EMBRACE RELIEF

WATER WELL DEPTH PROPOSAL

OUR MISSION AND VISION

▪ Delivering research-based, sustainable solutions to achieve lasting improvements for individuals and communities.

▪ Embrace Relief is committed to creating a lasting impact on the lives of individuals locally and globally. We implement research-based programs to achieve measurable, sustainable improvements in the lives of those in need. By constantly using research and closely engaging with those we serve, our innovative approach ensures we deliver the most beneficial services.

THE PROBLEM

> The African continent is in desperate need of assistance for clean water. It has the highest total volume of non-frozen surface water of any continent, yet much of this surface water is contaminated. The distribution is incredibly poor, with only five percent of rural Africans obtaining piped water.[1]

▪ Highest rates of waterborne illnesses from diseases like schistosomiasis, diarrhea, and typhoid fever.

▪ The most prevalent disease is cholera in Niger, Cameroon, Zimbabwe, Nigeria, Somalia, and more.

▪ Lack of regulation on industrial practices that pollute bodies of water from effluent runoff.

[1] UNEP. (2010). "Africa Water Atlas". Division of Early Warning and Assessment (DEWA). United Nations Environment Programme (UNEP). Nairobi, Kenya

THE SOLUTION

- Providing access to clean water is digging wells to provide groundwater access to communities.

- A further distance from the surface means a greater amount of rock layers to pass through, which act as natural filters, and therefore, the risk of potential contamination is decreased.

- Decreased sensitivity to surface land-use practices and drought resistance since there would no longer be dependent on seasonal rainfall.[2]

[2] Digging Deeper: 4 Benefits of Well Deepening - Dalmik Well Drilling - Putnam. [n.d.]. Retrieved June 12, 2019,from https://nearsay.com/c/237216/73036/digging-deeper-4-benefits-of-well-deepening

HYPOTHESIS

If a water well is to deliver clean water effectively and sustainably then, it must be dug to a minimum of 45 meters. Figure 1 shows an outline of the Embrace Relief well design that we implement on all our sites, which retains our quality standards for all contractors in Africa.

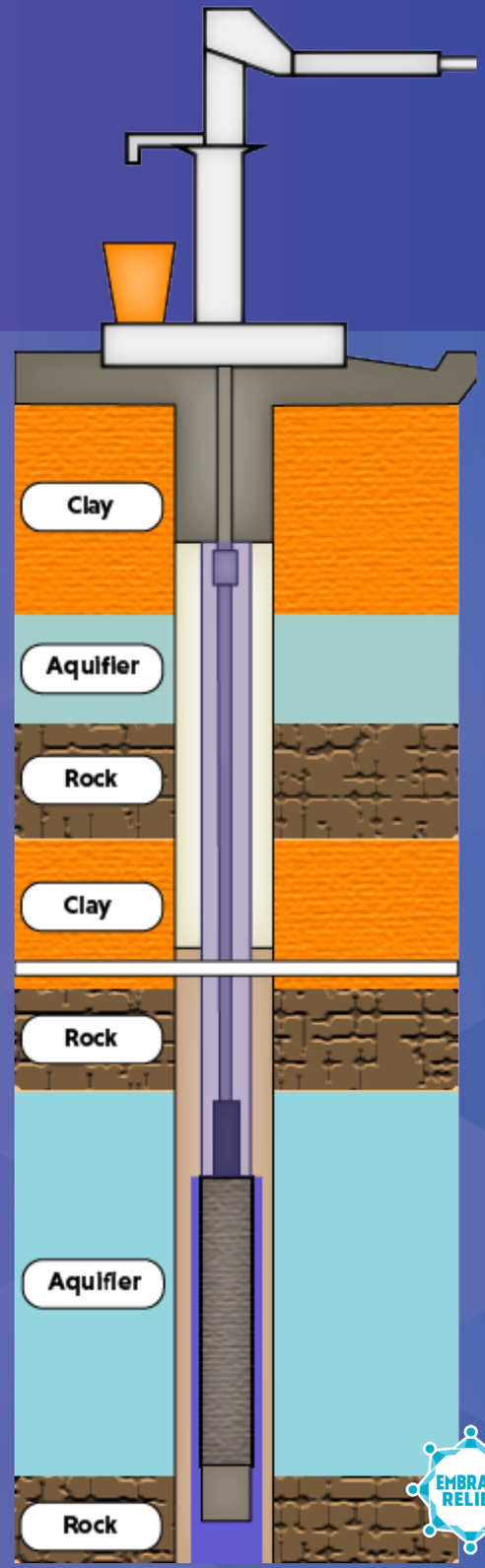


Figure 1. This diagram represents all the components that go into our well structures. The rock layers are based on assumptions of aquifer depths and will vary based on the local geography of a given area.

