RWSSHP Resource Manual # 3a

Hand Dug Well

Construction Manual

Introduction

This manual is part of a series of technical manuals prepared by the Ministry of Water Resources for the implementation of the Rural Water, Sanitation & Hygiene Program (RWSSHP). The complete series is as follows:

Manual #1 – Contract Management and Supervision Manual
Manual #2 – Community Operation and Maintenance Manual
Manual #3 – Hand Dug Well and Spring Development Construction Manual
Booklet #4 – Training Notes

This Manual is targeted at the Contractors, otherwise known as Artisans and Hand Dug Well Technicians. These are the people who will be contracted, on behalf of Communities, to construct water points (Hand Dug Wells and Spring Developments) in those communities, and train WaSHComs in Operation, Maintenance and Management.

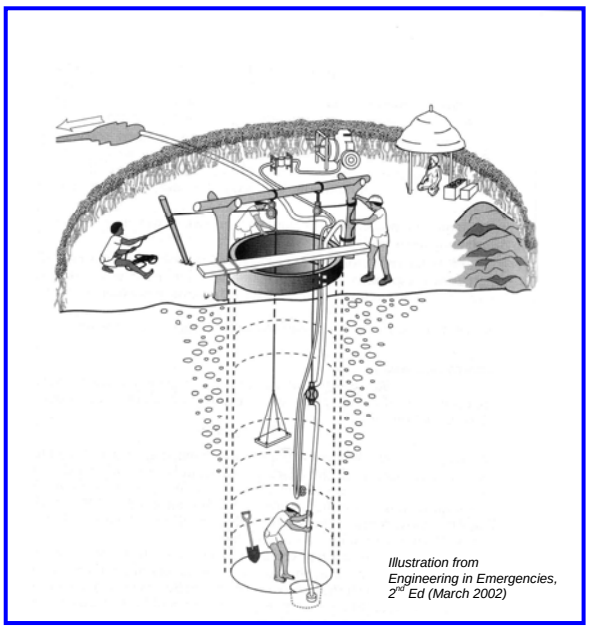

Illustration from Engineering in Emergencies, 2nd Ed (March 2002)

It is divided into three parts:

3a Hand Dug Well Construction
3b Spring Development Construction
3c Contract Management

It is meant to be a reference Manual that Contractors can use and draw on during the construction process. It covers the main aspects of planning, design and technology options as well as construction processes for Hand Dug Wells and Spring Developments. It also gives some guidelines for contract management, including financial management, reporting and administration. Whilst every effort has been made to cover the important aspects of HDW and SD construction, it should be noted that this manual is by no means comprehensive, and Contractors are encouraged to refer to other similar documents as well.

All of these manuals draw upon materials and experience from other of Rural Water Supply, Sanitation and Hygiene Programs – including those in Ghana, Malawi and Tanzania – as well as early experience in Ethiopia. It is expected and encouraged that these manuals be modified considerably over the first years of the Program as further experience is gained and local lessons are learned.

This manual is intended for use within the Program only.

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Hand Dug Well Construction

How to Use This Manual

The HDW Construction Manual is divided into the following sections.

- Preparation
- Construction – Well Shaft
- Construction – Well Intake
- Construction – Headworks
- Completion
- Improving Traditional Wells

These aspects of HDW construction are described in general terms in the manual. Throughout the manual references are made to Technical Detail Sheets for specific aspects of construction. Once you have read and understood the overall process of HDW construction, you can refer to individual Technical Detail Sheets for step by step details of how to do or make specific sections or parts of a HDW.

Preparation

Site Selection

As a Contractor, you will not generally be involved in site selection. This is the responsibility of the Community with assistance from a suitably qualified person such as a hydrogeologist. Detailed site selection information is covered elsewhere. However it may be useful for you to check that the selected site is a good one. An overview of site selection is contained in ***TDS 1 – Site Selection***

Work Planning

As the supervisor of a team of labourers working on a complex project, you should plan your work to ensure that everyone knows what they should be doing and all the tools, equipment and materials are ready for them to do it. This will ensure that everyone is occupied and time is not wasted.

THINK AHEAD. The most important thing in planning is thinking ahead. This means thinking about:

Now	• What is being done? • Is it being done correctly, or is help and/or advice needed? • Is the work progressing at the right pace, or does something need to be done to speed it up? • Is everyone occupied? Are there extra tasks for unoccupied people or can they be sent home? • Is the work being done safely?
Later today	• What needs to happen next? Do you have everything (tools, materials, people) ready for the next tasks? • Are any problems likely to arise? What can you do to prevent or solve them?
Tomorrow	• What stage will the project be at tomorrow?

