Construction of Hand-Dug Well

in rural villages in Sri Lanka

Helvetas

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Cover Photo
Hand-Dug Well in Matale Watte, Matale District
(by Sarvodaya Rural Technical Services)

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FOREWORD

It is with great pleasure that I am writing this message on the occasion of the publication of this manual which is the result of a joint effort of **HELVETAS** and **S**arvodaya **R**ural **T**echnical **S**ervices **(SRTS)**.

The improvement of health conditions of the rural community in Sri Lanka by providing pure drinking water and improving sanitation facilities is a vital task performed by the **SRTS**. A number of gravity water supply schemes, hand dug shallow wells and latrine projects have been constructed by **SRTS** in various districts through out the country during the past 15 years to achieve this objective.

In this exercise the **SRTS** personnel have worked not only as technical people but also as community development workers, using appropriate technology and suitable methodologies wherever it is necessary. It is commendable that the **SRTS** is now in a position not only to contribute to such an important manual through the vast experience they have gained during the last few years but also to provide the technical expertise to other NGOs who are involved in the rural water and sanitation sector in Sri Lanka.

In this connection our sincere thanks should go to our research partners from **HELVETAS**, Switzerland, who came with technological expertise, but gave the recognition to our own spiritual cultural resources that we were using in our movement. It should be stated that the contribution from **HELVETAS** financially as well as technically towards the **SRTS** activities should be highly appreciated.

Finally, I would like to give my thanks to everybody who made their valuable contribution towards the publication of this manual.

Dr..A. T. Ariyaratne,
Hon. President,
Lanka Jathika Sarvodaya Shramadana Sangamaya (Inc.)

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PREFACE

In 1978, a fruitful partnership commenced between the Sarvodaya Rural Technical Services (SRTS) and HELVETAS. In the beginning a small but motivated unit supported the Sarvodaya Shramadana Movement by providing training to young men and women in agriculture and artisan skills.

Initially SRTS was engaged mostly in the northern districts of Sri Lanka, but with increasing numbers of skilled staff its activities were successfully extended to the other parts of the island. Over the years there was a shift from training and agricultural activities towards more technical (rural infrastructure) projects. SRTS specialised in assisting the rural communities in improving the infrastructure of their villages through the construction of Gravity Water Supply Schemes, Hand-Dug Wells, Bridges, Culverts, Latrines etc.

The large number of similar projects implemented by SRTS made it advisable to standardize the design and construction procedures. The manuals and standard drawings which were consequently prepared by the senior SRTS staff together with the HELVETAS engineers reflect the experiences gained throughout the years.

In August 1991, HELVETAS decided to update and to revise all these technical papers with the broader aim to make them available not only to SRTS but also to other organisations, institutions or individuals interested and engaged in this field of work. As a result of these efforts the following manuals are now available:

- **"Construction of Latrines in Rural Villages in Sri Lanka"**
  (also available in Sinhala and Tamil)
- **"Construction of Hand-Dug Wells in Rural Villages in Sri Lanka"**
  (also available in Tamil and Sinhala)
- **"Design, Construction and Standardisation of Gravity Water Supply Systems in Rural Villages in Sri Lanka"**
  (available also in Sinhala)

It should be noted that these manuals are technical handbooks for those involved in the planning and construction of hand dug wells, gravity water supply systems and latrines. Other related aspects of such projects, like health education, participatory planning and involvement of the villagers in the construction phase or maintenance of completed projects are only touched or not discussed at all.

We are grateful to all who contributed to the completion of these manuals and would appreciate comments or suggestions for further improvements. For any inquiries you can contact our office under the following address:

HELVETAS, 15/2, Ekanayake Avenue, Nugegoda (Sri Lanka)
Tel. 01-85 24 54; Fax: 01-81 19 92

Nugegoda, March 1994

1 INTRODUCTION

The need for water is common to all living things. Human beings' health and well-being depend on an adequate water supply. Where water is inadequate, life is a struggle.

As it is/was not always possible to make use of the fresh water available naturally on the earth's surface, people started thousands of years ago to sink wells to tap underground water. In Sri Lanka people have long experience of sinking hand-dug wells to exploit ground water. But many of these "old" wells are unlined and unprotected holes which are liable to collapse and a constant danger to health due to polluted water. Today's wells are permanent, safe and hygienic and contribute towards improving the health of the users.

This manual briefly touches the health aspects and the theoretical part of the hydrologic cycle but concentrates mostly on practical information for well sinking in rural areas with a high degree of community participation. From our experiences in Sri Lanka we learned that community contribution of around 30% of the total cost (including over head costs) can be reasonably expected.

The techniques described in this manual combine traditional know-how with modern skills in such a way that those who do the work will not need a high degree of education. Nevertheless, the site supervisor (in charge of well construction) should have at least basic knowledge/experience as a mason.

In the first part of this manual we briefly discuss the health aspect of safe drinking water and some basic theories of the hydrologic cycle. Then you will find detailed information about the selection of a well site, types of wells and the actual construction of a well (including wellhead and apron). The last chapters cover the topic of improving existing wells, water lifting devices and operation and maintenance.

Detailed standard drawings of a wellhead and prefabricated concrete rings are attached to this manual in the Appendix.

The construction of hand-dug wells is recommended in all areas where gravity-fed water supply schemes are not feasible, e.g. most of the coastal belt, flat lands, dry zone, etc.

Water supply schemes which necessitate the use of pumps are hardly affordable in rural villages and are, therefore, not recommended. The design and construction of gravity fed water schemes are discussed in the manual:

- *Design, Construction and Standardisation of Gravity Water Supply Systems in Rural Villages in Sri Lanka*

The Appendix to this manual includes references and a bibliography for further reading.

2 HEALTH ASPECTS

As mentioned in the introduction to this manual, the need of water is common to all living things. Water was always considered to be very important for human beings but its importance to health is a more recent realization. During the last hundred years or so it was discovered that ***inadequate or contaminated water is an important reason for the spread of water-related diseases.***

2.1 WATER-RELATED DISEASES

Water-related diseases can be listed as follows:

- **Water-borne diseases** occur when a pathogen in water is drunk by a person who then becomes infected. Typical diseases are cholera and typhoid but also others such as infectious hepatitis, diarrhoea and dysentery.
- **Water-washed diseases** are directly related to domestic and personal hygiene and can be drastically reduced if ample water were available for washing and hygiene. Scabies, tropical ulcers and infantile diarrhoea are examples
- **Water-based diseases** are parasitic diseases, where the organism causing the sickness spends a part of its life cycle in an aquatic host, for example guinea worm or bilharzia (schistosomiasis).
- **Insect-vector diseases** are those which are spread by insects that breed in water, for example malaria, dengue, filaria.

Water-borne and water-based diseases can be drastically reduced by providing clean and safe drinking water.

Water-washed diseases can be prevented by providing sufficient water for domestic hygiene and personal washing.

Insect-vector diseases cannot be directly affected by the construction of a well, but there can be indirect effects like the cleaning up of infected areas around traditional water holes.

Class two and three of the above diseases can also be reduced/prevented by improved, safe disposal of excreta. Please refer to our manual *"Construction of Latrines in Rural Villages in Sri Lanka".*

While planning and constructing hand-dug wells with a community, it is important to emphasise hygiene education. The users of a well must be aware of the risks of contaminated water, the importance of safe excreta and waste disposal and their interrelation.

Obviously, a well can only benefit its users if it is designed and constructed in a way to protect the water from contamination and to allow easy maintenance. The technical details of the above will be dealt with in the remaining pages of this manual.

2.2 PREVENTING A WELL FROM BECOMING POLLUTED

Below we list the three routes through which a well can become polluted, and measures to prevent the contamination.

2.2.1 WELLHEAD

Rain and spillage water can easily enter an open well without a headwall. Additionally, the immediate surrounding of such a well is an ideal place for various organisms that carry infectious diseases. These organisms can be washed into the well and contaminate it or they can penetrate the skin of the users of the well. Attention has to be paid also to the use of contaminated buckets!

Solution: To exclude most of these hazards, a ***wellhead*** has to be constructed. A wellhead consists of two elements:

- ***Headwall*** rising sufficiently (min. 80 cm) above the apron. The thickness of the headwall should be narrow so as not to allow the users of the well to stand on it.
- ***Apron*** which is impervious and about 2m wide. The apron should slope away from the well in all directions and it has to be drained thus removing the surface (spillage) water to a place in the vicinity where it can be used, eg. vegetable garden, fields, etc. The apron has to resist a lot of wear and must, therefore, be carefully constructed to avoid any cracks that could decrease its effectiveness.

For more technical details about wellheads, please refer to chapter *6.5 Construction of Wellhead.*

The use of individual ropes and buckets bears another risk of polluting an open well. It can be avoided by fixing a bucket inside or near the well in a way that neither the rope nor the bucket come in contact with contaminated materials. Please refer to chapter *6.7 Water Lifting Devices* for more details.

Finally, a moveable cover will protect the well from dust and rubbish. A permanent cover can only be provided together with a handpump. Please refer to chapter *6.7 Water Lifting Devices* for more details.

2.2.2 WELL LINING

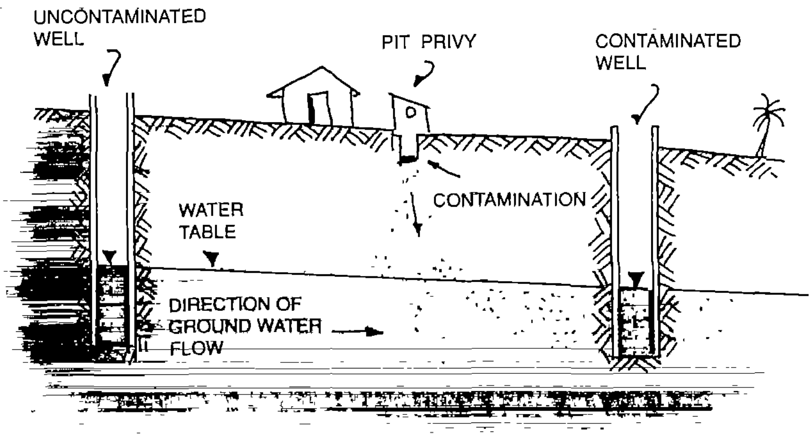
Seepage water from the surface may enter the well through the top few metres of the well lining if it is not watertight near the surface.

Solution: The lining of the well shaft has to be ***waterproof, at least the top 3m.*** Please refer to chapter *6.4 Lining of Well Shaft* for technical details.

2.2.3 INTAKE OF WATER INTO WELL

The ground water exploited by a well may become polluted before it reaches the ***intake of a well. This can happen because the well is located too close to pit latrines, soakaway pits or refuse dumps***, whose influence may extend up to about 20 m under normal soil conditions.

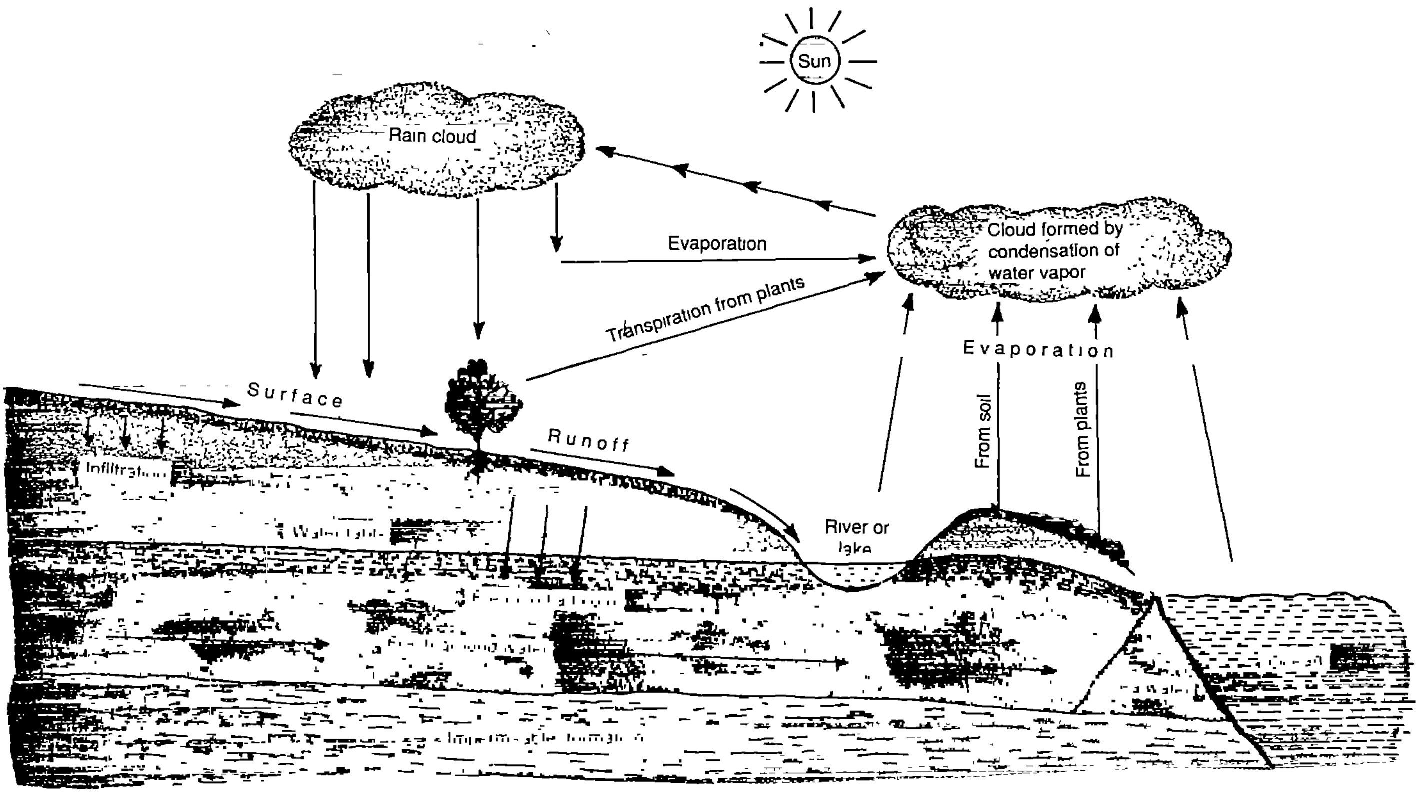
Solution: The only way to avoid polluted ground water is a careful selection of the location of a well. Please refer to chapter *4 Selection of Well Site.*



Contamination of well from pit latrine

3 HYDROLOGIC CYCLE AND GROUND WATER OCCURRENCE

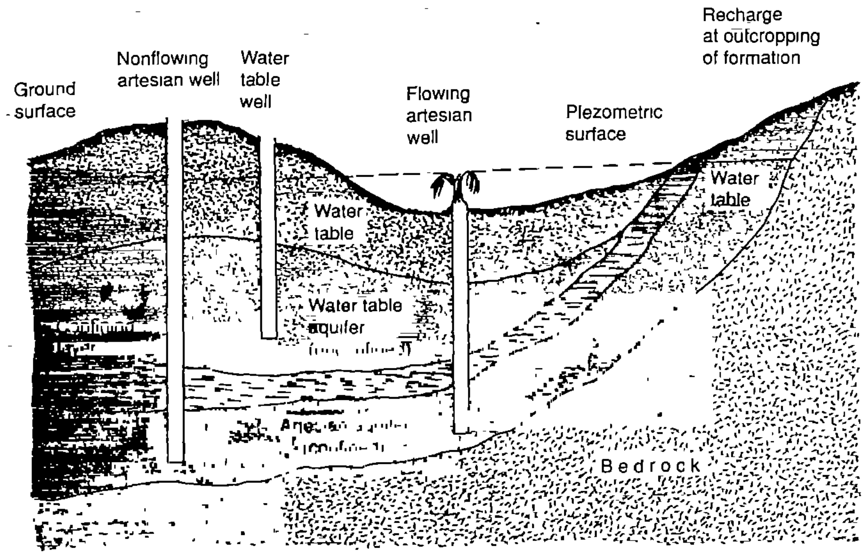
3.1 HYDROLOGIC CYCLE



The above drawing shows the ***hydrologic cycle*** which means the circulation of water in its liquid or vapour state. We will concentrate here on the parts of the hydrologic cycle that are of importance to a well-sinker.

Some of the rain falling to the earth evaporates. Some runs off in streams or rivers. Some infiltrates the ground and is used by vegetation or sinks below root level through porous soil until it reaches an impermeable layer. Under the force of gravity, the water finds its way downhill along the impermeable formation until it either emerges as springs or returns to the sea. It is this section of the hydrologic cycle, when the water is flowing through an ***aquifer***, (saturated porous soil layer that contains ground water) that is of importance to a well-sinker. In this stage water is called ***ground water*** and can be tapped by a well.

