
TECHNICAL PAPER ## 61

UNDERSTANDING LOW-COST WELL DRILLING

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Understanding Low-Cost Well Drilling
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UNDERSTANDING LOW-COST WELL DRILLING

By VITA Volunteer Stephen Greenwood

INTRODUCTION

Safe drinking water is a basic human need. For a small community, no single project is more important to long-term social and economic well-being, health, and comfort than a safe drinking-water supply.

Ground water is a very common source of drinking water. In planning to build a well to tap and use ground water, people must first decide between hand-dug and drilled wells. Drilled wells can be deeper, safer, and more durable than hand-dug wells, but their construction is more expensive and technically demanding. Fortunately, most of the equipment for drilling a small well can be manufactured locally. In addition, simple and relatively inexpensive machinery for drilling wells has now been developed that can be used if money or expertise is available.

THE PLANNING STAGE

Care in planning the design and location of a water well requires extra effort, but improves the likelihood of building a successful well. In the early planning stages, these items must be taken into account: the specific needs of the community regarding well location and required amounts of water; the collection of available geological data; site inspection to avoid contamination; and ground water exploration, if there are no other wells in the area.

In selecting the site, avoid areas of possible contamination. Checking local maps and the closest water wells to the proposed site can give valuable information on the amount of water that can be expected from the well. Samples of water from existing wells can be sent to a laboratory to determine the mineral and bacterial content.

Contamination from surface sources must be avoided in selecting the site. The well should be constructed at least 50 meters (m) from the nearest potential source of surface contamination. Such sources include latrines, animal stalls or barns, polluted creeks, cemeteries, agricultural fields (pollution from chemicals), and roads (petrol and oil).

The next steps are to identify the best drilling method based on geological factors and local experience; determine such specifications as the material and size of the casing, approximate depth of casing and well screen, and labor requirements; and agree on the persons who will be responsible for record keeping, operation, and maintenance of the well.

WELL DESIGN

A number of items influence well performance and design. These include geological formations penetrated by the well, ground water recharge or rate of replenishment, amount of water needed, and type of soil in the aquifer (water-bearing formation below the surface of the ground). A complete or "engineering" analysis of these factors is beyond the scope of low-cost, manually drilled wells. Nevertheless, decisions must be made on the location, well diameter, length and type of well casing and well screen, grouting, and type of pump if necessary (Fig. 1). (This paper does not

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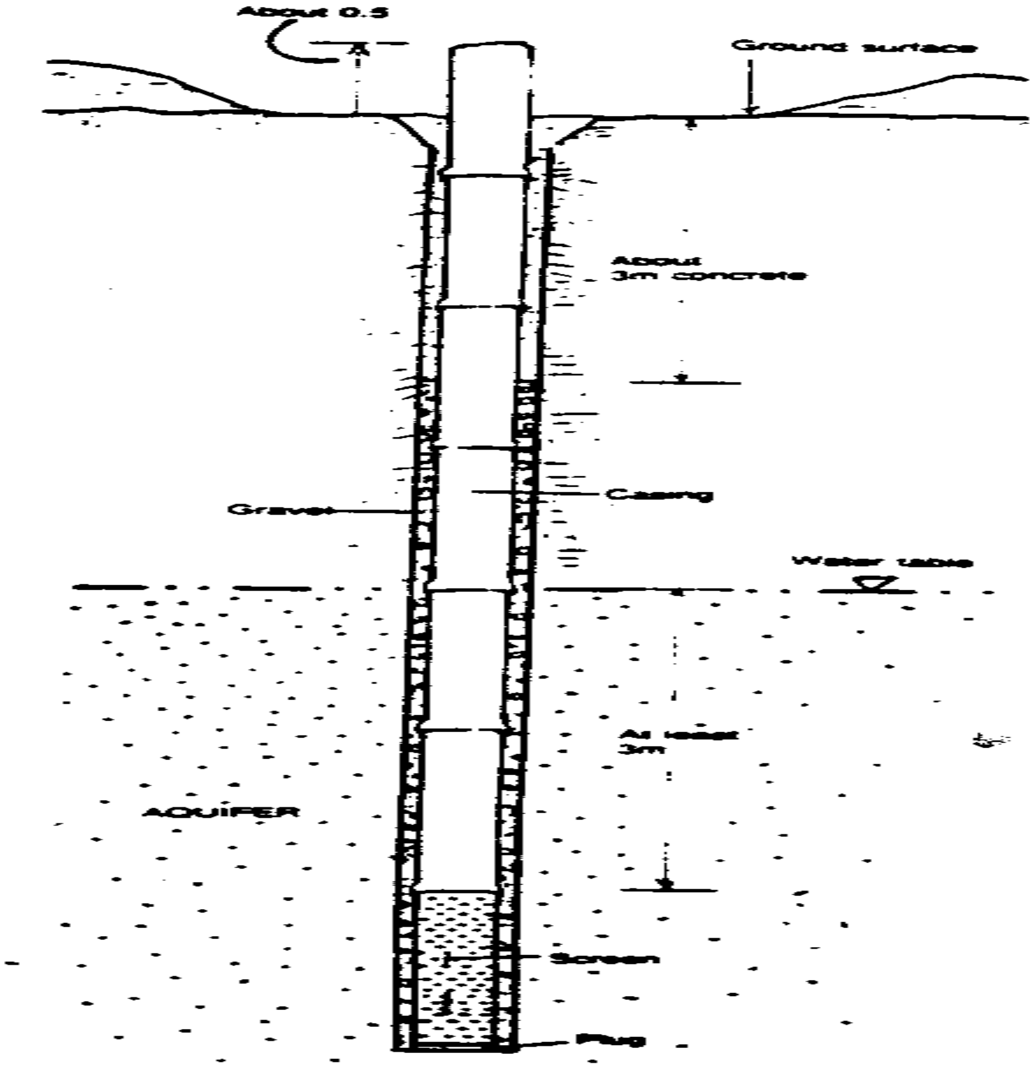

Fig. 1: Cross Section of a Drilled Well

describe pumps; the VITA Technical Paper on "Understanding Water Wells" and other references contain pump information.)

Well Casing

The well casing prevents the collapse of the bore hole and protects the pumping equipment. Among major cost items, it ranks after the pump. A thicker-walled casing costs only a little more and lasts longer. For steel casing, use "standard wall" (schedule 40 steel) or thicker.

Plastic well casing is most widely used, especially for shallower wells, because of its low cost, good handling properties, high corrosion resistance, and likelihood of local manufacture. A 15-cm diameter polyvinyl chloride (PVC) casing should have a minimum wall thickness of 0.6 cm. A 10-cm diameter polystyrene (ABS) pipe should have a minimum wall thickness of 0.5 to 0 6 cm.

Determining the depth at which the casing should stop and the well-screen should start requires careful observation by the well driller. The casing usually ends 2 to 3 m below the top of the aquifer.

The Well Screen

Well-screen design is a critical element in planning the well. The screen permits water to flow into the well and keeps sand and gravel out. It must be strong enough to prevent the collapse of the bore hole, but should not excessively restrict water flow rates. Recommended features of a well screen are as follows: a high proportion of open area, close spacing of the slots, sufficient strength to prevent collapse, single-metal construction (including screws, if possible) to prevent corrosion, and end fittings for installation.

The four common types of well screen are continuous slot, louvre-slotted pipe, low-level sawn slot, and perforated pipe (Fig. 2).

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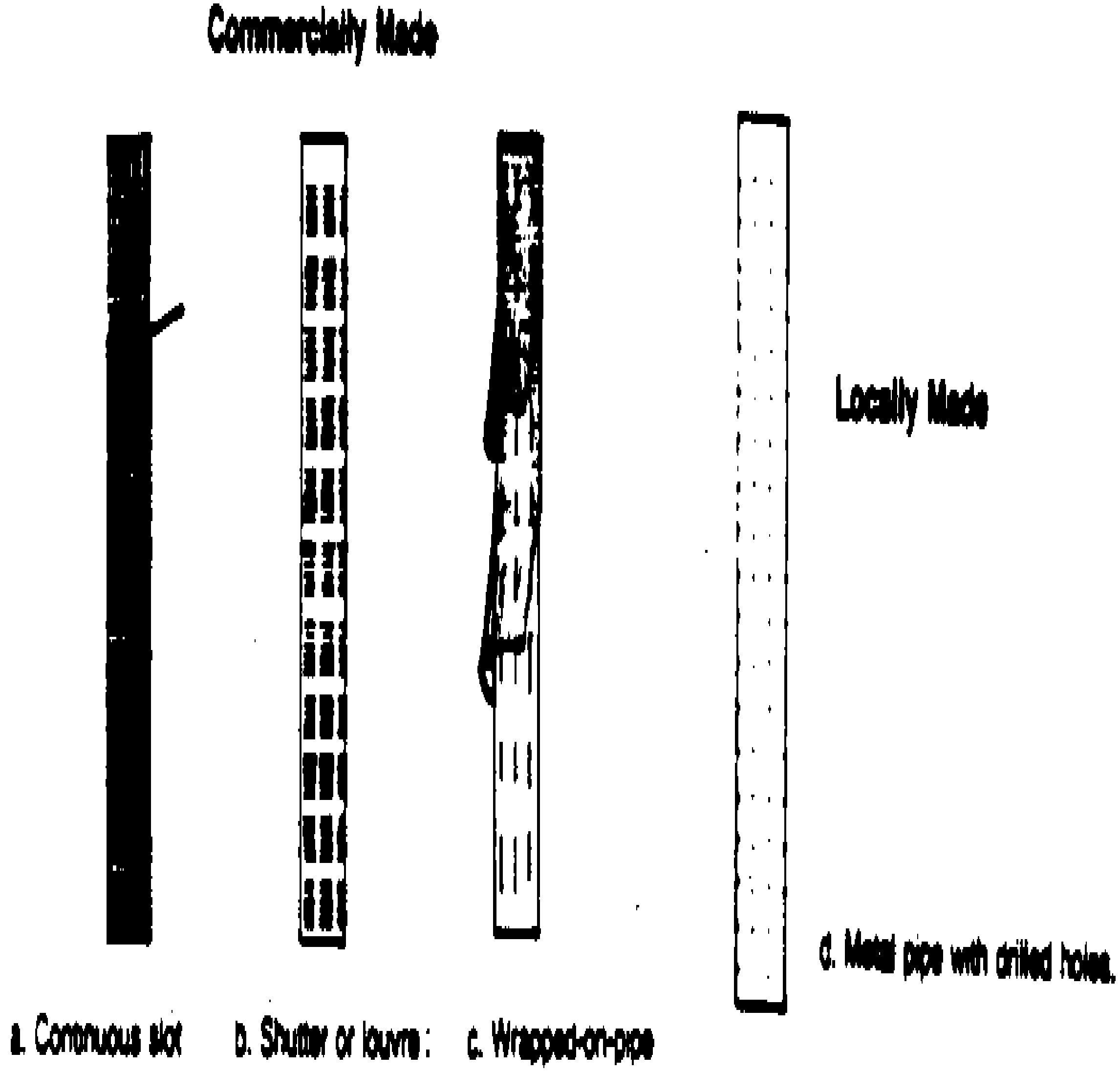

Fig. 2: Common Well Screens

The continuous-slot screen that is commercially available has more intake area per square meter (sq m) than any other type of screen, but can be expensive. However, its use in economical when the aquifer is not thick and is high yielding. But if a low flow rate within the aquifer is causing a slow recharge, a greater number of openings will not increase it.

