathing and washing?
- Can or should a handpump be installed?
- Is a pulley system going to be installed?
- Will the pulley system be replaced by a handpump in a few years from now.
- If the well will also be used for bathing and washing, will it be necessary to build a washing bench or a water trough near the well?

The standard plan for the construction of an apron can be found in annex 1. This plan can be modified to some extent to suit the local conditions.

For the installation of the handpump refer to the "Manual for the Installation and Maintenance of the Sarvodaya Handpump SL 5".

2.4 LIST OF MATERIALS

usually supplied by the village	supplied by SRTS
1 meter length of <u>shaft</u> requires (\varnothing 120 cm):	
sand: 15 - 20 pans (120 l)	cement: 1.5 bags (57 l) ring formwork
metal (1/2"): 24 - 30 pans (190 l)	
coconut oil: 1/2 l	
1 meter length of <u>filter ring</u> (\varnothing 120 cm) requires: (mixture 1:4 with only 1/2 and 3/4 " metal)	
metal (1/2"): 40 - 50 pans (308 l) (and 3/4")	cement: 2 bags (77 l) ring formwork
coconut oil: 1/2 l	
1 meter length of <u>filter packing</u> with rubble and <u>concrete seal</u> (15 - 20 cm thick) requires:	
rubble: 600 pieces (1.2 m ³)	cement: 1.5 bags (57 l)
sand: 15 - 20 pans (125 l)	
metal: 25 - 30 pans (190 l)	
construction of the <u>apron</u> as shown in annex 1, requires:	
sand: 75 - 90 pans (600 l)	cement: 6.5 bags (incl topping coat) reinforcement, \varnothing 6mm: 75 m (17 kg) PVC-pipe \varnothing 50 mm: min. 4 meter length and one elbow with strainer apron formwork
metal (3/4"): 105 - 120 pans (840 l)	
rubble: 700 pieces (1.4 m ³)	



The Public Health Inspector opening the well project at Mahavita/ Gampaha district, February 1988

3. WELL CONSTRUCTION

3.1 SAFETY PRECAUTIONS

Whenever wells are under construction, simple safety rules must be observed:

- Nobody should work alone in a well. There must always be somebody outside the well too.
- always keep something ready as an emergency escape, for example a ladder, a rope ladder or a strong pulley.
- The edge of the pit must be secured with planks or logs. (see also 3.3: Step 1)
- Whenever somebody is working in the well, his head should be protected, if possible with a safety hat.

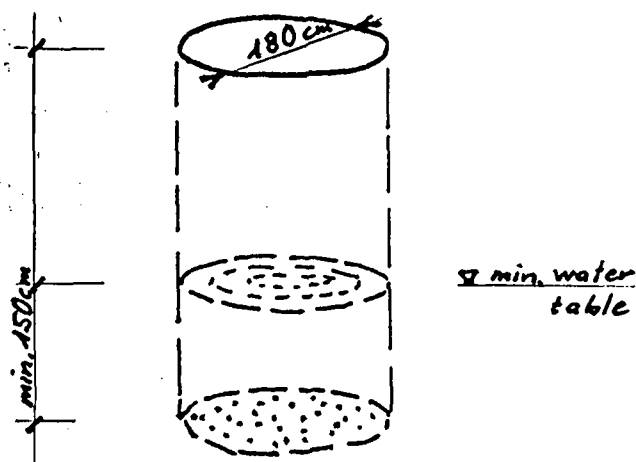
3.2 DIGGING THE WELL SHAFT

After the well sites in a village have been selected and approved, the villagers usually will dig the wells without any support by SRTS.

To avoid any misunderstandings or frustrations on the part of the villagers, the requirements for the constructions of the wells should be explained very clearly to them:

Measurements for the excavation of the well shaft :

1. - diameter of the shaft excavation = min. 180 cm (6 feet)
2. - depth of the shaft = according to the ground-water table, but at least 150 cm (5 feet) lower than the lowest water table. This is especially important when a handpump will be installed.



When wells must be constructed in loose soil or sand, refer to chapter 3.4.

For the materials required from the villagers refer to 2.4.

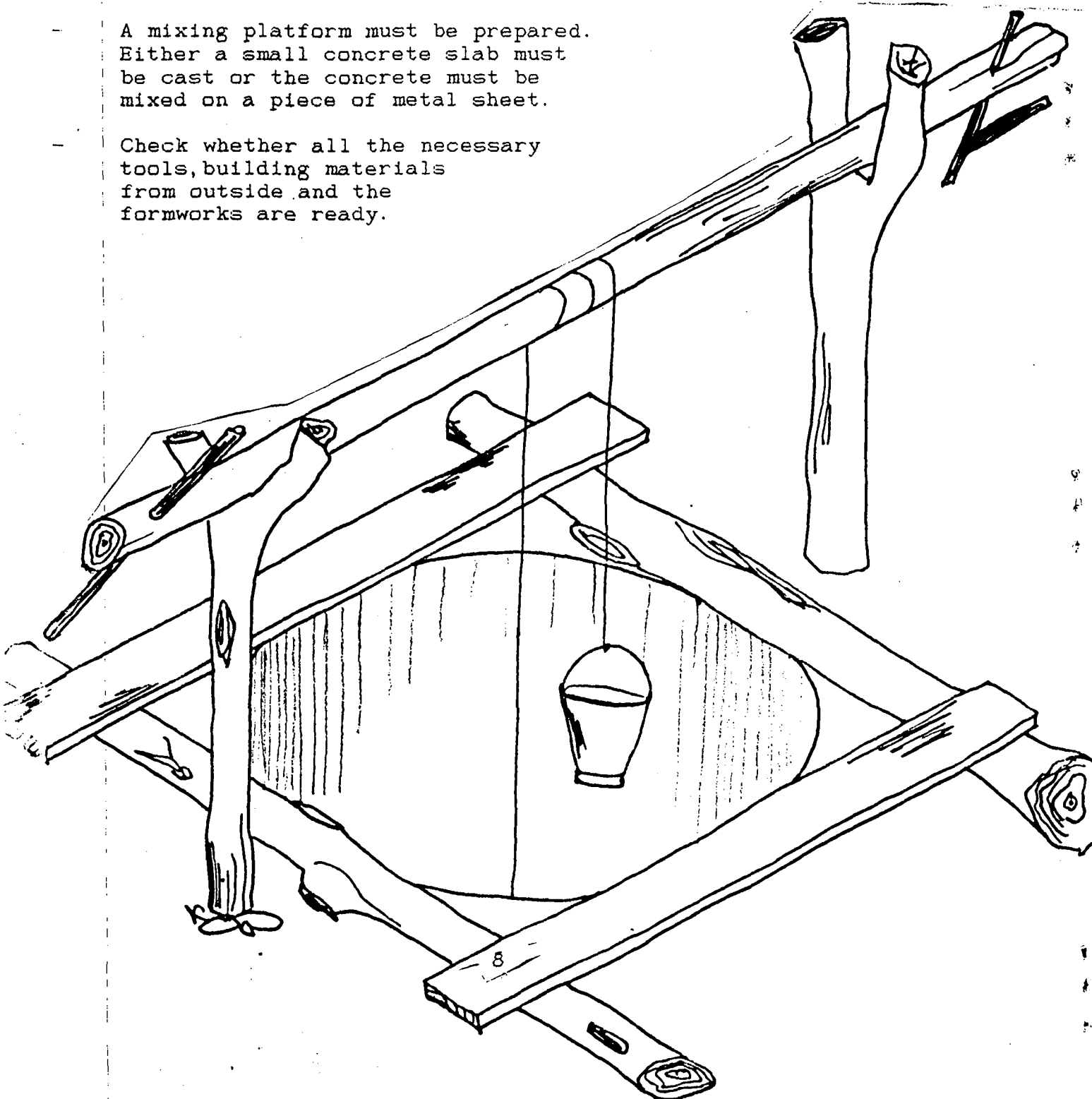
3.3 WELL SHAFT CONSTRUCTION IN STABLE SOIL

Step 1: PREPARATION

- Ask the villagers to prepare the wellsite and its surrounding for the construction of the shaft. Explain them clearly, what is expected :
 - * The edges of the excavated shaft should be secured with planks or poles.
 - * Especially for deeper wells a simple pulley should be installed.
 - * The building materials to be provided by the villagers must be ready at the site for the construction of the shaft.

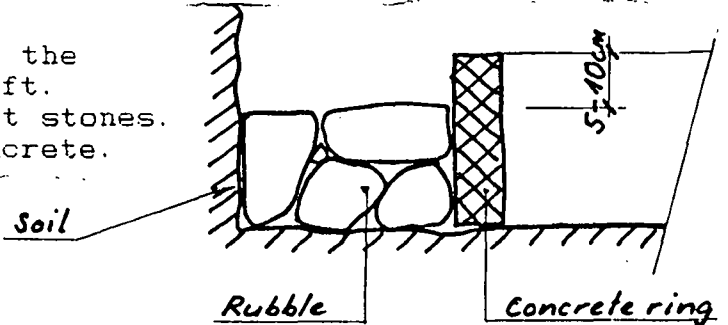
- A mixing platform must be prepared. Either a small concrete slab must be cast or the concrete must be mixed on a piece of metal sheet.

- Check whether all the necessary tools, building materials from outside and the formworks are ready.

