2.500 Desalination and Water Purification

Spring 2009

Rainwater Cistern Plan for Paulette and Phaeton

2.500 Water Purification & Desalination

14 May 2009

Design Considerations

Design Considerations

- Cost
- Materials
- Complexity/Reliability
- Operational Considerations

All four considerations are critical.

Design Considerations
Cost

- Current price: \$1.20 per m^3 water
  (\$0.0012 per liter)
- Target price: \$0.60 per m^3 water
  (\$0.0006 per liter)

- Compare to Ashkelon desalination (seawater RO): \$0.45 per m^3 water
  (\$0.00045 per liter)

Design Considerations

Overall

System	Cost	Complexity	Material	Operation
RO				
MSF, MEE				
VC				
Solar Still				
Cistern				

Design Considerations
Solar Still vs. Cistern

Solar Still	Cistern
Comparable footprint.	
Materials widely available.	
Distributed solution.	
No existing infrastructure.	Collecting area already exists.
Lower manufacturing tolerance.	Higher manufacturing tolerances.
More likely to break.	Less likely to break.
Daily upkeep.	Monthly upkeep.
Requires pumped or hauled water.	Water supplied by rain.

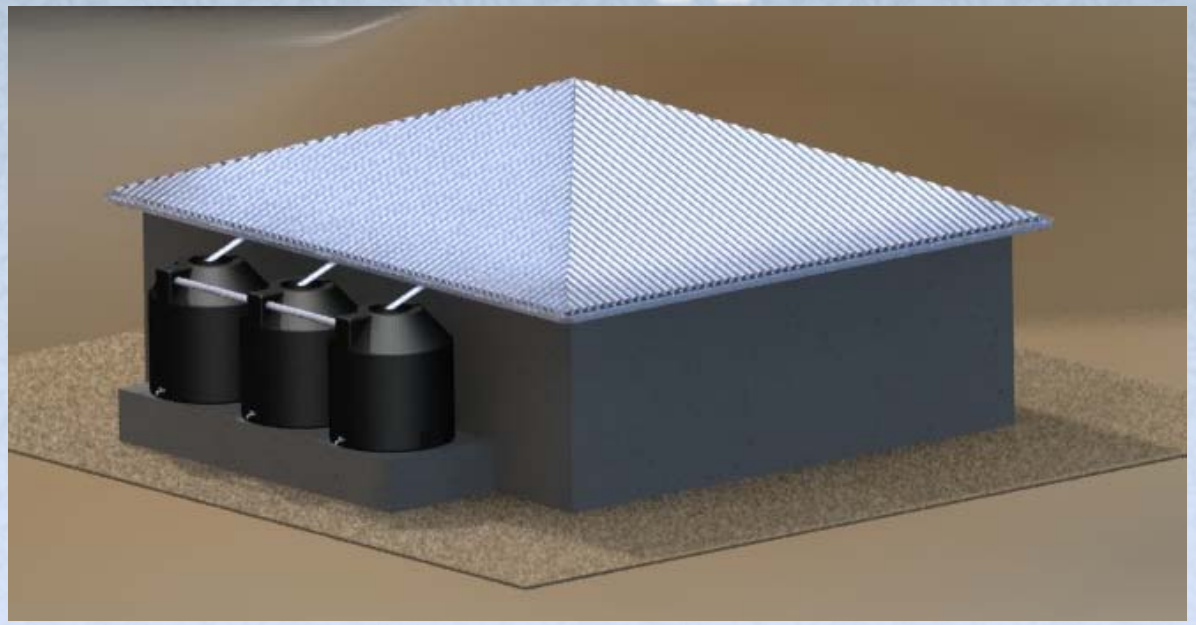
Alternate Approach

Alternate Approach
Optimize the Pump

- Current water supply uses a pump which is most likely not operating at its highest efficiency.
- Replace pump with correctly-sized pump for cost savings without major change of infrastructure.
- Examine the 15-km piping for leakage.

