Clean Drinking Water Project
Burgula, Telangana State
India
Project Report

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Introduction

Water is an absolute necessity for human survival. In everyday life, water is used for cleaning, bathing, drinking and cooking. In developed countries, the fact that the water used for these purposes is clean and safe, is often taken for granted. This is not always a guarantee that can be provided in the less fortunate regions of the world. Around the world, approximately one in nine people do not have access to safe water. Because of this, approximately 850,000 people die every year. These statistics are appalling considering the amount of clean water wasted while performing common, everyday tasks. As it is, water remains an irreplaceable commodity and human beings will continue to consume what is available to them, regardless of the quality.

Unclean Water

Unclean drinking water comprises of suspended particles, organic and inorganic impurities giving it foul odor and murky color. The bacterial contaminants can lead to a variety of diseases like cholera, typhoid, and severe diarrhea. Excess amounts of some minerals in water can lead to conditions like fluorosis with teeth and bone deformities (figure 1). All in all, the risk to human health is extremely prevalent when consuming contaminated water.

Table 1: Maximum allowable quantity of contaminants in drinking water in India.

Contaminant	Mg/L
Arsenic	0.05
Fluoride	1.5
Cadmium	0.010
Chromium	0.05
Lead	0.002
Mercury	0.001
Nitrate	100
Iron	1
Edrin	0.0002

Lindane	0.004
Methoxuchlor	0.1
Toxaphene (2,4,5 –dichlorphenoxy)	0.0005
Acetic Acid	0.01
Turbidity NTU	1 – 5

Burgula, Telangana State

Many villages in India have water sources consisting of the organic and inorganic substances depicted in Table 1 in large quantities. The village of Burgula in Mahbubnagar district of Telangana State of India is no different. It has a population of approximately 5000 residing in an estimated 1100 homes. Most citizens work on agricultural lands as farmers and raising the livestock. Along with their own lives, much of the work they perform is predicated on the availability of water. According to an initial survey done in 2014 by students volunteering for Engineers Without Borders (EWB) - India, water in Burgula contained approximately 10 mg/L of fluoride. This primary contaminant has ignited long term issues related to fluorosis in many residents. Fluorosis causes weakening of the bones leading to eventual bowing of the legs and damage to tooth enamel. Along with this condition, several people experienced stomach pains and diarrhea because of bacterial contaminants. In December of 2014, a team of engineers from Wheels Global Foundation (WGF) visited the village and performed water analysis, confirming the findings of the EWB students. Subsequently, a clean drinking water plant was set up in Burgula.

Figure 1: Three residents affected by fluorosis can be seen with bowed legs in front of the water plant.

Technology

The method used to filter the ground water uses a process called as reverse osmosis at its core. To understand the process of reverse osmosis, a brief explanation is provided. When a particle moves from an area of higher concentration to that of lower concentration, the movement is known as diffusion. For example, when someone opens a bottle of cologne or perfume in a room, the people sense it without actively attempting to smell the contents of the bottle. In this scenario, the particles that comprise the odor have traveled from a state of higher concentration, the bottle, to a place of lower concentration, the air outside the bottle. Similarly, water moves across a semipermeable membrane in a container from lower to higher concentration of the solute by osmosis. Reverse osmosis occurs when higher solute (contaminated) water on one side of a semi-permeable membrane moves to lower solute concentration under pressure generated by a pump yielding clean drinking water.

A three way partnership was developed between the villagers, Global Pragathi, and WGF. The villagers agreed to provide a shed for the design of a water plant. Unclean water istaken directly from the ground source, chlorinated, and collected in a storage tank. The tank is connected to a pressurized sand filter. The water travels through the sand filter where large and small turbid particles including rust are trapped. Turbidity is in essence, the lack of clarity of the water. The water then goes through a carbon filter. The carbon

bed within the filter removes color, odor, organic chemicals, chlorine, and fluorine from the water. Both of these beds are cleaned daily by performing a backwash on the system. This allows the trapped particles to be flushed out of the system. Once a year, this carbon bed is to be replaced. The water then reaches the reverse osmosis system. A high pressure pump increases the pressure to approximately 100 psi in order to perform the reverse osmosis. This is the final step of filtration as about 98% of dissolved solids are prevented from passing the semi-permeable membrane. Two separate streams are then formed from this step. One is of "clean water" and the other is highly contaminated "reject water" which is drained out of the system. The stream of clean water then goes through ultraviolet radiation to kill the microbial organisms and ultimately enters the final storage tank as drinking water, ready for use. A panel is present indicating the following: the pressure inside the reverse osmosis system, the flow within the reverse osmosis system, the total dissolved solutes (TDS) of the water, the percentage of reject water, and the total running time of the pump and system. The panel also includes an automatic switch to turn off the pump should the pressure exceed the necessary levels.

Figure 2: The system is shown excluding the two storage tanks at the beginning and end of every cycle.

Impact

The primary goal of Global Pragathi is to provide preventive health care in impoverished communities. Because of this water plant, the residents now have access to palatable water produced at a relatively fast rate. This will prevent gastrointestinal bacterial infections and fluorosis, reducing the mortality rate. Additionally productivity of the residents will increase. To make this self-sustaining project cover the costs of manpower and maintenance, the water is made available at Rs. 2 for 20 liters (3.3 cents for 5 gallons). Also, at a cost of Rs. 8 for 20 liters (13.2 cents for 5 gallons) to cover the employment and transportation expenses, water is supplied to those who desire the delivery service. Through the revenues collected, three village youth have been provided employment. School children and the rural health center get water free of charge. Currently, approximately 50% of the water initially placed in the raw water storage tank is not effectively cleaned and is considered "reject water." This reject water is currently being used to flush bathrooms in the school. Previously, some bathrooms were not in use due to the lack of water needed to flush the toilets. Another area of use being explored is the irrigation of certain crops in the field.

Simply providing the people with methods of purifying the water is not enough, however. Educating them on how to sustain the flow of clean water, repair any issues in this flow, and eventually establish further renditions of the supplied methods, is important. This idea is no different from the ancient proverb, "Give a man a fish and he eats for a day. Teach a man to fish and he can feed himself for life." By learning how to create clean water, the villagers are able to expand upon existing knowledge. This allows them to not only help themselves in situations where the process malfunctions but to eventually actively partake in the everlasting quest for newer methods that are all in all, better. It could result in the water becoming even cleaner, the purifying process becoming more efficient, and/or the technology becoming cheaper. Finally, it promotes social entrepreneurship.The successful implementation of a self-sustaining clean drinking water plant with all the benefits outlined above will serve as a great model for future endeavors.