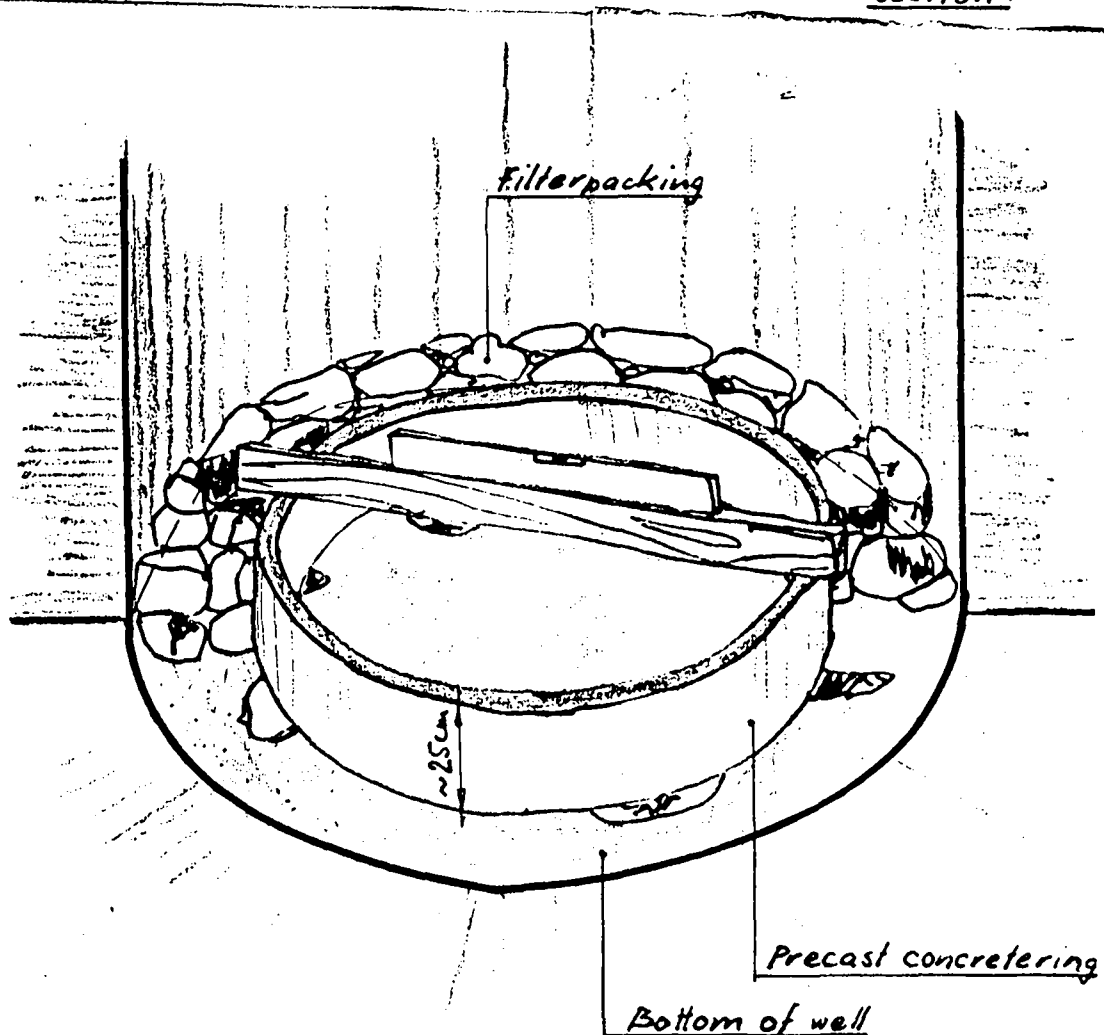


Step 2: PRECAST GUIDING RING

- Cast a small concrete ring outside the well (only about 25 cm high), which will be used as a guidance for the well shaft. Use mixture 1:2:3, vibrate it well and let it set for at least 5 days before use. Try to make the ring as correct as possible, especially the wall thickness.
- Drain the water out from the well, if necessary with the help of a pump. Clean all the loose soil out from the bottom of the well.
- Place the small precast ring at the bottom of the excavated wellshaft. Level it properly with some flat stones. If necessary use some stiff concrete.
- Fill up with rubble around the ring till about 5-10 cm below the top of the ring.



Section:

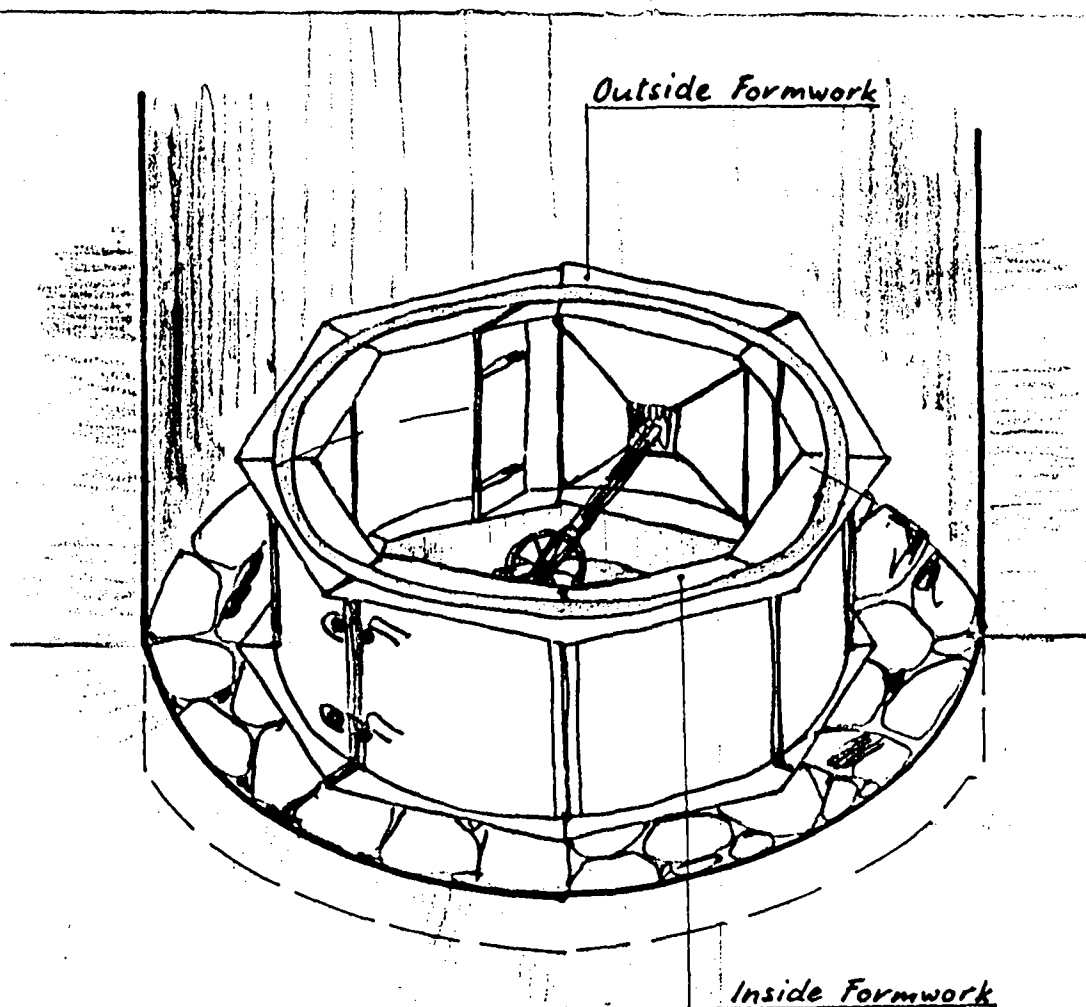


Step 3: FILTER RING

- Lower first the outside formwork. Place it and check level and plumb.
- Then lower also the inner formwork. Level and plumb it, then tighten it.

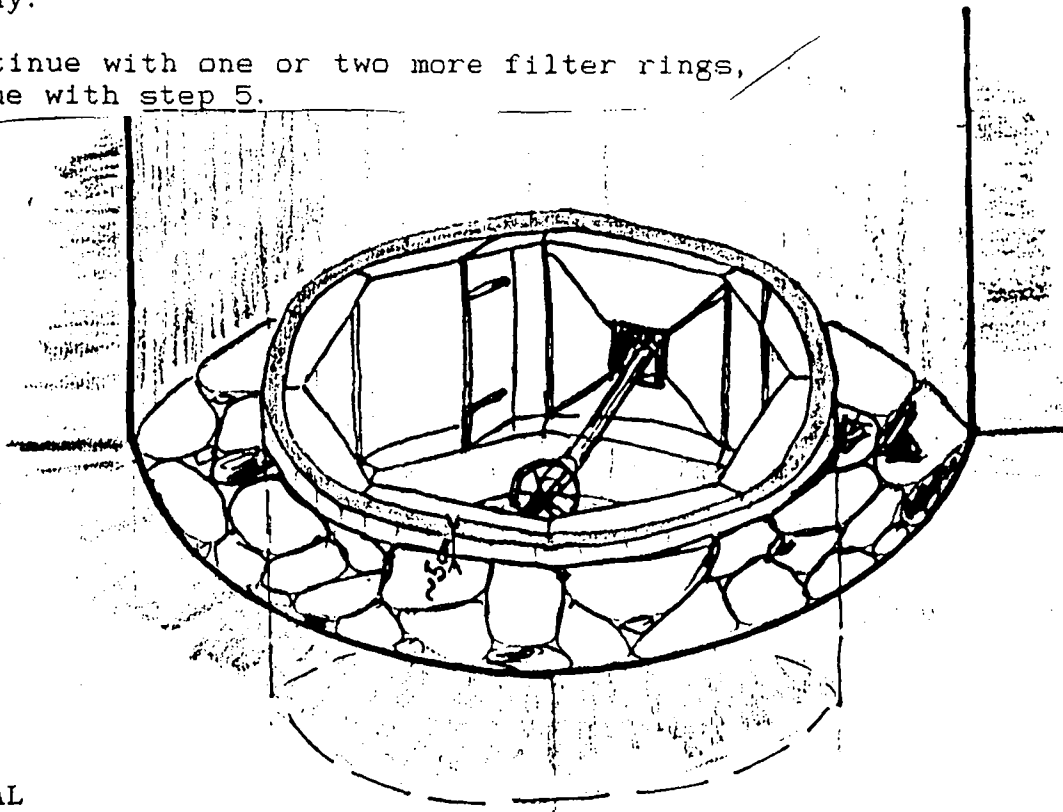
Note:!!The formwork must be properly oiled before each use!!