	• What tasks will need to be done tomorrow? • Do you have all the tools, materials and people ready for these tasks?
Next Week	• If all goes well, what stage will the project be at next week? • What will you need then in terms of tools, materials, people? • Do you need to order any of these or arrange transport now? • What do you need to do if all does not go well?

And so on. These are just a few examples of what you need to think about.

WRITE IT DOWN. You should write your plan down on a piece of paper or in a log book. For example, you can write a list of steps for the next process, and list next to each step what is needed in terms of tools, equipment, transport and labour.

Site Preparation

If you plan and prepare your site properly, then the processes for constructing a hand dug well (digging, cement mixing, ring casting, equipment storage and so on) will go smoothly and will not interfere with each other.

The steps for site preparation are as follows:

1	Clear the site	***See TDS 2 - Clearing and Levelling the Site***
2	Leveling the site	
3	Plan the site layout	***See TDS 3 – Site Planning & Setting Out***
4	Constructing or assembling the Headframe	***See TDS 4 – Headframe Details***
5	Installing a brake post	
6	Casting a mixing slab	***See TDS 5 – Concrete & Mortar***
7	Constructing equipment and materials storage facilities	

Once you have completed all these steps, and have the necessary tools, equipment and materials at hand, you are ready to begin construction.

Equipment

The tools and equipment needed to construct a hand dug well are divided into the following categories:

Equipment Category	**Examples**
Measuring Tools	Tape measure, plumb bob, spirit level
Excavating tools & equipment	Shovels, picks, crowbars, buckets
Caisson Equipment	Caisson ring molds, binding rods
General Construction equipment	Hammers, axe, wrenches, drills
Expensive equipment	Chain block, hammerdrill, dewatering pumps
Safety equipment	Helmet, safety boots, ladders, first aid kit

A full list of tools and equipment, including relevant storage, handling and maintenance notes is contained in ***TDS 6 – Tools and Equipment***

You may not need all the equipment listed in ***TDS 6 – Tools and Equipment*** for each well that you construct, as some equipment will be specific to the design of the well or the type of construction method employed. However, as a contractor, you

should have as much of this equipment as possible so that you are able to take any contract on offer.

Look After Your Tools. It is extremely important that you maintain your tools and equipment in good working order. Blunt chisels, broken handles and buckets with holes will only reduce efficiency and slow down the work. At the end of each working day it is a good idea to check over all tools and equipment that have been used and identify any that may require maintenance. This can then be scheduled into the work plan for the following day.

Materials

The raw materials required to construct a hand dug well are generally divided into those that need to be procured and those that can be obtained locally. Examples of procured materials include cement and reinforcing steel bar. Locally available materials include stone, gravel and sand.

The materials needed for a particular site will depend on the conditions at the site and the technology choices made by the community or dictated by site conditions. For example a well constructed in collapsing ground will most likely require pre-cast concrete rings. This will mean a lot more cement is needed than a well in which locally available stone is used as the lining material.

Handling and storing your materials properly will ensure that they are in good condition when you come to use them. Cement that has been allowed to get wet will harden and become useless. Sand and gravel that contains vegetable matter (sticks and other plant material) or dirty water will cause a weaker concrete mix.

Before you start construction at a particular site you should make a calculation of how much of each material type you will need. The Bill of Quantities in your contract will assist but you should make a comprehensive list for yourself so that you can ensure that everything is ready before you begin excavation.

Details on quantities and types of materials needed for hand dug wells, as well as notes on handling and storage of materials is contained in ***TDS 7 - Materials***

Information on mixing concrete is contained in ***TDS 5 – Concrete & Mortar.***

Safety

SAFETY IS PARAMOUNT. It does not matter what is going on at the well site, you should think about safety. A work site is an extremely dangerous place and people have been killed due to lack of thought, carelessness and dangerous practices.

Safety is stressed throughout this manual, and specific safety considerations are included in each section as appropriate. The following is a list of general safety considerations that you should always be monitoring and aware of:

- **Helmets**: Any person who enters the well should wear a helmet and safety boots.

- **Tools and equipment** should be checked at the beginning and end of every day. Those not in use should be returned to their storage locations.
- **Children, animals** and onlookers should be kept away from the work site at all times. Only those **actively engaged in digging** should be allowed anywhere near the well shaft
- A watchman should be present whenever someone is in the shaft.
- During **lowering or lifting** of heavy objects, no one should be in the well shaft.
- **Petrol engines** should be placed to ensure fumes cannot enter the shaft. Petrol driven pumps must never be lowered into the well shaft.
- Proper first aid and safety equipment must be available on site at all times.
- **Handling Chlorine** should always be done with care and using appropriate protective clothing.

Be alert to possible danger, and follow the safety rules. If you ensure that everyone working on the site does this then you should have no accidents. See ***TDS 8 – Safety*** for full details.