Cistern Approach

Cistern Approach



- Cisterns would be
  - Targeted at poorer households
  - Possibly donated
  - Installed on roofs
  - Maintained by homeowner

Cistern Approach
Existing Roofs

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Design Specifications

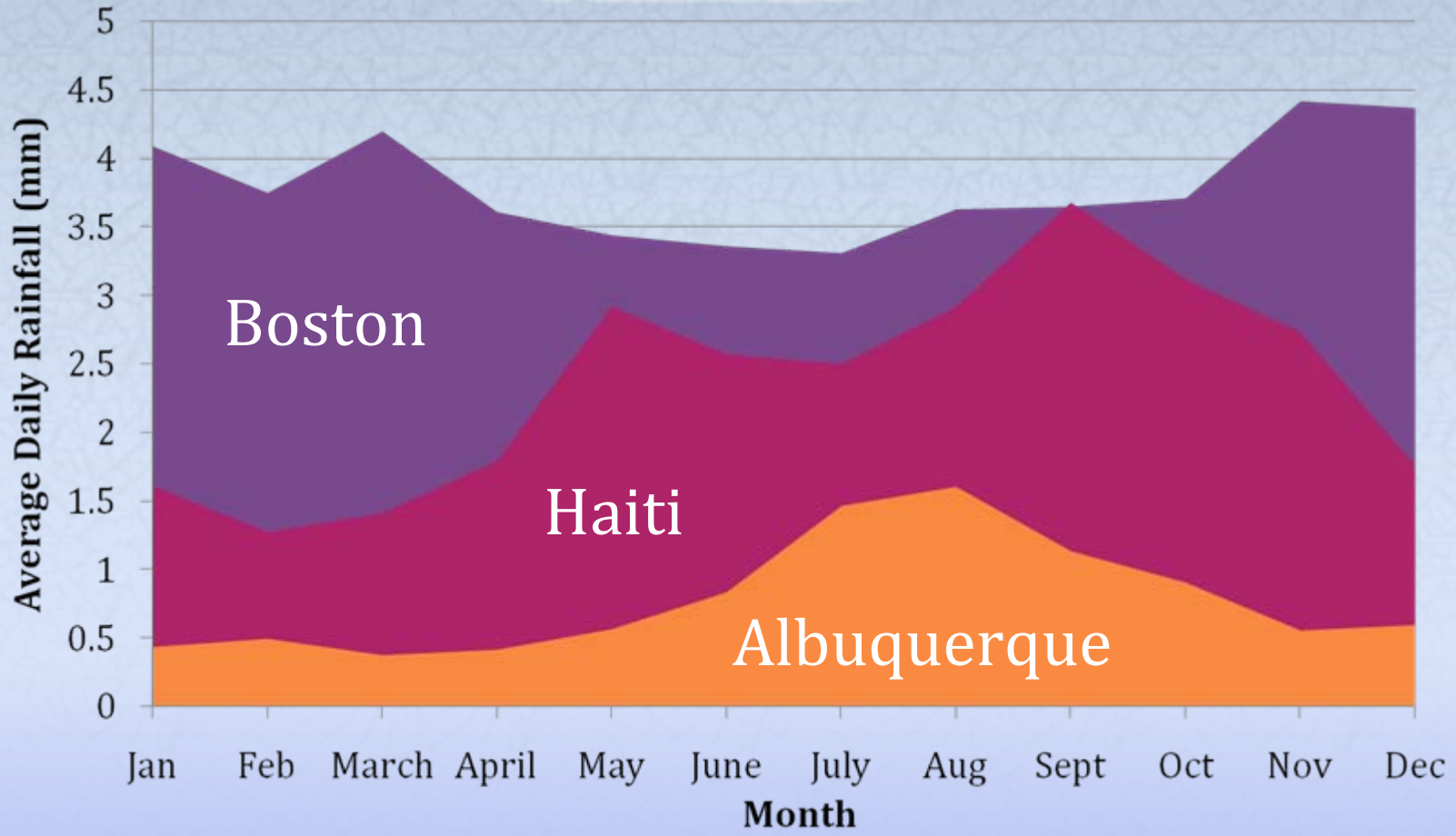
Design Specifications
Water Production Capacity

- Project statement
  - Fresh water usage in Paulette and Phaeton is ~4-8 buckets per household per day.
  - Corresponds to 20 L per person per day.
- UN data*
  - 15 L per person per day total water usage.
- System is designed for 10L per person per day.