- Fill the formwork with filter concrete 1:4. Ram it very little.
- Clean the outside of the formwork. Allow the concrete to set for a day.
Allow the (ground) water to fill the wellshaft again. It will cure the fresh concrete.



Step 4: RUBBLE FILLING FOR FILTERING

- Drain the water out from the well.
- Remove the outside formwork carefully and fill the space between the concrete ring and the soil with rubble, again till about 5 -10 cm below the top of the concrete ring.
- Remove the inside formwork. Clean both the inner and the outer formwork and oil it again.
- Place first the outside formwork, plumb and level it. Check that the thickness of the concrete wall will be equal all round.
- Fill the second ring also with filter concrete and allow it to set for one day.
- If necessary, continue with one or two more filter rings, otherwise continue with step 5.



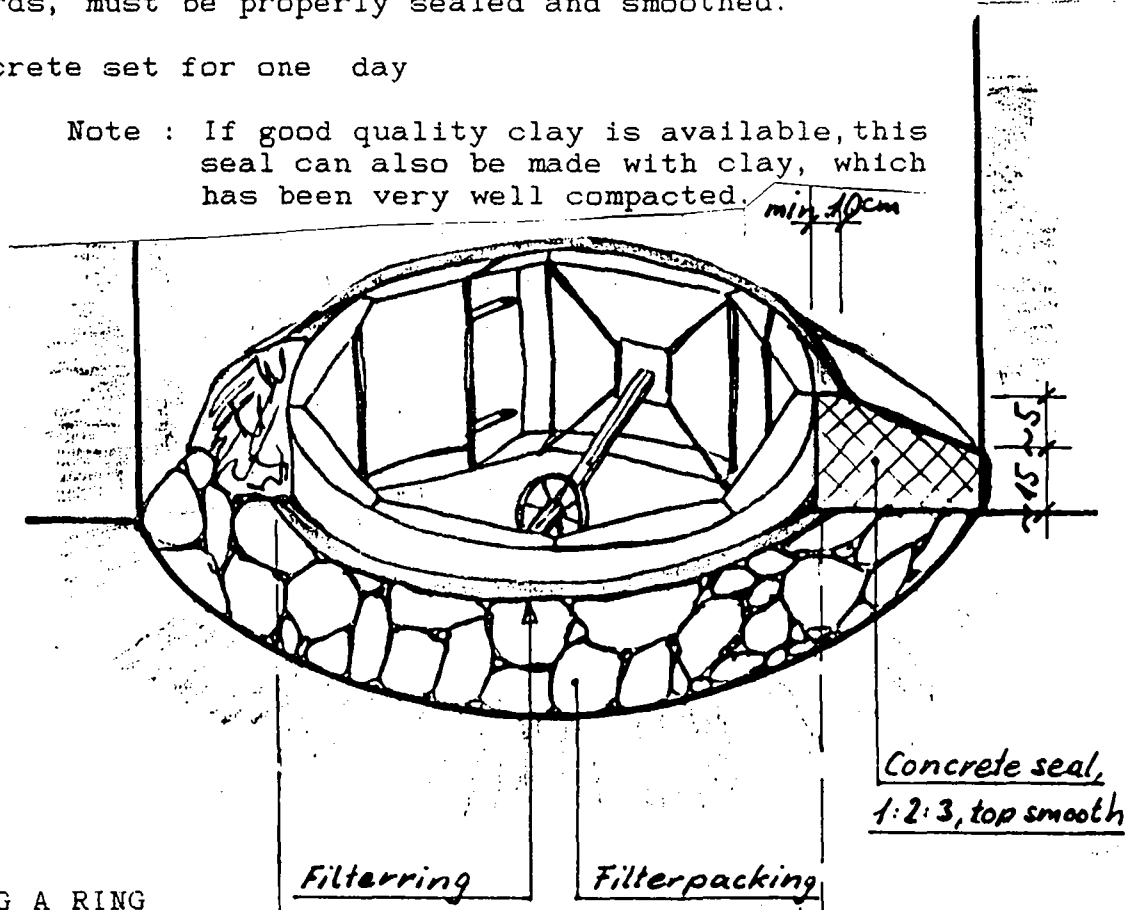
Step 5: CONCRETE SEAL

- Remove the outside formwork and fill the gap between concrete ring and soil with rubble.
- Remove the inner formwork, clean it, oil it and place it back, so that the top of the formwork will be about 20 cm above the top of the concrete ring.
- Clean the surface of the filter packing of soil and of all loose material. To obtain a good concrete seal it is sometimes necessary to dig 10 - 20 cm inside the walls of the shaft.

Fill the empty spaces between the stones of the filter-packing with smaller stones and metal. Then cast concrete on top as a seal (mixture 1:2:3). The top of the concrete must slope outwards, must be properly sealed and smoothed.

Let the concrete set for one day

Note : If good quality clay is available, this seal can also be made with clay, which has been very well compacted.



Step 6: CASTING A RING

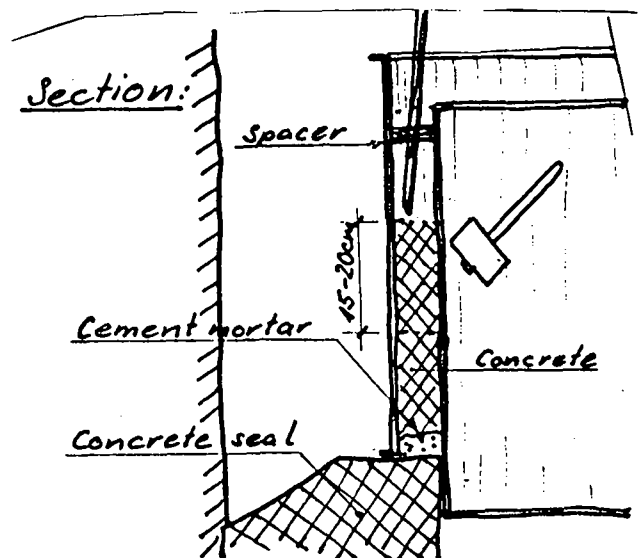
Remove the inner formwork, clean it and oil it! Then place it back inside the well ring. Plumb it and level it.

Place also the outer formwork. Use some spacers in order to get an equal concrete ring. Spacers can be made with cement mortar or with stones of the correct length.

Place a layer of about 5 cm of stiff-plastic mortar 1:3. Distribute it and ram it.

Fill the concrete in layers of about 15 - 20 cm and vibrate each of these layers well before adding the next one. Use a stiff-plastic mixture 1:2:3. Do not add too much water. This could easily cause pockets of metal only.

Let the concrete set for one day.

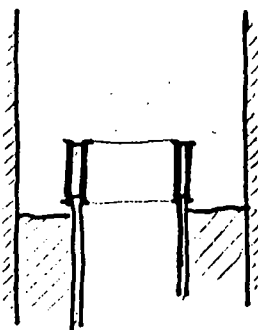


Note to Step 6: In case despite all the precautions some pockets of metal occur in the concrete, fill the voids immediately with fine cement mortar, after having washed the spot properly. Do not plaster the concrete!

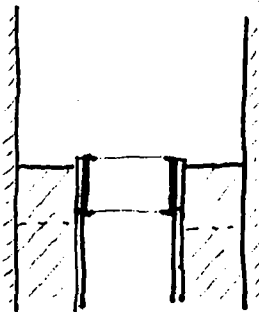
Step 7: COMPLETING THE WELLSHAFT

- Remove the outside formwork and fill the space between the concrete and the soil with excavated material. Fill it in layers of about 20 - 30 cm and compact it till about 5 - 10 cm below the top of the concrete ring.
- Remove the inside formwork, clean and oil it (just like the outside one).
- Place the outside formwork back, level and plumb it, then place also the inner one. Check, that the thickness of the concrete is everywhere equal.
- Fill the mortar and the concrete into the formwork as described in step 6.
- Let the concrete always set for one day.
- Continue with casting of rings till the groundlevel, then start with step 8 :

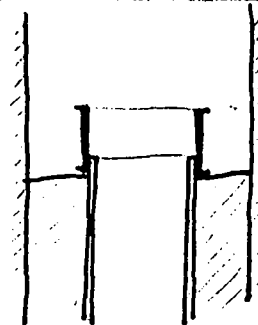
Sequence of removing and placing the formwork



