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Drilling Fewer Boreholes Keeps your Drill Rigs Busier

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Performance-Based Well Construction Standards

You probably woke up this morning, made coffee or tea, brushed your teeth and took a shower before getting dressed for the day. You expect fresh, cool water to flow when you turn on the faucet or flush the toilet. But in most of the world, water comes from a distant water hole and it is often contaminated.

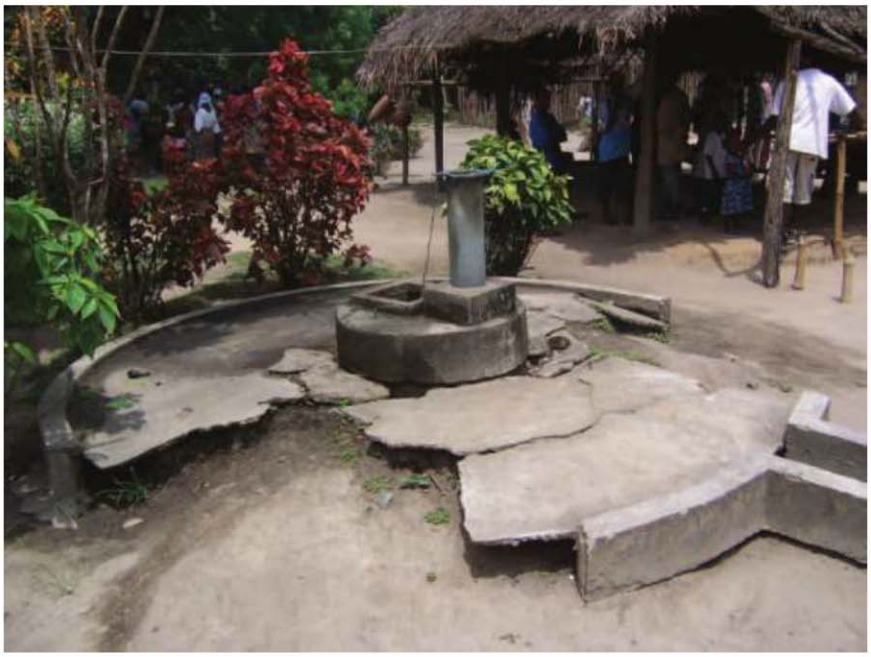
It is hard for us to grasp what it is like to live without safe, convenient water. Amina, a young mother living in Liberia, gets up in the dark and rushes along the long path to the water hole, hoping to arrive before animals stir up the mud. With the heavy five gallon water jug on her head and her young son on her back, she treks back to her hut – the first of three trips to the water hole completed. Amina's drinking water often contains cholera or other water-borne diseases which make her family sick. Her village is no different from most, and 15 per cent of the children die before age five from drinking unsafe water.

Lifewater.ca is a non-profit group run by Well Drillers, Hydrogeologists, Nurses and other professionals who volunteer their time helping train and equip people in developing countries to drill water wells. We believe that whether a child lives or dies should not be determined by where they are born. With the generous support of donors like you, Lifewater trained workers put a new well in Amina's town - one of the 227 communities that received safe water and improved sanitation this past year.