GOALS

- Our goal is to allow these communities to thrive because they will no longer be constrained by having to walk countless hours to find water.

- Our goal is to make sure that these villages of extreme poverty become places of economic opportunity with improved quality of life.

ACHIEVEMENTS

- We have constructed over 330 water wells across Africa, with all of them still operational and several scheduled for construction later this year.

- All wells are designed to last at least five years without fail, but with our provided additional maintenance, they are functional for at least ten years.

- The operational maintenance is also paid for, where we replace parts like galvanized steel pipes, to keep rust out of the water and maintain operational pumps.

WELL CONTAMINATION

REPUBLIQUE DU TCHAD Unité-Travail-Progrès جمهورية تشاد وحدة – عمل – تقدم
PRESIDENCE DE LA REPUBLIQUE رئاسة الجمهورية
MINISTERE DE L'ENVIRONNEMENT, DE L'EAU ET DE LA PECHE وزارة المياه البيئة والصيد
LABORATOIRE NATIONAL DES EAUX المختبر الوطني للمياه
N°46/PR/MEEP/LNE/2019

N'Djamena, le 19 JUIL 2019

Le Directeur Général du Laboratoire National des Eaux
A
Monsieur le Directeur Général de l'Entreprise de Construction et des Travaux Divers (Hydraulique et Maintenance
N'Djamena

Monsieur le Directeur Général,

Suite à votre correspondance du 17/07/2019 sollicitant des informations relatives à la profondeur des forages et les qualités de leurs eaux dans les différents quartiers de la ville de N'Djamena.

Au niveau de la ville les profondeurs peuvent être variés on peut trouver des ouvrages de 300 mètres cas des forages de marché de mil. En général les ouvrages exécutés par les organisations non gouvernementales (ONG) pour l'apprivoisement des personnes non desservies par la société Tchadienne des Eaux (STE), ces ouvrages varient entre 40 à 45 mètres. Concernant la qualité des eaux de tous les ouvrages réalisés à N'Djamena les analyses effectuées par le Laboratoire National des Eaux montrent que ces eaux sont conformes aux normes de l'OMS.

A cet effet, je vous recommande de faire vos ouvrages à des profondeurs qui varient entre 40 à 45 et chaque que vous réalisez des ouvrages d'envoyer les échantillons d'eau au Laboratoire National des Eaux pour les analyses avant de mettre les ouvrages en exploitation.

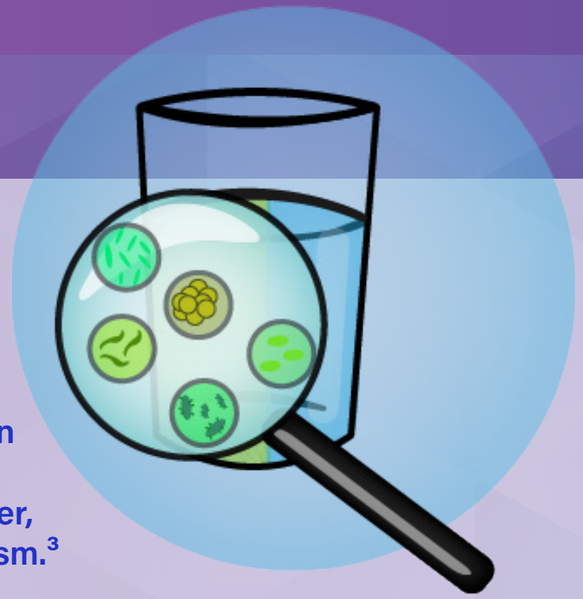
Veuillez recevoir Monsieur le Directeur Général mes salutations les plus distinguées.

IBRAHIM TAHA DAHAB

Figure 2. This letter comes from the National Water Laboratory of the Republic of Chad. Translated, it outlines the procedure for building water wells in rural areas of Chad. In these areas, the Lab recommends that the well depth be between at least 40-45 meters as conforming to standards that all NGOs are held to.

WELL CONTAMINATION

> "In sub-Saharan Africa, only **30%** of people are covered for improved sanitation facilities.[5]"



- One of the issues with shallower wells is the contamination of bacteria and parasites into the water. These contribute to over twenty waterborne disease in West Africa, which include schistosomiasis, typhoid fever, cholera, diarrhea, and botulism.[3]

- In a Brazilian study of 66 wells, it was found that wells of 3 the greatest depth contained the lowest amount of contamination. They were divided by wells of less than 5 meters, 5-10 meters, 10-15 meters, and greater than 15 meters. In this order, it was found that there were less and less total coliforms, E. Coli, various other
bacteria, and yeast.

- Another study comparing well depth with bacteria count from the University of Colorado found there to be a statistically significant correlation between the two factors. Of the 30 wells tested, it was found that those with depths under 60 meters were much more likely to suffer from bacteria contamination than wells deeper than 60 meters.