Construction – Well Shaft

Technology Options

Hand Dug Wells can be lined, unlined or a combination. In all wells, however, at least the top 3 metres should be lined to prevent (potentially dirty) surface water seeping in.

There are several options available for lining a well shaft. These are:

- **Pre-cast concrete rings**, cast on the surface and lowered into the well shaft (***TDS 9 – Pre-cast Concrete Rings***)
- **Concrete rings cast in-situ** in the well shaft (***TDS 10 – In-Situ Concrete Lining***)
- **Masonry lining** using bricks or local stone (***TDS 11 – Masonry Lining***)

The choice of lining method will depend on the ground conditions, cost and the availability of local materials. A summary of when to use which method is shown in the Table:

Lining Method	Conditions when used
Pre-cast concrete rings	Collapsing ground (sandy, loose gravel etc) Unstable ground (wet, sand or silt layers) Once the aquifer has been reached. Can be used in all conditions.
In-situ Cast Concrete	Stable, solid ground
Masonry Lining	Stable, solid ground where there is an abundance of local stone
Unlined	Solid rock

A well shaft (or a section of a well shaft) can only be left unlined when the surrounding ground is solid rock (including pumice), although even in these circumstances it may be desirable to line the shaft anyway.

Safety Note:
A well shaft should never be left unlined during construction if there is a chance of rain

Construction & Excavation Techniques

The ground conditions in a well shaft will vary from site to site, and also within one shaft. You need to be familiar with a range of excavation techniques and technologies so that you can handle whatever circumstances you find in a safe and efficient manner.

Ground may be ***collapsing*** (meaning as you dig the adjacent soil falls into the hole) or ***self supporting*** (meaning as you dig the adjacent soil stays where it is). Soils containing high levels of gravel or sand will tend to be collapsing, whereas soils with high clay content will tend to be self supporting.

Safety Note:
Even in self supporting soils there is always the danger that the shaft walls will collapse if left unsupported

In some cases, ground that is self supporting when dry can become collapsing when it is wet (for example after rain).

There are two main excavation techniques that can be employed when constructing a lined well shaft. They are:

1. **The Dig-Down-Build-Up Method**
2. **The Caisson Method**

Note: there is a third method – lining-as-you-go – however this has not generally been used in Ethiopia and so is not discussed here. Details of this method can be found in "Water, Sanitation and Hygiene for Populations at Risk (X)"

The **Dig-Down-Build-Up Method** can only be used in self-supporting soils. It involves digging a shaft down a certain way (usually no more than 5 metres; less when the ground is less stable) then installing the lining up to the surface. This is known as the first ***lift***. Once the lining is complete, the shaft excavation continues below the first lift for a similar distance (3 -5 metres again) or until either solid rock or the aquifer is reached. At this point the well is lined back up to the bottom of the first lift, creating the second lift. This process continues until solid rock or the aquifer is reached.

See ***TDS 12 –Excavation*** for details of the Dig-Down-Build-Up Method.

The **Caisson Method** can be used in either self supporting soils or collapsing soils. The process involves digging a shallow hole and placing a pre-cast concrete ring in the hole. The ground underneath the ring is excavated which allows the ring to settle further into the hole at which time a second concrete ring is placed on the first one. This process continues until the bottom of the well, or solid rock is reached.

The first ring placed in the hole is the ***cutting ring***. This is a specially designed concrete ring with a beveled edge and a wider outside diameter than the concrete lining rings. The purpose of the cutting ring is to make excavation easier, and to create a larger diameter excavation hole so the rings above have space to move down easily.

TDS 13 - Caissoning gives details of the Caisson Method, including the use of a cutting ring.

Safety Note:
The Caisson Method is safer than the Dig-Down-Build-Up Method because the ground is never left unsupported.

Which technique should you use?

Deciding which excavation method to use is something that comes with experience. The recommended process for excavating a well shaft is as follows:

Begin excavating shaft. When you have excavated a metre or so, assess whether the ground is self supporting or collapsing.

Is the Ground Collapsing?

If **YES**, then:

- Use the Caisson excavation method, using large diameter caisson rings (for example ID1.5m, OD 1.7m). See ***TDS 13 - Caissoning*** for details.
- Continue excavating using this method until the ground water (aquifer) or solid rock is reached.
- Below the ground water the caisson excavation method is used using smaller diameter caisson rings (for example ID1.0m, OD1.2m). See ***TDS 13 - Caissoning*** for details.

