IPRO 323:

Design of a Reliable, Cost Effective Water Pumping System

Problem Formulation

- Water related diseases kill a child every eight seconds and are responsible for 80% of all illness and deaths in developing countries.
- Rural communities all over the world do not have a reliable source for clean, potable water.

IPRO 323

- **<u>Overarching Principle</u>**

  To design an affordable, sustainable, and reliable system to access potable ground water for communities in developing countries.

Monterrey, Mexico

Objectives

- Evaluate water sources and water demands of the target community
- Design and construct a small-scale test system to approximate the performance of a full-scale system
- Design a full-scale solar powered water pumping system- Kankakee
- Research available components and perform cost-benefit analysis
- Work toward Mexico proposal

System Selection Process

Technical Considerations

Power Options

- Utility Grid
- Gas Generator
- Wind Turbine
- Solar Generator
- Ram Pump
- Hand Pump

Storage & Distribution

- Storage
  - Gravity Fed
  - Pressurized lines
  - Ground tank
- Pump
  - Low cost vs. low maintenance

Conditions to Consider

- Geographic variables
- Weather consistency
- Gov. Utility infrastructure
- Water Demand

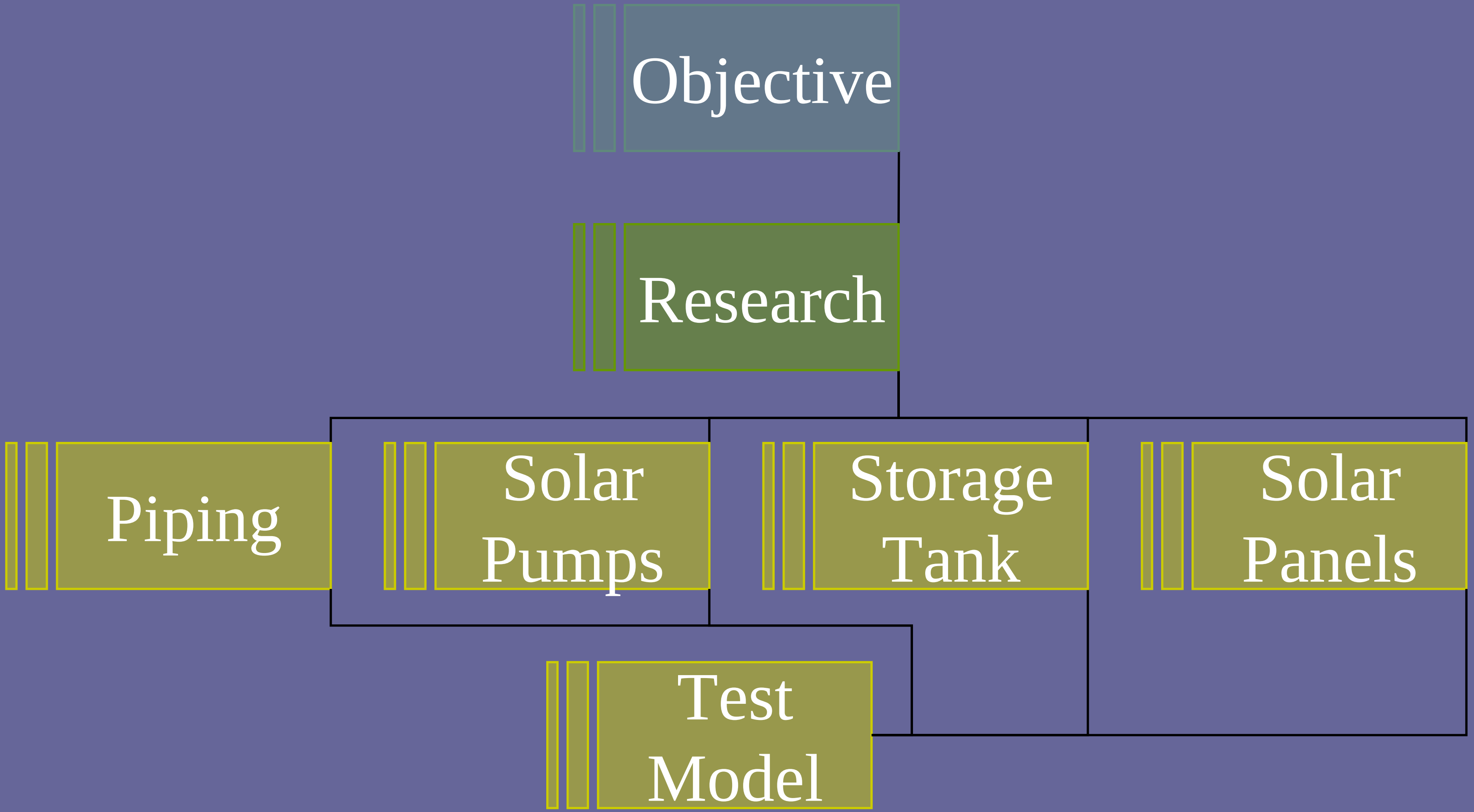
Kankakee/Mexico

- No Utility infrastructure
- Consistent sunlight
- Low water demand <1000 G/day
- Poor wind conditions
- Flat terrain

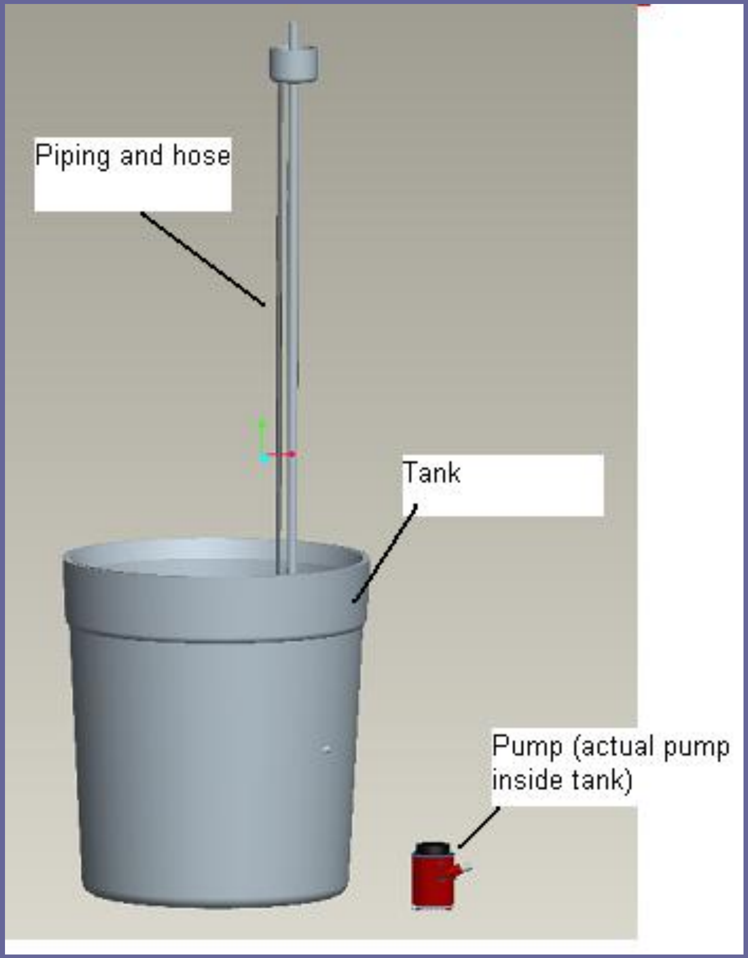
The Team

- Team break-down
  - Two sub-groups
    - Test model – Farr Hall
    - Kankakee Design