Louvre-slotted and perforated pipes can be easily and cheaply made in most locations. It is often best to select them even though they are less efficient than some other types. Slotted plastic pipes are being used more often in small diameter wells because they are light in weight, noncorroding, and inexpensive. The slots can be made at the construction site with a sharp saw. The length of the screen depends upon the thickness of the aguifer, pumping rates, aquifer particle size, and the type of screen. Selecting the exact dimensions requires experience. For small-diameter wells, doubling the length of the screen will double the amount of water from the well. Placing the screen at the bottom of the aquifer will decrease the chance of a dry well during a period when the water table is low. If it is not possible to put the screen there, the top of the screen should generally be at least 2 m below the top of the aquifer.

Selecting the Size of the Screen Openings

The choice of hole and slot size will depend on the particle size of the sand and gravel in the aquifer. In order to maintain the strength of the pipe, the holes should not be too closely spaced. Most locally made pipes have a small open area but are adequate for general use.

During final stages of drilling, a soil sample should be taken from the formation where the screen will be placed. The proper screen size opening can best be selected by using a well-screen selector field kit (Fig. 3). Although the kit is not absolutely

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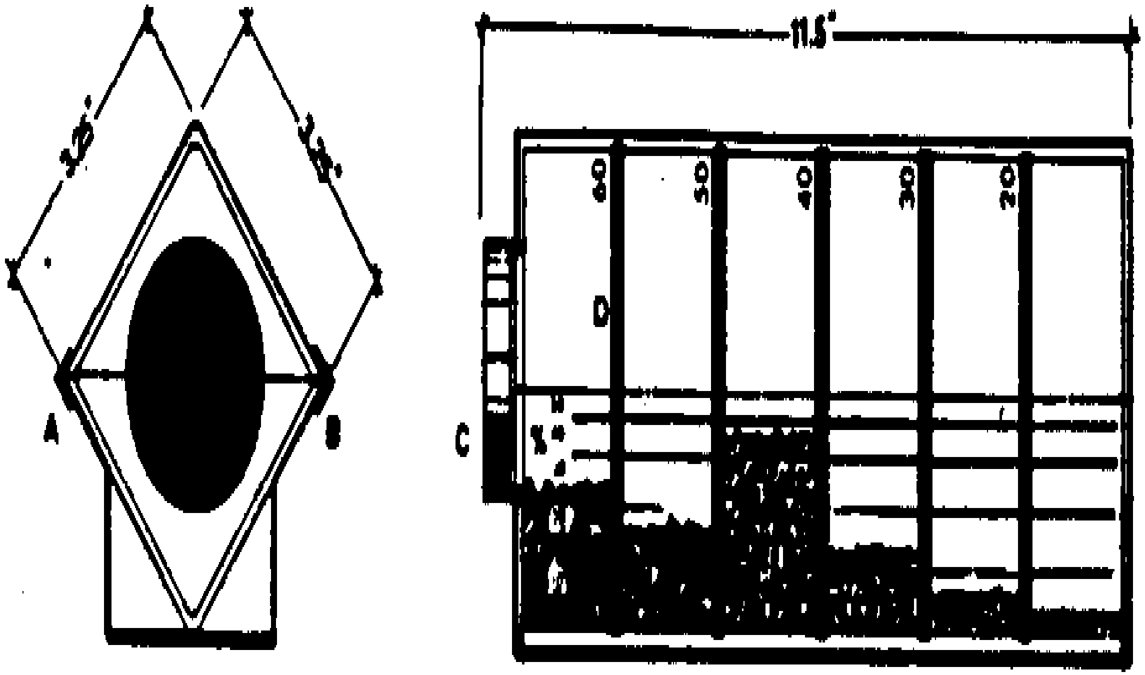

A. Latch

B. Hinge

C. Cap

D. Removable Screens

Fig. 3: Well-Screen Selector Kit

necessary to well construction, it is described here to aid in understanding the relation of screen size to soil particle size. The device is a box with removable square screens. Equally spaced lines are drawn along the inside of the box. Wire mesh screens with openings of five different sizes are placed inside the box with the largest opening at the top of the box.

A dry sample from the soil in the aquifer is placed in the upper compartment and thoroughly shaken. The box is then placed on its side and the side door is opened. Using the drawn lines, the height of each fraction of the sample between screens is measured. If the total amount of sample is known, the percentage of the sample that passed each screen can be calculated. The screen that lets about 40 percent of the sample pass through should be selected to represent the screen-opening size that should be used. The slots will seldom be more than 3 millimeters (mm) wide.

SANITARY PROTECTION DURING CONSTRUCTION

Contamination of the well during construction can spoil the well site and make the well unusable for a while. Here are the steps to be taken while the well is being built to protect it f rom contamination:

o The well should always be covered when work is not in progress.

o The well casing should extend at least 0.5 m above the highest known flood level.

o The ground around the well should be sloped to drain water away from the well. Building a concrete slab around the well will reduce the amount of mud during construction.

o The casing joints should be tight so that no water seeps through.

o The space between the bore hole and the well casing should be sealed with concrete grout to at least 3 m below the ground.

WELL CONSTRUCTION: GENERAL METHODS

Well construction consists of six basic operations: drilling, casing installation, screen installation, gravel packing, development, and disinfection. There are two drilling methods, percussion and rotation. The well driller must know the advantages and limitations of each method to determine which is best suited to the geological formation and local experience. For example, both types of drilling methods may be used for the same well. If there is soft sandstone above a hard "rock" (compacted soil) formation, a rotation method can be used to drill through the sandstone and a percussion method used in the hard formation.

Percussion Drilling

Percussion methods raise and drop a heavy drill bit to break up the soil. The material can then be removed f rom the hole by several means, including a cable-driven bailing bucket and a dry bucket. In soft formations, the cut material is merely pushed into the sides of the well.

The drill bit may be raised either manually or with a motor. Two

methods of manually raising the drill bit are shown in Fig. 4.

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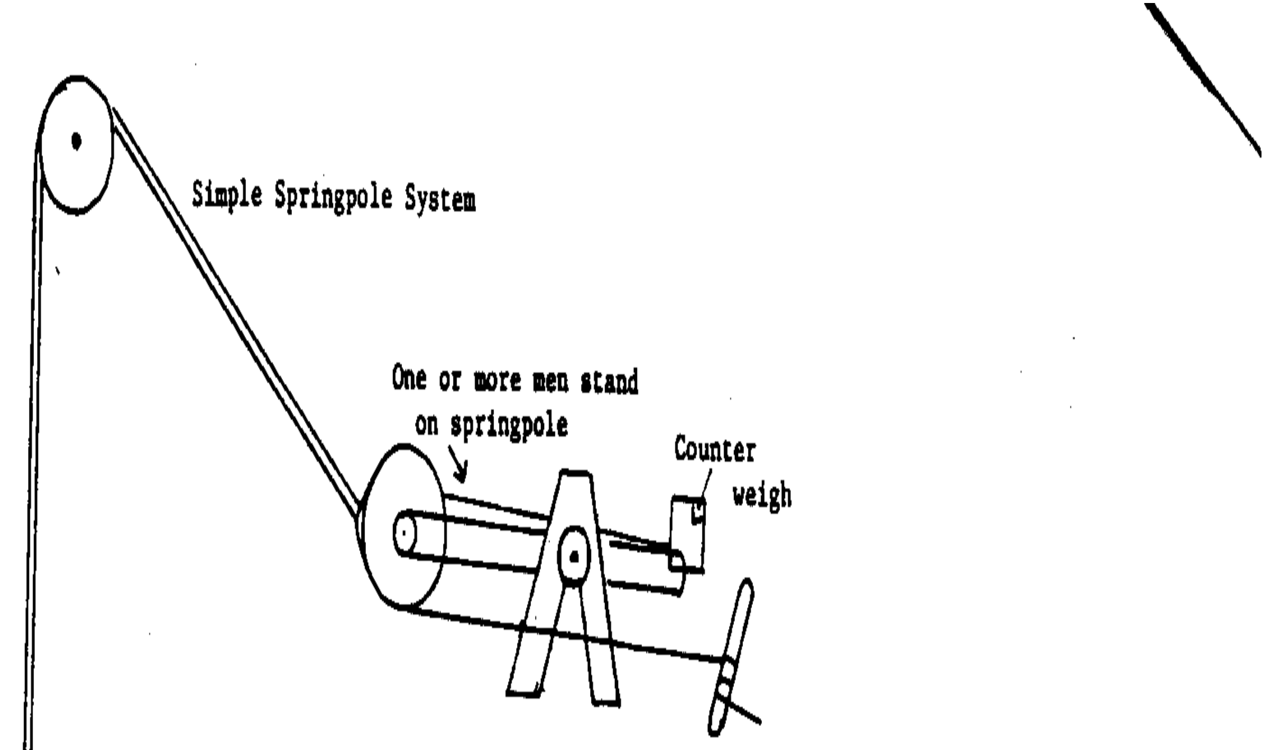

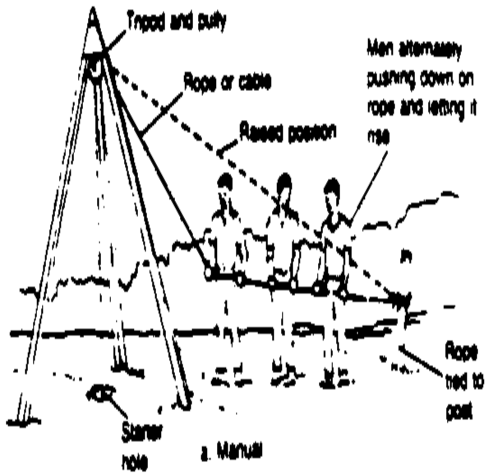

Fig. 4: Two methods of manually raising a drill bit--using a pulley with counter weight (above) and pushing the cable by hand (right).