3.2 AQUIFERS

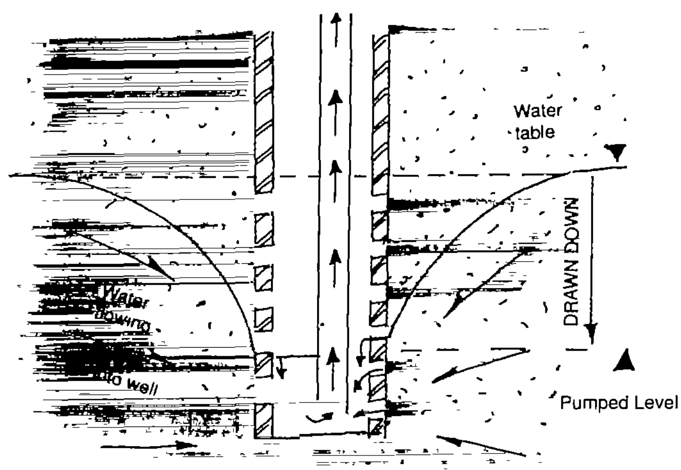


Types of Aquifers

From above drawing we can gain some basic information about different types of aquifers. If you want more information about this topic and details about ground water flow, please refer to the bibliography in the Appendix of this manual for further reading.

3.3 TAPPING GROUND WATER

Ground water can be tapped by digging a hole into the aquifer. This hole has to be lined to prevent it from collapsing. Through the porous lining or the bottom of the hole, water will flow into the hole (well) until the water level inside the well coincides with the surrounding water table. Once water is extracted from the well (by bucket for example) the water level inside the well will drop causing a difference between the internal and external water pressure and hence an inward flow through the porous lining or the bottom of the well.



Water flowing into Well

3.4 QUALITY OF GROUND WATER

As ground water flows through the aquifer there is a continuous filtering process going on. Most of the suspended particles will be removed by small pores in the aquifer. Therefore, ground water is usually clear, colourless and does not require any treatment. Even bacterial pathogenes will be eliminated from ground water after a certain distance of water flow through the aquifer, generally ***less than 30m!***
Very often, however, ground water is aggressive (corrosive) to metals and even concrete.

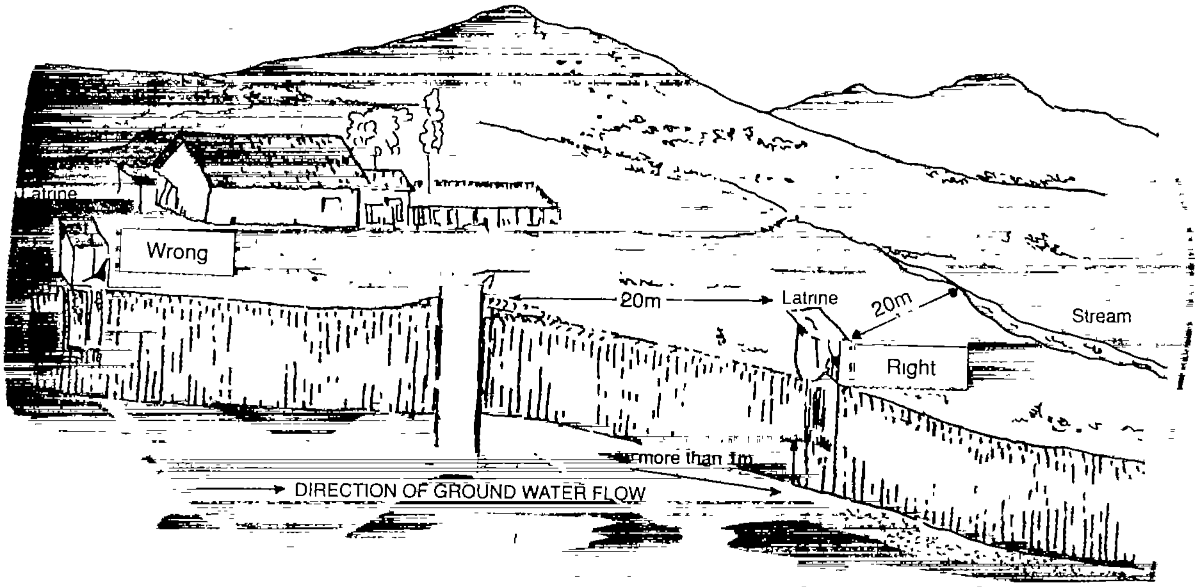
If there are any doubts about the quality of the ground water to be exploited, have the water tested in one of the existing laboratories in Sri Lanka rather than testing it with a test-kit on your own!

4 SELECTION OF WELL SITE

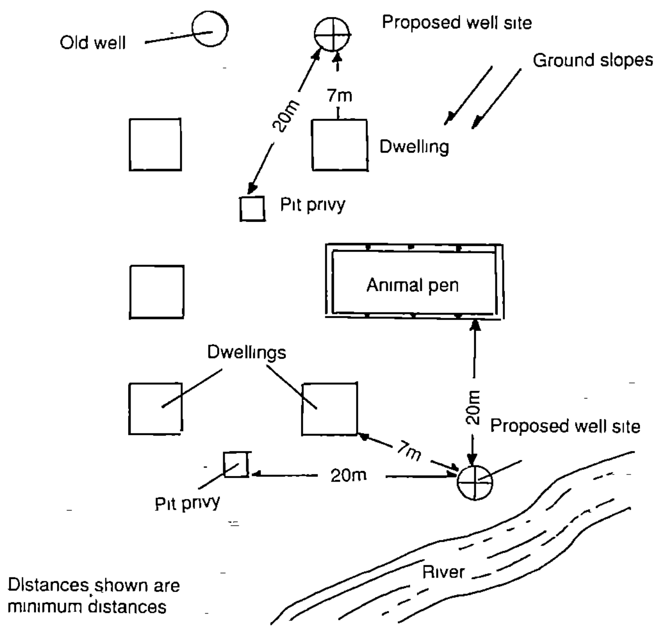
It is the local community, or users, who should decide upon the location of a well. In most of the rural villages in Sri Lanka there are people whose knowledge of the surrounding areas and its ground water is excellent. In rare cases, were there is no such local know-how available, professional advice should be asked for.

There are some basic rules to be kept in mind before deciding on a particular location for a well:

- Well must be above flood level of rivers or tanks.
- Drinking water wells should ***not*** be built in paddy fields (pollution by agro-chemicals).
- Free access to a well for all users must be guaranteed (in writing).
- Distance to the nearest possible source of pollution must be ***at least 20m*** in the direction of the ground water flow! Sources of pollution can be latrine pits, cattle sheds, drains etc.
- One well should serve ***at least 6 - 8 families***, with a maximum of 50 families!
- None of the users should have to walk more than ***250m*** to the nearest well.



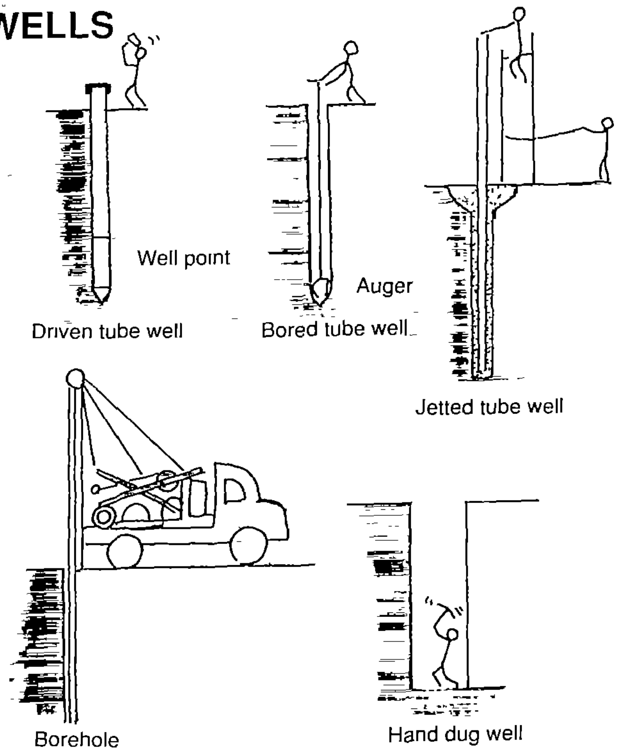
Location of Well Site



Location of Well Site
(Plan View)

5 GENERAL INFORMATION ABOUT WELLS

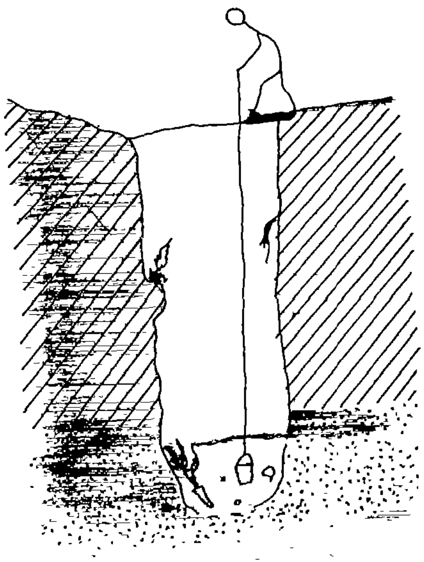
5.1 TYPES OF WELLS



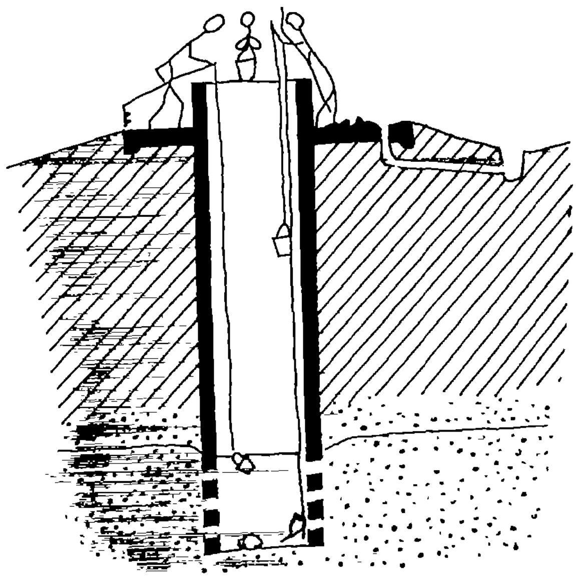
Types of Wells

We will concentrate on hand-dug wells only.

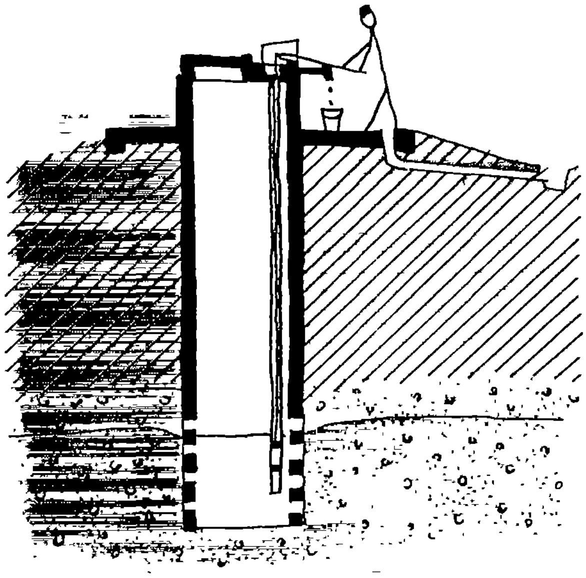
5.2 HAND-DUG WELLS



Type A
Unprotected, unlined open well



Type B
Lined and protected open well



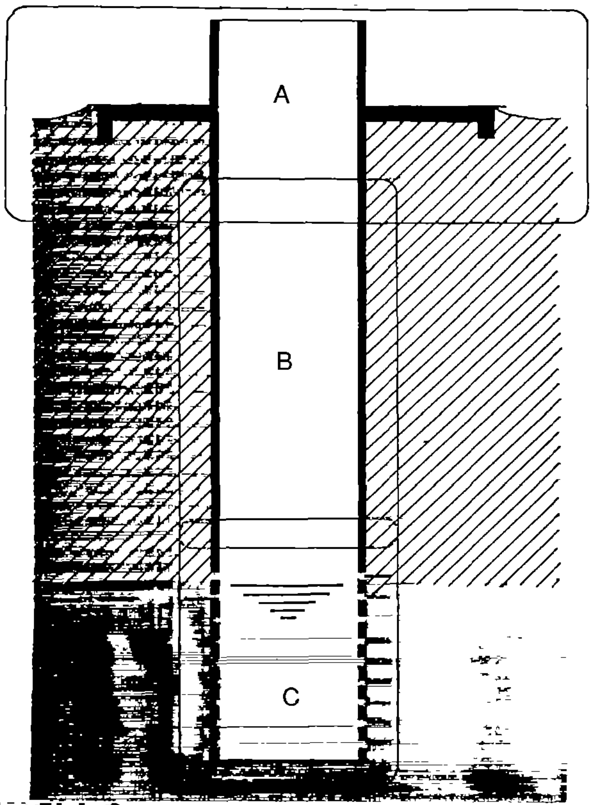
Type C
Protected well with handpump

Type A (unprotected, unlined open well) is not recommended because it is inferior and its water is very likely to be polluted.

Type C (protected well with hand pump) is the optimal solution. But experience shows that in Sri Lanka an open well is preferred to a sealed one. Moreover, the handpump is expensive and needs maintenance. ***Therefore, a handpump should not be installed unless arrangements have been made to maintain it.***

5.3 ELEMENTS OF A HAND-DUG WELL

A hand-dug well consists of the following elements:



A : **Wellhead**

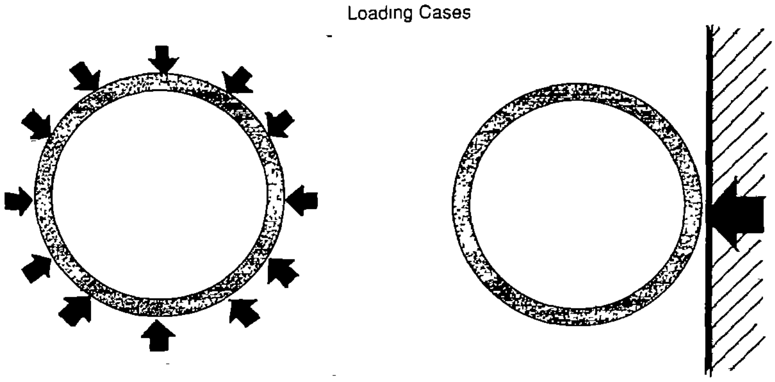
B : **Well Shaft**

C : **Well Intake**

5.4 DIMENSIONS OF HAND-DUG WELLS

Most of the traditional wells in Sri Lanka had a more or less circular shape. The reason for this is that a round well produces the greatest amount of water for the least amount of work. Additionally, a circle is the ideal shape for the lining of a well. In this manual we deal only with ***circular wells*** because they withstand best the external forces acting on the lining.

Loading Cases



Uniform Loading　　Concentrated Loading

The ***diameter*** of a well is determined by economic and practical consideration. The smaller the diameter of a well, the less soil will have to be excavated and the less material will be required to line the well. On the other hand, there should be enough space for the sinkers of a well:

- 0.90m is the minimum diameter for one worker
- 1.20m is the minimum diameter for two workers (who achieve more than one worker in two days).

Our recommendation is: **inner diameter = 1.20m**

Depth of a Hand-dug Well: Although there are cases where a well was sunk more than 120m it is usually considered that ***60m*** is the practical limit. For deep wells, deeper than ***40m***, some sort of ***ventilation*** is necessary to provide the sinkers of the well with enough oxygen!