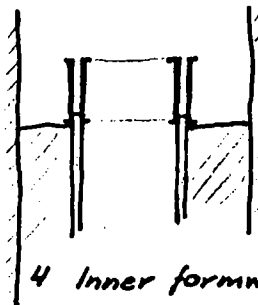
1 Ring is cast



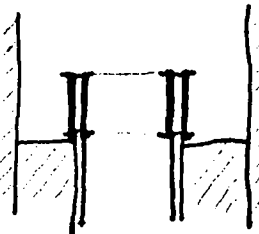
2 Outside formwork removed, backfilling



3 Inner formwork removed, outer formwork placed again (outside always first!)



4 Inner formwork placed again

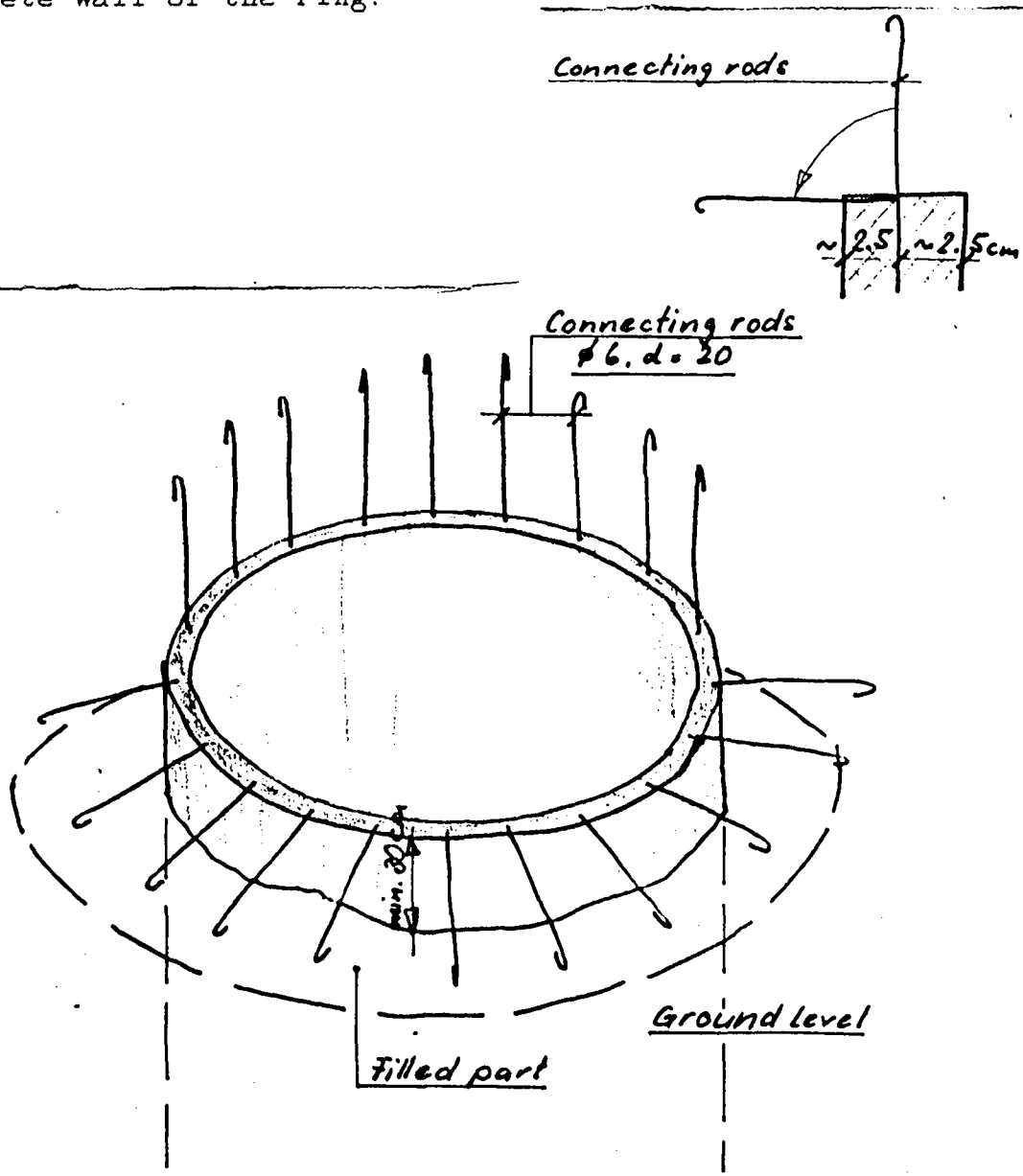


5 Casting of the next ring

Step 8: FIXING CONNECTING RODS

Cast the rings up to a level which is at least 30 cm above the natural ground level (depending on the topographical situation).

Put some connecting rods into the fresh concrete of the cast ring (ϕ 6 mm or 8mm, $d=20$ cm). The rods should be put in the middle of the concrete wall of the ring.

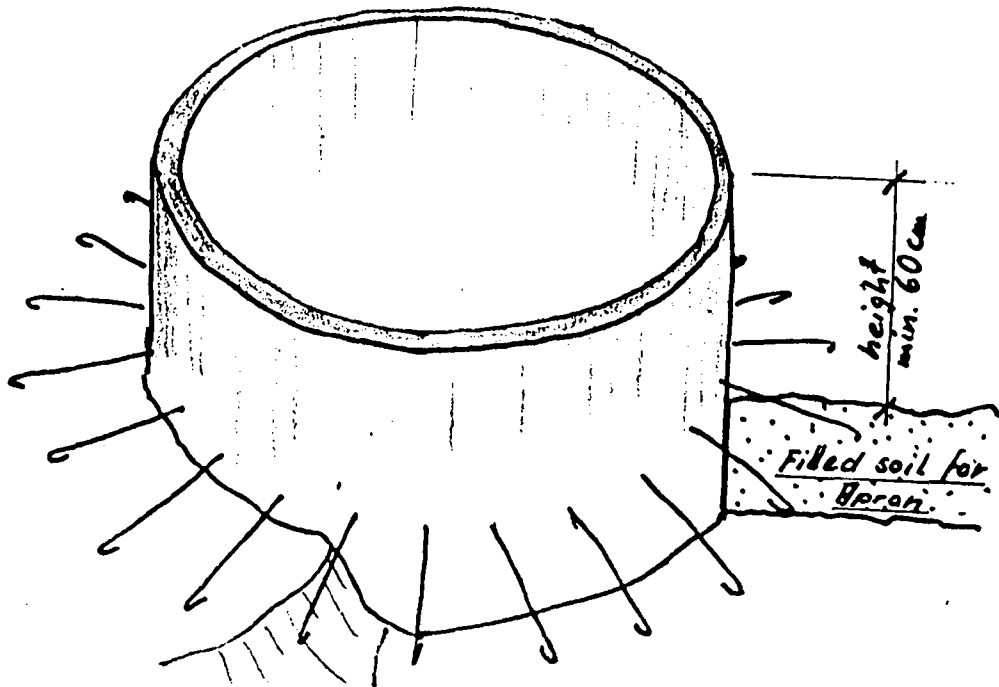


Step 9: THE LAST RING

Bend these connecting rods down and cast at least one additional ring on top, so that the well can safely be used.

Ask the villagers to fill the surrounding of the well up to the connecting rods with good soil and compact it. Make the area to be filled equal to the size of the proposed apron + 1 additional meter all round.

Pour water on the filled soil and ram it. Let it set for some time.





on-site construction of the concrete well rings.
Note that the concrete seal has already been made
at the bottom of the well.
Matara/Matara district, March 1987

3.4 WELL SHAFT CONSTRUCTION IN LOOSE SOIL OR SAND

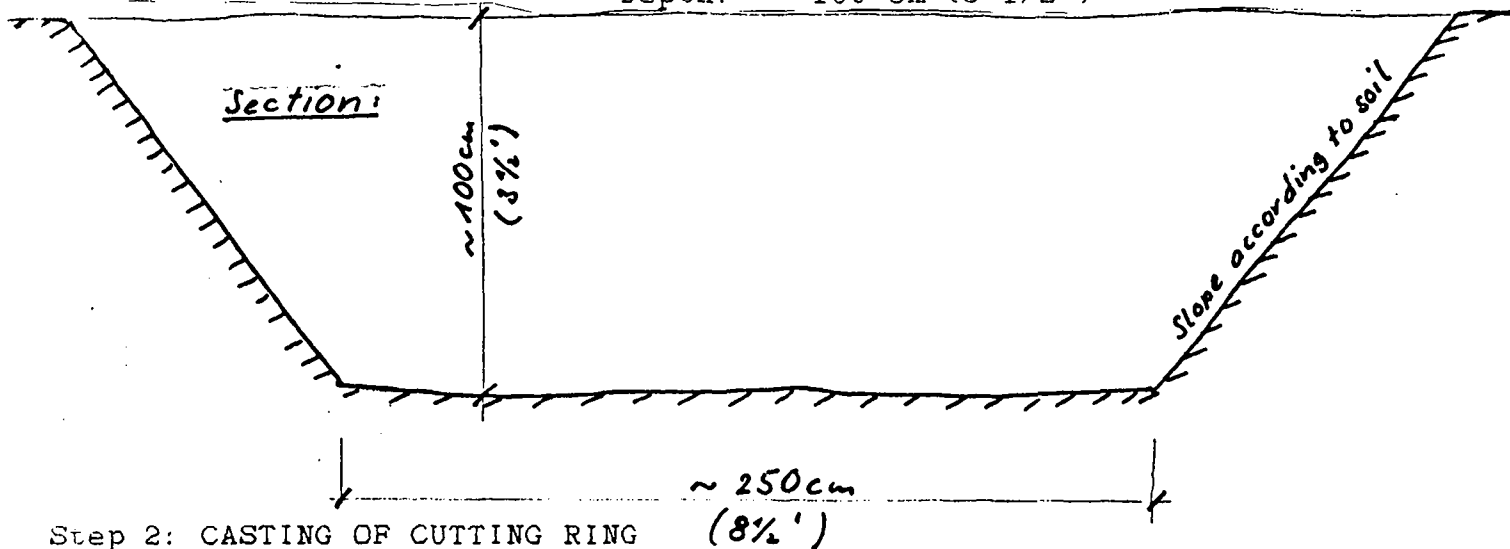
Step 1: PREPARATION

Make sure, that all the building materials and tools are ready on the site.