The drill bit should be raised about half a meter before it is dropped. A bouncing action is preferred; as the cable stretches and springs back from the impact of the drill tool, lifting

action is applied to keep it bouncing. Experience develops this skill. When the reverse-circulation technique is used, flowing water assists the percussion drilling process.

The drill bit can be mechanically lifted by the use of a cathead (capstan) attached to a jeep, truck motor, or other power source (Fig. 5). The cathead consists of a metal spool, welded together

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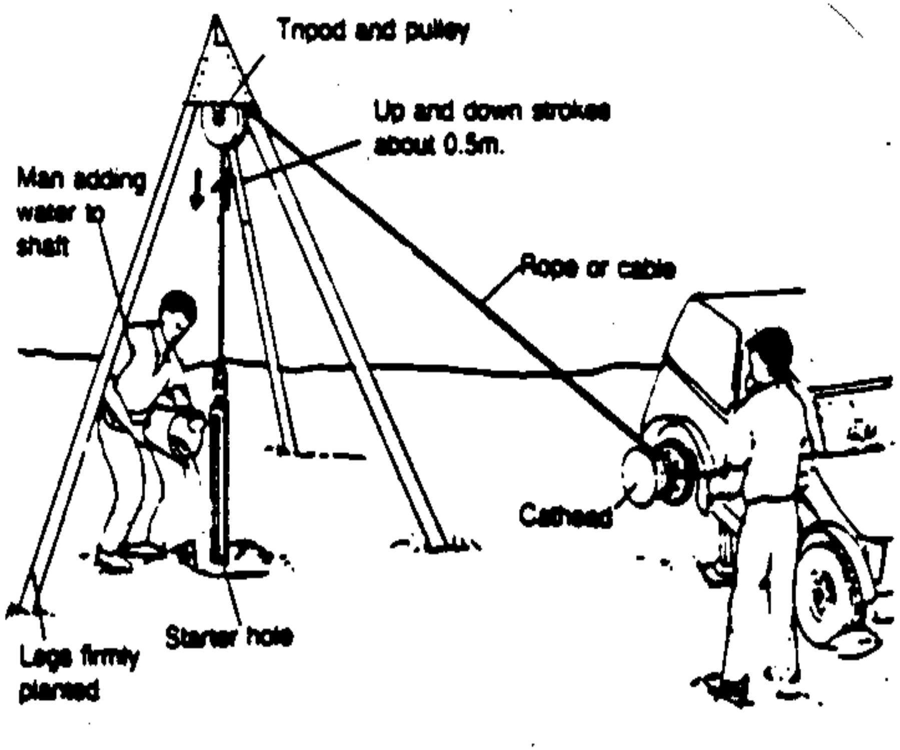

Fig. 5: Using a cathead to raise the drill bit.

from a scrap section of metal pipe and two steel disks, one of which is drilled and bolted to the vehicle (Fig. 6). The vehicle

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ocally Fabricated Cathead Mounted to a Rear Wheel Hub

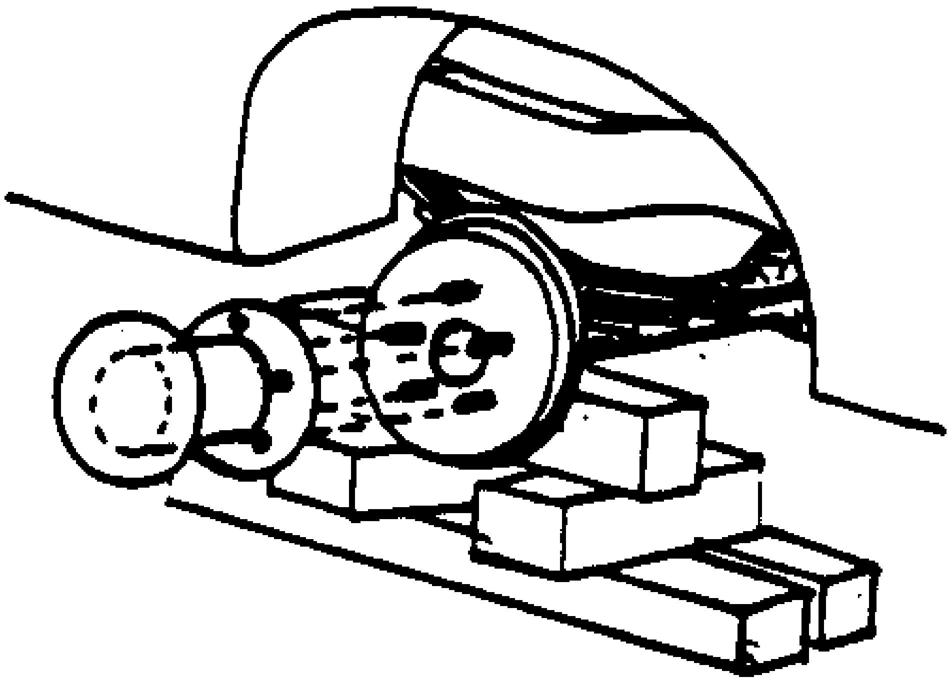

Fig. 6: Mounting cathead on wheel hub.

should be parked 4 to 6 m from the well, the rear end elevated by placing rocks under the axle for support. The rear wheel is removed and a cathead is attached to the wheel hub. The rope or cable supporting the drill bit is wrapped around the cathead. Alternately tightening and loosening the rope will allow the rotating cathead to raise and drop the drill bit. Since unprotected ropes and cathead are very dangerous, they should be covered to protect the operator from accidental injury.

Rotation Methods

The drill bit is turned to create the hole. Turning requires wood rod handles or chain tongs clamped to the drill rod as shown in Fig. 7. Examples are the bored (augered) well and the jetted

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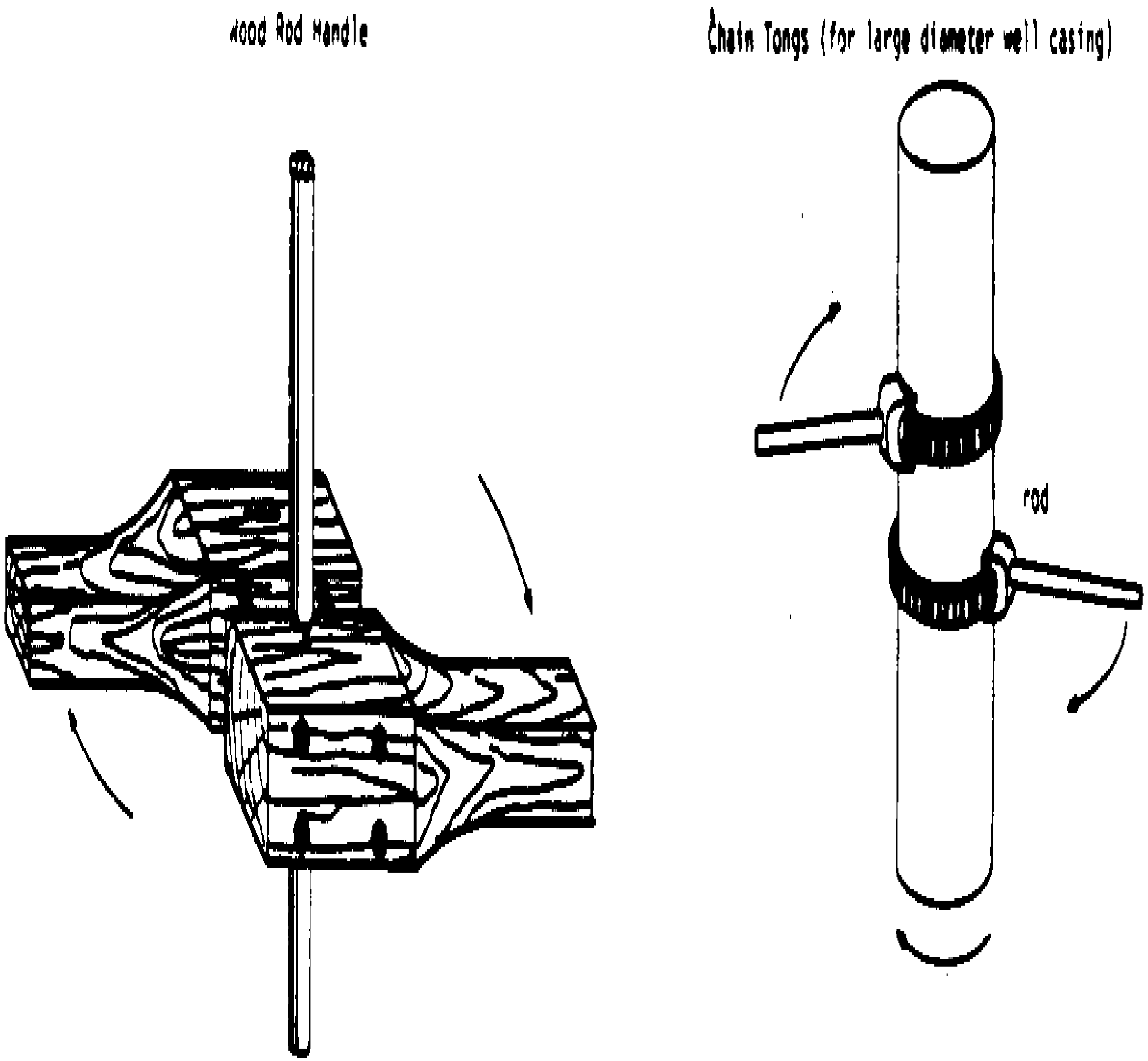

Fig. 7: Handles used to turn drill rods

well. Jetting uses water to assist the action of the drill.