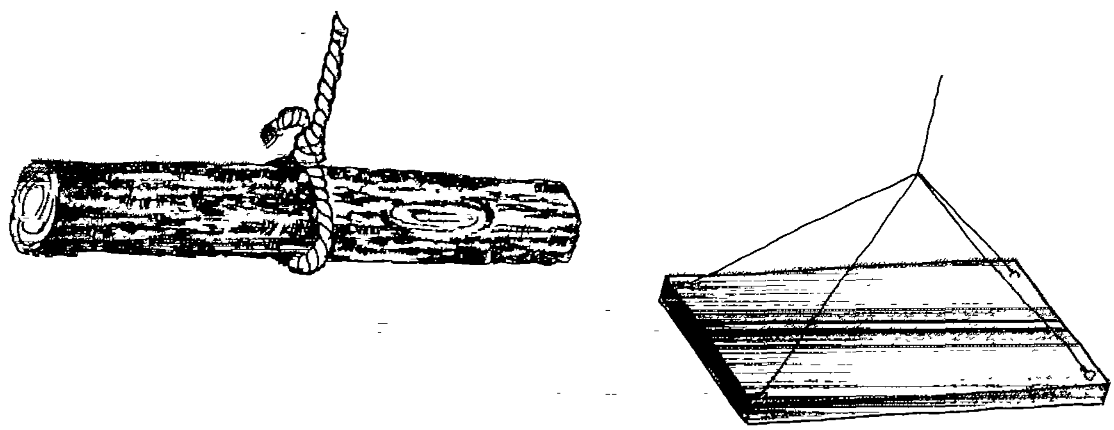
Do not lower a petrol or diesel driven pump down a well shaft unless you can guarantee adequate ventilation!

5.5 SAFETY MEASURES IN WELL CONSTRUCTION

The site supervisor who is in charge of the construction of a well should have some experience in the excavation of wells. He is then in a better position to prevent accidents!

The most common causes of accidents are poor equipment, material falling down the well shaft, collapse of the well and occasionally asphyxiation from gases. ***The deeper the well, the greater the risk of accidents***. The following is a list of safety rules that must be observed:

- Check all equipment regularly and thoroughly. Replace all faulty equipment immediately!
- Always work in teams, ***never work alone***. Whenever men are working in the well someone must be in close attendance at the top of the well.
- Keep an emergency escape ready all the time, e.g. ladder, rope-ladder, etc.
- Ensure a safe way of ascending and descending, e.g. on a bosum's chair.
- Prevent materials and people from falling into the well. Provide hand rails (fencing) and secure the area around the top of the well with planks or logs! Remove all loose equipment away from the well!
- It is not advisable to construct a well in lifts deeper than ***5m*** without a well lining unless the soil is very stable and the well sinkers are very experienced.
- Sometimes, in certain types of ground, gases may be released that can be dangerous to the sinkers. The local people should know about such a risk. ***The quality of the air can be tested by lowering a lighted candle.***
- As far as possible, safety helmets should always be worn down the well.



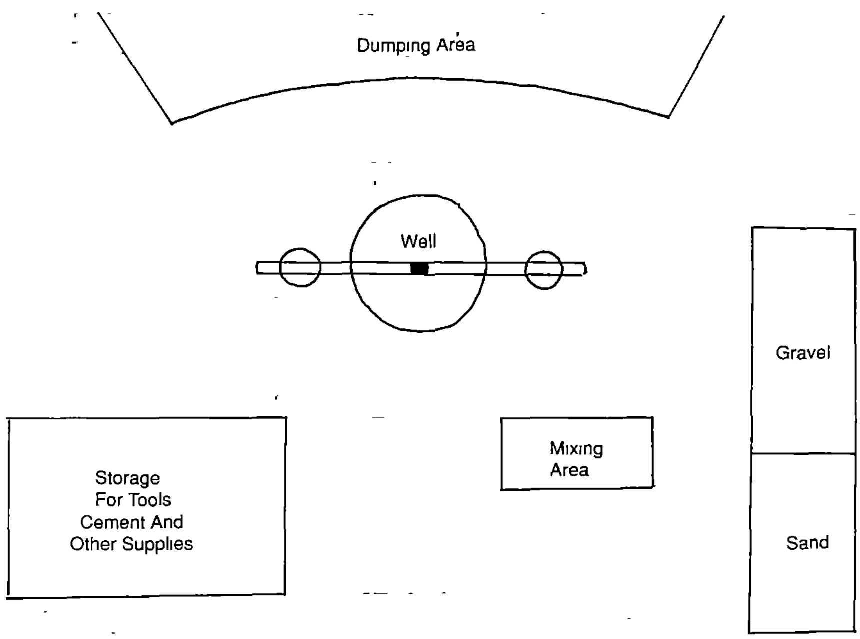
Possible Designs of Bosum's Chair

6 CONSTRUCTION OF HAND-DUG WELLS

6.1 PREPARATION OF WELL SITE

- **Cooperation with Local Community**: The future users of a well should be involved in the whole planning phase of a well project. But this manual concentrates mostly on technical matters and not on community development activities. A community project is different from an ordinary project done on a contract basis. The local community does most of the work itself with some outside assistance for materials and technical know-how which are not locally available.

- **Setting out of Working Space:** Once the users of a well have decided upon the location of a new well, a working space of about 15 m radius has to be cleared around the well. Roughly level the ground and mark out areas for the different activities according to the sketch below:

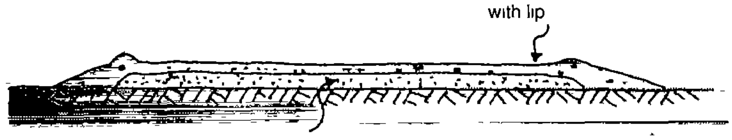


Organisation of Well Site

A good setting out of the working area ensures that there is enough working space for each operation and that no one stage of work hampers another. ***It also prevents accidents!***

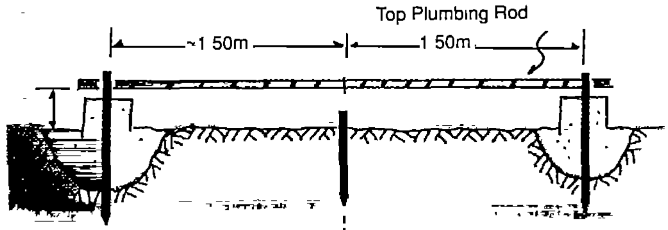
- **Checking of Materials and Equipment**: Before you start any work on the well ensure that all necessary equipment is readily available and that enough materials were collected and stored properly at the correct place according to the sketch above.

- **Casting the Mixing Slab**: A slab for mixing mortar and concrete has to be constructed about 3m away from the well. Level off an area of about 4m2, remove grass and vegetation and cover the area with a tamped gravel layer with a thickness of 5cm. Spread cement mortar 1 : 4 (1 part cement to 4 parts sand) over the gravel and make a smooth finish. Form a lip around the edge to prevent the loss of slurry (see sketch below). As an alternative to a mixing slab, you can make use of GI sheets.



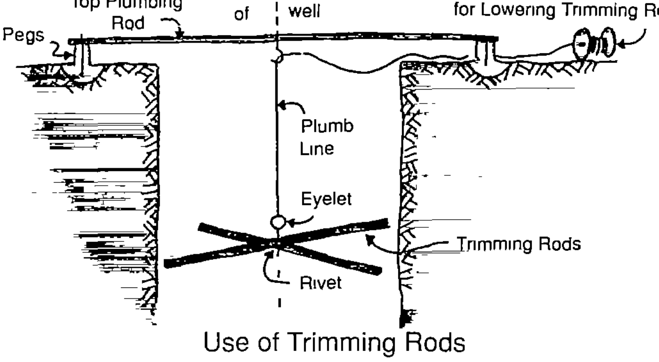
Casting the Mixing Slab

– **Centring the Well**: It is useful to fix a ***Centre Point (CP)*** before you start digging. As soon as you start with the excavation, the CP will, of course, be lost. It is, therefore, necessary to fix ***two offset (permanent) pegs*** outside of the excavation. With the help of these permanent pegs it is always possible to reconstruct the CP and to use it to keep the well truly vertical. The permanent pegs should be placed far enough from the well so that the excavation works are not obstructed, but close enough to be of easy use.



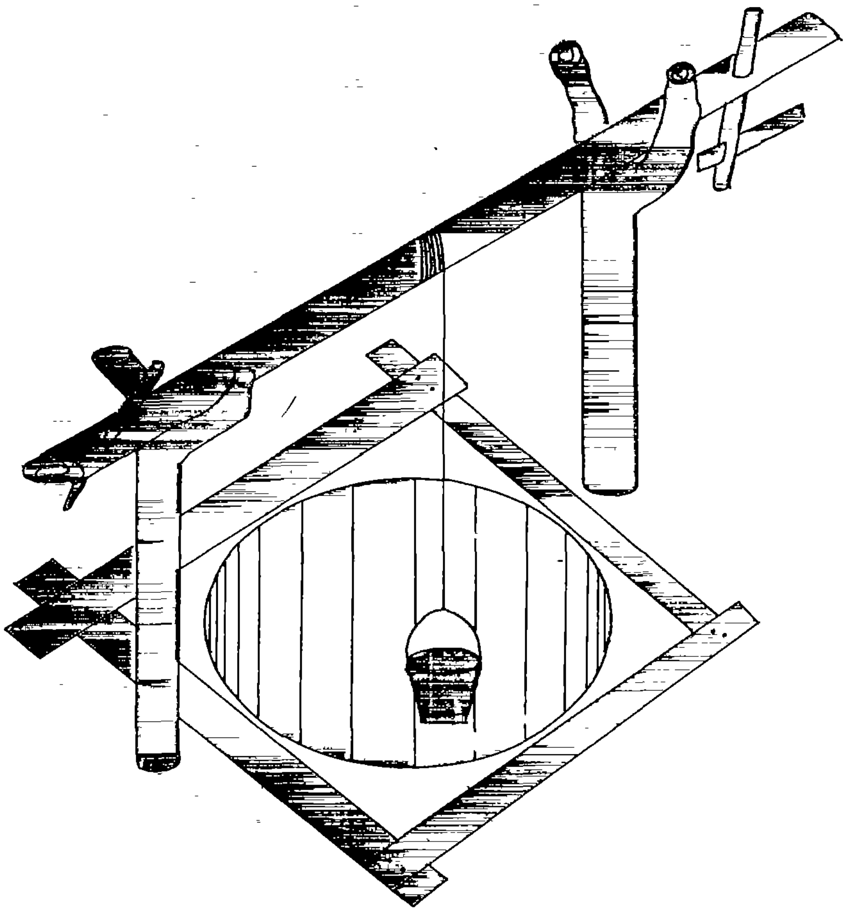
Fixing of Offset (permanent) Pegs

In case a tripod is used during the construction of the well, make sure that the centre point is exactly beneath the headsheave pulley of the tripod. Use a plumb bob to check it! ***The CP is important to keep the well truly vertical.*** To check whether the well shaft is being excavated correctly, fix a set of trimming rods to the plumb line and lower them into the well. The ***trimming rods*** can be made of timber, or even better of reinforcement rods (15mm dia.). They have to be riveted together exactly in the centre sufficiently loosely to enable them to be opened out into a cross during use, or folded together for storage at other times. A hook or eyelet attached to the rivet enables them to hang from a plumb line. As the diameter of the excavated well shaft is 1.80m a convenient ***length of the trimming rods will be 1.75m.*** This means that when you lower the trimming rods into the well and turn them on the plumbing line there should be a small gap of 2.5cm between the end of a rod and the well shaft. See drawing below.



Use of Trimming Rods

Installation of Simple Pulley: If no tripod is available, a simple pulley should be installed. See the sketch below for an example:



Simple Pulley

6.2 EXCAVATION OF WELL SHAFT

6.2.1 GENERAL REMARKS

Excavate a well during the dry season!

There are different techniques of excavating a well:

1. The whole well is excavated to its full depth and then lined either with precast concrete rings or with in-situ cast concrete rings.
2. The well shaft is excavated down to the water table and then lined. The soil of the aquifer is excavated inside a caisson which is lowered down the lined well shaft.
3. The well is excavated and lined in lifts of up to 5 m. The second lift is started only after the first lift is lined.
4. The diameter of the excavated well is much bigger than the lined well which allows to cast the lining in-situ with an inner and outer formwork.

5. The diameter of the excavated well is slightly bigger than the lined well and the lining is cast in-situ against the ground and an inner formwork only.

Most of the above techniques can be combined. In this manual we concentrate on a combination of techniques one and four.

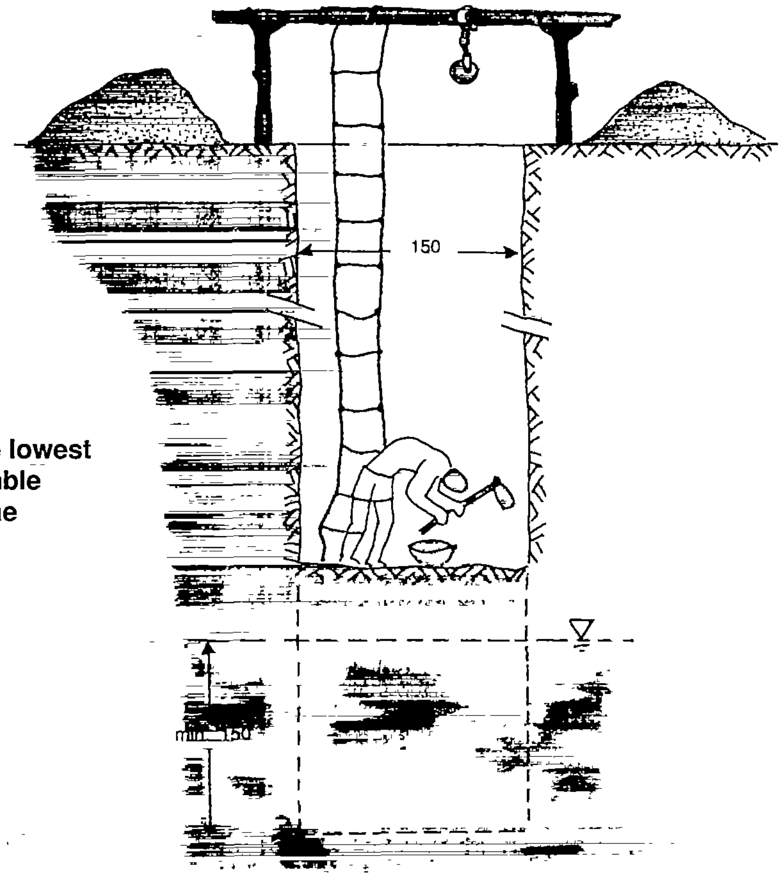
6.2.2 EXCAVATION OF WELL IN HARD, STABLE SOIL

Hard, stable ground is the most common soil condition in Sri Lanka. Nearly all the traditional wells (unprotected and unlined) were constructed in this type of soil. Therefore, in most villages in Sri Lanka, the know-how of excavating a well shaft in hard, stable soil is readily available. ***Only when such local know-how is available and where the soil is really stable should the following procedures be followed:***

The future well users excavate the well shaft without any assistance according to the following dimensions:

diameter = 1.80m

depth = at least 1.50m deeper than the lowest ground water table (at the end of the dry season)



Use a pump to remove the inflowing water when the excavation reaches the ground water table. Once the excavation work is completed the lining of the well can be started (refer to chapter *6.4 Lining of Well Shaft*).

In case local know-how is not available or the soil is questionable (danger of collapse) refer to chapter *6.2.3. Excavation of Well in Semi Hard Soil* for more information.

For the excavation of a well shaft in loose soil, please refer to chapter *6.2.5. Excavation of Well in Soft Soil or Sand.*

6.2.3 EXCAVATION OF WELL IN SEMI HARD SOIL

In case the soil condition does not allow the well shaft to be dug down to the aquifer without collapsing, ***then the well shaft has to be supported with shuttering.*** Again, there is widespread expertise available in Sri Lanka. Traditional well sinkers have been using the techniques of shuttering for hundreds of years. In Sri Lanka shuttering is also widely used by gem miners.