Ask the villagers to excavate a pit with the following approximate measurements:

Diameter: 250 cm (8 1/2')

Depth: 100 cm (3 1/2')



Step 2: CASTING OF CUTTING RING

Cast a concrete cutting ring nearby. Use good quality concrete 1:2:3. Reinforce the top of the ring with 3 rods \varnothing 6mm. Try to keep the rods in the center of the concrete, so that they may not rust. Bevel the top of the ring as shown below.

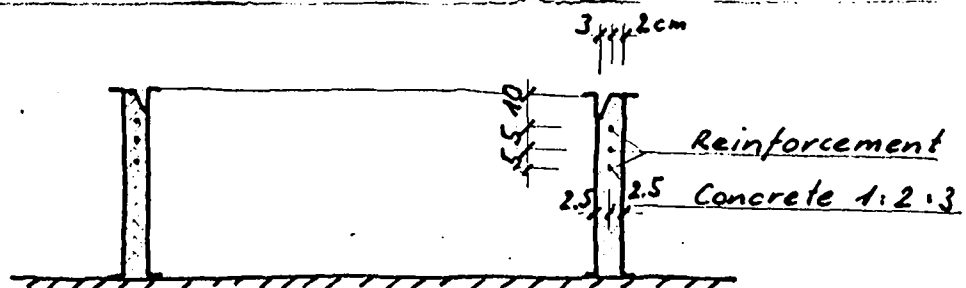
!!Note, that this ring is actually cast upside-down!!

The formwork can be removed after one day. But make sure to cure the concrete ring very well and allow it to set for about 5 days.

Note: Steel formworks get very hot when exposed to the sun, and that can affect the quality of the concrete.

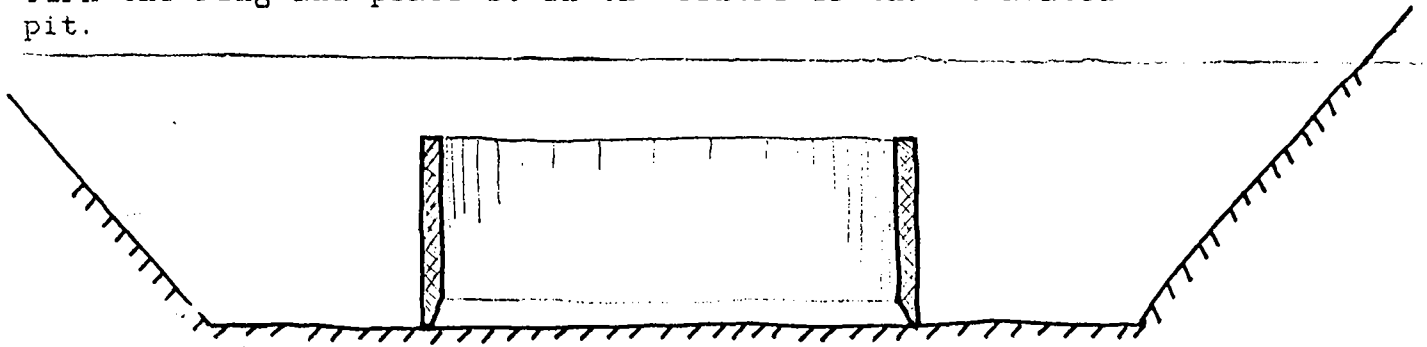
Therefore cover the rings after casting with palm leaves or similar coverings and sprinkle water for cooling.

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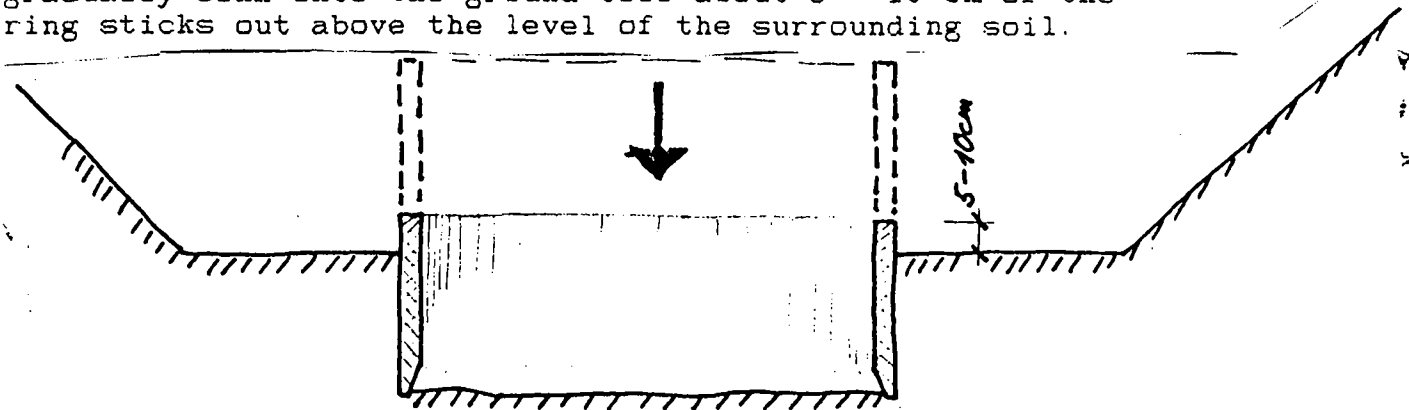


Step 3: DIGGING THE WELL SHAFT

Turn the ring and place it in the centre of the excavated pit.



Now excavate the inside of the wellring and let the ring gradually sink into the ground till about 5 - 10 cm of the ring sticks out above the level of the surrounding soil.

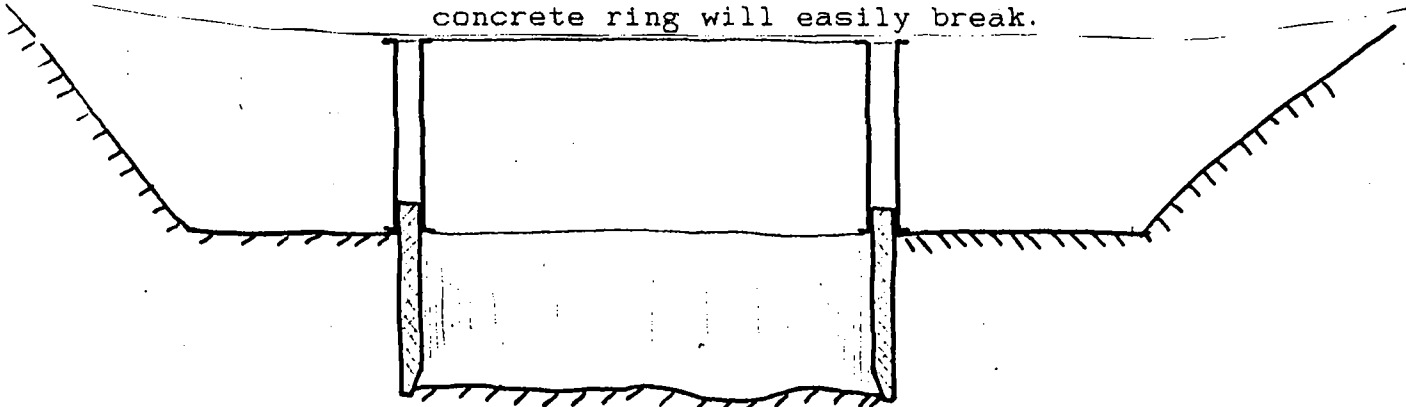


Step 4: CASTING THE FILTER RING

Clean the top of the first concrete ring. Place first the outside, then the inside formwork. Plumb it and level it properly, then fill it with filter concrete 1:4.

Cure it and allow it to set for one day.

Note: Place always first the outside formwork, plumb it and level it. Only after tightening it properly place also the inside formwork, otherwise the fresh concrete ring will easily break.



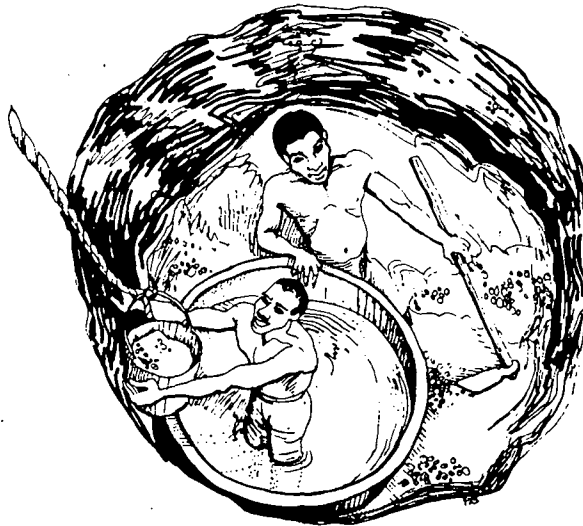
Step 5:

- Remove the formwork. Clean it and oil it.
- Dig out the soil inside the wellrings, so that they sink gradually into the ground till only about 5 - 10 cm of the ring sticks out above the surrounding soil.
- Cast another filter ring on top as described in step 4.

