PURDUE UNIVERSITY

CAPSTONE EXPERIENCE 2012

Agricultural & Biological ENGINEERING

Bore Well and Water Delivery Kiosk

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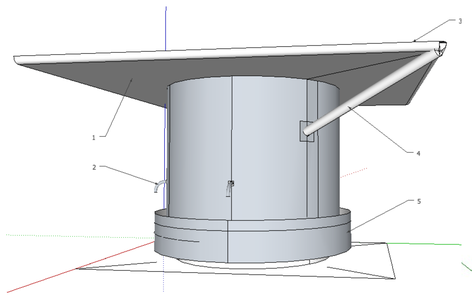
Statement of Problem

- Design a water delivery system for the Mathare Valley slum in Nairobi, Kenya in collaboration with WorldServe International.
- The water delivery system must serve 600 patrons per day.
- The design must use solar power, be space efficient, and be simple to operate.



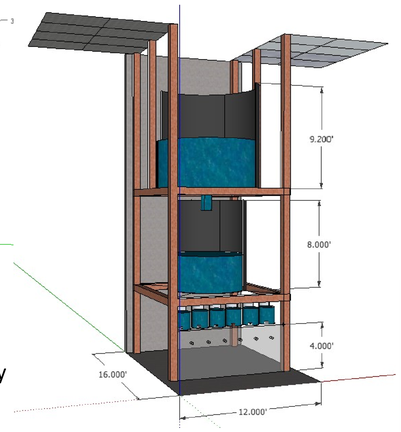
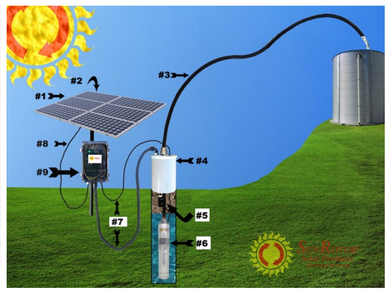


Figure 1 (Above): Initial design of water delivery kiosk. Single reservoir, four faucets.
Figure 2 (Right): Final design of water delivery kiosk. Two stacked reservoirs, six volume control tanks, six faucets.

Water Delivery

- A 20 GPM pump is required to provide 10 gallons of water per day to 600 people from a water source 300 feet underground
- Two tanks deliver to six faucets



Solar Modules → **Energy Controller** → **Submersible Pump** → **Water Source** → **Storage Tank** → **Secondary Tank** → **Faucets**

- The solar modules provide DC power
- The controller is an electronic communication device between the solar modules and the pump
- The submersible pump uses DC powered motor
- The two tanks are stacked vertically
- The top tank solely acts as storage
- The secondary tank is top-fed from the storage tank and delivers to the faucets
- Multiple faucets efficiently serve the population

Constraints

Environmental
- Water quality: "Would you drink the water?"
- Depth and location of water source
- Hours of sunlight per day

Social
- The kiosk will aid in the reduction of deaths due to water-borne diseases
- Easy access and quick delivery is essential for the flow of people to be accommodated
- Security of expensive equipment

Economical
- Space limitation of land plot: The need for a compact design is important due to the cost of land acquisition per 6 by 8 foot plot.
- The site is difficult to access due to the slum location, the design needs to be sustainable and easily maintained.

Alternative Solutions

- **Filtration:** If water source is contaminated, hollow fiber membrane filters are recommended
- **Wind energy in addition to solar energy:** Can provide energy to the solar pump at low sunlight, therefore increasing water storage
- **Security:** Barbed wire is recommended surrounding the solar array and tanks. An additional electronic security system could be easily integrated
- **Grundfos LIFELINK:** An electronic payment system could be easily integrated

Solution Options

1. **Reduce number of solar panels, therefore reducing output**
   If the sponsor wishes to serve the same number of patrons with a reduced flow, it is recommended that more than one kiosk is constructed.
2. **Filtration options, depending on water quality data**
   If water from aquifer is safe to drink, filtration for contaminants will not be necessary. Filtration built into pumping system for particulate matter will suffice.
3. **Pump options, depending on depth of water source**
   For the purpose of this project, the depth of the water source was assumed to be 300 feet and designed for a 350 foot total lift. If actual depth is much less than this, a new pump should be selected.
4. **Increase water storage**
   To store enough water to supply for one day in case of malfunctioning system, 6000 gallons of water should be stored each day. This will require an increase in output flow and increase in area required.

Budget

Item or Service	Quantity	Unit Cost ($)	Total Cost ($)
Bore-Hole Drilling and Equipment	1	12,000	12,000
Land Plots	2	30,000	60,000
Solar Modules	16	374.99	5,999.96
Module Rack	2	1,273.50	2,547
SunRotor Pump	1	654	654
SunRotor Motor	1	587.28	587.28
SunRotor Float Switch	2	41	82
Electric Controller	1	3,656	3,656
Kentainers Tanks	2	250	2,929.33
Concrete, Steel, Kiosk Construction			10,000
Lights, Fencing, Barbed Wire			500
Plumbing Miscellaneous			1,000
Total			99,955.57

References
1. SunRotor Systems. (n.d.). *SunRotor Solar Products. Retrieved April 15, 2012, from https://www.sunrotor.com/*
2. WorldServe » Projects. (n.d.). *WorldServe International. Retrieved April 15, 2012, from http://www.worldserveintl.org/*

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