As for excavating a well in hard soil, local communities need hardly any assistance in excavating a well in semi hard soil. Nevertheless, the site supervisor has to make sure that the spacing between the supporting beams of the shuttering allows the lowering of the well moulds and other materials necessary for the lining of the well. Use a pump to remove the inflowing water when the excavation reaches the ground water table. Be careful not to over-pump, or caving will take place, putting great stress on the shuttering. The dimensions of the well shaft are the same as in hard soil:

diameter	=	**1.80m**
depth	=	**at least 1.50m deeper than the lowest ground water table (at the end of the dry season)**

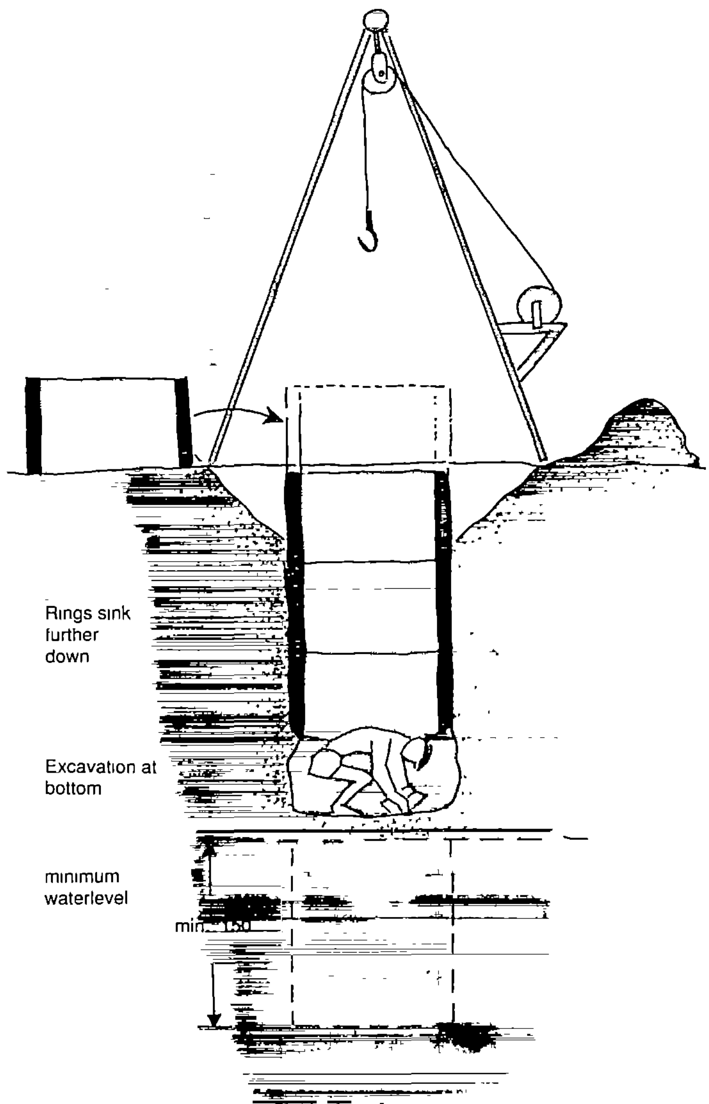
6.2.4 EXCAVATION OF WELL IN ROCK

In case you encounter rock (not boulders) while sinking a well, only continue when you are sure to reach an aquifer beneath the rock layer. It is possible, but very hard work, to penetrate such a strata by traditional methods. In the past, well sinkers used to break up hard rock by lighting fires on the surface of the rock layer. Then, they poured cold water on the hot surface to split and crack the rock by a rapid change of temperature.

Nowadays, it is more common to use explosives or compressed air tools, both of which are outside the immediate scope of this manual.

6.2.5 EXCAVATION OF WELL IN SOFT SOIL OR SAND

If the soil is very soft or sandy, a completely different technique of excavating a well has to be applied. As it is not possible to dig a hole deeper than 50cm without collapsing, a continuous lining has to be provided. The most efficient way to do this, is to dig the well inside self-sinking concrete rings. The following drawing gives you an idea about this particular technique:



Excavating a Well in Soft Soil or Sand

Step by step instructions:

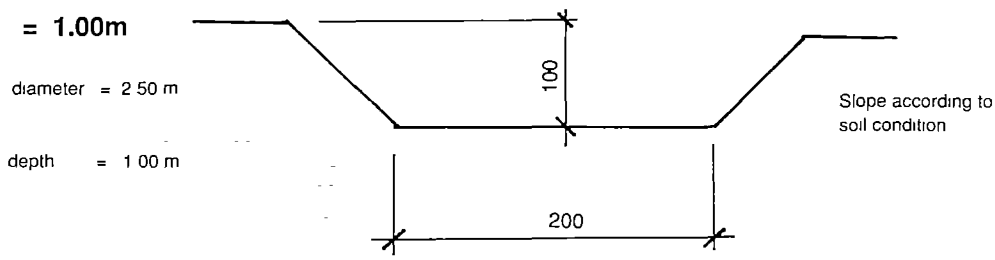
1. Be sure that a cutting ring is ready. Refer to chapter *6.4.3. Casting of a Cutting Ring.*

2. Excavate a pit of the following size:

Section of Pit

diameter = 2.50m

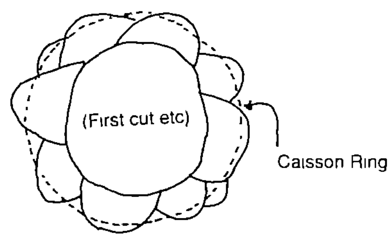
depth = 1.00m



3. Place the cutting ring in the centre of the excavated pit with the ***cutting edges downward.***

4. Start to excavate ***inside*** the ring according to the following procedure:

   – A hole is dug in the centre of the ring.
   – Cut back in layers all around the sides towards the ring. ***Take care*** with this excavation as digging away too much on one side may cause the well shaft (lining) to sink out of line.
     The lining will sink slowly under its own weight!
   – Let the ring sink until the top of the ring almost reaches the ground level (about 10 cm should still be visible).



Sequence of Cutting

5. Clean the top of the cutting ring. Than, either cast a ***filter ring in-situ*** or place a ***precast filter ring*** on top of the cutting ring. Please refer to chapter *6.4.4.1 In-Situ Casting of a Filter Ring* or to *6.4.4.2 Precasting of a Filter Ring.*

6. Clean the top of the ring.

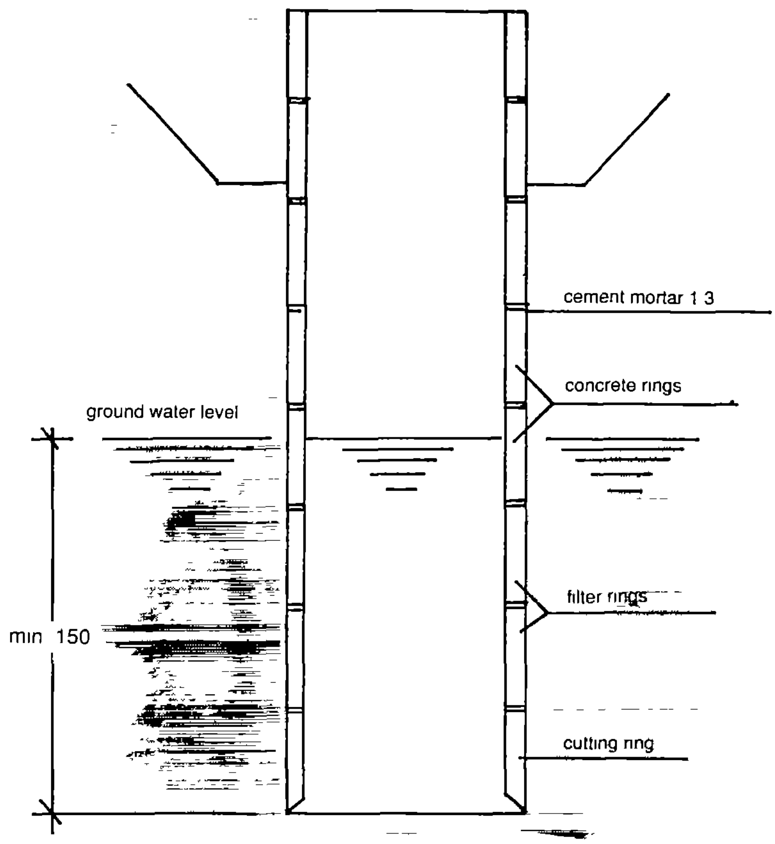
7. Repeat steps 4,5 and 6.

8. Pour a ***layer of mortar*** 1 : 3 on top of the last ring.

9. Either cast a concrete ring in-situ or place a precast concrete ring into the mortar layer. Please refer to chapter *6.4.2.1 In-Situ Casting of Concrete Rings* or to *6.4.2.2 Precasting of Concrete Rings.*

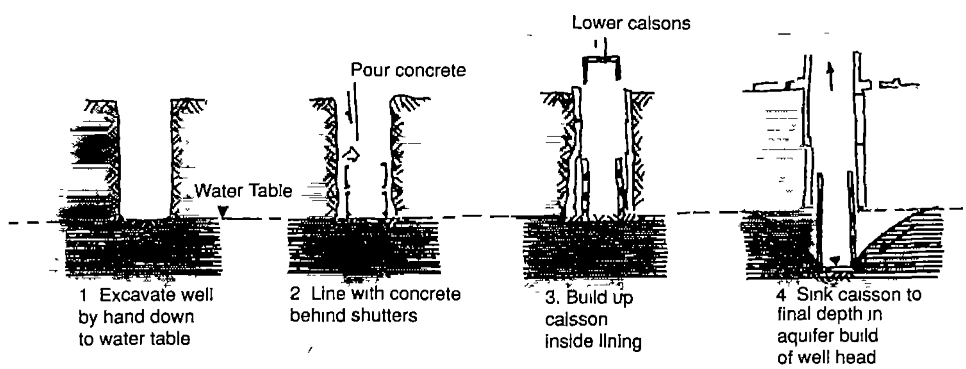
10. Repeat steps 4,6,8 and 9 until the bottom of the well reaches a level that is at ***least 1.50m*** below the lowest ground water table (dry season). See sketch next page:

11. Backfill the excavated pit and construct ***the apron. Do not forget the connecting rods!*** For the construction of the apron please refer to chapter *6.5 Construction of Wellhead.*



6.2.6 EXCAVATION OF WELL WITH CAISSONING

This technique is used in case the soil of the intake or the part of the shaft that lies within the aquifer is not stable enough. First the well shaft is excavated down to the water table and then lined. In a second step, a caisson is lowered inside the lined shaft and excavation of the soil within the aquifer is done inside the caisson. See drawing below.



Excavation of Well with Caissoning

6.3 CONSTRUCTION OF INTAKE

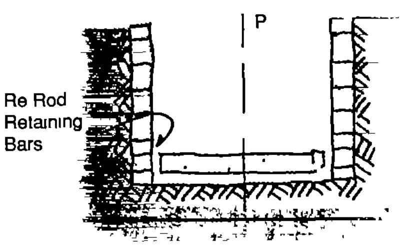
Once the excavation of the well is completed you can start to construct the intake. Be very careful as it is through the intake that water is flowing into the well. A well constructed intake will ensure a continuous flow of water and will prevent the silting up of the well.

Step by step instructions:

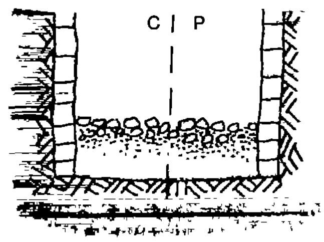
1 Lower and place a ***precast guiding-ring***. Please refer to chapter *6.4.5 Precasting of a Guiding-Ring.*

2. ***Take great care to level and plumb the guiding-ring!***

3. Construct the ***base plug***. The base plug prevents the aquifer material from flowing up into the well. The plug can be made of porous concrete or from layers of sand and gravel:

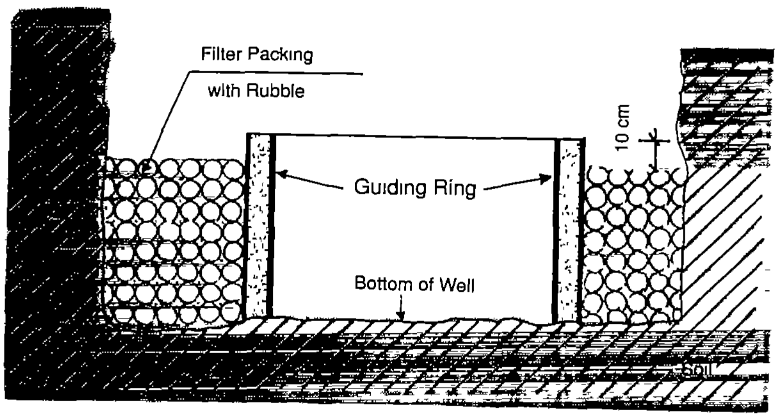


Porous Concrete: Use concrete 1 : 4 (one part cement/four parts gravel/ ***no*** sand) Re-rods retaining bars are optional.
d ≈ 5cm



Graded Aggregate: Use first sand and then increase the size of the aggregate. You can even place a thin, porous concrete slab on top.
d ≈ 20cm

4. Backfill the space between the soil and the concrete ring with rubble up to about 10cm below the top of the ring. This backfilling acts as a filter.



Section through Bottom of Well

5. Clean the top of the ring.

6. Either cast a ***filter ring in-situ*** or place a ***precast filter ring*** on top of the last ring. Please refer to chapter *6.4.4.1 In-Situ Casting of a Filter Ring* or to *6.4.4.2 Precasting of a Filter Ring.*

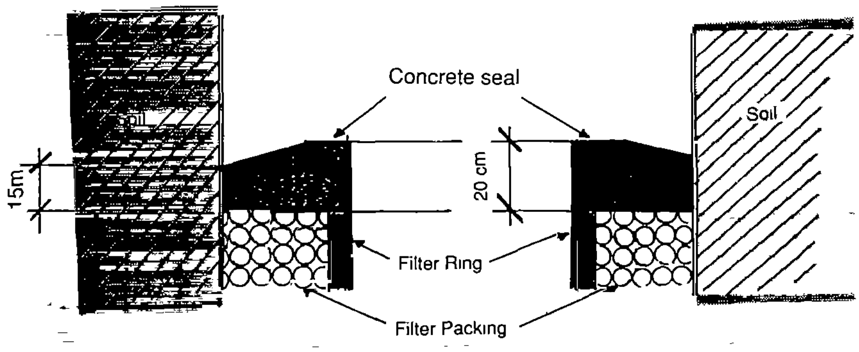
7. Repeat steps 4,5 and 6.

8. If necessary, add one or two filter rings.

9. Clean the surface of the filter packing and the top of the last filter ring.

10. Seal the top of the filter packing (incl. filter ring) with a concrete layer(mixture 1 : 2 : 3). Use the inner well mould as formwork!

The top of the seal has to be smoothed and should be allowed to set for one day before you continue.



Section through Concrete Seal

6.4 LINING OF WELL SHAFT

6.4.1 GENERAL REMARKS

As soon as the construction of the intake of a well is completed (incl. sealing), the well shaft has to be lined. There are various methods of lining a well:

- In-situ casting of concrete rings
- Placing of precast concrete rings
- In-situ casting of a concrete lining against the soil and an inner formwork.
- Lining with self sinking concrete rings, etc.

In the following chapters we will discuss above methods.

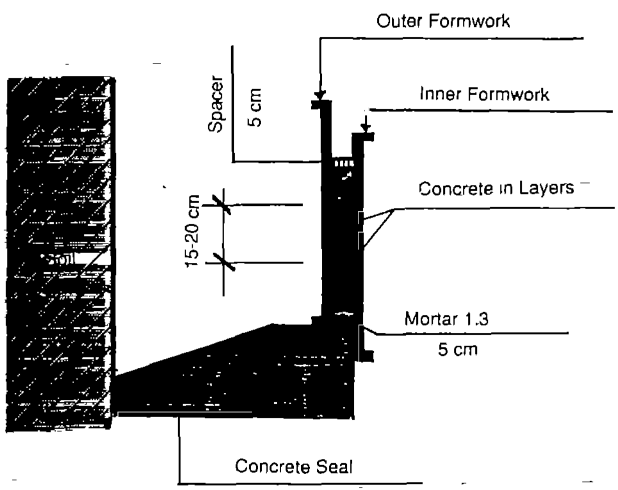
6.4.2 CASTING OF CONCRETE RINGS

6.4.2.1 In - Situ Casting of Concrete Rings

Please refer to the Appendix for the ***standard drawing no. W - 1.***

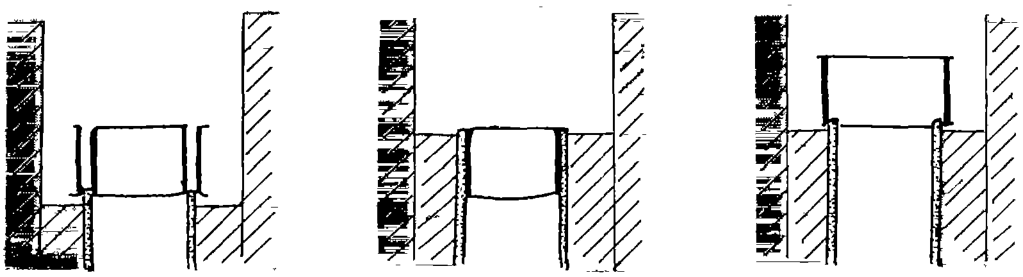
Step by step instructions:

1. Clean the top of the sealing of the intake.
2. Fix the inner formwork to the inner side of the concrete seal. Plumb and level it.
3. Fix the outer formwork so that the thickness of the concrete ring will be 5cm. Be sure to plumb and level it. Prefabricated spacers can help you to get an equal distance between the inner and outer formwork.