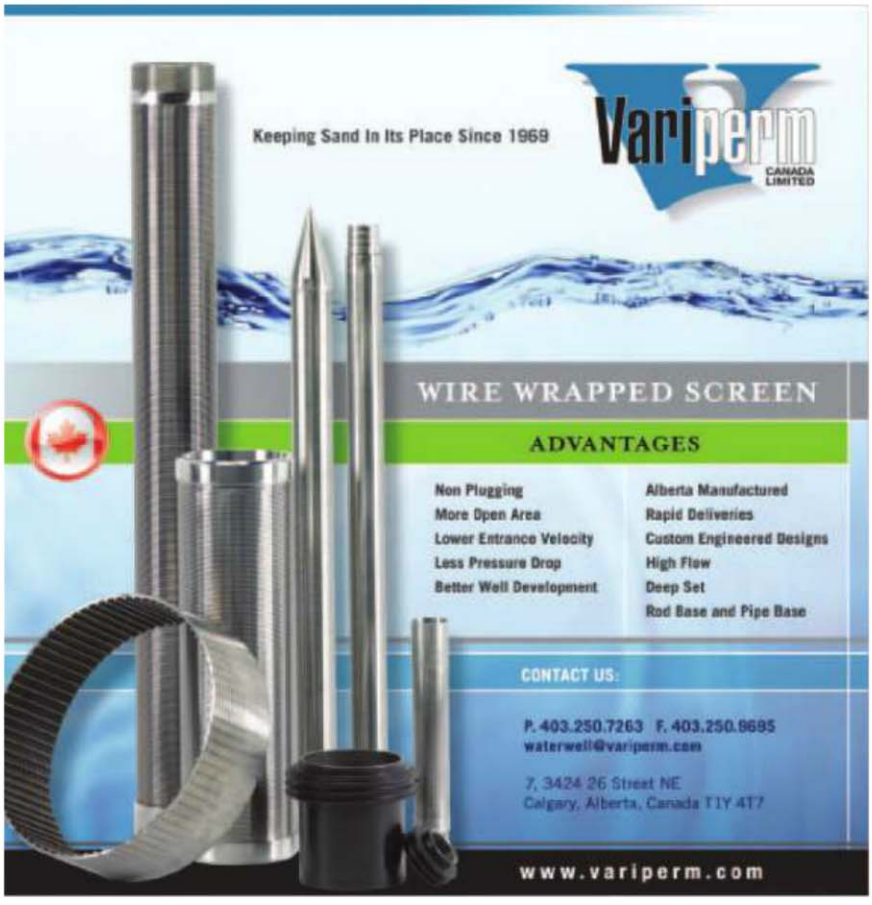
However, not all wells are properly constructed and can sometimes be a source of disease and death. Shallow dug wells frequently go dry during the long hot season. Few wells have annular seals, and sealant is never used between well tiles which rarely have interlocking lips. Many wells are left open and are repeatedly contaminated by water buckets and ropes left lying in the dirt when not in use.

Lifewater conducted a survey of 150 communal wells in Monrovia on behalf of the European Union. Over 90 per cent of the wells were less than 30 feet deep and most had well head sanitation problems including: cracked pads, direct infiltration of surface water, significant water ponding and growth of algae, weeds and mud holes around the wells. Seventeen per cent of the wells contained nitrate-nitrogen concentrations of 10 ppm or higher – levels life threating to infants. In addition, the water was very warm (27 – 30 degrees C); Eighty-three per cent of the bacteria tests were positive for pathogenic organisms and Total Coliform bacteria were detected in 45 per cent of the samples.

Following the 2010 Haitian earthquake, Lifewater volunteers assessed hundreds of wells in Northern Haiti in order to help stop the spread of cholera. Many similar problems were found: turbid water, lack of sustainable yield, missing or broken pads, absent annular seals etc. When these results were tabulated, volunteers wanted to discuss them with responsible government authorities but found there is no regulatory oversight of well drilling in rural areas of Northern Haiti. Even more significantly, we learned that here, as in Liberia, there are no well construction standards. Everyone drilling wells is free to do so as they see fit. Some seal annular spaces and penetrated confining zones, some don't. Some develop wells to remove turbidity, some don't. Some disinfect finished wells, some don't. It is hard to educate drillers or to assess if a well was properly constructed when there are no well records and no standards to benchmark against!



In contrast, well regulations and practices here in Canada are the result of decades of evolution, education and technological changes. In Ontario, for example, well construction has been governed since the 1940s and Regulation 903 now covers licensing of contractors and technicians and has specified proactive minimum well construction standards. These standards are among the most comprehensive in Canada, covering details such as separation distance from pollution sources, well casing type, thickness and above-ground stick-up, annular size and sealing, well caps and venting, disinfection, plumbing connections, well maintenance and abandonment. The



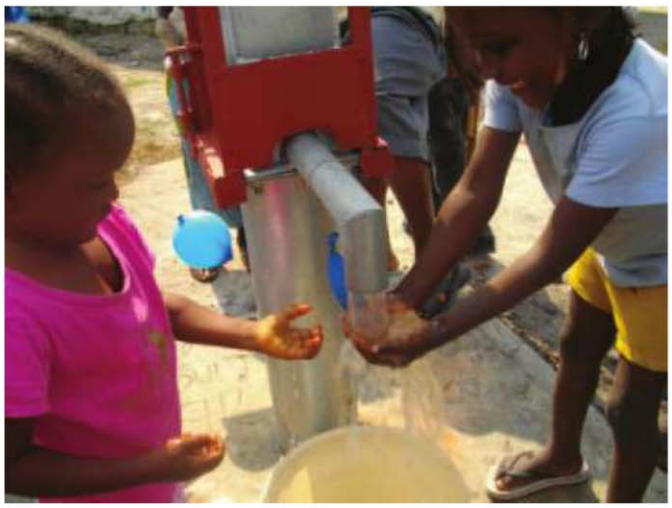
regulation itself is a dozen pages of detailed specifications and the recently released interpretation and best practices guide is nearly 1,000 pages long.