Common Materials and Methods

The items required for well construction can include: casing pipe, well screen, pipe couplings, concrete mix, tripod, pulley, ropes, drill bit, bailer, "fishing" tools, hammers, hacksaw, metal files, pipe wrenches, screwdrivers, shovels, measuring tape, plumb bob, chain tongs, pipe-joint sealing material, wood saw, wire, cold chisel, pipe dies, rod dies, first-aid kit, and hard hats. Some items exist in several types according to the methods of well construction.

The tripod is the most widely used and locally manufacturable type of drilling-support structure. Tripods can be made of bamboo, wood, or pipe (Fig. 8). The height of a tripod is limited

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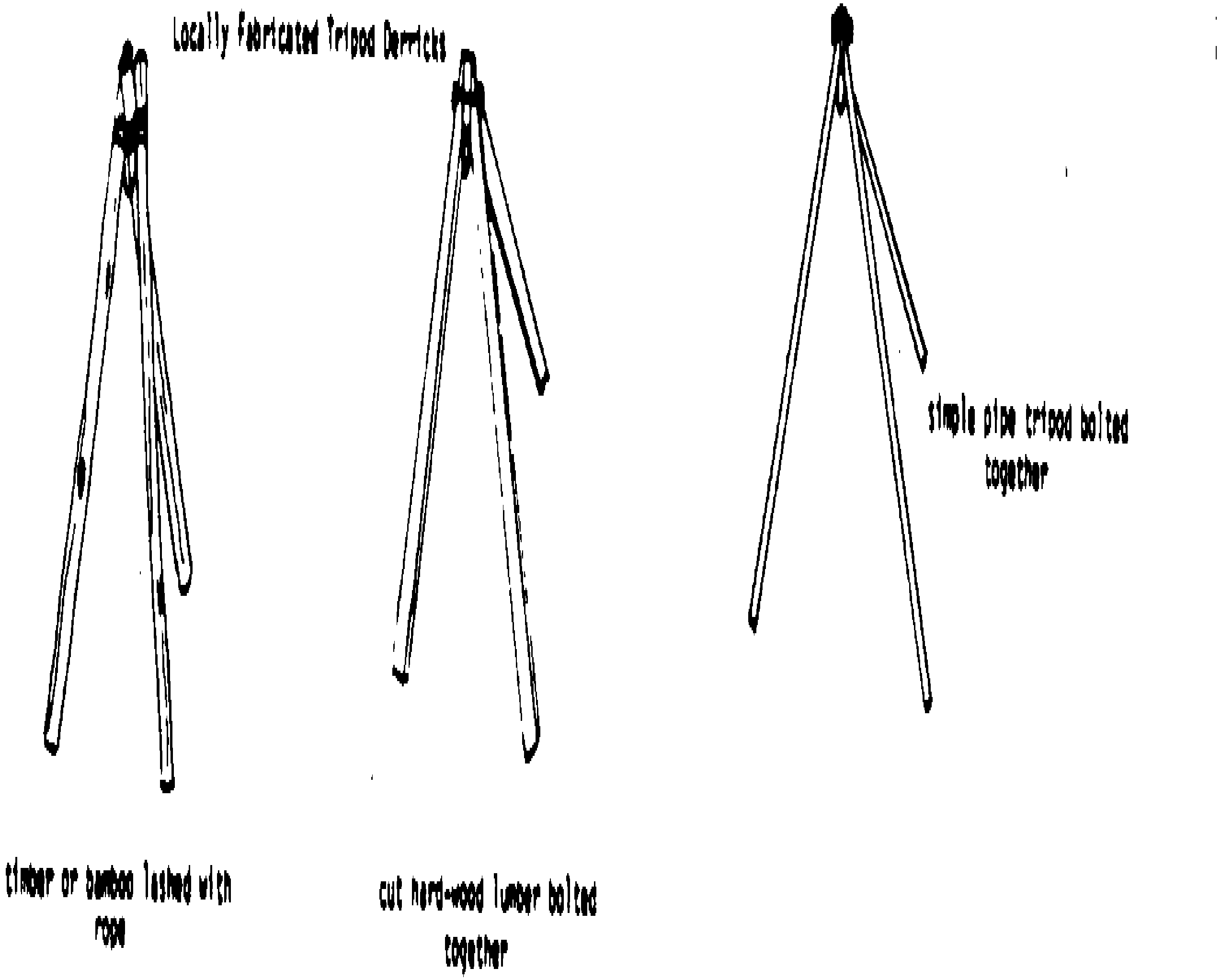

Fig. 8: Drilling tripods

by the strength of the legs. Generally, the tripod should be at least 4 m high.

Bailing--raising water, sand, and clay to the surface for removal--is a common procedure during drilling and afterward during the process of development. Bailing involves lowering the bailer (a bucket device) to the bottom of the well and lifting it to the surface for disposal.

When drilling reaches the desired depth, the well screen is installed and the well is grouted, developed, and disinfected.

WELL CONSTRUCTION: SPECIFIC METHODS

This section briefly describes the most commonly used methods of drilling or boring wells. For each method, essential equipment and basic procedures are given. Essential equipment can usually be made locally.

Driven Wells (Percussion)

A hammer of at least 20 kilograms (kg) is repeatedly dropped on the well casing. This method works best when the water table is less than 10 m below the surface and there are no rocks. A well screen with a

special pointed drive shoe should be used. The main kinds of hammer are shown in Figs. 9 and 10.

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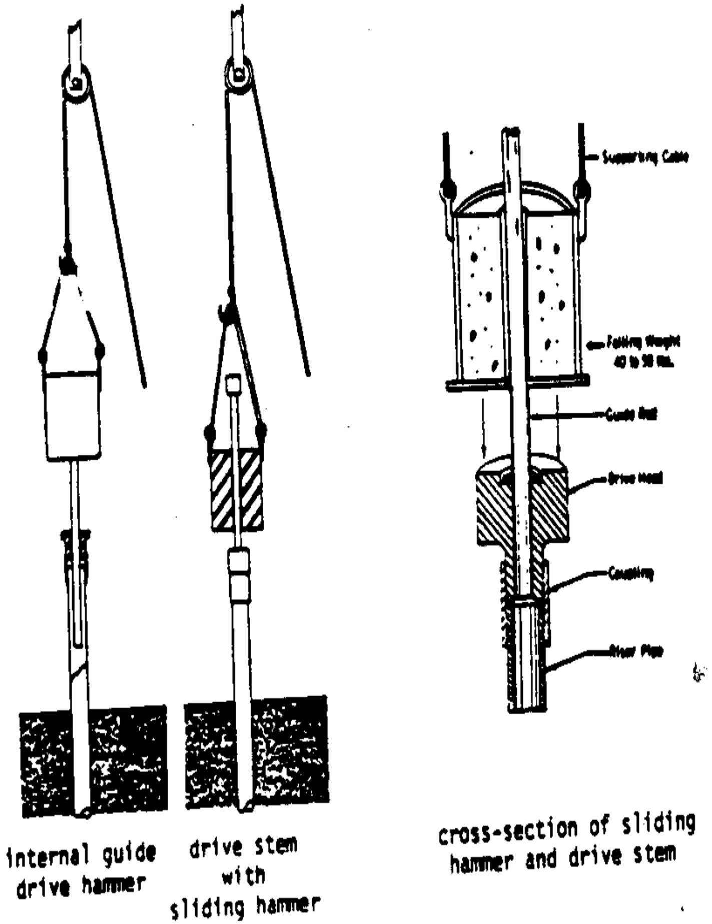

These assemblies provide an effective means for driving both well screens and casings.

Fig. 9: Heavy duty sliding Hammer and Drive Stem Assembly

one or two people can perform the drilling.

Equipment: Sliding weight, drive head to protect the casing, tripod, ropes and pulleys, well drive-point and casing. Standardweight pipe is usually not strong enough; stronger drive pipe and couplings are usually needed.

Procedure: Dig a vertical starter hole about half a meter deep and slightly larger than the diameter of the well. Erect the tripod. Assemble the drive head, casing, and well point. Insert the well point into the starter hole. Start driving the well point into the ground by the selected hammering method. When the top of the casing is near the

ground, remove the drive head. Add a section of well casing and install the drive head on the top of the casing. Continue driving and adding sections until the desired depth is reached.