* United Nations Development Program, “Human Development Report 2006”, 2006

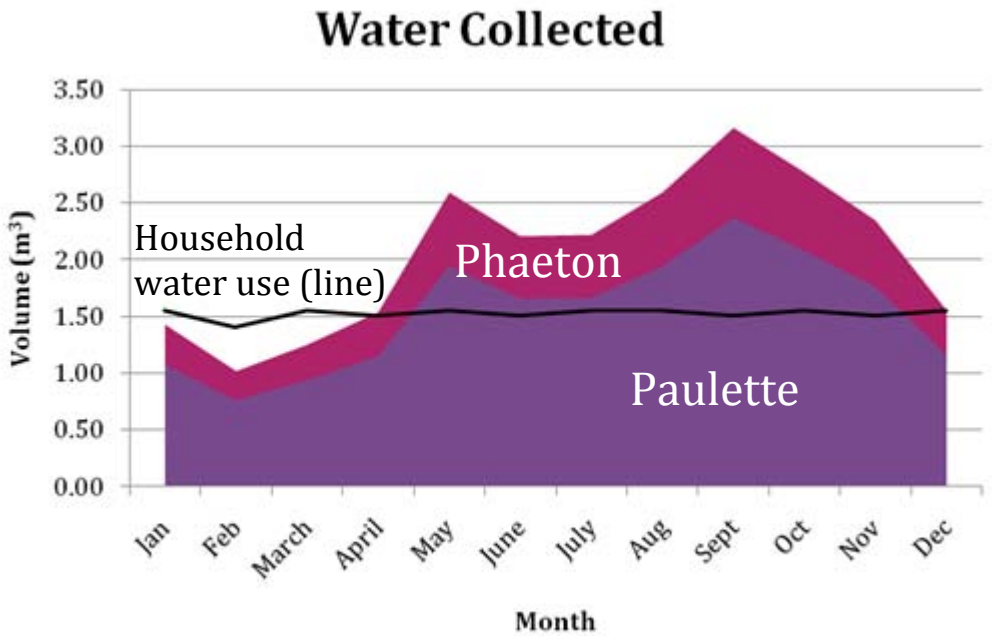
Design Specifications

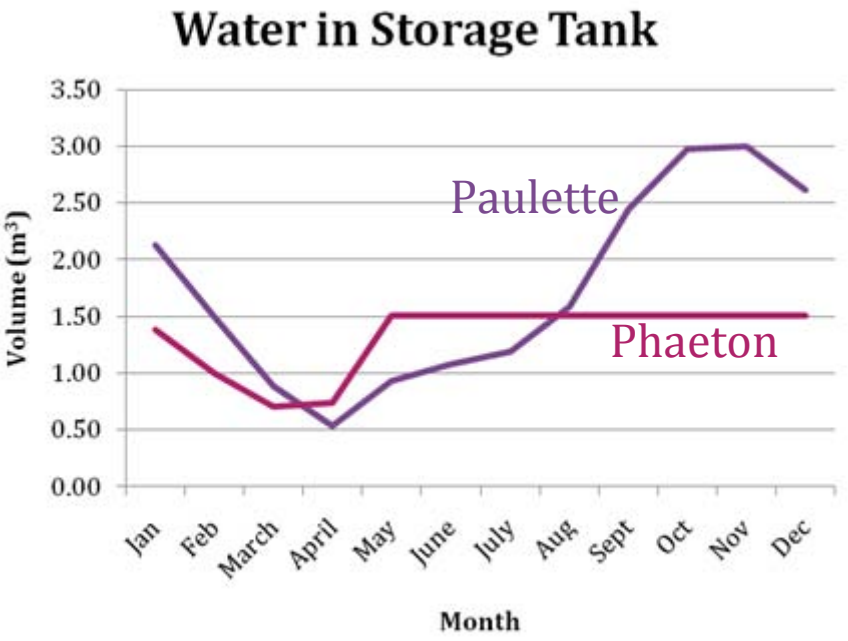
Rainfall



- 75% Collection Efficiency – 28 m^2 of collection area required
  - Paulette Roof – 29 m^2
  - Phaeton Roof – 38 m^2

Design Specifications
Capacity





- Tanks are the dominating capital cost, don't want to oversize.
- Requirements
  - During average year, always have >0.5 m^3 water in the tank
  - Minimum size of 1.5 m^3 (one-month water supply)
- Tank size was chosen using a monthly balance.
- Start with large tank and decrease size to reach design limits.

Design Specifications
Treatment

- Water treatment required
  - Water collects dust, dirt, animal droppings, etc. from roof
- Liquid chlorine, in the form of laundry bleach, added to cistern
  - 2 fluid ounces (¼ cup) per 1,000 gallons of rainwater
- Purification before drinking is also recommended

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Critical Evaluation