If **NO**, then:

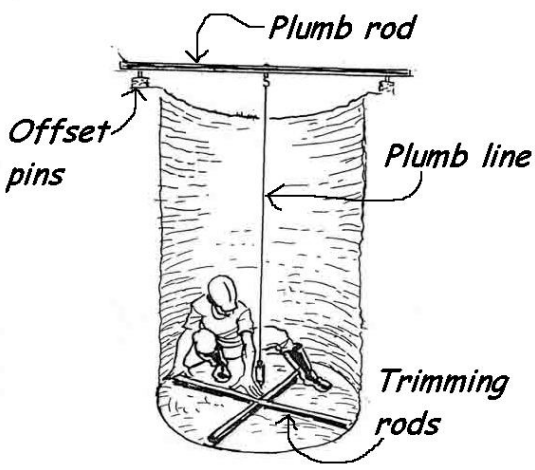
- Excavate carefully down approximately 5 metres. If the ground is stable, then continue excavating until the ground water (aquifer) or solid rock is reached.
- At this point line the well shaft using in-situ concrete lining (see ***TDS 10 – In-Situ Concrete Lining***), masonry lining (see ***TDS 11 – Masonry Lining***) or large diameter pre-cast concrete rings (see ***TDS 9 – Pre-cast Concrete Rings***).
- If the ground becomes unstable, or you are not sure whether the ground is stable, then STOP excavating, and line back to the surface using one of the techniques listed above. Continue excavating using either the Dig-Down-Build-Up excavation technique or the Caisson technique (using large diameter pre-cast concrete rings), depending on which lining method you choose.

Note: Once the aquifer or water table has been reached, the Caisson Method should always be used. See 'Construction – Intake' Section below.

If you reach solid rock, you need to decide whether it is worth continuing with the excavation using rock breaking techniques (see ***Digging in Rock*** below), or whether you should abandon the site and start excavating in a new site.

Keeping the Shaft Vertical

It is extremely important to keep the well shaft **vertical**. The distance that the shaft can be out of vertical is 10mm for every metre of depth. You should check this regularly during construction as a well shaft that is not vertical is difficult to construct and difficult to use when it is finished.



The recommended method for checking verticality during excavation is by using ***offset pins***, a ***plumb rod and line*** and ***trimming rods***. Alternatively, the plumb line and trimming rods can be suspended from a tripod.

See ***TDS 3 – Site Planning and Setting Out*** and

TDS 12 – Excavation for details of offset pins, plumb rod and line, trimming rods, and checking the verticality of the shaft.

Digging in Rock

Very often when excavating a well shaft, rocks and boulders and even a solid layer of rock will be encountered. Small rocks and boulders (up to about 30 – 40 kg) can generally be extracted and removed without the need for any special techniques. However if larger boulders or solid rock is encountered then it may be necessary to use techniques and/or special equipment to break the rock into manageable pieces.

Techniques for breaking rock include:

- Using a crowbar, sledgehammer, rock chisel or similar.
- Using a mechanical tool such as a jack hammer or hammerdrill
- Heating and rapidly cooling the rock to cause it to crack
- Using explosives

Safety Note:
Before raising boulders or large pieces of rock from the well shaft, all people should leave the well shaft

The technique employed will depend on the type and size of rock encountered, and the availability of equipment. Details of techniques for dealing with rocks and boulders are given in ***TDS 12 – Excavation***. Explosives are not recommended.

Construction – Intake

Technology Options

The intake is the section of the well shaft that lies within the aquifer. The intake is designed to allow water to enter the well, but to exclude sand, silt and other particles. The aquifer will be either pervious (meaning it can hold and transmit water) ground comprised of soil, sand, clay or a combination, or rock with fissures (small cracks through which water flows).

Pervious ground is inherently unstable as the movement of water loosens particles and allows them to move over each other. This is particularly so in sand and gravel (which are generally excellent water bearing materials). It is therefore very important that the lining method be structurally sound and the excavation method safe. For this reason, it is recommended that the Caisson Method be used to excavate into the aquifer (see '***Construction & Excavation Techniques***' below).

In fissured rock, an intake lining may not be needed, however, unless it is absolutely sold it should be lined anyway. Only the Supervisor can make the decision not to line a well shaft.

There are three lining options for intakes:

1. **Perforated Concrete Rings**
2. **Porous Concrete Rings**
3. **Solid Concrete Rings (flow from underneath)**

Note: Perforated Rings should be used unless there is a clear reason to use one of the other options.

Perforated Rings are normal Pre-cast Concrete Rings except that they have small holes cast into them through which water flows into the well. The holes are generally 10 – 20mm in diameter and so have the **disadvantage** that sand and small gravel can pass through them into the well. The **advantage** of perforated rings is that they are strong so there is no danger they will break during construction.

Porous Rings are made from a concrete mix that contains cement and gravel but no sand. The resultant concrete has spaces between the gravel which allows water to flow through. The main **advantage** of the porous ring is that the voids are generally small enough to allow water to pass whilst filtering out most particles (sand, gravel etc). The main **disadvantage** of the porous rings is that they are weak (compared to normal concrete rings) and so can easily break when they are being handled during construction.