- Several studies indicate that nitrate pollution coming from the sanitation of 5 people as a combination of human and livestock runoff is the most significant factor in African groundwater contamination.[4] [5]

- Various chemicals and heavy metals can leach into the water from local industrial and agricultural processes. In the same Brazilian study, it was found that the depth also correlated with less acidity, turbidity, fluorine counts, and chlorine counts Metals like arsenic are also damaging to humans because of their link to skin, lung, and liver cancer.[6]

- In a study in Bangladesh conducted across over 84,000 wells, it was found that wells below 50 meters were much more likely to contain arsenic, while those that were deeper than 50 meters were less likely to contain arsenic levels above WHO standards of 0.01mg/L.[7]

[3] Thomas Weiss. [2018]. Water-borne Diseases: Types and Information. Retrieved June 26, 2019, from Disabled World website: https://www.disabled-world.com/health/water-diseases.php

[4] Ouedraogo, I., & Vanclooster, M. [2016]. A meta-analysis of groundwater contamination by nitrates at the African scale. Hydrology and Earth System Sciences Discussions, 1–43. https://doi.org/10.5194/hess-2016-120

[5] Xu, Y., & Usher, B. [2006]. Issues of groundwater pollution in Africa. https://doi.org/10.1201/9780203963548.ch1

WELL CONTAMINATION

▪ In another study that took place in Northern India, 9 water quality tests were taken three times in eight different well sites. In the only site that reached 50 meters, we can see it has the best water quality index measurement, which is calculated by the total acidity, hardness, sulfate, fluoride, chloride, and total dissolved solids. All other sites ranged from 5 to 30 meters with higher amounts of contamination, and the authors concluded, "Groundwater depth was found negatively correlated with chemical parameters." [8]

▪ In a 2016 US Geological Survey study on Pennsylvania wells, it was found that shallower wells were more likely to suffer from contamination issues. Those that were shallower were more likely to suffer brine intrusion and increased levels of total dissolved solids as well as bromine, lithium, and methane contamination. Surface applications can have great effects on the health of groundwater.[9]

[6] Health risks of heavy metals | APEC Water. [n.d.]. Retrieved June 27, 2019, from https://www.freedrinkingwater.com/water-education/quality-water-heavymeatal.htm
[7] arsenic and iron correlation in Bangladesh: GIS approach. International Journal of Applied Environmental Sciences, 4[4], 437+. Retrieved from http://find.galegroup.com.ezproxy.bucknell.edu/grnr/infomark.do? &source=gale&idigest=6f8f4a3faafd67e66fa023866730b0a1&prodId=GRNR&userGroupName=bucknell_it&tabID =T002&docId=A216041418&type=retrieve&PDFRange=%5B%5D&contentSet=IAC-Documents&version=1.0
[8] Gupta, P., & Sarma, K. [2014]. Evaluation of groundwater quality and depth with respect to different land covers in Delhi, India. International Journal of Applied Science and Engineering Research, 2, 630–643. https://doi.org/10.6088/ijaser.020600004
Clune, J. W., & Cravotta

KEYS TO SUCCESS

▪ Climate change brings in a new challenge as far as groundwater recharge. We will see more heavy rain intensity, but the overall occurrence of rain will fall.

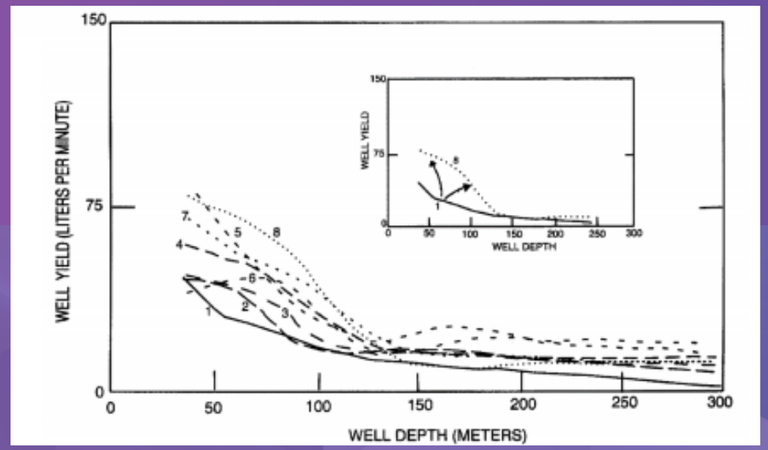
▪ In Nigeria, for example, "The projected increase in precipitation variability, both in intensity and frequency, is most likely to lead to a decrease in recharge." This type of climate change will be present across much of Africa and will leave people particularly vulnerable to water and food insecurity.