Step 6:

- Remove the formwork and clean and oil it.
- Dig out the soil inside the wellrings, so that they sink gradually into the ground till only 5 -10 cm of the ring projects still outside.
- Place first the outside, then the inside formwork on top of the last ring. Level and plumb it.
- Cast the next ring with normal concrete, mixture 1:2:3. Vibrate it well.
- Cure it and allow it to set for a day.

**Continue digging inside the ring.
Wells can be de-watered by bucket and hard
work, or by a small diesel, petrol or hand-
operated diaphragm pump.**

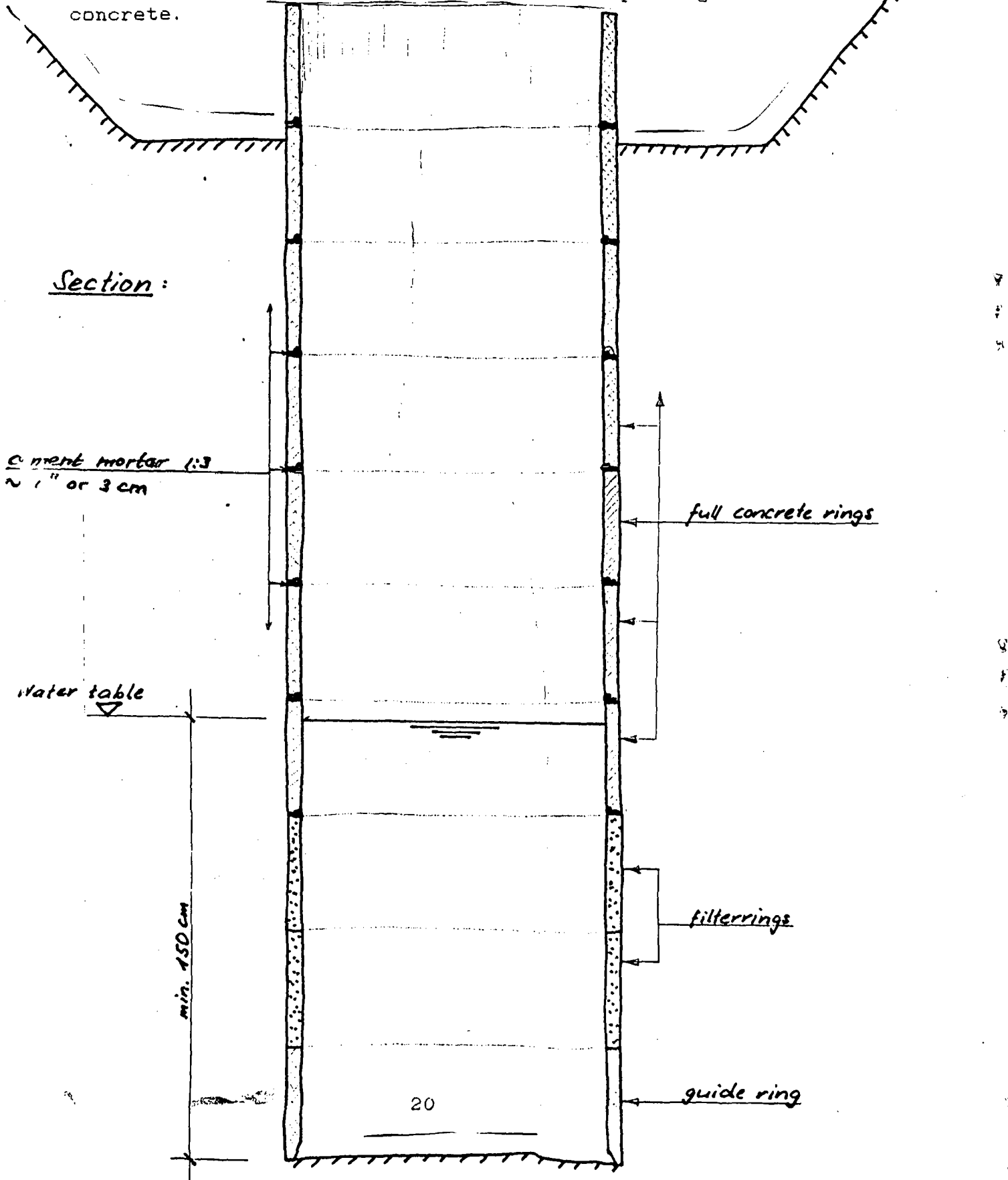


Safety

Workers should wear helmets and buckets should be tethered while they are down the hole. Keep engine-driven pumps away from the hole to avoid the build-up of toxic fumes.

Step 7: COMPLETING THE WELL SHAFT

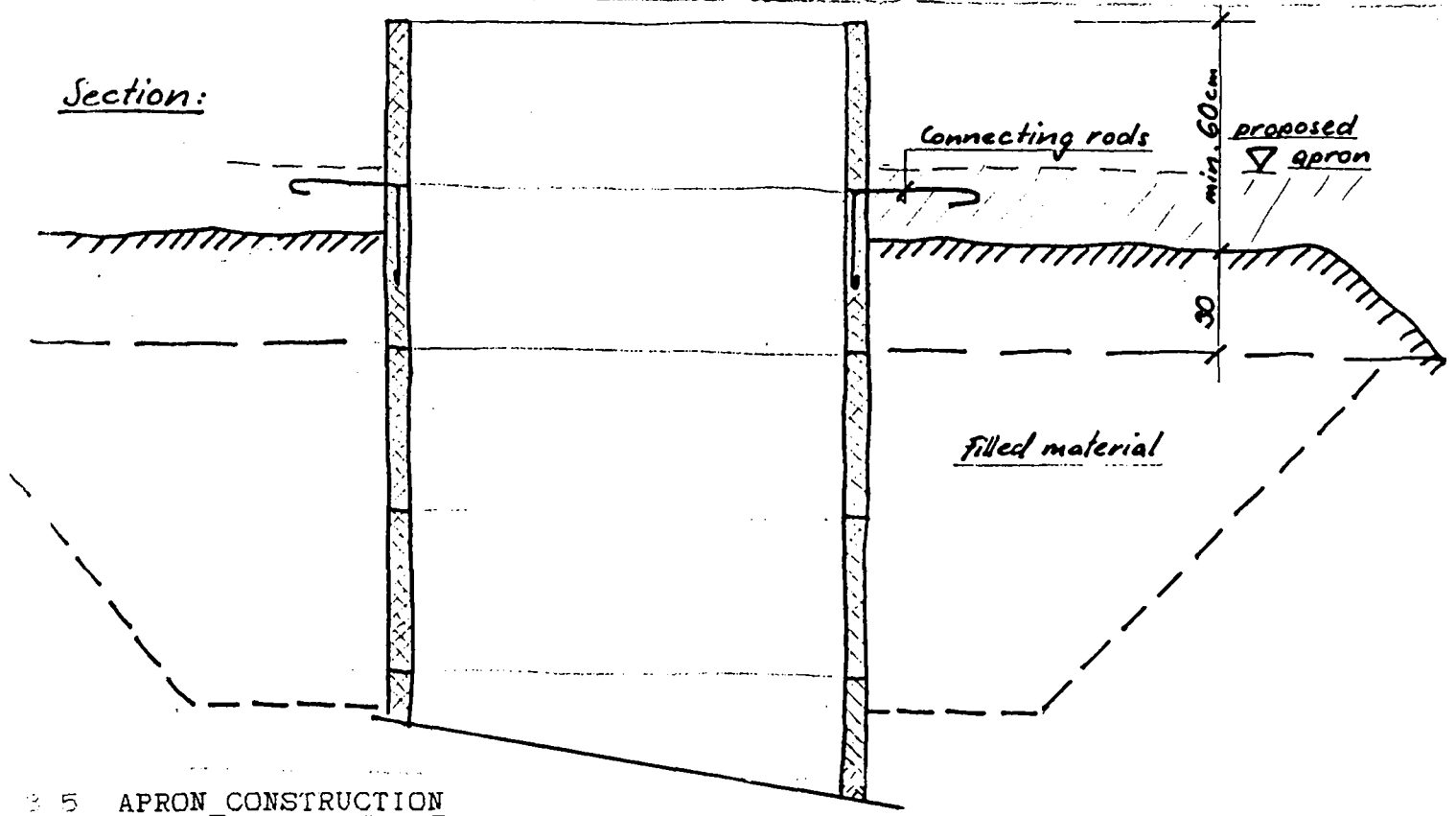
Continue this procedure till there is at least 1.5 m of water inside the wellshaft (dry season).
Do not forget to place always a layer of about 3 - 5 cm of cement mortar 1:3 into the formwork before pouring the concrete.



Step 8: FILLING IN OF THE PIT

Fill the excavated pit around the well shaft with soil up to a level which is about 30 cm higher than the surrounding soil. Cast one or two more rings on top, so that the well can be safely used.

Do not forget to place the connection rods pointing into the apron at the level at which the apron will be constructed. (see also step 8 of the "well construction in stable soil")



5 APRON CONSTRUCTION

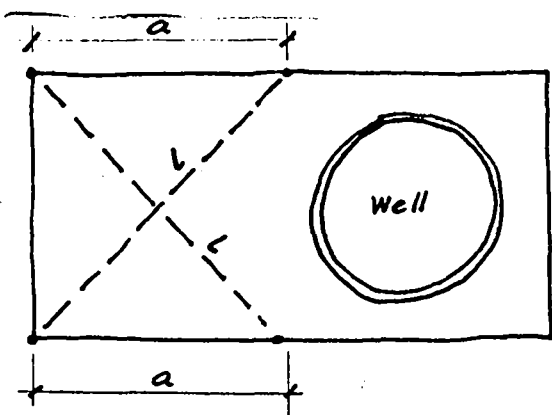
STEP 1: CASTING THE APRON

Discuss and carefully consider the best way to make the apron. Look for the best drainage place to which the drain pipe can be led.