Solid Concrete Rings are used when the aquifer has a lot of water and/or the ground in the aquifer contains fine sand or silt. Under these conditions water flows into the well from underneath or through the joints in the concrete rings. Solid Concrete Rings are identical to the Pre-cast Rings used in the well shaft.

See ***TDS 9 – Pre-Cast Concrete Rings*** for details of all three intake ring types.

Construction & Excavation Techniques

One of the main differences between traditional hand dug wells and improved hand dug wells is that the latter continue to supply water to the communities even in the driest seasons. This is achieved by ensuring that the well shaft penetrates the aquifer by at least 3 metres, that an adequate yield is achieved (*see Note 3 below*) and the design of the shaft is such that it can be readily deepened should the water table fall.

The excavation method used to dig 3 metres or more into the aquifer is the ***Caisson Method***. This is described above in **'Construction – Well Shaft'**. The only difference being that when excavating below the water table, ***De-Watering*** is required (see below).

Safety Note:
Sometimes the Dig-Down-Build-Up Method is used for excavating into the aquifer. This is NOT recommended as the risk of the walls collapsing on workers is very high.

See ***TDS 13 - Caissoning*** for details of the Caisson Method.

The only variation of this technique that is sometimes used to deepen wells if they dry up is '***Telescoping'***. In this technique, smaller diameter concrete caisson rings that fit within the rings used in the original construction are used to excavate further into the aquifer. See the section on **Well Deepening** below.

De-Watering

De-watering is extremely important for allowing excavation to penetrate 3 metres or more into the aquifer. The lack of effective de-watering is the main reason why traditional hand dug wells have dried up in dry seasons.

De-watering can be done by ***bucket and rope*** or with a ***pump***. In general the bucket and rope method should be used in the first stages of excavation into the aquifer, and only when the water flows into the well faster than it can be effectively bucketed out should pumping begin.

In some cases where the flow into the well is slow or can be restricted (for example if perforated concrete rings are used in the intake section, the holes can be temporarily blocked with wooden plugs during digging to limit the flow of water into the hole) then bucketing may be adequate for the whole excavation. In most cases, however, pumping will be required for the deepest section of the well shaft.

Safety Note:
Directly driven petrol de-watering pumps should never be lowered into the well shaft as exhaust fumes sink to the bottom and can kill workers.

See ***TDS 14 – De-Watering*** for more details.

Finalising the Well Shaft

Once you have established that the well shaft is deep enough and it has been fully lined, there are a number of things that need to be done to finalise the well shaft. These are:

1. Install the Base Plug
2. Gravel pack and seal the shaft
3. Develop the well

Base Plug:
The base plug is used to stabilize the bottom of the well to prevent erosion and control the flow of water into the well from underneath during periods of heavy use to ensure that sand and silt are not carried into the well. It can be constructed of perforated concrete, or formed by placing graded layers of gravel at the bottom of the well.

Gravel Pack and Sealing:
The void between the concrete rings (if used) and the surrounding ground should be packed with uniformly graded gravel. This helps to stabilize the surrounding ground and control the flow of sand, silt and water into the well.

If a combination of the Dig-Down-Build-Up and the Caisson excavation methods was used, then there will be a gap in the joint between the two. This should be sealed.

The top 3 metres of the well shaft must also be sealed to prevent surface water seeping into the well.

Developing the Well:
Developing the well involves pumping or surging a bailer up and down in the water in the well. This forces water to move backwards and forwards through the small pores and voids in and around the intake. This effectively cleans them, removes loose particles and establishes the pathways for the water to enter the well.

Details of all these are contained in ***TDS 15 – Finalising the Well Shaft***.

Well Deepening

Water tables and aquifer levels can vary from the dry season to the wet season and from year to year. It is not uncommon for wells to dry up in a dry season, particularly in times of drought or exceptionally dry years. The aim of constructing improved Hand Dug Wells is to ensure that water is available all year round, even in times of drought, and so if a well dries up in the years subsequent to its construction it will be necessary to deepen it.

To deepen a well that has been completed, unless the intake is in solid rock, the Caisson Method is used. Depending on the well the process will involve excavating and extending the Caisson Lining that was originally placed in the well, or telescoping a smaller diameter Caisson Lining inside the original one.

See ***TDS 17 – Well Deepening*** for details.

Notes:

1. Whatever the construction and excavation method used, the top 3 metres of the hand dug well must be sealed to prevent surface water from entering the well. See ***TDS 15 – Finalising the Well Shaft*** for details.
2. If a combination of the Dig-Down-Build-Up method and the Caisson method has been used, then there will be a gap between the outside of the top pre-cast concrete caisson ring and the inside of the lining used above that. This gap will need to be sealed to prevent soil and other materials entering the well. See ***TDS 15 – Finalising the Well Shaft*** for details.
3. The well should go 3 metres into the aquifer and yield a minimum of 10 litres per minute. If higher yields are achieved before you have dug 3 metres into the aquifer, then you may be able to stop digging sooner, subject to the following guide.