4. Pour a layer of stiff-plastic mortar 1 : 3 with a thickness of about 2 - 3cm into the formwork (all around the well shaft).
5. Fill the formwork with stiff-plastic concrete 1 : 2 : 3 in layers of 15 - 20cm and vibrate each layer well before pouring the next one. ***Do not add too much water!*** This could create pockets of metal.
6. ***Let the concrete set for one day.***
7. Remove the outer formwork and backfill with excavated soil in ***layers of 20 - 30cm*** (well compacted) before removing the inner formwork. If pockets of metal (honeycombs) occur, wash the pockets and fill the voids with fine cement mortar.
8. After removing the inner formwork ***clean and oil the inner and outer formwork.***
9. Place and fix the outer formwork. Level and plumb it and also fix the inner formwork. Check the distance between the formworks (5cm).
10. Repeat steps 4, 5, 6, 7, 8 and 9 until you reach about ground level.

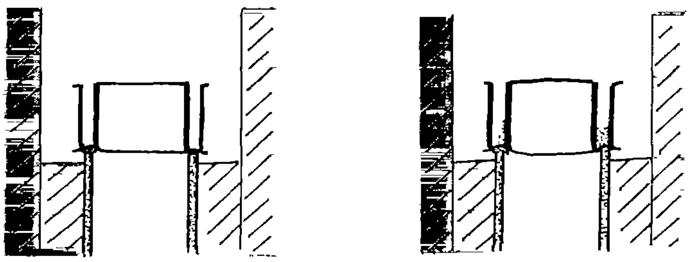
Sequence of forming and casting in-Situ of Concrete Rings



1 Cast Concrete Ring

2. Remove outer Formwork and backfill

3 Remove inner Formwork and place outer Formwork again
Outer always first !



4. Place inner Formwork again

5. Cast next Concrete Ring

6.4.2.2 Precasting of Concrete Rings

Please refer to the Appendix for the ***standard drawing no. W - 1.***

Cast the rings as far in advance of need as possible (setting and curing)!

Step by step instructions:

1. Prepare a flat surface near the well and cast a working slab in the same way as you did for the mixing slab (***see 6.1 Preparation of Well Site***). The size of the slab depends on the number of well moulds available. Remember that you can only ***remove the formwork after one day at the earliest*** and that you ***must not move the ring for three days***. Therefore, the working slab has to serve as a workspace but also as a curing area.
2. Assemble the inner formwork. Level and plumb it. ***Do not forget to oil the inner and outer formwork!***
3. Place and fix the reinforcement bars according to the standard drawing. The re-rods will give enough strength to a precast ring to be moved and lowered down the well.
4. Assemble the outer formwork. Use prefabricated spacers to get an equal distance of 5cm between the inner and outer formwork.
5. Fill the formwork with stiff-plastic concrete 1 : 2 : 3 in layers of 15 - 20cm and vibrate each layer well before pouring the next one. ***Do not add too much water!*** This could create pockets of metal (honeycombs). Smooth the top of the ring with a trowel and scratch the date of casting into the trowelled surface.

6. ***Let the concrete set for at least one day.***
7. Remove the formwork carefully and ***do not move the ring for at least three more days.*** The fresh concrete has to be protected from sunlight and ***kept wet (curing)*** by covering it with wet sacking or leaves for ***one week*** (minimum).
8. After curing, the concrete ring is ready to be lowered into the well. Roll the ring that was cast first (date scratched into it) to the side of the well and fix it carefully to the hook of the ***tripod.*** Remember that the weight of one concrete ring is about 240kg which makes the use of a tripod absolutely necessary.
9. Place some logs or planks across the open well shaft, lift the precast concrete ring carefully and manoeuvre it centrally over the well shaft until it is in the correct position supported by the logs or planks.
10. Raise the ring a few centimetres and remove the logs or planks before you lower the ring very slowly down the well shaft.
11. Place the ring into the correct position.
Do not forget the mortar layer for the joints between the rings!

6.4.3 CASTING OF A CUTTING RING

In chapter *6.2.5 Excavation of Well in Soft Soil* or *Sand* you were asked to use a ***cutting ring.*** Below you will find detailed instructions on how to cast a *cutting ring.* Please refer to the Appendix for the ***standard drawing no. W - 3.***

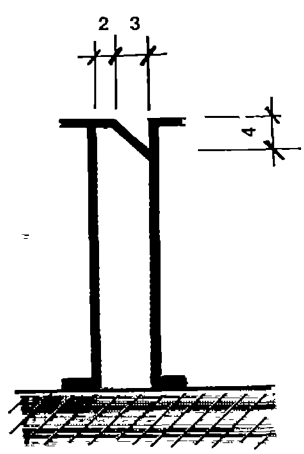
Cast the cutting ring as much in advance of need as possible!

Step by step instructions:

1. Assemble the inner formwork on the working slab (see step one of precasting of concrete rings) and level and plumb it. ***Oil the inner and outer formwork!***
2. Place and fix the reinforcement bars according to the standard drawing. The re-rods will give the ring enough strength to be moved and lowered down the well.
3. Assemble the outer formwork. Use prefabricated spacers to get an equal distance of 5cm between the inner and outer formwork.
4. Fill the formwork with stiff-plastic concrete 1 : 2 : 3 in layers of 15 - 20cm and vibrate each layer well before pouring the next one. ***Do not add too much water!***
5. Bevel the top of the cutting ring according to the sketch on the right.

   Note: The cutting ring is cast upside down and you have to turn it around before use.

6. ***Let the concrete set for one day!***
7. Remove the formwork carefully and ***do not move the cutting ring for at least three more days!***
8. Protect the fresh concrete from sunlight and keep the ring wet by covering it with wet sacking or leaves for ***one week.***



Detail of Cutting Ring

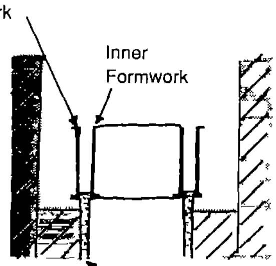
6.4.4 CASTING OF A FILTER RING

The ground water contained in the aquifer enters the well through the bottom of the well and through the lining. To allow this to happen the lowest part of the well lining has to be made porous by using so-called filter rings.

6.4.4.1 In - Situ Casting of a Filter Ring

Please refer to the Appendix for the ***standard drawing no. W - 2.***

Step by step instructions:



1. Once the cutting or guiding ring is set, clean the top of the ring and fix the outer formwork. Remember that the inner and outer formwork have to be ***oiled*** before use. Then place and fix the inner formwork. Use prefabricated spacers to get an equal distance between the formworks. Level and plumb the formwork!
2. Pour a layer of stiff-plastic mortar 1 : 3 with a thickness of 2 - 3cm into the formwork.
3. Fill the formwork with stiff-plastic ***filter concrete 1 : 4*** (one part cement/four parts gravel/***no*** sand) in layers of 15 - 20cm and tamp it.
4. Let the filter ring set for one day.
5. Remove the formwork and oil it.

6.4.4.2 Precasting of a Filter Ring

Please refer to the Appendix for ***standard drawing no. W - 2.***

Cast the filter rings as far in advance of need as possible.

Step by step instructions:

1. Assemble the inner formwork on the working slab (*refer to chapter 6.4.2.2 Precasting of Concrete Rings, step 1*) Remember to oil the inner and outer formwork before use.
2. Place and fix the reinforcement bars according to the standard drawing. The reinforcement will give enough strength to a precast ring to be moved and lowered down the well.
3. Assemble the outer formwork. Use prefabricated spacers to get an equal distance between the inner and outer formwork.
4. Fill the formwork with stiff-plastic ***filter concrete 1 : 4*** (cement:gravel) in layers of 15 - 20cm and tamp it.
5. Let the filter ring set for ***at least one day.***

6. Remove the formwork carefully and ***do not move the filter ring for at least five more days.*** The fresh concrete has to be protected from sunlight and ***kept wet (curing)*** by covering it with wet sacking or leaves for ***one week.***
7. After curing, the filter ring is ready for use.

6.4.5 PRECASTING OF A GUIDING RING

In chapter *6.3 Construction of Intake* you were asked to use a ***guiding ring***. It is important that such a ***guiding ring is cast very accurately*** because it will be used as the first ring of the well lining and thus determines the plumbness of the shaft.

Please refer to the Appendix for the ***standard drawing no. W - 4.***

Step by step instructions:

1. Assemble the inner formwork on the working slab (refer to chapter *6.4.2.2 Precasting of Concrete Rings, step 1*). Level and plumb it carefully. Remember to oil the inner and outer formwork before use.
2. Place and fix the reinforcement bars according to the standard drawing. The reinforcement will give enough strength to a precast guiding ring to be moved and lowered down the well.
3. Assemble the outer formwork. Use prefabricated spacers to get an equal distance between the inner and outer formwork. Take care to construct the guiding ring ***very accurately.***
4. Fill the formwork with stiff-plastic concrete 1 : 2 : 3 in two layers of 15cm each. ***Do not add too much water!*** Vibrate each layer well.
5. ***Let the concrete set for one day.***
6. Remove the formwork carefully and ***do not move the guiding ring for at least five more days***. The fresh concrete has to be protected from sunlight and ***kept wet (curing)*** by covering it with wet sacking or leaves for ***one week.***
7. After curing, the guiding ring is ready for use. ***Take great care to level and plumb the guiding ring*** once it is placed at the bottom of the well.

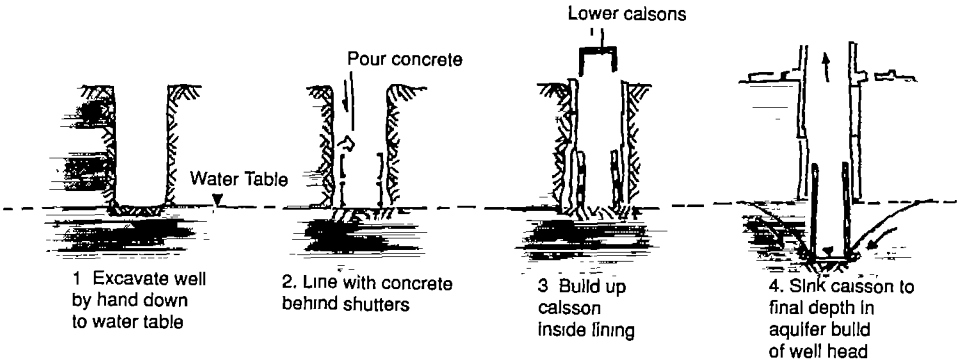
6.4.6 OTHER METHODS

There are more possibilities and methods of how to sink and line hand-dug wells. Below we will briefly suggest alternative methods to those explained in detail earlier in this chapter.

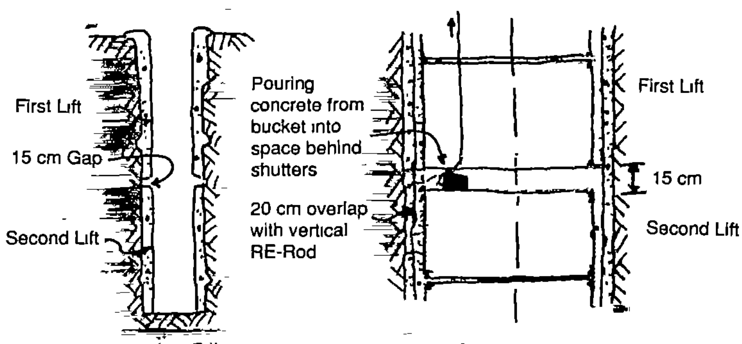
– **<u>Dig-Down-Build-Up and Caissoning</u>**

  See chapter *6.2.6 Excavation of Well with Caissoning.*

  The excavation of the well can be done in lifts with a ***maximum of 5m*** each. The lining is cast against an inner formwork and the ground.



Dig-Down-Build-Up and Caissoning



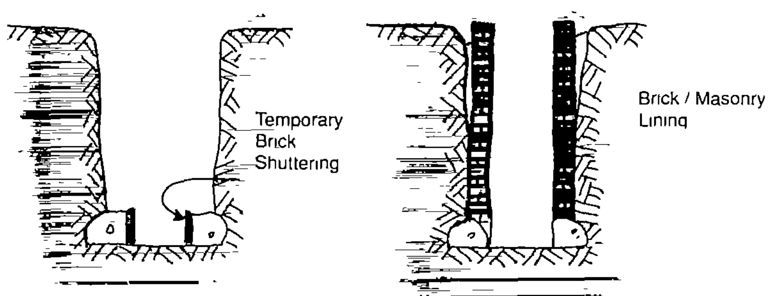
Pouring of Second Lift

- **Dig a Metre, Pour a Metre**

  In very soft soils it is not possible to dig more than one metre without the wall covering in. Under such conditions it is most likely that you use the technique discussed in chapter *6.2.4 Excavation of Well in Soft Soil or Sand.* An alternative is to dig one metre and than line one metre. This method is similar to the above technique of Dig-Down-Build-Up and Caissoning. The only difference is, that the lifts are much shorter: only one metre.

- **Lining with Bricks or Rubble Masonry**

  Instead of concrete rings, you could use bricks or rubble masonry to construct the lining of a hand-dug well. But brickwork and masonry are very weak under tension and the stresses built up by collapsing earth sides can often fracture the linings. Moreover it is difficult to make brickwork and masonry watertight which is important, at least for the top three metres. We, therefore, ***do not recommend this method.***



Lining with Bricks

6.5 CONSTRUCTION OF WELLHEAD

The wellhead consists of two elements:

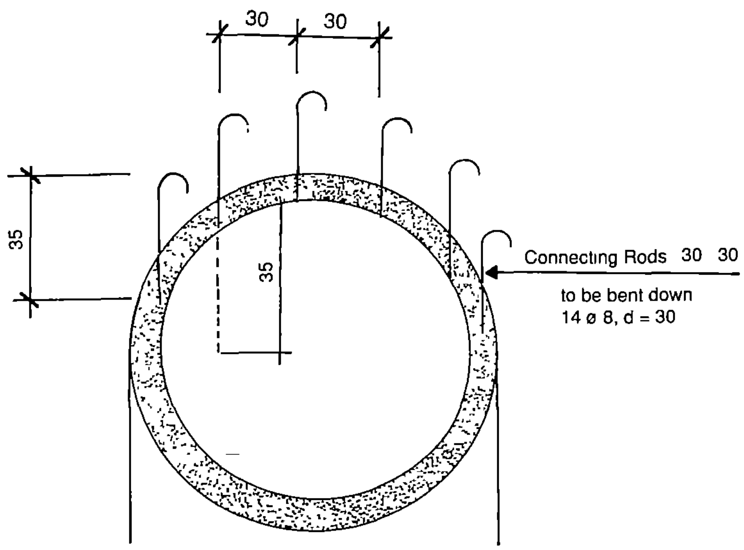
- **Headwall** rising sufficiently (min. 80cm) above the apron. The thickness of the headwall should be as narrow as not to allow the users of the well to stand on it.
- **Apron** which is impervious and about 2m wide. The apron should slope away from the well in all directions and it has to be drained, thus removing the surface water to a place in the vicinity where it can be used for irrigation. The apron has to resist a lot of wear and must, therefore, be carefully constructed to avoid any cracks that could decrease its effectiveness.

