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**DELIVERING WATER, SANITATION AND HYGIENE SERVICES  
IN AN UNCERTAIN ENVIRONMENT**

**Professionalization of Manual Drilling in Ghana**

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**BRIEFING PAPER**

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*This paper provides an overview of the initial steps in the professionalization of manual drilling in Ghana through the training of two manual drilling businesses. The training follows the approach outlined in the “Toolkit for the Professionalization of Manual Drilling in Africa” (UNICEF, 2010) and began with the selection of appropriate businesses followed by training in basic hydrogeology and rotary jetting. These business will be used by the USAID funded Ghana WASH Project to drill addition wells for the project under the supervision of trained well drillers. In addition to the well drilling businesses project staff and staff from a local NGO also received training so that they can act as supervisors and coaches to ensure that that quality of the drilled wells is maintained. Furthermore a local workshop has been trained to make the drilling tools to make sure that replacement tools will be available in Ghana.*

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**Introduction**

In the forested Central Region of Ghana access to many villages is hindered by the forest cover and the streams that crisscross the landscape. This makes it difficult for large drilling rigs to reach many of the smaller villages. Improved water supply has relied on placing hand pumps on covered hand dug wells that only penetrate a meter or two into the aquifer. These wells that generally do not exceed 8 meters in depth, dry up in the dry season forcing people to return to polluted unimproved sources. In order to improve this situation, EnterpriseWorks, using the approach from the toolkit, has begun the professionalization of the manual drilling sector in Ghana.

The goal is to develop a professional manual drilling sector in Ghana that can drill high quality wells that equal or exceed the quality of machine drilled wells using locally made tools and equipment that can reach less accessible sites. Manual drilling can provide an excellent complement to machine drilling for drilling in sedimentary formations where the water table is less than 25 meters from the surface.



**Figure 1. Inaccessible Village in Assin North, Central Region, Ghana**



**Figure 2. Hand Dug Well with Hand Pump**

## Building Local Capacity

### Selection of Businesses

The USAID funded Ghana WASH (GWASH) program decided to begin a program of professionalizing the manual drilling sector in Ghana. GWASH has been working with local well construction and pump installation businesses over the past several years. These businesses were asked if they would be interested in learning to drill wells by hand, using the rotary jetting technique that EnterpriseWorks has used successfully in Senegal, Niger and Nigeria. After evaluating expressions of interest, two of the more reliable companies were selected to participate in a three week training program.

### Drilling Tools

Prior to the start of the training program a set of tools for rotary jetting was acquired from Niger and these tools were copied in a local workshop. It is important that tools are available locally in order to ensure that the drilling businesses will have access to replacement tools in the event of loss or breakage. The design of the tools is changing faster than the manuals in the toolkit can be updated, so it is important to get an initial set of tools from people who are actively drilling. While the basic set of tools is standard, the bits will need to be modified to reflect the local drilling conditions.

While the tools can be made locally there are two parts that require particular care to make correctly, the swivel and the couplings for the drilling rods. Couplings with standard pipe threads are not strong enough to withstand the rigors of manual drilling, so special couplings are made that use a square thread. These need to be turned on a lathe by an experienced machinist to ensure that all of the couplings have the same thread. The swivel allows the drill shaft to turn while the hose remains in place, it uses a ball bearing welded to the supply pipe and sealed with a metal plate to prevent leakage. Welding on a ball bearing requires care to ensure that the bearing is not damaged.



Figure 3. Coupling for drilling rod (50 mm)