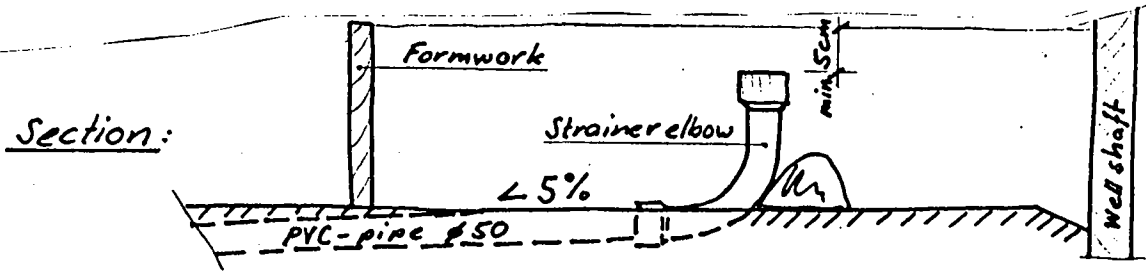
Level the filled-up ground and place the formwork for the apron on the ground. Level the formwork and check the right angles (diagonals!).

Groundplan:

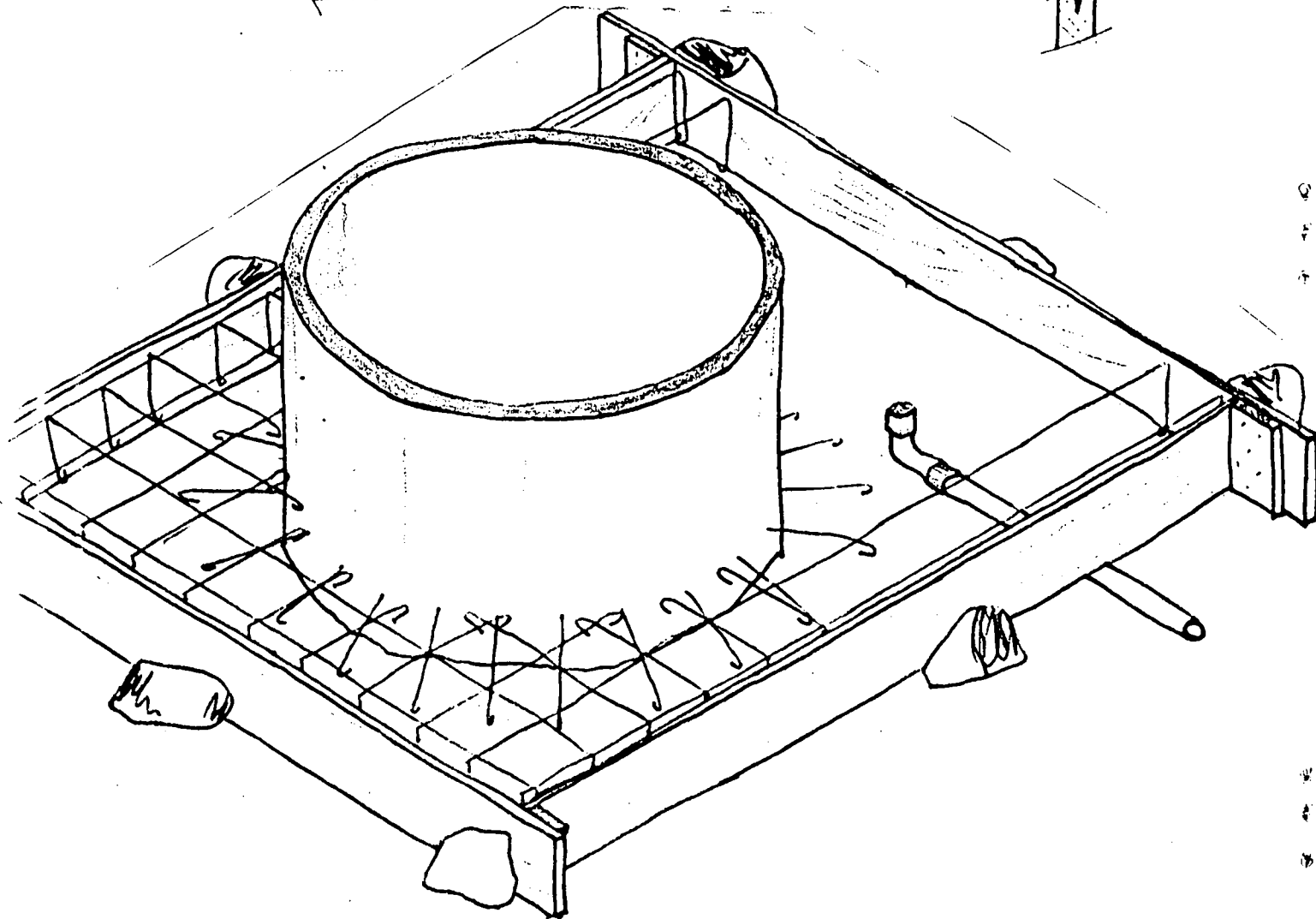
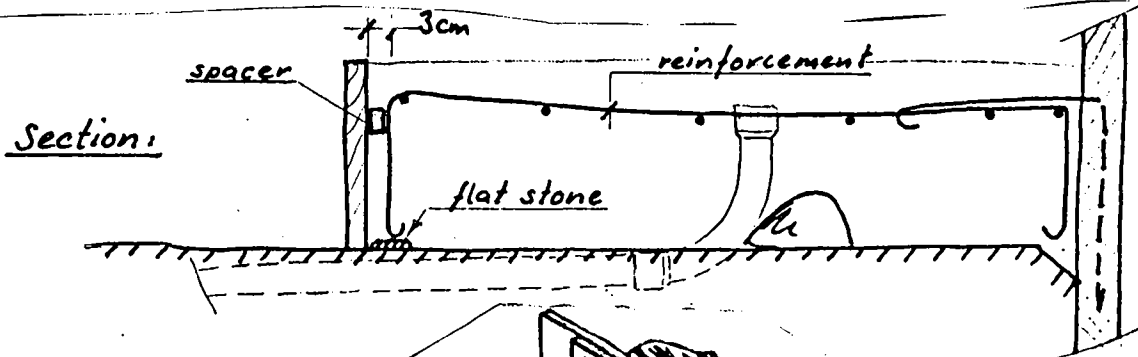
$\underline{l = l}$



Place the strainer elbow at least 5 cm (depending on the size of the apron) below the top of the formwork. Lay the drainpipe in a proper slope (min. 5%) and support it with stones or some lean concrete. If possible, the outlet of the drainpipe should be at least 4 m away from the well.



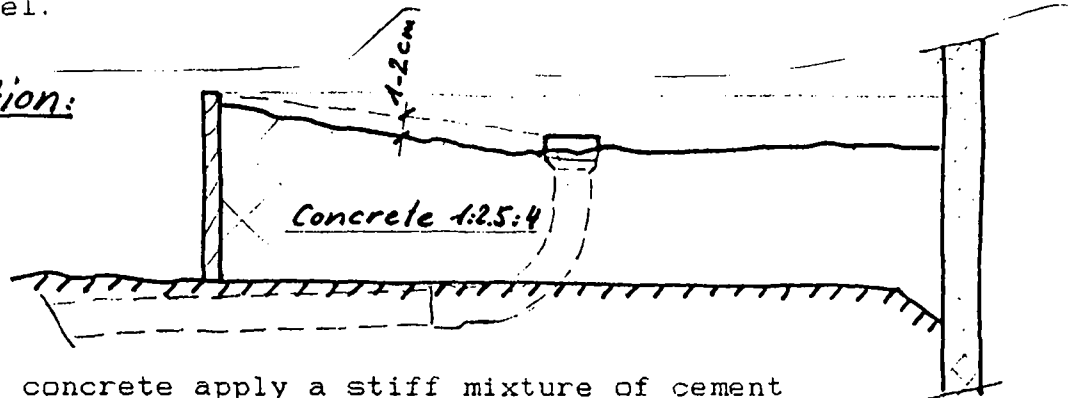
Clean the connection rods coming out from the well shaft. Place the reinforcement according to the plan. Check, that the reinforcement is not touching the formwork anywhere. Support the hooks with flat stones.



- Fill the formwork with plastic mixed concrete 1:2.5:4. Compact it properly, and make sure to knock the formwork. Check, that the reinforcement and the strainer remain in the correct position.

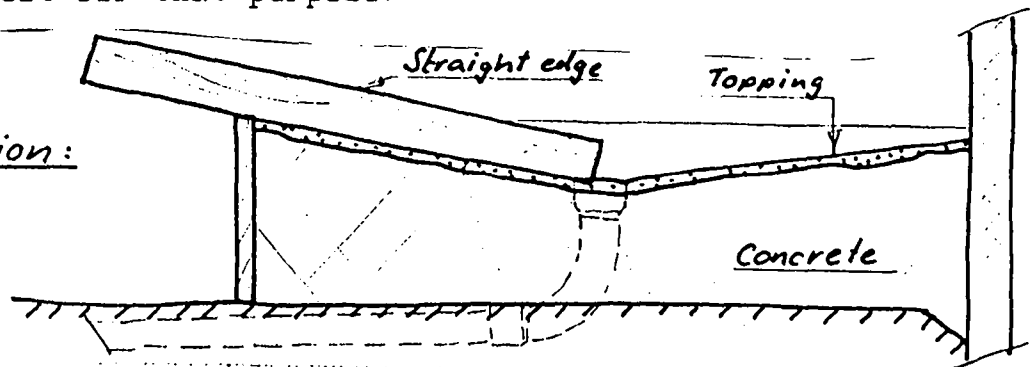
- Screed the concrete roughly between the formwork and the strainer. Leave a space of about 1 - 2 cm upto the final level of the apron. Do not smooth the top of the concrete with the trowel.