Please refer to the Appendix for the ***standard drawing no. W - 5 of the apron.***

Step by step instructions:

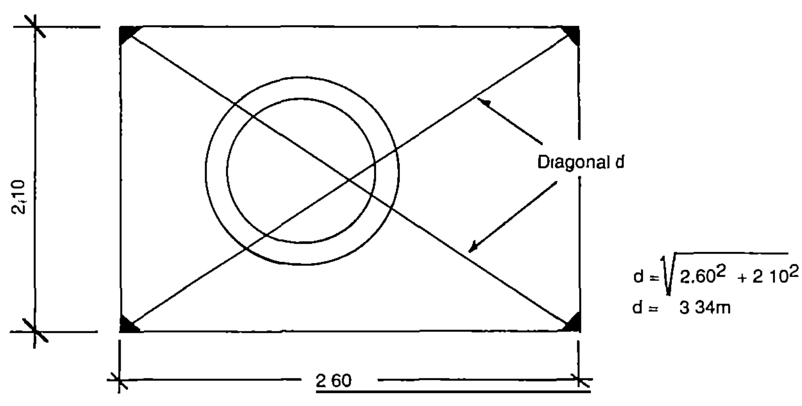
1. Once the lining of the well shaft reaches the original ground level, cast one more concrete ring according to the instructions given in chapter *6.4.2.1 In-Situ Casting of Concrete Rings.* After step 5 (filling of formwork with concrete) ***insert connecting rods into the fresh concrete and vibrate the concrete again.***

Connecting Rods



2. Bend down all connecting rods so that they are horizontal.
3. Cast ***two more rings*** on top of the ring with the connecting rods.
4. Fill the area around the well with excavated material up to the level of the connecting rods. The area should be one metre (on all four sides) larger than the planned apron. Ram the filled area well (the use of water helps to compact the soil better) and let it set for one or two weeks. Then ram it again. Decide upon the location of the drainage of the apron.
5. Assemble the formwork for the apron according to the standard drawing (see Appendix) and level it. To check the angles, measure the diagonals:

Checking of Angles

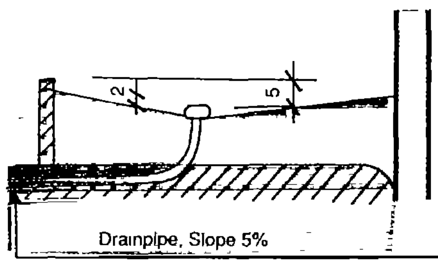


6. Place the ***strainer elbow*** for the drainage. Be sure that the top of the apron slopes sufficiently towards the top of the strainer. A distance of 5 cm between the top of the strainer elbow and the top of the formwork is appropriate. Lay the ***drainpipe (PVC ø 50mm)*** with a slope of about **5%**. The outlet of the drainpipe should be no nearer to the well than ***4m.***.
7. Clean the connecting rods (extending from the headwall) and place the reinforcement bars for the apron according to the standard drawing. Take care that the re-rods do not touch the formwork, the ***concrete cover must be at least 3cm.***

8. Pour plastic concrete 1 : 2.5 : 4 into the formwork. Ram it properly (knock at the formwork to vibrate the concrete). Be sure that the re-rods, drainpipe and strainer remain in place. Pour some concrete around the outlet of the drainpipe.

9. Screed the concrete roughly. Remember that the apron has to slope towards the strainer and that the top 2 cm will be filled with cement mortar. Do not smooth the top of the screeded concrete!

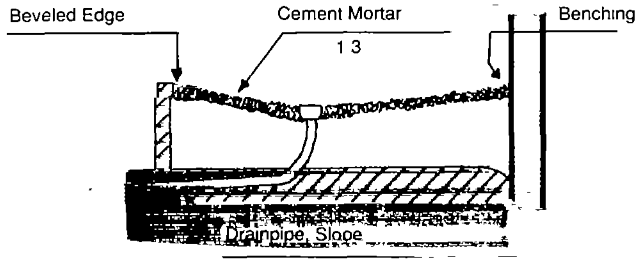
Casting of Apron



10 Apply stiff-cement mortar 1:3 ***wet in wet.*** Screed and float it but do not smoothen it. ***Bevel all edges*** with a trowel and apply a ***benching*** all around the headwall.

Do not forget to spare the openings for the pulley stand (refer to 6.7 *Water Lifting Devices*).

Finish of Apron



11. ***Cure*** the concrete for ***at least one week.*** Plug the drainpipe and flood the apron with water.

12. Remove the formwork and clean it.

13. Fill the area around the apron with dry stone masonry.

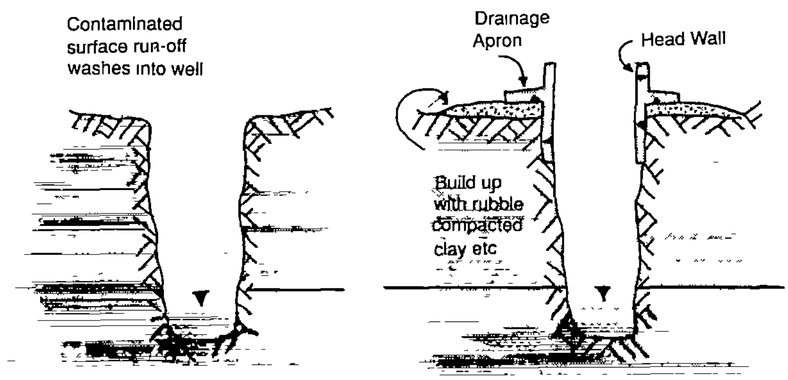
6.6 IMPROVING EXISTING WELLS

6.6.1 GENERAL REMARKS

It might sometimes be more appropriate to rehabilitate an existing, old well than to construct a new one. In some cases, the villagers want to continue using an old well due to social or historical reasons. Do not attempt to overrule them but check whether it is possible to improve the existing well.

The simplest, but most important, single improvement to an existing well is the construction of a ***wellhead.*** It can only be done in solid ground where there is no danger of the shaft collapsing.

A headwall and an apron have to be constructed with reinforced concrete. ***It is important to line the top 3m.***



Improving an Existing Well

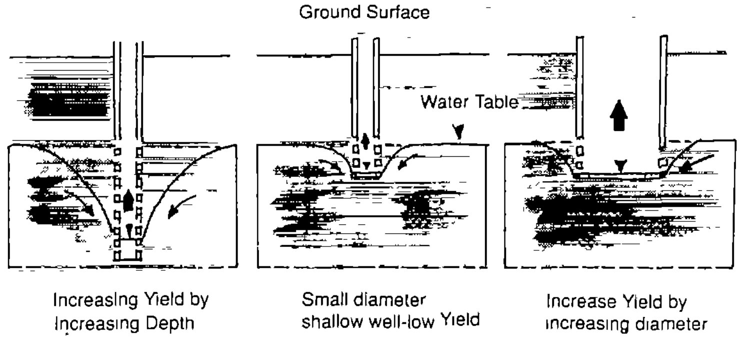
In case there is any doubt about the stability of the ground, it is recommended to construct a lining. The bottom of the well has to be cleaned and most probably enlarged or decreased. Then, you can proceed as discussed in chapters *6.3* and *6.4.*

6.6.2 IMPROVING THE YIELD OF A WELL

There are two ways of increasing the yield of a well:

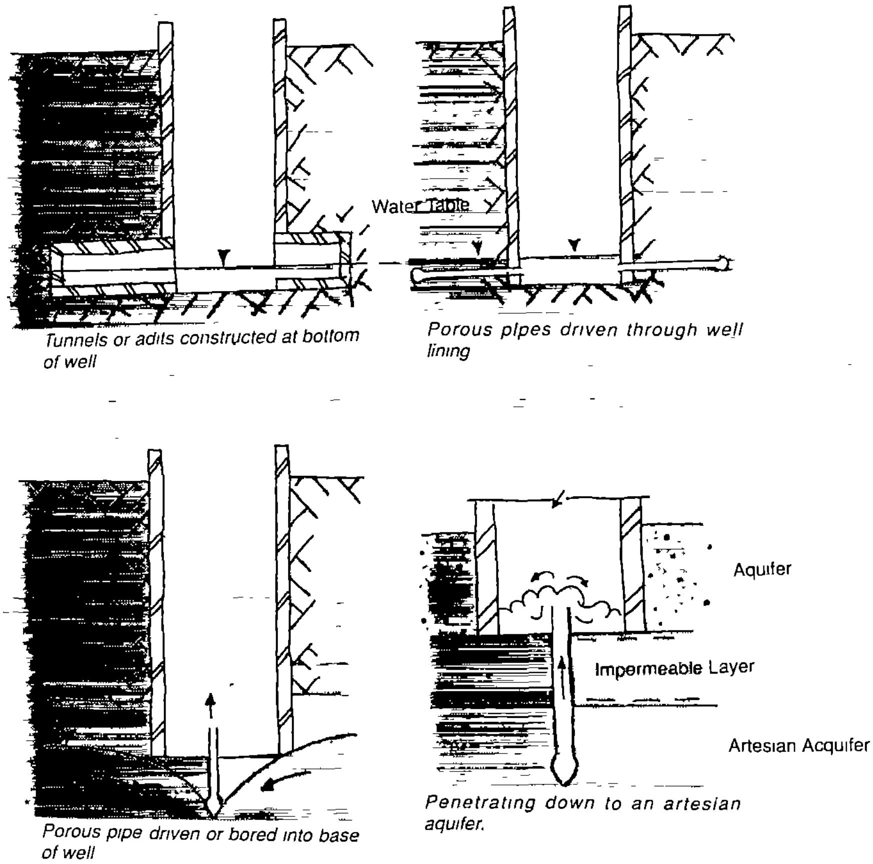
- Deepening the well
- Increasing the diameter of a well

In most cases it is easier and more promising to ***deepen a well*** to increase its yield. However, it might be difficult to keep the water level sufficiently low for the workers to deepen the well; a pump can help. ***Be careful not to overpump the well (cave in) and do mind the exhaust of the engine of the pump.***



Increasing the Yield of a Well

To increase the diameter of an existing well is virtually impossible. There are other techniques but they are not very applicable in rural villages in Sri Lanka.



Other Methods to Increase the Yield

6.7 WATER LIFTING DEVICES

6.7.1 GENERAL REMARKS

The choice, design, construction, operation, maintenance and repair of water lifting devices is a large subject that cannot be adequately covered in this manual.

Before deciding on a particular device, it is most important to investigate the water lifting systems that are used on traditional wells. These systems are culturally accepted and people know how to handle them. In case you want to introduce a new device, be sure that the users of the well accept it and can handle and maintain it. ***In Sri Lanka, the most traditional device is rope and bucket.***

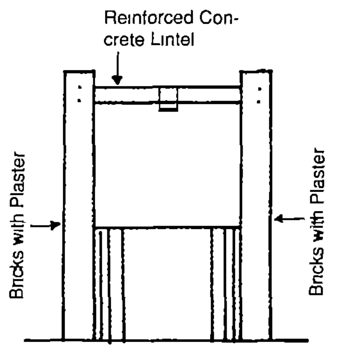
6.7.2 ROPE AND BUCKET SYSTEM

This is the traditional system used in Sri Lanka. There is only one major disadvantage: ***The well is not covered.***

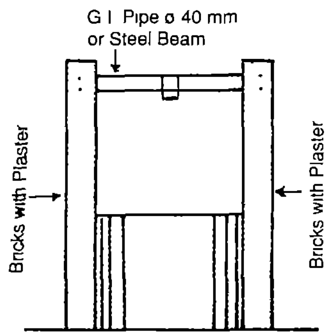
But our experience is that well users take great care not to contaminate an open well by throwing unhygienic objects into it. In most cases people preferred a well with a pulley system to one with a hand pump.

Usually, each well user will bring his or her own bucket and rope and thus, there is the risk that the well will become contaminated by waste carried into the well on the buckets or ropes. To prevent this it is advisable to ***store a common bucket and rope*** inside the well or on a pole just beside the well.

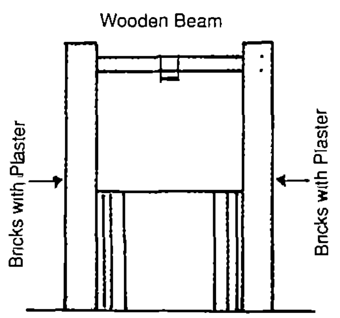
There are various alternatives for a pulley stand:



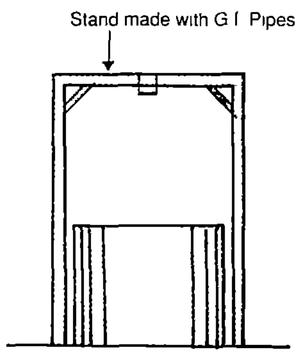
Recommended



Alternative



Not Recommended



Not Recommended (expensive)

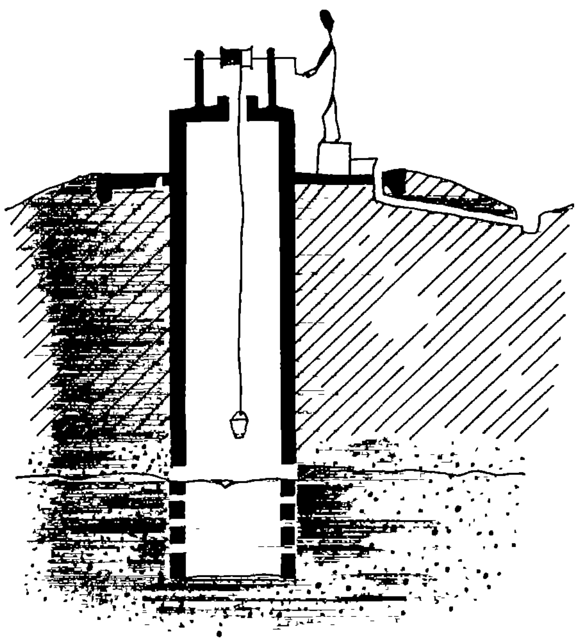
6.7.3 HANDPUMP

If a handpump is installed, the well can be covered and sealed. This makes it impossible to contaminate the water through the top of the well.

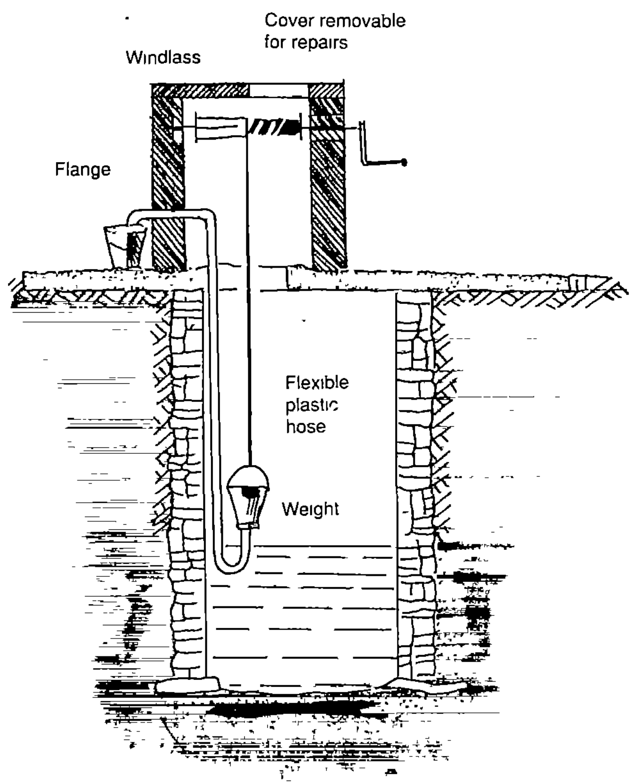
However, a handpump has to be maintained and sometimes repaired. Maintenance and repair will cost money and an organisational set up to manage it. Moreover, it seems that in Sri Lanka people prefer an open well to a sealed one. Therefore, unless people really want a handpump to be installed - ***and cover the additional expenses*** - and arrangements have been made to maintain it, ***we do not recommend to install a handpump***. In case a handpump has to be installed, please refer to the applicable handpump manual.