▪ Providing wells that reach farther down from the surface allows communities to have consistent amounts of water even during these droughts by touching the lower parts of the upper aquifer.

▪ "In general, most simulated models for climate change and variability predicted a more than 70% decrease in recharge for south-western Africa by 2050. Thus, groundwater stress would be more severe in most parts of West Africa by 2050." [10]

[9] Clune, J. W., & Cravotta III, C. A. [2019]. Drinking water health standards comparison and chemical analysis of groundwater for 72 domestic wells in Bradford County, Pennsylvania, 2016 [USGS Numbered Series No. 2018–5170; p. 76]. Retrieved from U.S. Geological Survey website: http://pubs.er.usgs.gov/publication/sir20185170
[10] Aizebeokhai, A. [2012]. Potential impacts of climate change and variability on groundwater resources in Nigeria. African Journal of Environmental Science and Technology, 5. https://doi.org/10.5897/AJESTX11.001

Figure 3. This data compares the average yield of a well with the depth it is dug to. The numbers 1-8 indicate groupings, of types of wells built over 1984-1998. 1 being the earliest and 8 being the most recent.



- When constructing wells, we want to make sure that we are able to provide enough water to sustain a community.

- In a New Hampshire study on private water wells, it was found that if we propose wells that are too deep, we will start to see lower yields.[11] As indicated in Figure 3, regardless of what type of well is being indicated by the 1-8 groupings, there is a clear trend relating well depth and the average well yield. While deeper wells do provide a greater quality of water, it is important to consider how much quantity we can produce to support a community's needs.

- As a precaution, surface or subsurface stored chemicals such as gasoline, diesel fuel, home heating oil, fertilizer, pesticides, etc. should be at least 100 feet away. Additionally, stables, animal barns or feeding pens, milkhouses, livestock runs, or silos should be 50 feet away. Our wells sites are researched to be away from sites like these that can easily contaminate the water supply, and digging further into the ground prevents these various features from doing damage.[12]

- Another point of success for us is constructing wells that are sustainable and last in communities for years to come.

- According to a 2009 report by The International Institute for Environment and Development (IIED), up to US $360m were spent on wells and boreholes that are no longer functional. As a result, 50,000 water supply points are not functioning across rural Africa.

- For example, across Uganda, there are instances of poorly constructed wells where they were created too shallow and within a few years became subject to worm contamination.[13]

[11] Drew, L. J., Schuenemeyer, J. H., Armstrong, T. R., & Sutphin, D. M. (2001). Initial Yield to Depth Relation for Water Wells Drilled into Crystalline Bedrock–Pinardville Quadrangle, New Hampshire. Groundwater, 39(5), 676–684. https://doi.org/10.1111/j.1745-6584.2001.tb02357.x

[12] ISDH: Recommended Standards For Private Water Wells. (n.d.). Retrieved June 12, 2019, from https://www.in.gov/isdh/23258.htm

[13] Kelly, A. (2009, March 26). Money "wasted" on water projects in Africa. The Guardian. Retrieved from https://www.theguardian.com/society/katineblog/2009/mar/26/water-projects-wasted-money
[14] Digging Deeper: 4 Benefits of Well Deepening - Dalmik Well Drilling - Putnam. (n.d.). Retrieved June 12, 2019, from https://nearsay.com/c/237216/73036/digging-deeper-4-benefits-of-well-deepening
[15] Deep Well Systems. (n.d.). Retrieved June 18, 2019, from Griffin Dewatering website: https://www.griffindewatering.com/construction-dewatering/deep-well-system/

CONCLUSION

- We propose that all wells created for communities in Africa to gain access to a sustainable water supply should be at least 45 meters. According to the data we researched, we found that by digging to at least this depth, we can provide water for a long time that remains clean even during periods of climate change.[14]

- Deepening a well is one of the most recommended solutions to ensure a drought-resistant water supply. This is because deep wells, which are further below the water table, are not likely to go dry during an arid period. However, we propose a 45-meter depth, because digging too deep will lower our total yields. Shallower wells can produce better short term yields but are heavily reliant on recharging of the aquifer based on precipitation. This is especially important for the incoming climate change that will bring longer droughts. Deep wells are usually constructed when a large amount of volume is required to be pumped. This summarizes a village well because the villages consist of at least 2000 people.[15]

We also want these deeper wells to prevent communities from consuming water that may be affected by contamination. In some communities, they have poor sanitation practices that lead to Cholera outbreaks, so creating a larger buffer allows for increased security. Industrial and agricultural processes nearby a community can heavily alter surface water in ways that damage their health, so we work to prevent cancer and other bodily damage that toxic chemicals can cause.

If you wish to join us in our cause for a better world with a bright future, become a donor of a cause you are passionate about with Embrace Relief today!

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