Well construction in Sub-Saharan Africa and Haiti is currently at the state of development where Ontario was prior to World War II. It is clearly unrealistic to try and move developing countries from their current lack of well construction governance to adoption of detailed prescriptive regulations such as Ontario's 903. On the other hand, Lifewater volunteers are not satisfied with the status quo where individuals with little or no training drill wells as they always have, dictated by cost and time constraints, traditional approaches, and limited local availability of poor quality well drilling supplies.

The first step in bringing about change is developing and voluntarily adopting readily measurable standards that can be used to ensure that wells provide reliable supplies of water that we would not hesitate to have our loved ones drink. Les Babcock (Lifewater Drilling in Bow Island, AB), Norman Moreau (Moreau Wells in New Richmond, QC) and I drafted the following six performance based standards that can be easily taught to illiterate drillers. They include best practices to achieve the desired results:

Standard #1: The well must be drilled straight to a minimum depth of 60 feet. The problem is that PVC well casing shipped from other countries is sometimes not round. In addition, drill bits on lightweight rigs can "wander," especially if the rig is not straight or firmly anchored in place. Finally, boreholes frequently collapse after drilling, resulting in completed wells being as much as 40 feet shallower than the borehole. As a result of these problems, submersible pumps sometimes cannot slide down to minimum 50 foot mark without jamming. In order to have straight, round wells, the following best practices are encouraged:

1) Check casing at the time of purchase to ensure it is round and not bowed;
2) Use bentonite and/or polymer during drilling to prevent open hole collapse;
3) Firmly anchor the drill rig in a plumb (vertical) position;
4) Ream holes with a 7 inch bit before



placing 4" PVC casing so that the filter pack can be properly placed.

5) Use drill collars or heavy weight drill rod to keep the hole straight

6) Let the casing hang off the bottom and do not press casing down or pull it straight if it is slightly crooked since these actions will create a banana shape well!

Standard #2: Develop the well until the water is clear for immediate drinking. To save time and money and due to lack of training, wells are often not flushed, surge bailed, and/or pumped to remove turbidity and develop the filter pack prior to the handpump being installed. These wells cannot be effectively disinfected, water remains cloudy and people may return to using clear but unsafe surface water. In addition, pump cylinders can be badly scratched by the suspended particles, resulting in on-going premature failure of cup leathers or sealing o-rings. Finally, drill teams leave without confirming that the wells were properly constructed, and lack of filter pack or screen placement in clay formations sometimes results in water never clearing up. To ensure water clarity, the following best practices are encouraged:

1) If commercial #10 or #20 slot screen is not available, cut screen with three rows of slots a maximum of two inches apart. This is to minimize sediment entrainment by minimizing entrance velocity into the well;

2) Use at least 10 feet of screen for a well finished with a handpump and a minimum 20 foot screen for wells fitted with submersible pumps (where there is sufficient aquifer thickness). This is to help ensure adequate well efficiency;

3) Use end caps or place filter or seal material inside well. This is to prevent sediment from being continuously stirred-up from the bottom of the well;

4) Set the screen in zones of sand/gravel, not against clay formations. In addition to the obvious well yield problems, this is to prevent the "grey water" that can be seen in some wells drilled years ago;

5) Use centralizers if placing filter pack. This is to ensure even distribution of the filter pack around the well screen and the annular seal;

6) Surge the well with a bailer if a filter pack is not placed. This is to ensure adequate development of a natural filter pack;

7) Pump the well with an electric pump until the water is clear. Wells that pump clear water with an electric pump always produce drinkable water from handpumps since the groundwater flow rate and drawdown is much less (10 GPM vs. 2 GPM).