6.7.4 OTHER WATER LIFTING DEVICES

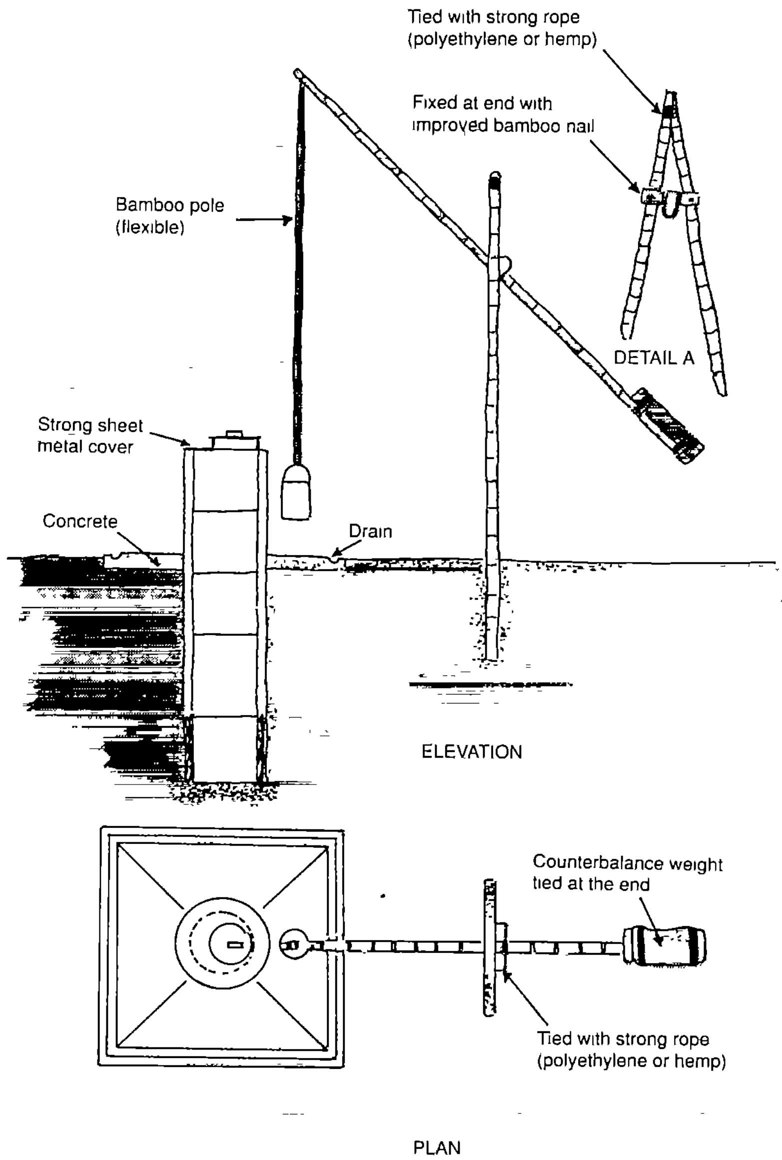
Below we give you some ideas about three alternative water lifting devices:



Covered Well with a Winch and Rope and Bucket



Well completely covered with Windlass, Rope and Bucket


Tied with strong rope (polyethylene or hemp)
Fixed at end with improved bamboo nail
Bamboo pole (flexible)
DETAIL A
Strong sheet metal cover
Concrete
Drain
ELEVATION
Counterbalance weight tied at the end
Tied with strong rope (polyethylene or hemp)
PLAN

"Shaduf"

❼ OPERATION AND MAINTENANCE

Immediately after completion, a newly constructed well has to be ***disinfected.***

Step by step instructions:

1. The well shaft has to be disinfected. Prepare a disinfecting solution by dissolving ≈ 100g of bleaching powder in one 10 litre bucket of water. Scrub the entire well shaft with this solution.
2. The intake can be disinfected by pouring disinfecting solution into the well. About 100 g are needed per m3 of water (two concrete rings hold approx. 1 m^3). Again the required quantity of powder is dissolved in the appropriate quantity of water and the solution then poured into the well. The water has to be stirred well and left in the well for at least 12 hours.
3. Pump the well to waste until the odour of chlorine disappears.

Above proc*edure will keep the well disinfected for a few days only.*
Therefore, ***take the necessary measures to prevent the well from getting re-contaminated:***

- Keep the area around the well clean.
- Take care that the apron is properly drained and the drainage not blocked.
- Do not allow children to play near the well.
- Keep animals away from the well.
- **Health and hygiene education are a must** and will have a long lasting

A well has to be cleaned and disinfected once a year!

The chlorination of a well (step two from above instructions) may be a worthwhile temporary measure during an epidemic (for example cholera) which is suspected to be water-borne.

APPENDIX

REFERENCES AND BIBLIOGRAPHY

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DETAILED DRAWINGS

Number	*Title*
W - 1	**CONCRETE RINGS**
W - 2	**FILTER RINGS**
W - 3	**CUTTING RING**
W - 4	**GUIDING RING**
W - 5	**WELLHEAD**

කොන්ක්‍රීට් වළලු තැන්වාත්තු සහ පෙරවාත්තු

CONCRETE RINGS

Cast in-situ & prefabricated

கொங்கிறீட் வளையங்கள்

நிலையத்தில் வைத்து வார்த்தலும் முன் வாரக்கப்பட்டதும்

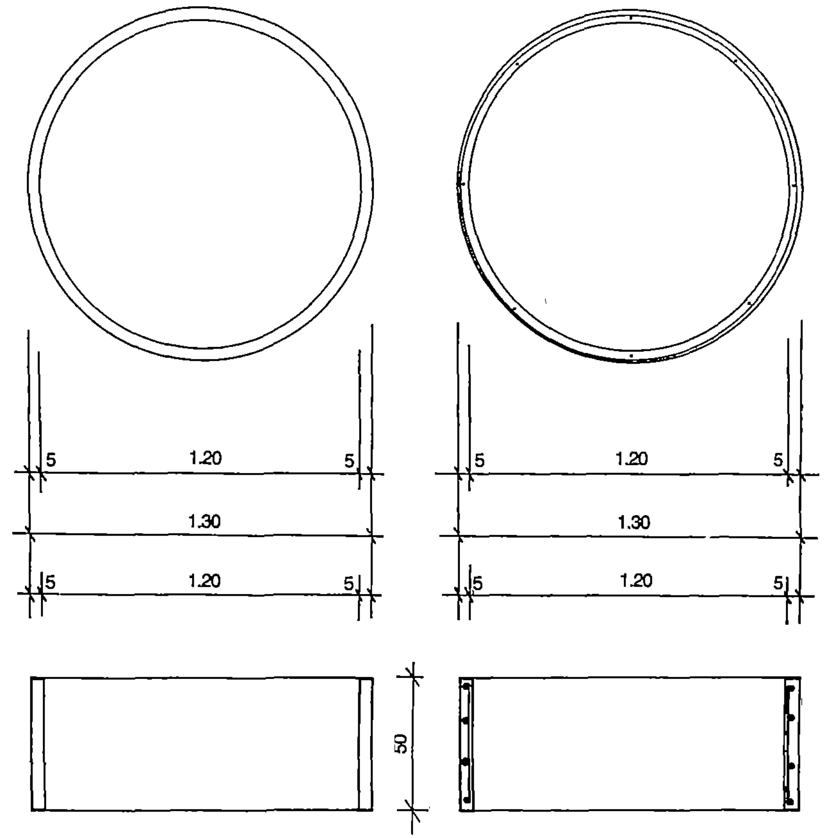
සැලසුම Plan No திட்டப்பட இல	W - 1	දිනය Date திகதி	*April 1992*	සංශෝධන Amendments முதிருத்தம்	දිනය Date: திகதி	විසින් By யாரால
පරිමාණය Scale· அளவுத் திட்டம்	1:20	අඳිනු ලැබුවේ Drawn by வரைந்தவர்	*Kumuduni*			
සිතියම Map Sheet· திட்டப்படத் தாள	—	නිර්මාණය Designed by. திட்டமிட்டவர்	*R. St. & H. Pf*			

අවශ්‍ය ද්‍රව්‍ය List of Materials பொருட்பட்டியல்

මීටර 1 ක් උස වළල්ලක් සඳහා for one metre of shaft ஒரு மீற்றர் உட்புறத்துக்கு

	තැන් වාත්තු **Cast in-situ** நிலையத்தில் வார்த்தல	පෙර වාත්තු **Prefabricated** முன் வார்க்கப்பட்டது
සිමෙන්ති cement சீமெந்து	~ කොට්ට 1.5 ~ 1.5 bags ~ 1.5 பொதிகள	~ කොට්ට 1 5 ~ 1.5 bags ~ 1.5 பொதிகள
වැලි sand மணல்	~ තාච්චි 15-20 (120 L) ~ 15-20 pans (120 L) ~ 15-20 தாச்சிகள (120 L)	~ වැලි තාච්චි 15-20 (120 L) ~ 15-20 pans (120 L) ~ 15-20 தாச்சிகள (120 L)
මැටල් metal பரல் கற்கள	~ තාච්චි 24-30 (190 L), උපරිම ප්‍රමාණය = 12.5 මිමි ~ 24-30 pans (190 L) max. size 12 5 mm ~ 24-30 தாச்சிகள (190 L) ஆகக்கூடிய அளவு 12 5 மி மீ	~ තාච්චි 24-30 (190 L), ~ 24-30 pans (190 L) ~ 24-30 தாச்சிகள (190 L)
කම්බි re-rods மீள்கம்பி		ø තුරු Ø 6 මිමි, L ~ 42 මී බර ~ 9.3 කි ග්‍රෑ ø 6 mm, L ~ 42 m, weight ~ 9 3 kg ø 6 மி.மீ., L ~ 42 மீ., நிறை ~ 9 3 கி.கி
පොල්තෙල් coconut oil தேங்காய் எண்ணெய்	ලීටර් 0.5 0 5 L 0.5 லீ	ලීටර් 0 5 0.5 L 0 5 லீ
ළිං අච්චු well mould கிணற்று அச்சு	කෑලි 1 1 pc 1 துண்டு	කෑලි 1 1 pc 1 துண்டு

තැන්වාත්තු **Cast in-situ** நிலையத்தில் வார்த்தல	පෙරවාත්තු **Prefabricated** முனவாரக்கப்பட்டது
බර ~ 235 kg weight ~ 235 kg நிறை ~ 235 கி கிராம	බර ~ 240 kg weight ~ 240 kg நிறை ~ 240 கி.கிராம
කොන්ක්‍රීට් 1 2 3 concrete 1.2·3 கொங்கிறீட் 1 2·3	කොන්ක්‍රීට් 1 2 3 concrete 1:2 3 கொங்கிறீட் 1.2 3



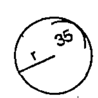
කම්බි තුරු අනවශ්‍යය
No re-rods required
மீள் கம்பிகள் தேவையில்லை

45

කම්බි තුරු
re-rods
மீள் கம்பிகள்

8 ø 6 mm, L = 45 m (L total 3 60 m)

4 ø 6 mm, L = 4 3 m (L total 17 20 m)



පෙරහන් වළලු
FILTER RINGS
வடிகட்டு வளையங்கள்

තැන් වාත්තු සහ පෙර වාත්තු Cast in-situ & prefabricated
நிலையத்தில் வார்த்தலும் முன் வார்க்கப்பட்டதும்

සැලසුම් / Plan No. / திட்டபட இல	W - 2	දිනය / Date / திகதி	April 1992	සංශෝධන / Amendments / பிழைதிருத்தம்	දිනය / Date / திகதி	විසින් / By. / யாரால
පරිමාණය / Scale / அளவுத் திட்டம்	1:20	ඇඳීම් ලැබුවේ / Drawn by: / வரைந்தவர்	Kumuduni			
සිතියම් / Map Sheet / திட்டபடத் தாள	—	නිර්මාණය / Designed by: / திட்டமிட்டவர்	R. St. & H. Pf			

අවශ්‍ය ද්‍රව්‍ය List of Materials பொருட்பட்டியல்

1) මීටර 1 ක් උස වළල්ලක් සඳහා For one metre of filter rings ஒரு மீற்றர் வடிகட்டு வளையத்துக்கு

	තැන් වාත්තු / Cast in-situ / நிலையத்தில வார்த்தல	පෙර වාත්තු / Prefabricated / முன் வார்க்கபபட்டது
සිමෙන්ති / cement / சீமெந்து	~ 2 කොට්ට / ~ 2 bags / ~ 2 பொதிகள்	~ 2 කොට්ට / ~ 2 bags / ~ 2 பொதிகள
වැලි / sand / மணல்		
12.5 මි.මී. සහ 20 මි.මී. / metal only 12.5 mm and 20 mm / கல் 12.5 மி.மீ அளவு மாத்திரம்	~ 40-50 තාච්චි (308 L) / ~ 40-50 pans (308 L) / ~ 40-50 தாச்சிகள (308 L)	~ 40-50 තාච්චි (308 L) / ~ 40-50 pans (308 L) / ~ 40-50 தாச்சிகள (308 L)
කම්බි කූරු / re-rods / மீள்கம்பிகள		ø 6 මි.මී. 42 මී. බර 9 3 කි.ග්‍රෑ. ~ 9 3 kg / ø 6 mm, L ~ 42 m, weight ~ 9.3 kg / ø 6 மி.மீ., L ~ 42 மீ., நிறை ~ 9 3 கி.கி
පොල්තෙල් / coconut oil / தேங்காய் எண்ணெய்	0 5 ලීටර් / 0 5 L / 0.5 லீ	0 5 ලීටර් / 0 5 L / 0 5 லீ
well mould / well mould / கிணறு அச்சு	කෑලි 1 / 1 pc / 1 துண்டு	කෑලි 1 / 1 pc / 1 துண்டு

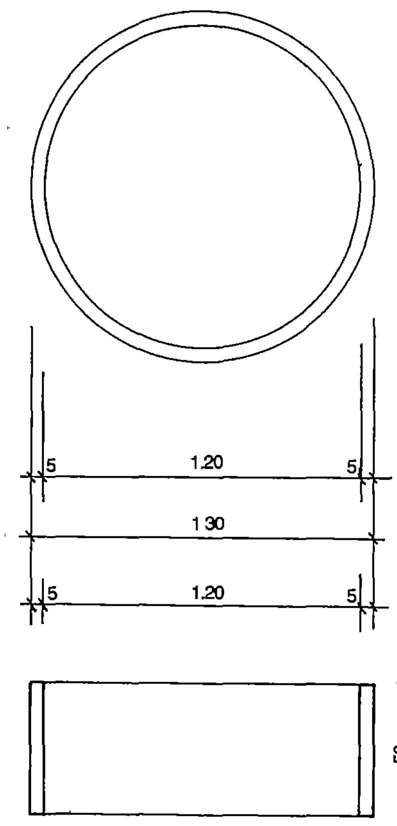
2) මීටර 1 ක පෙරහන් වළල්ලක් පිරවීම (කොන්ක්‍රීට්වලින් මුද්‍රා තබන ලද කළුගල් පෙරහන ද ඇතුළුව)
For one metre of filter packing (incl. concrete seal)
ஒரு மீற்றர் வடிகட்டு நிரப்புதலுக்கு (கொங்கிறீட் மூடி உட்பட)

- සිමෙන්ති කොට්ට 1.5/ cement ~ 1 5 bags/சீமெந்து 1 5 பொதிகள
- වැලි ~ තාච්චි 15-20/ (125 L)/sand ~ 15-20 pans (125 L)/மணல 15-20 தாச்சிகள (125 L)
- කළුගල් ~ 600 (1.2 m^3) කෑලි /rubble 600 pcs (1 2 m^3)/கண்ட கறகள 15-20 துண்டுகள (1 2 மீ^{3})
- මැටල් ~ තාච්චි 25-30/ metal 25-30 pans (190 L)/பரல கறகள 25-30 தாச்சிகள (190 L)

පෙරවාත්තු
Cast in-situ
நிலையத்தில வார்த்தல

බර ~ 235 කි.ග්‍රෑ.
weight ~ 235 kg
நிறை ~ 235 கி.கிராம

කොන්ක්‍රීට් පෙරහන 1 4 (සිමෙන්ති මැටල්)
filter concrete 1:4 (cement metal)
வடிகட்டு கொங்கிறீட் 1:4 (சீமெந்து பரலகற்கள)

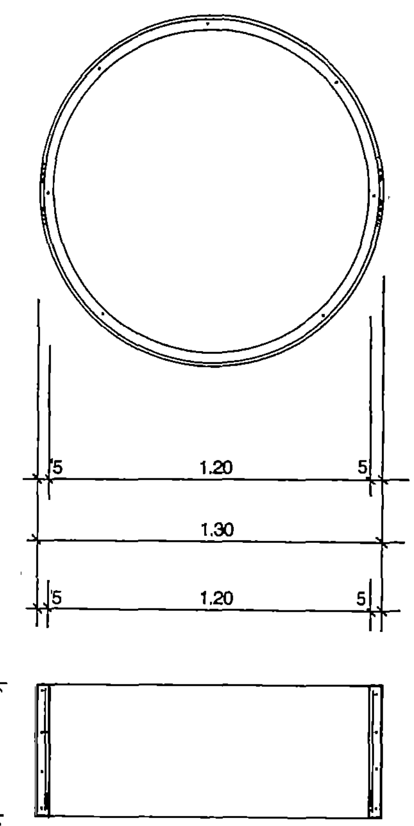


කම්බි කූරු අනවශ්‍යය
No re-rods required
மீள கம்பிகள தேவையில்லை

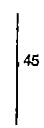
තැන්වාත්තු
Prefabricated
முன்வார்க்கப்பட்டது

බර ~ 240 කි.ග්‍රෑ.
weight Ω 240 kg
நிறை Ω 240 கி.கிராம

කොන්ක්‍රීට් පෙරහන 1 4 (සිමෙන්ති මැටල්)
filter concrete 1·4 (cement metal)
வடிகட்டு கொங்கிறீட் 1.4 (சீமெந்து.பரலகறகள்)



කම්බි කූරු
re-rods
மீள கம்பிகள



8 ø 6 mm, L = 45 cm (L total 3 60 m)

4 ø 6 mm, L = 4 30 m (L total 17 20 m)

r = 63 cm

කැපුම් වළල්ල පෙර වාත්තු
CUTTING RING
(Prefabricated)
வெட்டு வளையம்
முன் வார்க்கப்பட்டவை