Cable-Tool Drilled Wells (Percussion)

Cable-tool drilling is one of the most versatile methods because it can penetrate almost any type of geologic formation, including compacted soil. But drilling is slow and casing must be installed as drilling proceeds if the formation is unstable. A chisel-faced bit (Figs. 11 and 12) is repeatedly raised and

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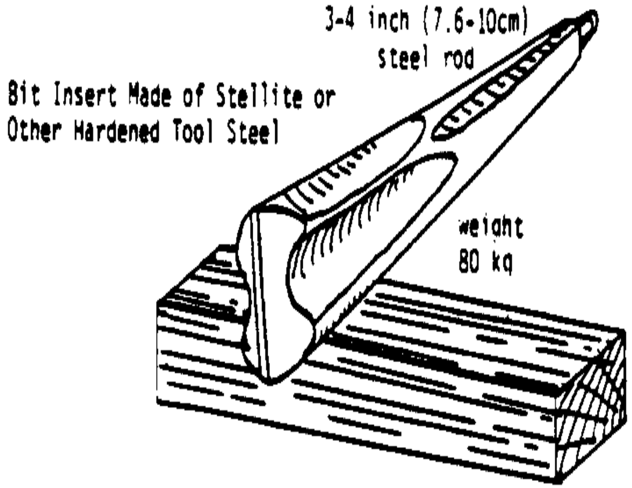

Fig. 11: Locally Fabricated Bit for Drilling Hard Rock

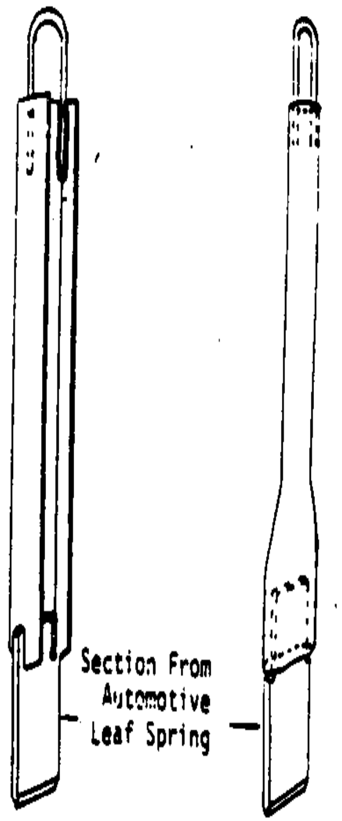

Fig. 12: Simple drill bits constructed from steel, pipe, scrap metal.

dropped, thus breaking and pulverizing the soil. Various methods can be used to raise and drop the drill bit, as previously described. Water is added during the process to make a slurry.

This will make bailing more efficient. The fall of the drill bit will be slowed when too much slurry has accumulated. The slurry must then be bailed out of the well. The drill bit is lifted from the hole and the slurry is removed with a bailer bucket. Water is then added to replace the lost slurry.

If the bit is lifted manually, at least six persons are usually needed. With mechanical lifting the work crew can be reduced to three or four.

Equipment: Percussion bit sized to fit inside the casing, bailer to fit the casing, tripod and pulley, ropes, casing, and screen.

Procedure: Dig a vertical starter hole about half a meter deep and slightly larger than the diameter of the well. Erect the tripod. Secure one end of the rope to the percussion bit and guide the rope over the pulley. Raise and drop the drill bit in short rapid strokes of about half a meter with a bouncing motion. Add some water to the bore hole so that the cuttings will form a slurry.

When the cuttings become so thick that the bit speed is significantly slowed, bail the well. First, remove the drill bit and lay it on the ground. Attach the bailer to the rope and lower it into the well. Allow the bailer to strike the bottom of the well a number of times to suspend and pick up cuttings. Raise the bailer out of the well and drop the contents at the side of the well. Repeat the process until the bailer is no longer picking up material. Remove the bailer and attach the drill bit. Continue

drilling and bailing, until the desired depth is reached.

Install the casing as the drilling proceeds. If a caving formation is encountered, drive the casing down more frequently.

Dry-Bucket Drilled Wells (Percussion)

A cylindrical dry bucket is repeatedly dropped to the bottom of the hole and lifted (Fig. 13). The impact forces the soil or

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rill bit to fit inside the casing, ropes

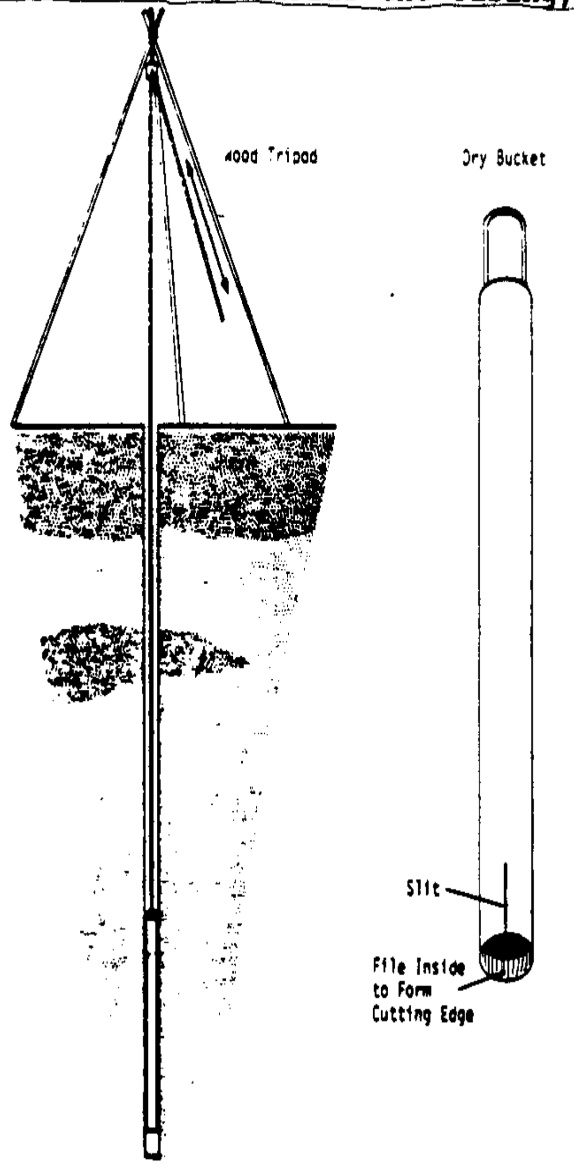

Fig. 13: Dry bucket drilling equipment

other material into the bucket. When penetration decreases, the bucket is lifted to the surface and the soil is removed by hitting the side of the bucket with a heavy object. When the soil no longer adheres to the bucket, a casing can be installed and an auger or bailer used to drill the hole below the water table.

This simple method of drilling is limited to depths of 20 m and diameters of 10 to 15 cm. It works well in most clays and silts, but not in heavy clay or loose sand. The formation should be free of rocks and fairly dry.

Equipment: Dry-bucket drill bit to fit inside the casing, ropes and pulley, tripod.

Procedure: Dig a vertical starter hole about half a meter deep and slightly larger than the diameter of the well. Erect the tripod. Attach rope to the dry bucket. Insert the bucket into the hole and begin repeatedly lifting and dropping it about half a meter. When penetration slows or stops, remove the dry bucket drill bit. Remove the dirt from the bucket. Install

casing as required. Continue operating the bucket until the desired depth in reached.

Reverse Circulation Wells (Percussion)

This commonly used method of drilling (also termed "sludger" or "hydraulic percussion" method) involves repeatedly dropping and raising the hollow drill bit, which is equipped with a one-way check valve (Fig. 14). The bore hole is kept filled with water

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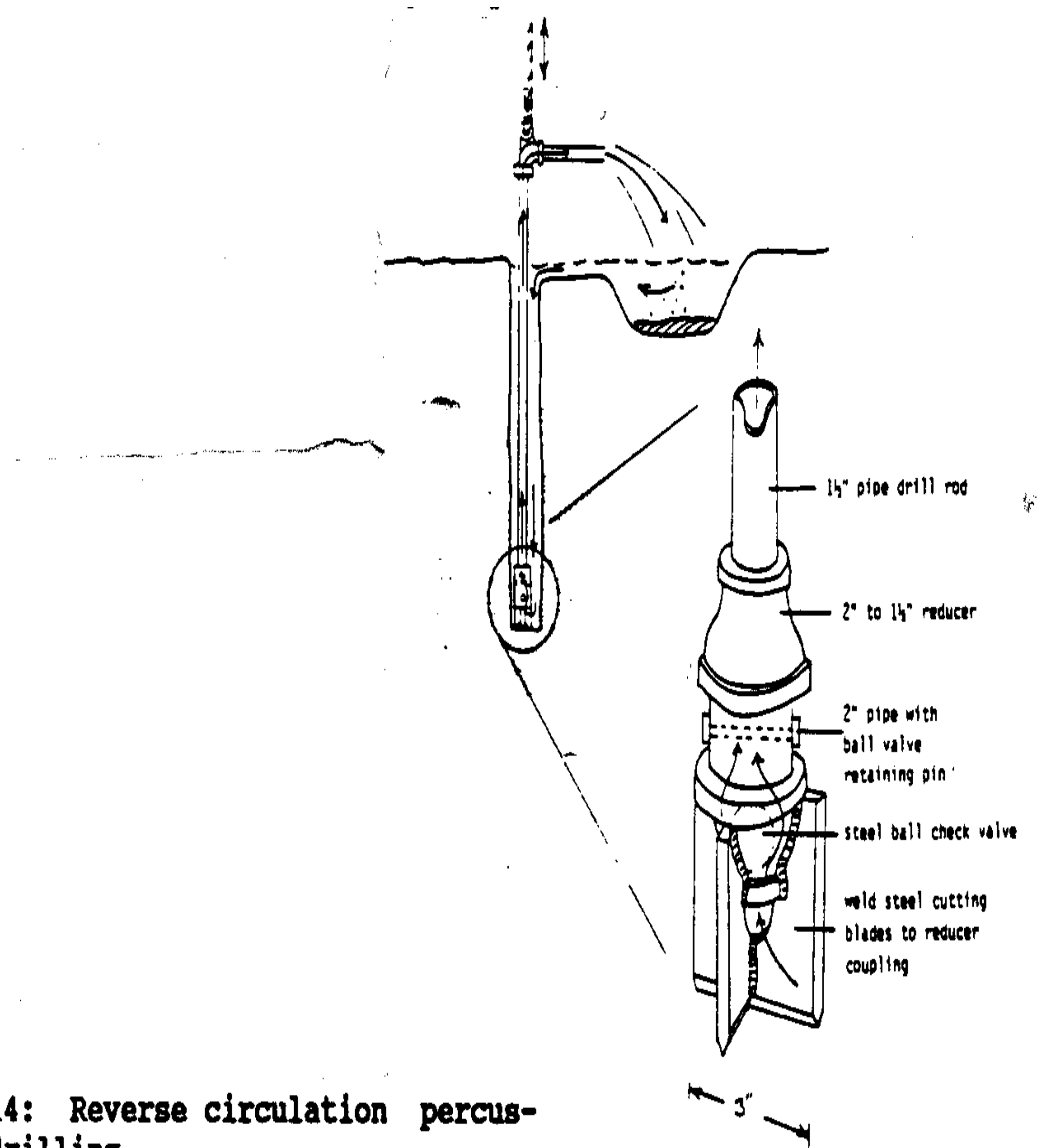

Fig. 14: Reverse circulation percussion drilling

from a settling pond. Cuttings in the well are removed through the hollow drill stem as the drill is raised and dropped. If the drill bit lacks a check valve, a drilling assistant can simply

stop the discharge on the up stroke by placing a hand over the stem and releasing the stem on the down stroke. The water and cuttings flow to the settling pond, where the cuttings settle out.