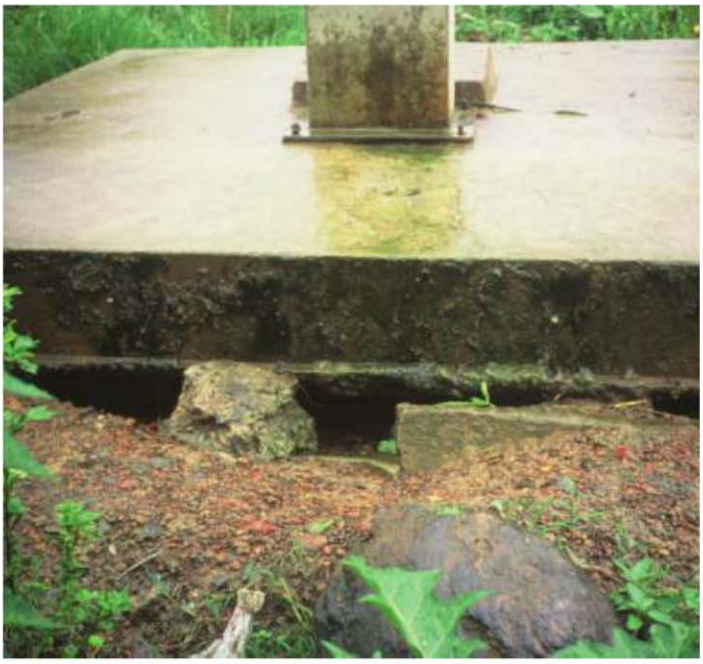
Standard #3: The water supply must be reliable. It is critical that the well does not run out of water when a handpump is used for two continuous hours and that it does not go dry during the hot season when water is needed most. To ensure that the well supply is reliable, use the following best practices:

1) Pump the well for at least one hour with a three or four inch electric pump set as deep as possible but staying above the well screen. Unless the well is very shallow, the pump should be set at a minimum depth of 50 feet;

2) Make sure the well screen is at least 15 feet below the static water level;

3) Make sure that the water is not drawn below the well screen when pumped.

Standard #4: The water must be safe to drink. This means passing a Hach Pathoscreen water quality test – a broad-spectrum assessment of the pathogenic quality of the water. It ensures that the well was properly chlorinated following



completion, since many wells are drilled using contaminated surface water and the resulting well water may be clear but unsafe to drink. To ensure suitable microbial water quality, the following best practices should be followed:

1) Locate wells a minimum of 15 metres from contamination sources such as latrines, garbage piles, or fuel storage;
2) Seal confining layers penetrated during drilling. Maintaining hydrostatic pressure in lower aquifers keeps upward hydraulic gradients isolating contaminated surface water from percolating downward;
3) Install grout in the annular space from the top of the filter pack (two metres above the top of the screen) up to surface or a minimum of 20 feet;

4) Chlorinate drilling water so that chlorine smell is present during drilling (unless using polymer which breaks down in the presence of chlorine);

5) After the well is completed and the well is pumped clear, chlorinate the well with one gallon of Clorox (Javex). Once the pumped water has a chlorine smell, lock the pump for the night. If the smell is still there in the morning after 10 minutes pumping, the well is ready to use. If not, repeat the chlorination process.

Standard #5: The pump pad must be well drained. Avoid development of muddy, stagnant water from pooling around the pad. Suitable pads can be constructed using the following best practices:

1) Dig mud pits a minimum of one metre from the borehole. This is to avoid cracking if the pad is built over the unstable ground of a filled-in mud pit;

2) Use rebar in pad construction to prevent pad cracking if the ground settles. Put rebar around the pad perimeter and at one foot spacing within the pad;

3) Construct a pad that is at least six inches thick and 1.5 metres diameter. This is to protect the annular seal and to provide a sanitary platform for water buckets;

4) Place the pump base so that the pump spout will face down-slope which ensures that water flows down the waste water channel avoiding run-off all around the pad, both pooling and undermining the pad;

5) Slope and ditch the area to avoid standing water within five meters of the pump. This should be considered when choosing the drilling location.

Standard #6: Keep the pump cylinder above the well screen. The cylinder is placed10-20 feet off the bottom of the well, allowing any dirt to settle in the bottom sump and avoiding disturbance associated with having the cylinder placed within the well screen.

We would really appreciate hearing from readers across the country with comments and suggestions on the proposed performance based standards outlined above. We hope to finalize the first draft and adopt them overseas in 2013. If you have feedback, please email me at gehrelji@yahoo.com. If you wish to help sponsor a well or be added to our annual newsletter mailing list, please email info@lifewater.ca.

Finally, downhole cameras effectively educate overseas drillers about what is happening inside wells and verify well completion details. If your company has a used camera in good working order that you would like to donate to an overseas team, please contact us immediately and we will get you a tax receipt and bring the camera to where it is needed.