   Acceptable aquifer penetration depths and yields:

   a. 2 metres and 20 litres per minute.
   b. 2.5 metres and 15 litres per minute
   c. 3 metres

   The Contract supervisor will authorise this if necessary. See ***TDS 16 – Measuring Yield*** for details
4. It may be necessary to check the quality of the water once the aquifer has been reached. The Contract Supervisor will tell you if this is necessary.

5. Construction – Headworks

Description

The ***headworks*** consists of all of the above ground components of a hand dug well. This includes the ***well head***, the ***cover slab***, the ***apron and drainage***, and, depending on the technology chosen, an optional ***windlass*** for use with a bucket and rope, or the ***handpump***.

The Community will have chosen one of the following options for extracting water from their hand dug well.

1. A bucket and rope
2. A handpump

Many of the features of the design of the headworks is the same for both options, and even if the community chooses to install a handpump, provision should be made to withdraw water using a bucket and rope when the handpump is broken.

Well Head

The ***well head*** is simply the extension of the well lining above the ground level. The well head should extend at least 300 – 400mm above the ground. This ensures that no surface water can enter the well.

If Pre-cast concrete rings are used, then the well head is constructed by adding additional rings to the well lining to achieve the desired height above the ground. If In-situ concrete lining is used, then this can be extended above the ground by using an outer mould as well as the inner mould, and if the lining is masonry, then this can simply be extended above ground to the desired height. See ***TDS 18 – Well Headwall*** for details.

Cover slab

The ***cover slab*** is a cast concrete cover that sits on top of the well head, and effectively closes the well. It will have an access hole with a removable hatch that is used for entering the well for maintenance or deepening. If no handpump is installed then this hatch will also be used for withdrawing water from the well using a bucket and rope. In this case the access hole should be raised by 500 – 600 mm above the cover slab level.

The cover slab will also have a 150mm diameter hole and associated bolts for fitting a handpump. The spacing and arrangement of the bolts will depend on the type of handpump chosen. Refer to the handpump manufacturer's installation instructions for details.

If no handpump is installed, then this should be closed with a cover, however it

should not be permanently closed in case the Community chooses to install a handpump at a later date.

See ***TDS 19 - Cover Slab*** for details of the cover slab.

Apron & Drainage

A concrete platform, known as the ***Apron***, is constructed around the Well Head to create a clean, solid surface on which to collect water, and to ensure any spilled water (or other surface water) drains away from the well.

The Apron should be founded on solid ground, and should be strong enough so that it does not crack or move over time. It should have a raised lip all around to prevent surface water from flowing onto it from adjacent ground, and it should incorporate a drainage channel leading off at least five metres so that spilled water can flow away.

The drainage channel may feed a small vegetable garden or an animal water trough if so desired. ***TDS 20 – Apron & Drainage*** contains details of the Apron and Drainage.

Handpump

Handpump installation procedures will vary from pump type to pump type. Refer to the handpump manufacturer's installation instructions for details of how to install. If a handpump is installed, however, then a concrete plinth should be constructed under the pump spout onto which water jars etc can be placed.

See ***TDS 21 – Installing an Afridev Handpump*** for details of how to install the Afridev which is the most common type of pump used in the Program. Refer also to the Afridev Pump manufacturer's installation instructions.

Windlass

If water is to be drawn from the well with a bucket and rope, then a ***dedicated bucket*** must be used. This will minimize the chances of contamination entering the well from user's own buckets.

To facilitate water collection using the dedicated bucket, some sort of ***windlass*** should be constructed. This consists of a frame constructed over the well (this can be a frame built during well construction for removal of spoil), with a pulley attached. This allows the user to stand back from the well head when drawing up water. See ***TDS 4 – Headframe Assembly*** for some examples of windlass structures.

Completion

Once the construction of the hand dug well is complete, there are still a number of things which need to be done before you have completed your contract. These are as follows:

Disinfection and Cleaning

The process of digging and constructing a hand dug well will almost certainly contaminate the water in the well, and so it must be disinfected before it can be used. This is done with ***chlorine*** which is a strong chemical that kills all organisms in the water.

Chlorine has a distinctive smell. Heavily chlorinated water should not be consumed and so once the chlorination process is complete, the well should be left for 24 hours and then pumped out. A small amount of residual chlorine in the water will not harm users, however in general people do not like to drink water that smells of chlorine, and so the usual practice is to continue pumping the water out of the well until no chlorine smell can be detected.