The method is good for wells having an average depth of 20 m, with a maximum depth of 80 m. It does not work well in hard formations or gravel, but is suitable for sand, clay, and silt. Drilling can be done very rapidly by an experienced drilling crew.

Equipment: Drill bit, preferably with one-way valve; hollow drill stem; tripod; ropes and pulleys.

Procedure: Dig a vertical starter hole about half a meter deepand slightly larger than the diameter of the well. Erect a tripod. Dig a settling pond nearby at least one meter square and one meter deep. Attach the drill bit, drill stem, and ropes. Fill the starter hole with water. Repeatedly raise and drop the drill bit a distance of half a meter If a one-way valve is unavailable, the drilling

assistant should substitute his hand as described above. Attach additional hollow drill stem sections and, if the walls of the hole are unstable, sink casing as the well deepens. When the desired depth is reached, remove the drill.

Bored (Augered) Wells (Rotation)

This is one of the oldest and simplest drilling methods. A hole is drilled by manually rotating a drill bit or auger. The auger must be periodically lifted to the surface and emptied. Drilling is rapid for the first five meters, but becomes slow at greater depths because the drill rod must be uncoupled as the auger is lifted to the surface. (Fig. 15)

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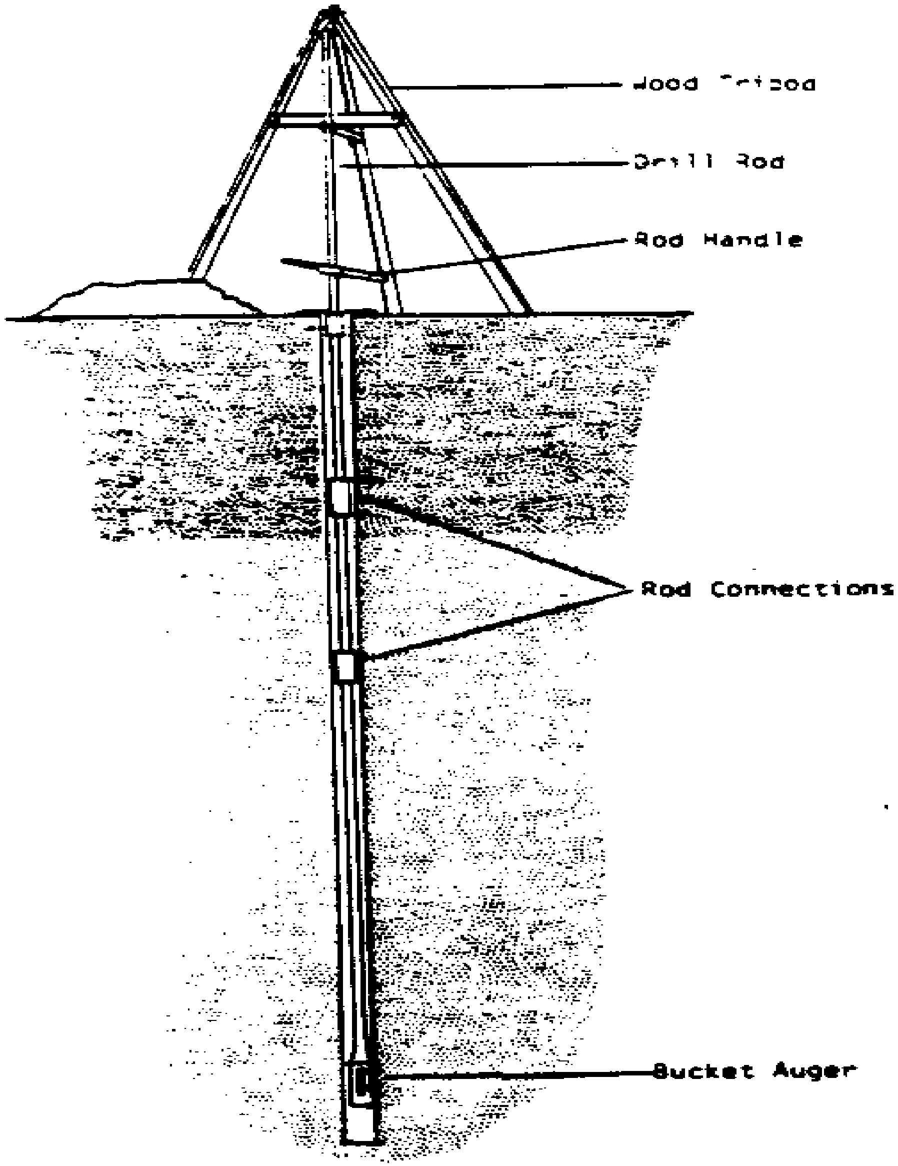

Fig. 15: Hand Auger Drilling

Drilling with an auger is suitable for sand, clay, silt, and some gravels, but not for rocks or thick gravel. Depths of 25 m

are obtainable. A four- to six-person crew is required.

One type of auger is used for such cohesive solids as clay. A different type of auger is used for loose solids such as sand and gravel. Augers of more advanced design often have many teeth mounted on rotating cones; these require machine operation and a level of expertise beyond the scope of this paper. (Fig. 16)

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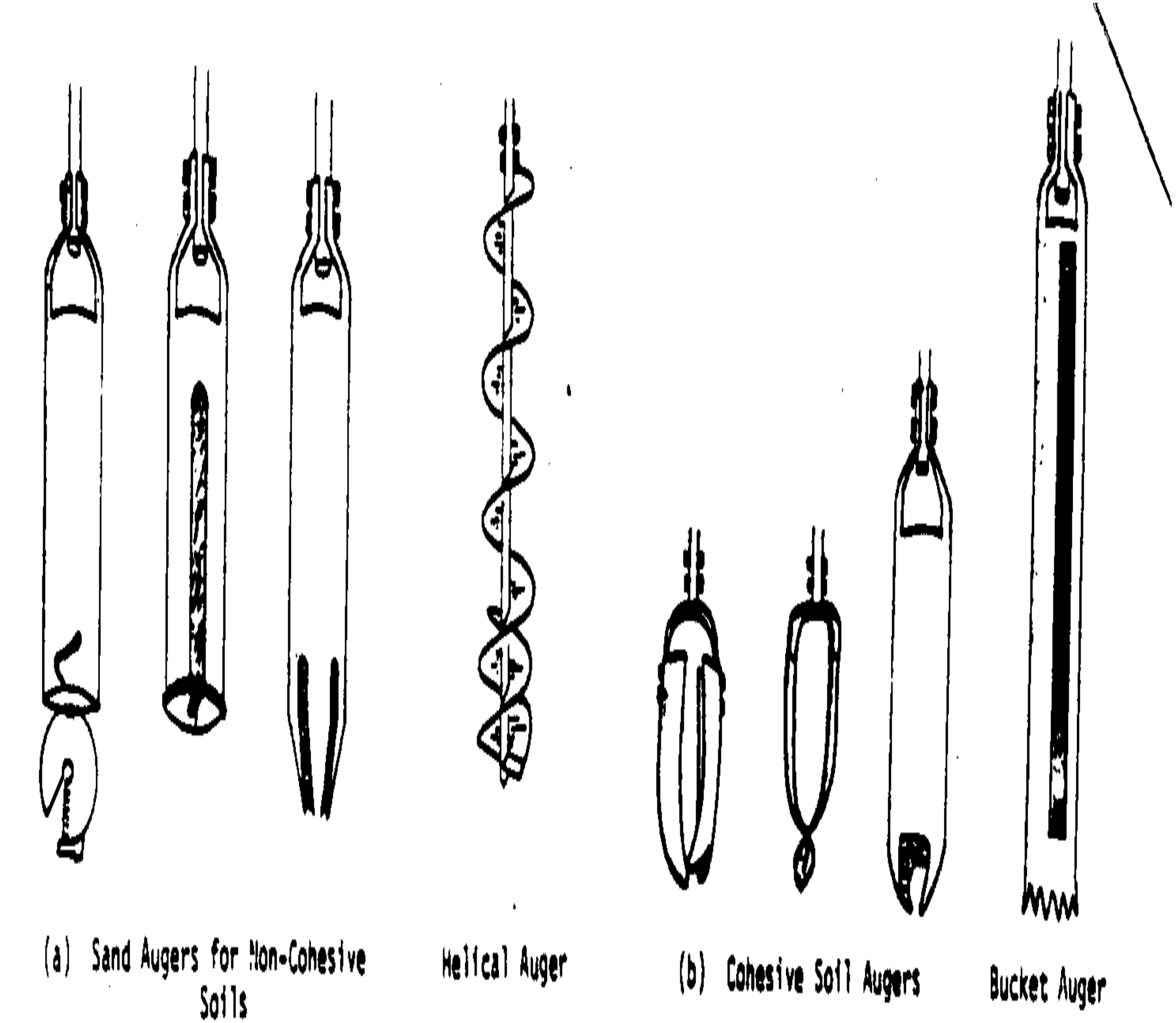

Fig. 16: Typical Hand Augers and Equipment

Equipment: Tripod, drill rod, auger, handles for turning the drill rod and auger.

Procedure: Dig a vertical starter hole about half a meter deep and slightly larger than the diameter of the well. Erect a tripod. Attach the auger to the drill stem.

Plumb the drill stem by adjusting the location of the support tripod. Turn the drill stem with a rod handle, until the auger fills or progress slows.

Lift the auger from the hole and remove the soil. Attach additional drill stem sections as the well gets deeper. They may have to be removed as the auger is raised to the surface. A raised platform can be constructed to provide additional support for them as they are lifted to the surface. When the desired depth is reached, remove the

auger and drill stem. Install the casing and screen.