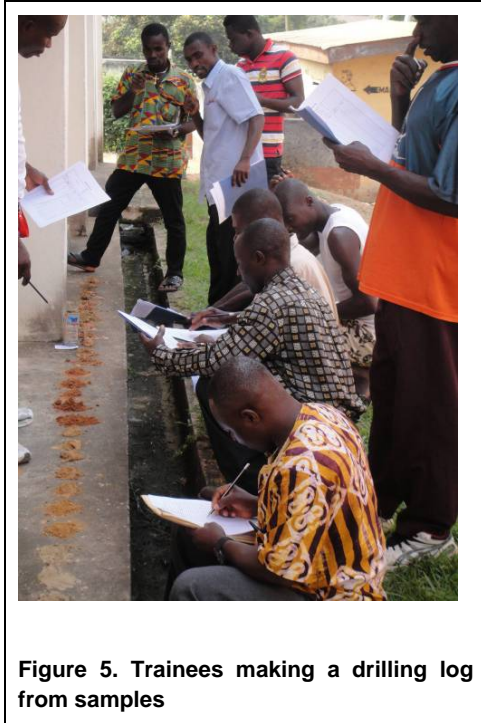


Figure 4. Swivel to allow rotation of the drilling rod without tangling the hose

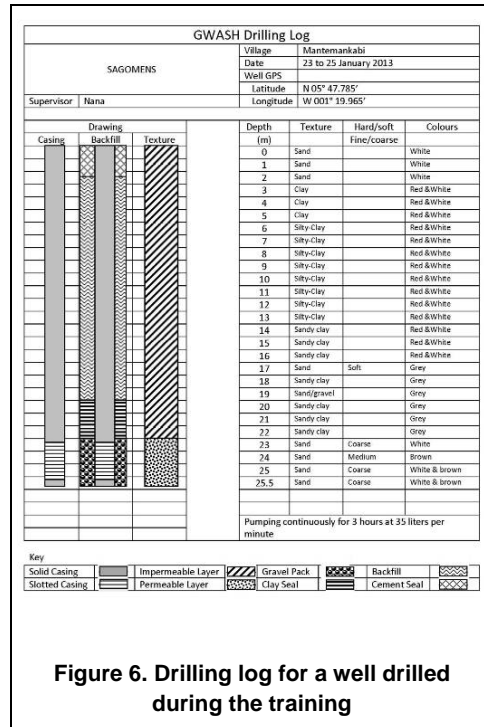
### Hydrogeology Training

Using the reference “Understanding Groundwater for Manual Drilling” from the UNICEF Toolkit a course was given to 19 trainees from the two selected business and 3 trainees from a local NGO that will provide supervision during drilling. The training program allowed the drillers to gain an understanding of groundwater flow and how geological strata are deposited over time. They also had practical exercises giving them experience in determining the texture and assessing the permeability of different strata that they will encounter while drilling. The course covered the importance of sampling and keeping an accurate drilling log. It provided trainees with practice in designing wells including the placement of the screen and gravel pack and the location of the sanitary clay seal based on the drilling log. The key factors in selecting a well site including distance from sources of pollution and the importance of protecting both the well and the aquifer from pollution and how to do it were also covered. Practical topics covering the use of drilling mud, hygiene, and well development were also addressed. Upon successful completion of the course the trainees had a better understanding of what is happening down the hole both during and after drilling than many of

their machine drilling colleagues, providing them with the information that they need to drill high quality water wells.



**Figure 5. Trainees making a drilling log from samples**



**Figure 6. Drilling log for a well drilled during the training**

**Rotary Jetting Training**

Rotary jetting is similar to rotary mud drilling and relies on a rotary motion of a drill bit to cut the soil and removal of the cuttings using circulating water that has been thickened with a drilling polymer. Of the variety of manual drilling techniques, rotary jetting, under appropriate conditions, is the easiest and fastest technique. Some of the tools can be purchased on the local market the rest can be made in local metal working and machine shops.

Tools	Quantity	Cost in Ghana (USD)
5 HP motorized pump with 2-inch outlet with 10 m of Spiral reinforced hose (50 mm) and brass foot valve with strainer	1	\$375
Drilling rods (3 meter lengths) with machined couplings	12	\$1250
Sand/Clay Bit, Rock Bit, Swivel, Handle, Casing Clamps (2), Fishing Tool	1-set	
Toolbox (24-inch pipe wrenches (2), pipe lifters (2), 3 lb sledge hammer, chisel pointed, chisel flat, Allen wrench set, screwdrivers (3), 10 mm socket wrench, 13 mm socket wrench, locking pliers, needle-nose pliers, utility knife)	1-set	\$400
Shovel (2), Pick (1) Wood Planks 5 x 15 x 100 cm (4), 1000-liter plastic containers (2)	1-set	\$310
<b>TOTAL</b>		<b>\$2335</b>

Following the five day theoretical training, the trainees were taken to the field for twelve days of practical drilling training with two experienced manual well drillers. Practical experience under the guidance of experienced drillers is the best way to learn how to manually drill wells because there is no substitute for hands-on experience. During the training five wells were completed and four other wells were started. The goal of the training was to provide trainees with the opportunity to drill in different strata so that they could learn the best combination of tools and techniques to use for the different conditions. The trainees experienced a wide range of drilling conditions from clay and sand to gravel, mica schist and quartz stones. They learned how to free stuck tools and how to recover broken drilling rods.