Safety Note:
Chlorine is a dangerous chemical. Anyone handling chlorine should use rubber gloves and wear safety goggles and a mask.

The inside walls of the well should also be cleaned. Any residual oil used to lubricate formwork should be cleaned off and the walls scrubbed with a weak chlorine solution.

Details on chlorination and cleaning are contained in ***TDS 22 – Disinfection and Cleaning***.

Fencing and Well Protection

The usual practice Communities adopt for using their well is to keep it closed except at certain times when access is controlled by a guard. It is also extremely important that animals are kept away from the well so that they cannot cause contamination or damage.

It is therefore important that the well and surrounds are fenced. If the fence used to protect the site during construction is adequate then no more work need be done, however if this was just temporary fencing then a new or improved fence will need to be constructed.

It is the Community's responsibility to construct this fence, however as the Contractor you should ensure that this is (a) done and (b) built to an adequate standard.

Operation and Maintenance Training

As the Contractor, you will be responsible for providing training to the Community WaSH Committees in Operation and Maintenance. You need to set aside adequate

time for this to ensure that the WaSH Committees fully understand how to use their Hand Dug Well properly, and the importance of maintenance.

If looked after properly, there is not much that can go wrong with a Hand Dug Well with a bucket and rope, however periodic cleaning and/or de-silting may be necessary, as well as repairing any cracks that may form in concrete. General cleaning around the well and repairs to the fence and drainage will also be necessary from time to time.

If a handpump is installed then more frequent maintenance and repairs will be needed. Details of maintenance schedules and spare parts requirements for handpumps are contained in the handpump manufacturer's user manuals. You should be thoroughly familiar with these and ensure the Community WaSH Committees are as well.

A separate "**Community Hand Dug Well & Spring Development Manual**" has been prepared which details Operation and Maintenance procedures that Communities should follow. This manual can assist you with Operation & Maintenance Training for the WaSH Committees.

Extra Features

Very often the Community will want to add some facilities and features to their hand dug well to make it easier to use or more useful. These include a modified headworks design that makes it easier for a woman on her own to collect water without assistance; a clothes washing rack, an animal watering trough and a small vegetable garden.

Although not essential for the safe construction of the Hand Dug Well, you may by contracted to build some or all of these features on behalf of the Community.

These features are described in more detail in ***TDS 23 – Hand Dug Well Extra Features***.

Handover of Facilities

Once all construction and completion activities have been carried out to the satisfaction of the Community and the Woreda WaSH Management Team, you can officially hand over the facilities to the Community.

However, should the well become dry within the first 2 years of operation, then it will need to be deepened. This is your responsibility as part of your contract. You will be paid for this work, but be aware that you may be called upon if this occurs.

See the section entitled **Well Deepening** above for details of how this is done.

Improving Traditional Wells

Overview

In some locations, rather than digging a new well, it may be better to improve a traditional well. Whether or not this is possible will depend on the conditions at the well, and how it was dug in the first place.

The main differences between a traditional well and an improved well are shown in the table below. Not all traditional wells will have the features (or lack of features) listed in the table, so when you are assessing a traditional well, you should make a note of what improved features it does have and which are missing.

Feature	Traditional Well	Improved Well
Site Issues	• May not have been sited properly	• At least 10m from any latrines or rubbish pits • Not located in cemeteries, swampy or flood prone areas •
Well Shaft	• Generally small diameter • May not be vertical	• Standard diameter • Vertical to 1cm for every metre of depth
Lining	• Usually unlined or only lined at the top	• Lined with concrete or masonry
Intake	• Only penetrates aquifer by one metre or so • Unlined • No base plug	• Penetrates aquifer by at least 3 metres (or 2 metres if very high inflow) • Lined with perforated or porous concrete rings (unless very high inflow) • Concrete or graded gravel base plug
Headworks	• Open • No concrete apron or drainage channel • May not have raised headwall • Nothing to prevent surface water entering the well • No protection against animals	• Closed • Apron, drainage and soakage pit • Raised headwall • Top 3 metres of shaft sealed to prevent surface water entering well • Diversion ditch to stop surface water flowing near well • Fenced
Water Extraction	• Users drop their own buckets into the well • Nothing to prevent children dropping items into well	• Closed with dedicated bucket, or handpump fitted • Community rules and regulations on use of well

Assessing Traditional Wells

The first thing you need to do when faced with improving a traditional well is to make sure that it is possible to improve it. Some characteristics of wells are able to be changed and some are not. Using the table above, the most important features that *cannot* be changed are:

- The Well Site
- The verticality of the shaft

The features that can be changed include:

- The shaft diameter
- The Well lining
- The intake section (including lining, base plug, aquifer penetration and so on)
- The Headworks
- The water extraction method

If the well has been badly sited in the first place and so is liable to become contaminated, then no amount of improvement will solve the problem. Similarly, if the well shaft is not vertical, then it will be very difficult to make it vertical.