Jetted Wells (Rotation)

A water jet cuts through the soil or other formation along with the action of a drill bit. Water pumped through the hollow drill rod forces the sand, silt, and clay to the surface, where the mixture is drained to a settling pond. Water from the settling pond is pumped back to the drill rod bit. The well casing fitted with a drive shoe is sunk as drilling proceeds. (Fig. 17)

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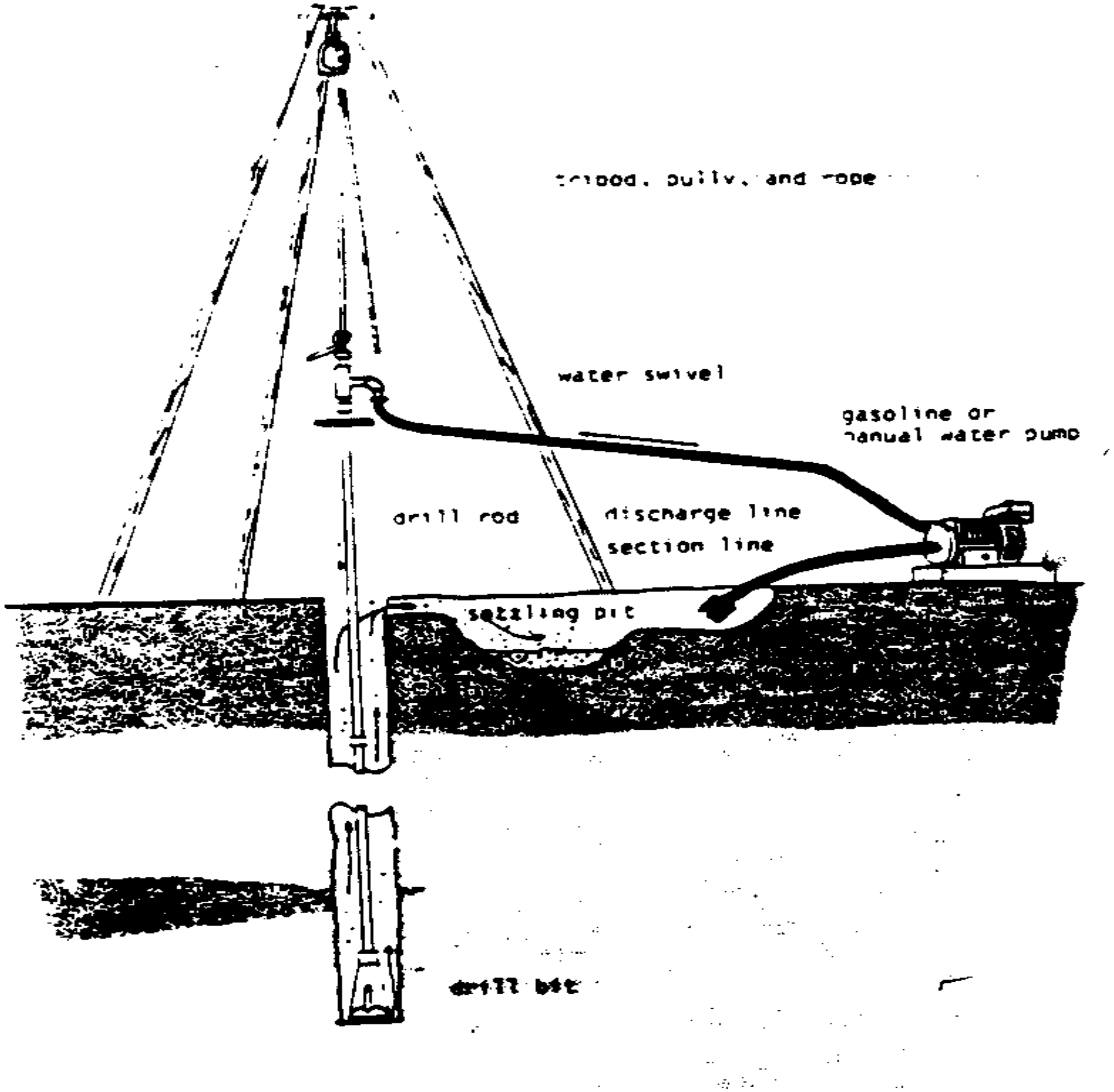

Fig. 17: Manual Jetting Equipment

Several types of drill bit suit different

geological formations (Fig. 18). The straight

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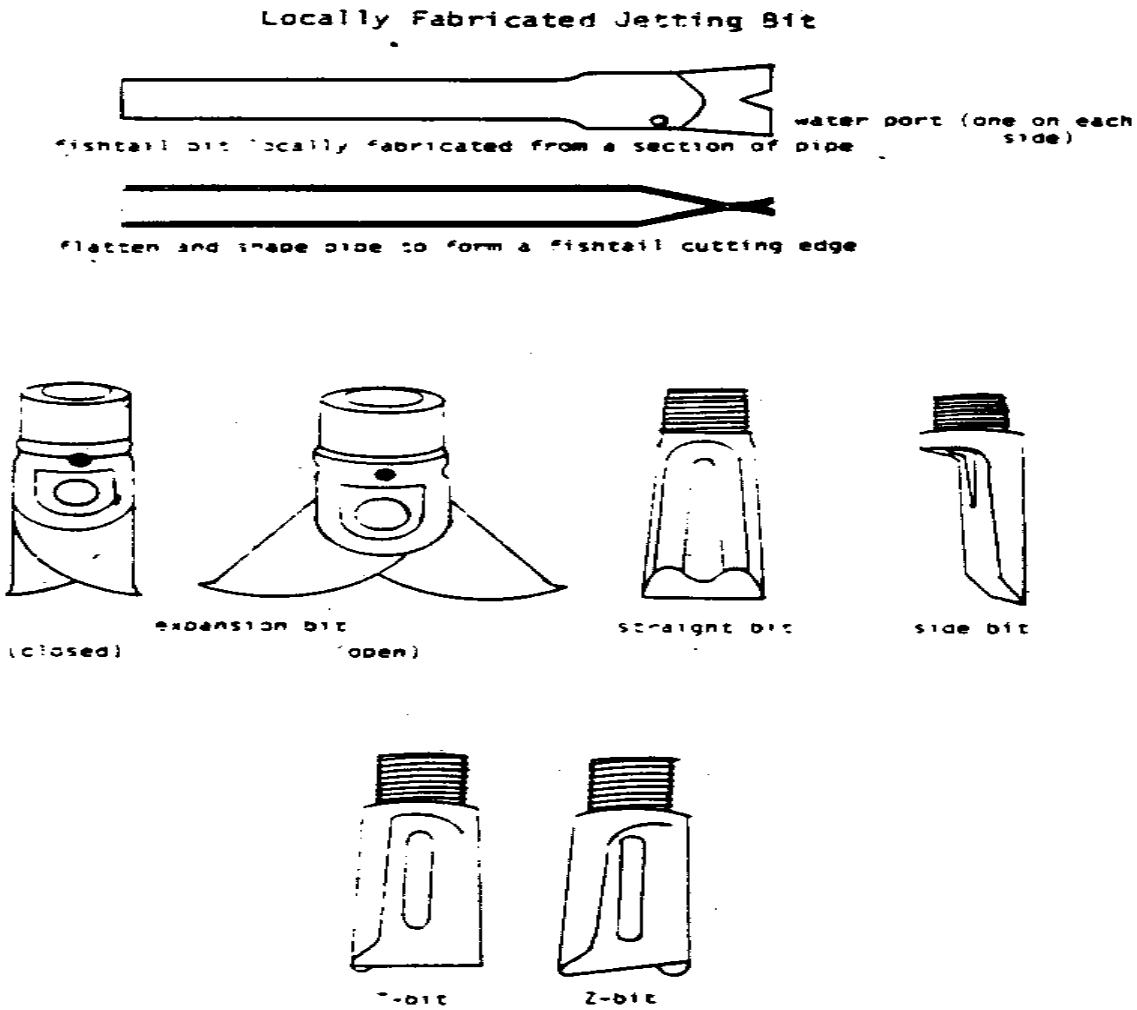

Fig. 18: Locally Fabricated Jetting Bit

bit is used for clays.
The side bit is used to
slip inside a casing and

expand below its lower end so that the new hole will be big enough for the next section of casing.

This method is excellent for drilling through sandstone and soft rock.

Equipment: Motorized or manual pump, tripod with rope and pulley, drill rod with couplings, drill bit, a water source, well casing and screen. This method uses specially designed equipment that may not be easily available.

Procedure: Dig a vertical starter hole about half a meter deep and slightly larger than the diameter of the well. Erect a tripod. Dig a settling pond nearby at least one meter square and one

meter deep. Install the drill bit, drilling rod, ropes, and pulley. Connect hoses from the settling pond to the pump and drilling rod. Start the pump. Rotate the drill rod to enhance erosion by the water. Install screen casing when the desired depth is reached.

WELL ALIGNMENT AND PLUMBNESS

A well may become crooked if the drill bit is deflected by large stones. A crooked well can strain the shafts and bearings of some types of pumps, or may result in damage to the casing by the pump shaft. The driller should check the alignment of the well several times during drilling of a deep well. In this way faulty construction is avoided or promptly corrected.

Wells 30 to 60 m a deep are often usable even if they are a little crooked. If the fault is serious, it is usually cheaper to start a new well than to correct the fault.

Vertical alignment can be checked by suspending a plumb ring from a tripod and lowering it to various depths (Fig. 19).

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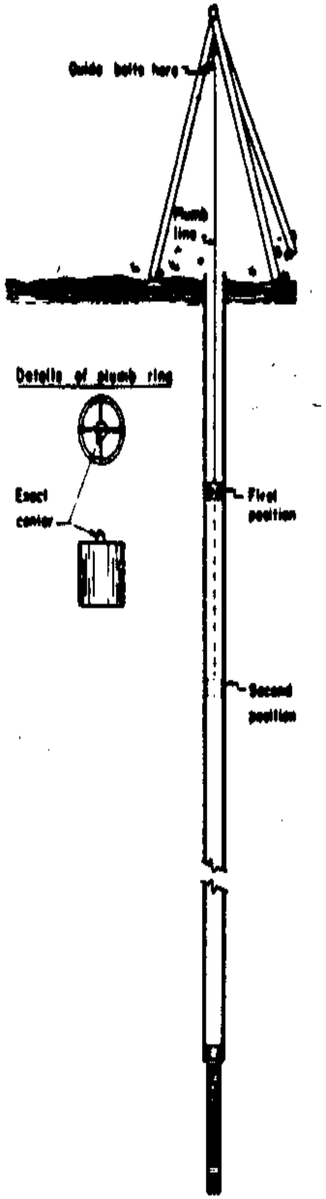

Fig. 19: Maintaining verticle alignment.