Section:

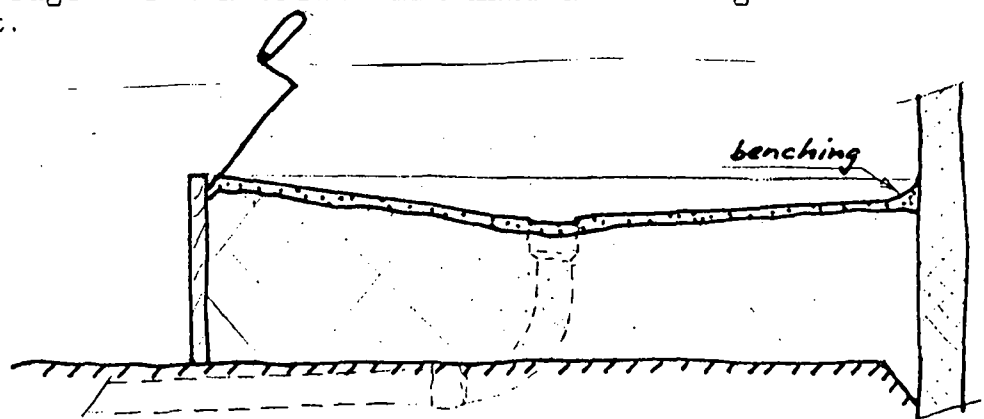


- On top of the concrete apply a stiff mixture of cement mortar 1:3 immediately after casting. Screed it and float it. Do not smoothen it! If a pulley stand is to be cast into the apron later, holes should be left for that purpose.

Section:



- Bevel all the edges with a trowel and make a benching around the well shaft.

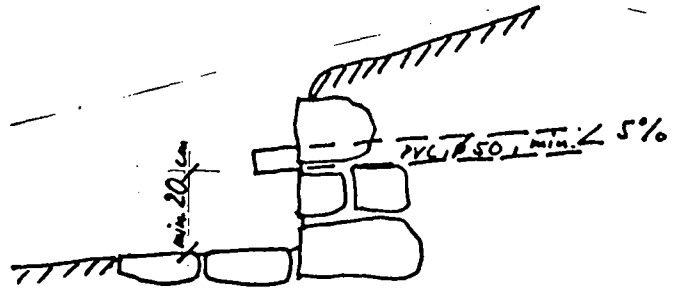


- Cure the concrete for at least 1 week. A good way would be to close the drain pipe and fill the whole apron with water.

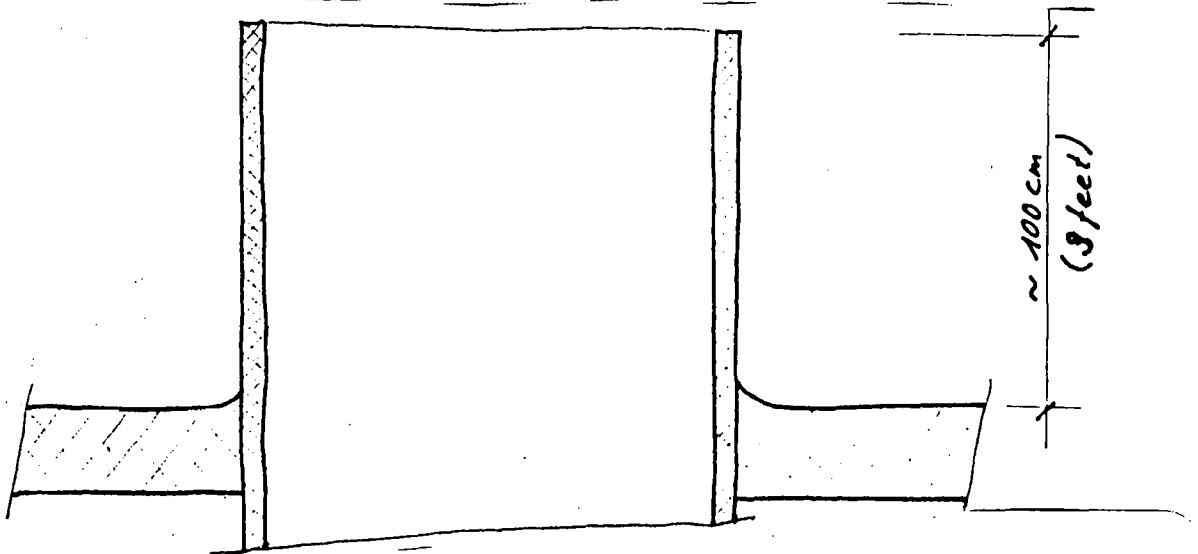
STEP 2: FINISHING THE APRON AND WELL HEAD

Remove the formwork and clean it.

Secure the outlet of the drain pipe with a dry wall or - if so necessary - with a concrete wall.



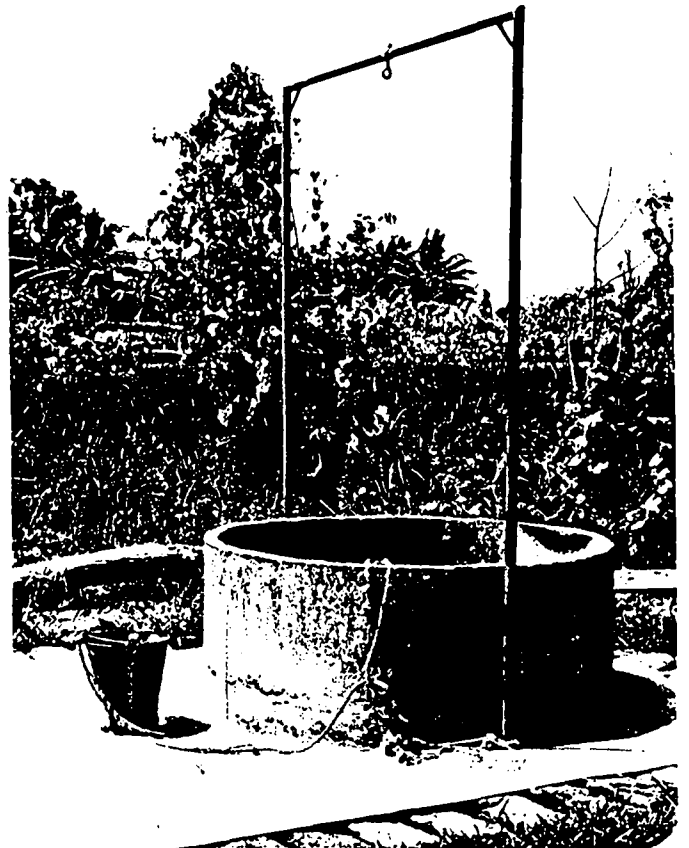
If necessary, cast an additional ring on top of the shaft, so that its top will be about 1 m (3') above the apron.



If a pulley system is to be constructed, then discuss with the villagers whether they would like a metal stand for their pulley or whether they can contribute to the construction of a traditional type of brick pillar pulley stand.

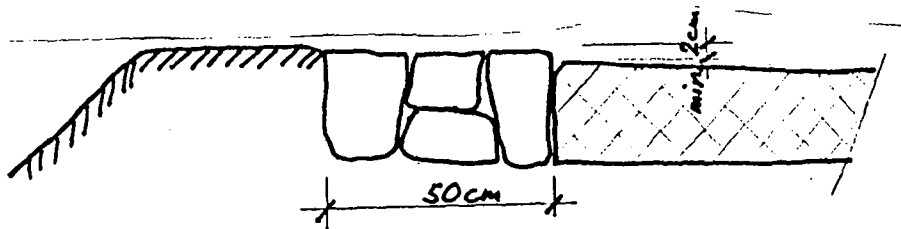
An example of a metal stand is given in the photograph on the right which shows a well built by SRTS in Chilaw district.

The metal pulley stand should be cast at least 30 cm into the apron and the ground below. Use good concrete with a mixture 1:2:3.

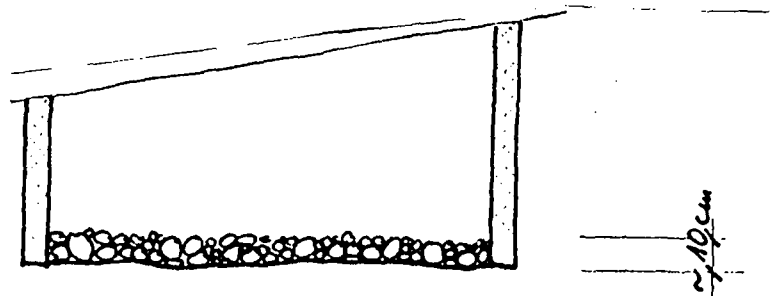


If a handpump is requested, consult the handpump manual (on the installation of the SL 5).

Place 50 cm of hardcore all around the apron. Place the stones at least 2 cm higher than the concrete.



Clean the bottom of the well out again and place a layer (about 10 cm) of metal or rubble on top of the soil.



Ask the villagers to plant a live fence around the apron and grass on the slopes.