Critical Evaluation

Cost

	Paulette		Phaeton	
Component	**Polypropylene Tanks**	**Concrete Tanks**	**Polypropylene Tanks**	**Concrete Tanks**
Gutters	$46	$46	$52	$52
Gutter Installation Components	$20	$20	$22	$22
Connecting Pipes	$12	$12	$12	$12
Sealant	$5	$5	$5	$5
Fittings, Valves, and Screens	$35	$20	$35	$20
Water Tanks	$615	$238	$308	$119
Total Capital Cost	$732	$355	$434	$245
Per m^3				
Operating Costs	$2.23/$m^3$	$1.39/$m^3$	$1.06/$m^3$	$0.82/$m^3$
Capital + Operating Costs	$3.61/$m^3$	$1.99/$m^3$	$2.22/$m^3$	$1.47/$m^3$

Current price: $1.20/$m^3$

Critical Evaluation
Alternate Implementations

- Rainwater collection on community buildings.

Critical Evaluation

Risks

- Possibility that families already collect rainwater
- Poorer homes unable to accommodate system
- Drought
- Hurricanes
- Market failure of pumped water system

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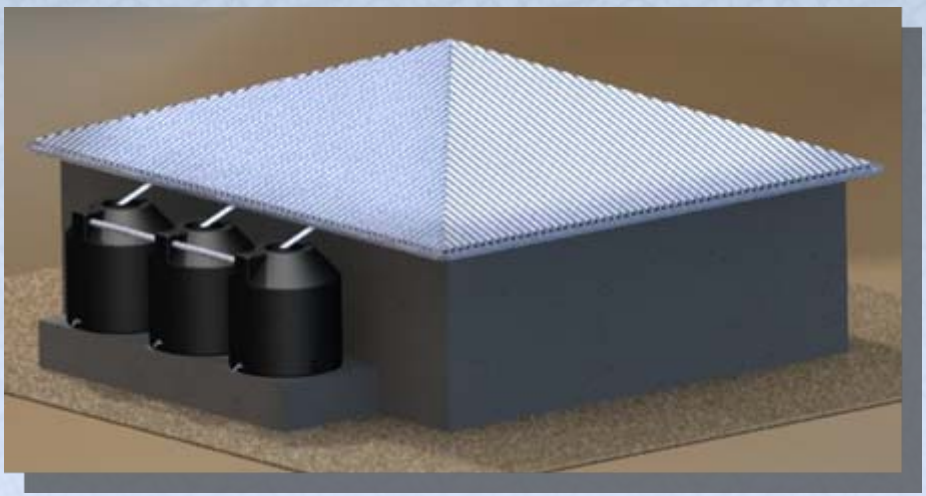
Questions



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