සැලසුම් Plan No. திட்டப்பட இல	W - 3	දිනය Date: திகதி	*April 1992*		දිනය Date திகதி	විසින් By: யாரால
පරිමාණය Scale: அளவுத் திட்டம	1:20	අඳිනු ලැබුවේ Drawn by வரைந்தவர்	*Kumuduni*	සංශෝධන Amendments திருத்தம		
සිතියම් Map Sheet திட்டப்படத் தாள	—	නිර්මාණය Designed by திட்டமிட்டவர்	*R. St. & H. Pf*			

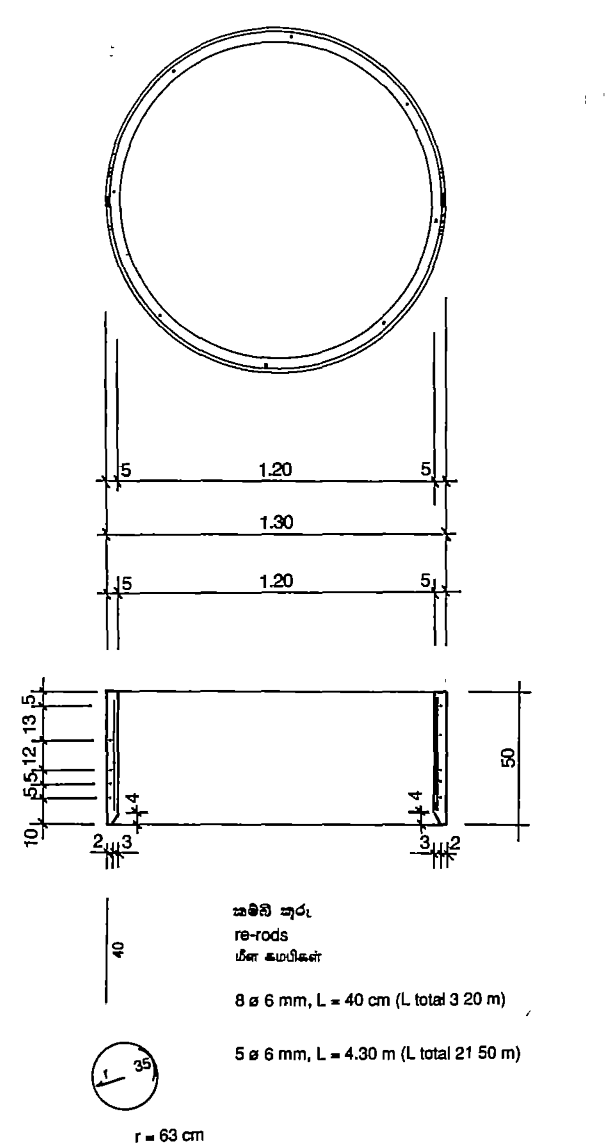
අවශ්‍ය ද්‍රව්‍ය **List of Materials** பொருட்பட்டியல்

එක කැපුම් වළල්ලක් සඳහා for one cutting ring
ஒரு வெட்டு வளையத்துக்கு

සිමෙන්ති cement சீமெந்து	~ කොට්ට 0 75 ~ 0 75 bags ~ 0 75 பொதிகள
වැලි sand மணல	~ තාච්චි 8-9 (60 L) ~ 8-9 pans (60 L) ~ 8-9 தாச்சிகள (60 L)
මැටල් metal பரல் கற்கள்	~ තාච්චි 12-15 (95 L), උපරිම ප්‍රමාණය = 12.5 මි.මී. ~ 12-15 pans (95 L) max size = 12 5 mm ~ 12-15 தாச்சிகள (95 L) ஆகக்கூடிய அளவு 12.5 மி.மீ
කම්බි කූරු re-rods மீளகம்பி	ø 6 මි.මී., L ~ 25මී., බර ~ 5 6 කි.ග්‍රෑ. ø 6 mm, L ~ 25 m, weight ~ 5 6 kg ø 6 மி.மீ., L ~ 25 மீ , நிறை ~ 5.6 கி.கி.
පොල්තෙල් coconut oil தேங்காய் எண்ணெய்	ලීටර් 0 5 0 5 L 0.5 லீ
ළිං අච්චු well mould கிணற்று அச்சு	කෑලි 1 1 pc 1 துண்டு

කැපුම් වළල්ල
Cutting Ring
வெட்டு வளையம்

බර weight நிறை ~ 240 kg   කොන්ක්‍රීට් concrete கொங்கிறீட் 1:2:3



මෙහෙයුම් වළල්ල (පෙරවාත්තු)
GUIDING RING
(Prefabricated)
வழிகாட்டு வளையம்
(முன் வார்க்கப்பட்டது)

සැලසුම් Plan No திட்டப்பட இல	W - 4	දිනය Date· திகதி	*April 1992*	සංශෝධන Amendments திருத்தம	දිනය Date: திகதி	විසින් By யாரால
පරිමාණය Scale: அளவுத் திட்டம்	1:20	අඳිනු ලැබුවේ Drawn by: வரைந்தவர்	*Kumuduni*			
සිතියම Map Sheet· திட்டப்படத் தாள்		නිර්මාණය Designed by: திட்டமிட்டவர்	*R. St. & H. Pf*			

අවශ්‍ය ද්‍රව්‍ය List of Materials பொருட்பட்டியல

1) එක් මෙහෙයුම් වළල්ලක් සඳහා For one guiding ring: வெட்டு வளையம் ஒன்றுக்கு

සිමෙන්ති cement சீமெந்து	~ කොට්ට 0.5 ~ 0 5 bags ~ 0 5 பொதிகள
වැලි sand மணல்	~ තාච්චි 4-5 (36 L) ~ 4-5 pans (36 L) ~ 4-5 தாச்சிகள (36 L)
මැටල් metal பரல கற்கள	~ තාච්චි 7-8 (57 L), උපරිම ප්‍රමාණය = 12.5 මි.මී ~ 7-8 pans (57 L), max. size = 12.5 mm ~ 7-8 தாச்சிகள (57 L), ஆகக கூடிய அளவு 12 5 மி.மீ
කම්බි කූරු re-rods மீள கம்பிகள்	Ø 6 මි.මී, L ~ 15මී, බර 3.3 කි.ග්‍රෑ ø 6 mm, L ~ 15 m, weight ~ 3.3 kg ø 6 மி.மீ , L ~ 15 மீ , நிறை ~ 3 3 kg
පොල්තෙල් coconut oil தேஙகாய எணணெய	ලීටර් 0.25 0.25 L 0 25 லீ
ළිං අච්චු well mould கிணற்று அசசு	කෑලි 1 1 pc 1 துணடு

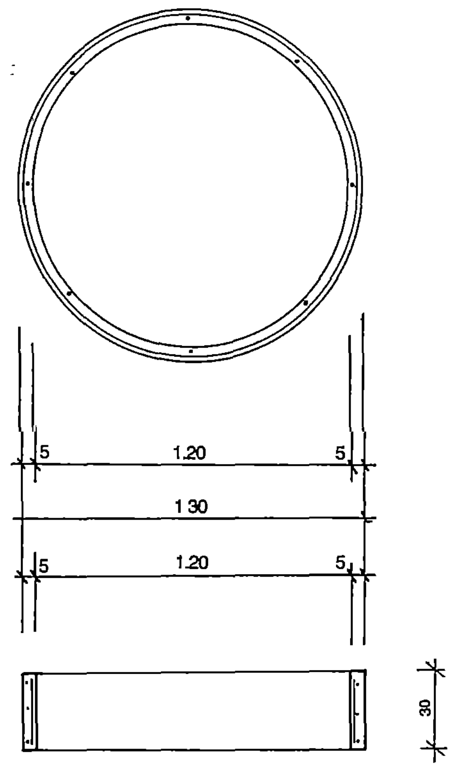
2) මෙහෙයුම් වළල්ල වටා පෙරහන් පිරවුම
For filter package around guiding ring
வழிகாட்டு வளையததைச் சுற்றி வடிகட்டு நிரபபலுக்கு

කළුගල් කෑලි 300 (0 6 m³)
rubble 300 pcs (0.6 m³)
பரல கற்கள 300 துண்டுகள (0.6 மீ³)

මෙහෙයුම් වළල්ල
Guiding Ring
வழிகாட்டு வளையம்

බර ~ 144 කි.ග්‍රෑ Weight ~ 144kg நிறை ~ 144 கி.கிராம்

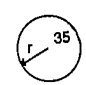
කොන්ක්‍රීට් 1:2:3 Concrete 1 : 2 . 3 கொஙகிறீட 1:2:3



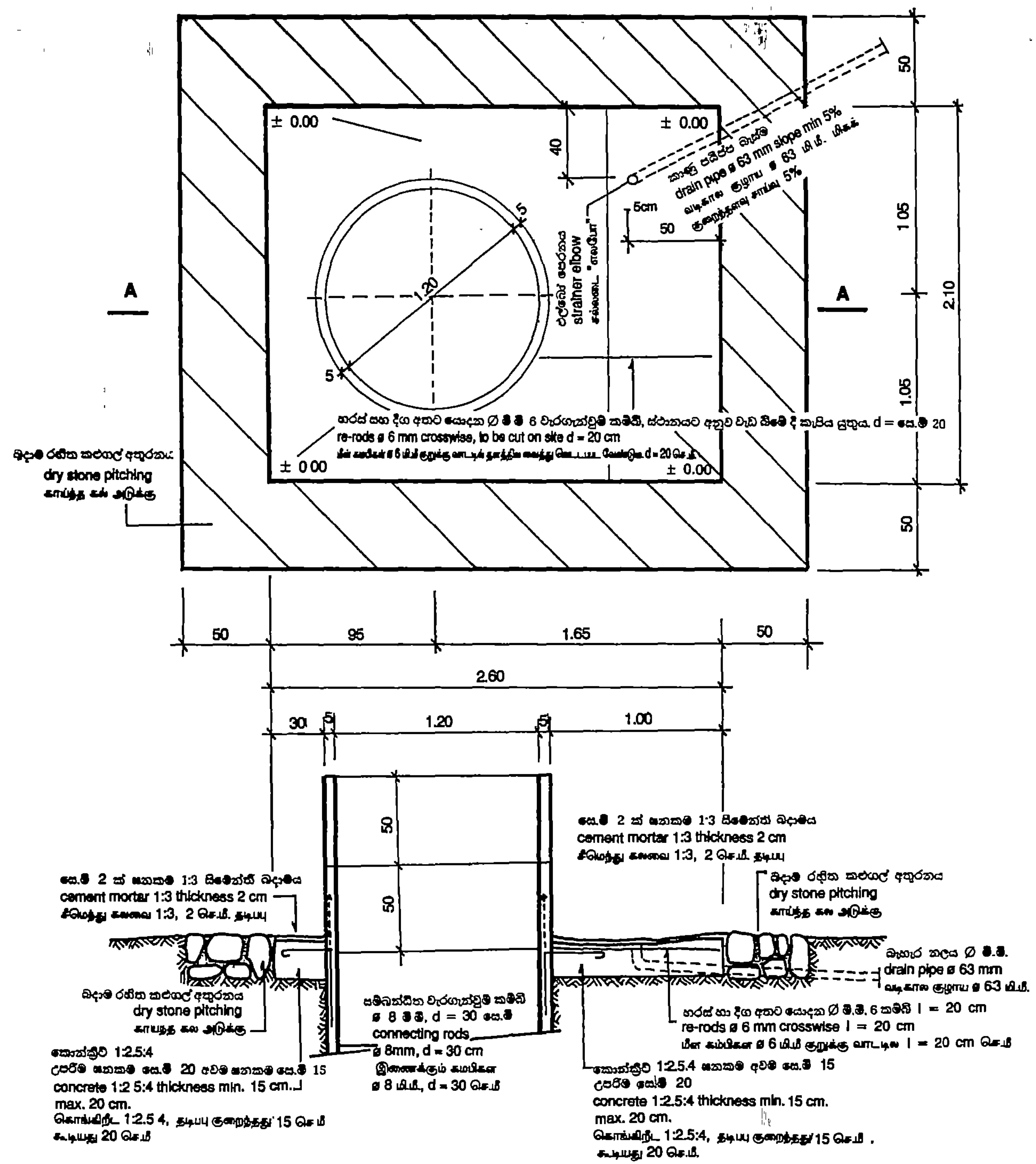
කම්බි කූරු
re-rods
மீள கம்பிகள

25 — 8 ø 6 mm, L = 25 cm (L total 2.00 m)

3 ø 6 mm, L = 4 30 m (L total 12 90 m)



r = 63 cm



A-A හරස්කඩ SECTION A-A பிரிவு A-A

ළිං සිරස (විවෘත ළිඳක් සඳහා)

WELL HEAD

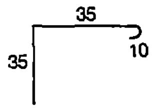
(for open well)

கிணற்று மேற்கட்டு

(திறந்த கிணற்றுக்கானது)

සැලසුම් Plan No. திட்டப்பட இல	W-5	දිනය Date: திகதி	April 1992	සංශෝධන Amendments பிழைதிருத்தம்	දිනය Date: திகதி	විසින් By: யாரால்
පරිමාණය Scale: அளவுத் திட்டம்	1:25	අඳිනු ලැබුවේ Drawn by: வரைந்தவர்	Kumuduni			
සිතියම Map Sheet: திட்டப்படத் தாள	——	නිර්මාණය Designed by. திட்டமிட்டவர்	R. St. & H. Pf			

වැරගැන්වුම් කම්බි
Re-rods
மின் கம்பிகள்



සම්බන්ධිත වැරගැන්වුම් කම්බි
Connecting rods
இணைக்கும் கம்பிகள்

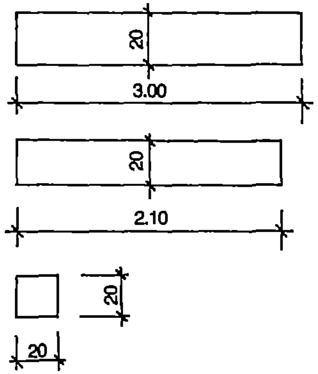
14ø6, d = 30 cm, l = 80 cm

l_{tot} = 11.20 m

ø 6, d = 20 cm, l_{tot} = 55 m

වැඩබිමේ දී අවශ්‍ය පරිදි කැලි කැපිය යුතුය
to be cut on site acc. to requirements
தேவைக்கு ஏற்ப தளத்தில் வைத்து சரியாக வெட்டப்பட வேண்டும்

ළිං මිදුල සඳහා හැඩයම
form work for apron
தாங்கும் பெட்டி வேலை



කෑලි 2
2 pcs
2 துண்டுகள்

කෑලි 2
2 pcs
2 துண்டுகள்

4 pcs
4 துண்டுகள்

අවශ්‍ය ද්‍රව්‍ය **List of Materials:** பொருட்பட்டியல்

සිමෙන්ති cement சீமெந்து	කොට්ට 6 6 bags 6 பொதிகள்
වැලි sand மணல்	තාච්චි 75-90 (600 ලී.) 75-90 pans (600 L) 75-90 தாச்சிகள் (600 L)
මැටල් metal பரல் கற்கள்	තාච්චි 105-120 (ලී.840), උපරිම ප්‍රමාණය = මි.මී 20 105-120 pans (840 L), max. size = 20 mm 105-120 தாச்சிகள் (840 L), ஆகக் கூடிய அளவு 20 மி.மீ
කළුගල් rubble கண்ட கற்கள்	කෑලි 700 (1.4 මී ^{3}) 700 pcs (1.4 m^3) 700 துண்டுகள் (1 4 மீ^{3})
කම්බි කූරු re-rods மின் கம்பிகள்	Ø 6 මි.මී. L = 66.20 මී.(බර = කි.ග්‍රෑ. 14.7) ø 6 mm, L = 66 20 m (weight-14.7 kg) ø 6 மி.மீ. , L = 66 20 மீ. (நிறை = 14.7 கி.கிராம)
දැව timber அரிந்த மரம்	ළිං මිදුලේ අච්චුවට form work for apron தாங்கும் பெட்டி வேலை
පී.වී.සී. නල pvc pipe pvc குழாய்	මි.මී 63 L = මීටර් 4 00 (අවම) පෙරහනක් සවි කළ පී.වී.සී. එල්බෝ 01 ø 63 mm (L_{min} = 4 m) minimum size 4 m - one elbow with strainer ø 63 மி.மீ ஆகக் குறைந்தது 4 மீ. - சல்லடை கொண்ட ஒரு "எல்போ"
ඇණ nails ஆணி	හැඩයම සඳහා for form work பெட்டி அடிக்க
බඳින කම්බි binding wire கட்டு கம்பி	වැර ගැන්වුම් සඳහා for reinforcement வலுப்படுத்த