If either of these things are not suitable, you should not attempt to improve the well.

See ***TDS 1 – Site Selection*** as well as the Community Facilitation Team booklets for more information on site selection. See ***Keeping the Shaft Vertical*** (in the section entitled **Construction – Well Shaft** above), as well as ***TDS 12 – Excavation*** for more information on shaft verticality.

If the well is in a good site, and the shaft is vertical (to within 1cm for every metre of depth) then it is likely that you will be able to improve the well. You should make a list of the features that need improving so that you can plan your work and make sure that the tools, equipment, materials and labour that you need are available.

Steps for Improving Traditional Wells

The following is a rough guide to the steps required for improving traditional wells. Every site will be different and so you will need to think through these steps for your circumstances. You may not necessarily need to complete each of these steps.

1. **Plan and set out the site, and make the necessary preparations for excavation**.

   You need to do the same preparation for improving a traditional well as for constructing a new well. Make sure during the site preparation that the well shaft is protected against items falling in (you should review all safety procedures – see ***TDS 8 – Safety Equipment***).

   See ***TDS 3 – Site Planning and Setting Out***, ***TDS 4 – Headframe Details*** for more information

   You also need to erect a suitable headframe for removal of spoil and lowering tools, equipment and lining materials into the shaft. All necessary tools, equipment and materials should be brought to site. See ***TDS 6 – Tools and Equipment*** and ***TDS 7 – Materials*** for details.

2. Excavate and Line the Shaft.

You need to decide on the lining and excavation methods. Which method you choose will depend on the site conditions. Most traditional wells are unlined, which means the ground is self supporting, however the process of enlarging the shaft may cause sections to become unstable, therefore you should take all the same precautions as with excavating a new well shaft (see ***Technology Options*** in the section **Construction – Well Shaft** above). See also ***TDS 9 – Pre-cast Concrete Rings***, ***TDS 10 – In-Situ Concrete Lining*** and ***TDS 11 – Masonry Lining*** for more details.

If the diameter of the existing shaft is greater than the outside diameter of the concrete rings then you can simply lower a column of concrete rings into the shaft and continue excavating using the Caisson Method to deepen the well. See ***TDS 13 – Caissoning*** for details. You should check the diameter of the shaft all the way down before lowering a concrete ring as a jammed concrete ring half way down the shaft is very difficult to move.

Make sure also that the first rings lowered are porous or perforated for the intake, and the cutting ring is installed at the bottom (if used). See ***TDS 9 – Pre-cast Concrete Rings.***

If the existing shaft is lined, and the lining is not suitable (if it is crumbling masonry or concrete, or rusting metal, then it should be removed. You should remove it in short sections (not more than 5 metres, and possibly less if the ground is not stable) and line as you go with whatever method you have chosen. See ***TDS 12 – Excavation*** for more information. You should also refer to the relevant TDS for the lining method you have chosen.

Note that for enlarging the diameter of an existing shaft, labourers will need to work suspended in a bosun's chair or similar. Loose material can be dropped into the well shaft and removed later. See ***TDS 6 – Tools and Equipment*** for details.

3. Construct the Intake Section

Almost certainly the intake section will need to be deepened to ensure a year round and drought proof water supply. The well shaft will, by now, be lined and completed to the surface, and so further excavation can proceed as with a newly constructed well.

Refer to ***TDS 13 – Caissoning*** for details of excavation into the aquifer.
Refer to ***TDS 14 – Dewatering*** for details of dewatering procedures.
Refer to ***TDS 16 – Measuring Yield*** for determining when you have excavated enough.

Once excavation is complete, finalise the well shaft as detailed in ***TDS 15 – Finalising the Well Shaft***.

4. Construct the Headworks

All the above ground components of the well should now be completed as with a newly constructed Hand Dug Well. This includes the headwall (see ***TDS 18 – Well Headwall***), the cover slab (***TDS 19 – Cover Slab***), the apron and drainage (***TDS 20 – Apron & Drainage***) and any extra features chosen by the Community and included in the contract (***TDS 23 – Hand Dug Well Extra Features***).

5. Complete the Hand Dug Well

Completion of the well is the same as for a newly constructed well. You should ensure that the well is properly cleaned and disinfected (see ***TDS 22 – Disinfection and Cleaning***), that the well is properly fenced and protected, and that the Community WaSHCOM is provided with adequate training in operation and maintenance.

As with a newly constructed well, you will be required to return and deepen the well should it dry up within 12 months of completion. See ***TDS 17 – Well Deepening*** for details.

The well is now ready to be handed over to the Community.