The diameter of the ring must be less than the diameter of the casing. An alternative

method is to lower to the bottom a dummy casing with a diameter one centimeter (cm) less than that of the regular casing. If the dummy moves freely to the bottom of the well, a pump will operate satisfactorily.

GROUTING

Grouting seals the space between the well casing and the bore hole. It is required to prevent contaminated surface water from entering the well. In addition, grouting extends the life of the casing.

Grouting is performed after installation of the casing and screen, and before well development. The best method is to pump the grout through a pipe to the lowest desired elevation, raising the pipe as the grout is placed. Because a grout pump is very expensive, an easier but less reliable method is used: pour cement grout into the space, upon a bed of gravel. Cement grout is made by mixing 20 liters (L) of water with 45 kg of cement. If there is a large volume to fill, sand and gravel can be mixed with the cement.
Procedure: Pour fine ("pea") gravel into the space around the casing to slightly above the water table, but at least 3 m from the ground surface. Mix the cement grout and pour it to fill the rest of that space.

WELL DEVELOPMENT

After well-screen installation and grouting, the well must be developed to ensure maximum water flow rates. Development consists of causing rapid reversals of water flow (called "surging") through the screen and the surrounding aquifier. It washes away very fine sand, silt, and clay that may have remained in the aquifer around the screen. These fine particles restrict the flow of water. In addition, drilling may compact the soil next to the bore hole; development returns the soil to a loose condition.

In development, the rapid outflow of water through the well screen dislodges fine particles from the surrounding layer. The inward flow of water allows the fine particles to enter the well. These are removed with a bailer or by pumping. The process leaves coarse material with good flow characteristics around the screen. (Fig. 20)

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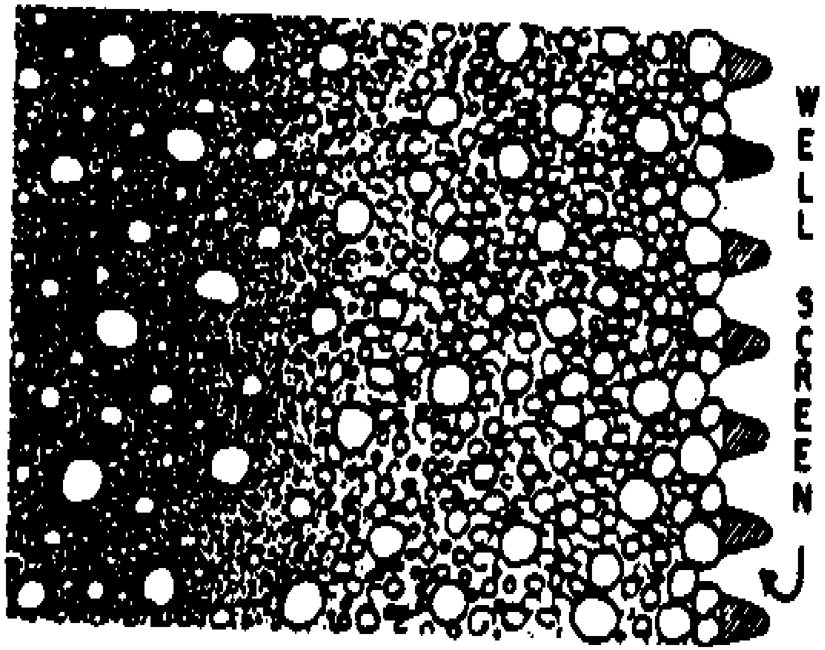

Fig. 20: Coarse material around well screen

The mechanical surging of the well can be done with a locally made surge plunger (Fig. 21) or a

ulw21x17.gif (486x486)

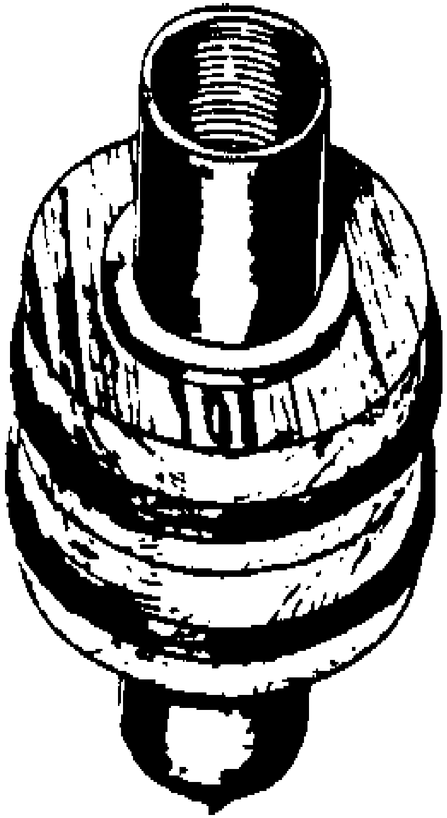

Fig. 21: Surge plunger

more expensive valved plunger.
The valved plunger has a lighter-surging action and may be converted to a solid plunger by plugging its hole if necessary. A light surging action is recommended to start the process.
Placing a heavy pipe above the

surge plunger is recommended for increased weight if needed.

Procedure: Remove any sand in the well by bailing or pumping. Lower the surge plunger until it is 2 to 3 m below the water surface and above the screen. Raise the surge plunger 2 to 3 m and then drop it. Repeat the action slowly; then increase the rate. After several minutes, pull the surge plunger to the top of the well and remove the sand by bailing or pumping. Notice how much sand is in the water. Repeat the operation of the surge plunger until little or no sand can be removed. Finally, lower the plunger through the screen to the bottom of the hole to further clean the screen.

WELL MAINTENANCE

Well and pump maintenance are critical to the longevity and performance of a water-well system.

Records of the well construction, water levels, and performance history are important for maintenance decisions. The following records of well construction and soil samples should be kept:

Owner's name; driller's name and address; a soil log, recording the formations that were encountered during drilling and the depths of the transitions; well drilling method; type and size of well casing; bore-hole diameter and total drilled depth; screen specifications;

static water level; any pumping records, indicating pumping rate and the descent of the water table; grouting material used; and pump specifications. The records should include a location map of the well showing the distance to sources of contamination, lakes, and rivers.

Such information as types and depths of geological formations can be easily forgotten. It can be critically needed if the well stops producing water. Such records also are useful in planning new wells in the area.

The data should be recorded as the drilling takes place or as soon as they become available.

Pumping rates of a well may decrease after a period of operation, causing a serious problem. Before any repairs are attempted, the operator should try to determine the cause of the problem. The original depth to the water table should be compared to the current depth. The pump can be removed for inspection. If both the water and the well pump are good, then the problem may be at the well screen.

Some common problems and solutions are given below:

PROBLEM SOLUTION

Lowered water table Drill the well deeper
(usually not possible)

Worn pump Repair or replace pump

Encrusted well screen Acid-treat or chlorinate well

Encrustation, the accumulation of precipitated material on the well screen, can be removed by acidifying the well. Usually hydrochloric (muriatic) acid or sulfuric acid is used.

Although hydrochloric acid is available in three grades, only the strongest grade (28%) should be used. The volume of acid used should be about twice the volume of the water in the screen section. The well should be agitated for two hours with a surge plunger immediately after the acid is added. After agitation, the well should be bailed out until the water is clean. It is useful to chlorinate the well after acid treatment. Then pump and discard the water until the acidity disappears.

Built-up bacterial growth on a well screen can be removed by adding concentrated chlorine solutions to the well sufficient for a chlorine concentration of 300 milligrams (mg) per L in the well water. After chlorination, the well should be agitated by means of a surge plunger and then bailed out until the water is clear.

DISINFECTION

By its nature, well drilling can cause contamination of the ground water. Disinfection of the newly completed well is required

to ensure the sanitation of the ground water. A concentrated chlorine solution is added to the well to produce at least 100 mg/L of chlorine. This solution should stand for 24 hours. Most types of chlorine compounds can be used to make the solution.

To make a solution with calcium hypochlorite (chlorinated lime), add a small quantity of water to the solid chemical and stir until there are no lumps. Add several liters of water and allow the solids to settle. The clear liquid should be used to disinfect the well and the remaining material discarded.

To make stock solutions with other chlorine compounds, simply add the compound to about 4 L of water, in the amount needed for the required chlorine concentration.

Procedure: After the well is drilled, clean and wipe the area as thoroughly as possible of grease, oil, and dirt. Pour the chlorine solution into the well. Mixing is aided with a hose or pipe. Ensure that all surfaces of the well casing are exposed to the chlorine stock solution. Lower the pump and its drop pipe into the well, washing their exterior surfaces with chlorine solution as they are lowered. Operate the pump, discarding the water, until a distinct chlorine odor can be detected. Allow the chlorine solution to remain in the well for 24 hours. Then pump the well until the chlorine odor disappears; discard the water.

WELL ABANDONMENT

If a well is abandoned because it does not produce water or because it is contaminated, it should be sealed to prevent contaminated surface water from entering it and mixing with the ground water. The common method of sealing a well by inserting a short wooden log into the top of the well casing is ineffective and should not be used. Fill the well with clay to within one meter of the top of the casing; then fill it to the top with concrete.

A well can also be sealed by injecting cement, concrete and/or clay into the well. The cement should be introduced at the bottom of the well first and placed progressively upwards to the top of the well.

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COMMERCIAL SOURCE

Lifewater International, P.O. Box 1126, Arcadia, California 91006 USA. Telephone 818/443-1787. Makes and sells a portable drilling machine, designed for use in developing countries, for water wells up to 30 m deep.

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