The field training began with a meeting with the villagers to select an appropriate site for the well based on: village preferences, topography, likely depth of the water table and distance to sources of pollution (latrines and garbage dumps). Once the site had been selected the layout, digging and plastering of the mud pit was begun. The mud pit provides a reservoir for the drilling fluid and a place for the cutting to settle out of the drilling fluid. The mud pits should be dug and plastered the day before the drilling crew arrives and the villagers asked to bring water to fill the plastic reservoirs so that drilling can begin as soon as the crew arrives on site.



**Figure 7. Mud pit and plastic water reservoirs**



**Figure 8. Drilling tools for rotary jetting**

During the training well drilling continued until an impermeable layer below the water table was encountered. In most cases this was a rock layer consisting of quartz and mica schist that could not be penetrated with the tools that were designed for use in sand and clay. Additional more aggressive bits will be made to enable thin layers of rock and laterite to be drilled through more easily.

Once the drilling was completed the well was designed using the information from the well log to determine the location for the screen, gravel pack and clay sanitary seal as shown in Figure 6. The sump was attached to the screen and the solid pipe is prepared. A rope is attached to the bottom of the casing to allow



**Figure 9. Well drilled using rotary jetting to a depth of 25.5 m**



**Figure 10. Preparation of the casing for installation**

it to be lowered slowly into the hole and to support it as additional sections are added. The rope remains in the hole after the well is completed. Once the casing and screen are placed in the correct location the polymer is removed from the well by pumping in a chlorine solution made up by mixing 5 chlorine tablets (NaDCC 1.67 g) in 220 litres of water and pumping it into the casing. The chlorine breaks down the polymer and forcing water down the casing cleans the screen. Once the polymer is removed from the well the gravel pack can be installed by pouring it slowly into the annular space around the well screen. The depth of the gravel pack is measured using a simple tool consisting of 8 mm steel bar and a string with knots tied every meter.



**Figure 11. Installation of the casing**



**Figure 12. Flushing the drilling polymer out of the well**



**Figure 13. Installation of the gravel pack**



**Figure 14. Installation of the clay sanitary seal.**

After installing the gravel pack a clay seal is placed above the gravel at the level of an impermeable or low permeability stratum. Often children in the village will be willing to prepare clay balls from the clay that is used locally as a building material. The balls are easy to drop into the annular space and form a water tight seal to prevent pollution from travel along the casing and into the aquifer.

In order to keep the costs of manual drilling reasonable well development is achieved by pumping the well with a 1 HP submersible pump at a rate that exceeds the rate that will be required for a hand pump, generally in excess of 12 liters/minute. In addition to pumping at a higher than anticipated discharge, the well can be surged by using the submersible pump as a plunger, this helps to remove the fine particles that are close to the well screen. As can be seen in Table 2 the cost for the generator and submersible pump is much lower than the cost would be for a compressor to use air lift to develop the wells.

Table 1. Equipment for well development		
Tools	Quantity	Cost in Ghana (USD)
1HP submersible pump with 40 meters of 1-inch PE discharge hose, 40 meters of power cord, and connectors.	1	\$450
2.5 KVA gasoline powered generator	1	\$450
TOTAL		\$900



**Figure 15. Developing well using a 1HP submersible pump and 2.5 KVA generator**



**Figure 16. Discharge during development 35 litres/minute**

## Conclusion

Two manual well drilling businesses in Ghana have begun the process of becoming professional drillers. They have drilled five wells and completed the hydrogeology course, but this is only the beginning. Following the training they will each be offered contracts to drill 20 wells for the project. This will give them the opportunity to continue to gain experience while being supervised closely. A return visit by one of the trainer will reinforce the training and help to resolve any issues that may arise during the contract drilling period.

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## References

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