Methodology

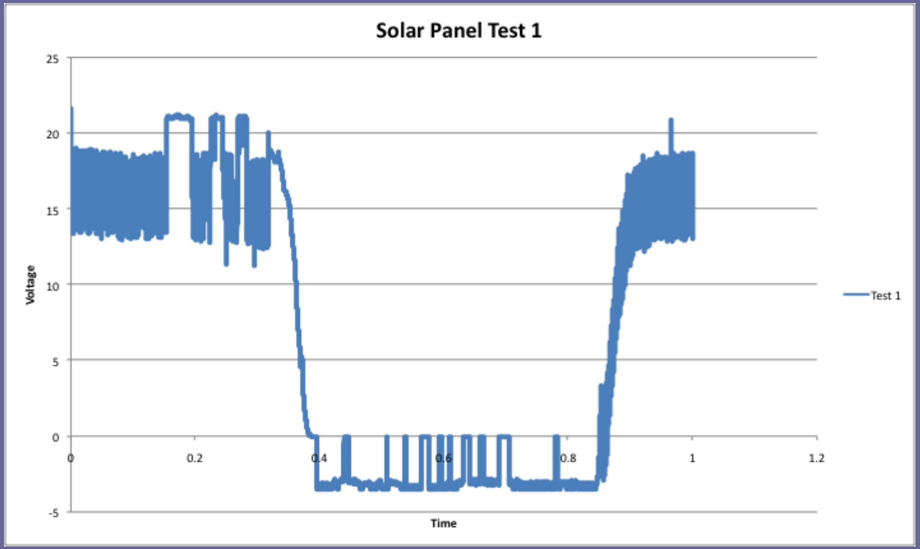


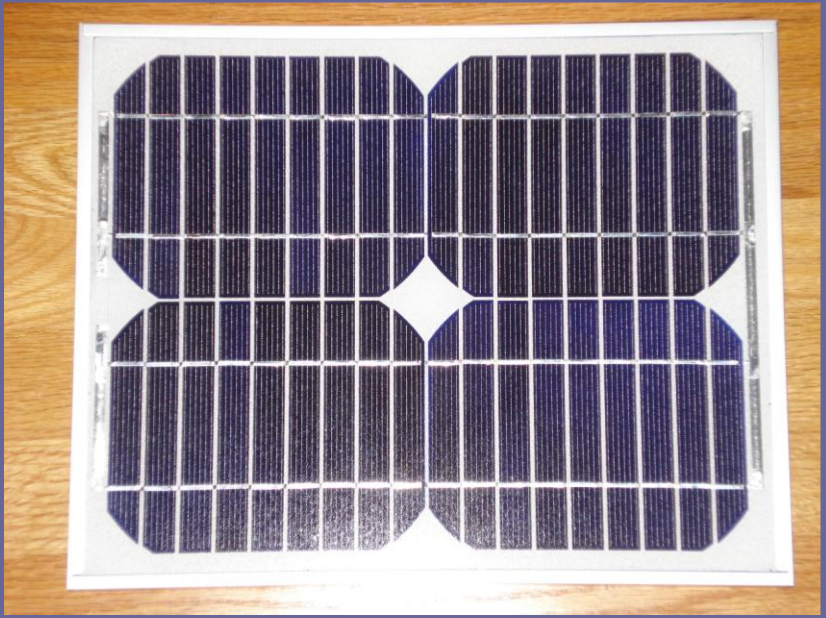
Conceptual Design



Pipes and Pumps

Storage Tank and Panels





Test Model Results

- Gained experience with components
- Experimented with the technology
- Observed correlation to manufacturer data

Test Model Results

- Measurements
  - Flow Rate
  - Electrical Output
- Lessons
  - Learned about the Circuitry
  - Correlated power to flow rate
  - Pressure Calculations
  - Insolation Values

Methodology Continued

Test Model

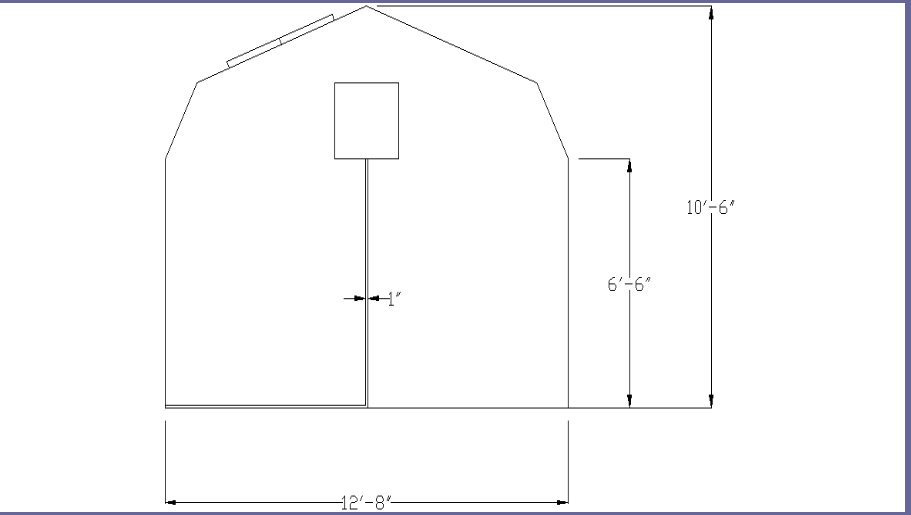
Full Scale Model

General Application

Large-Scale Proposal

Design, Construction and Performance Analysis of a Solar Water Pump For Kankakee , IL

<u>Kankakee Site</u>

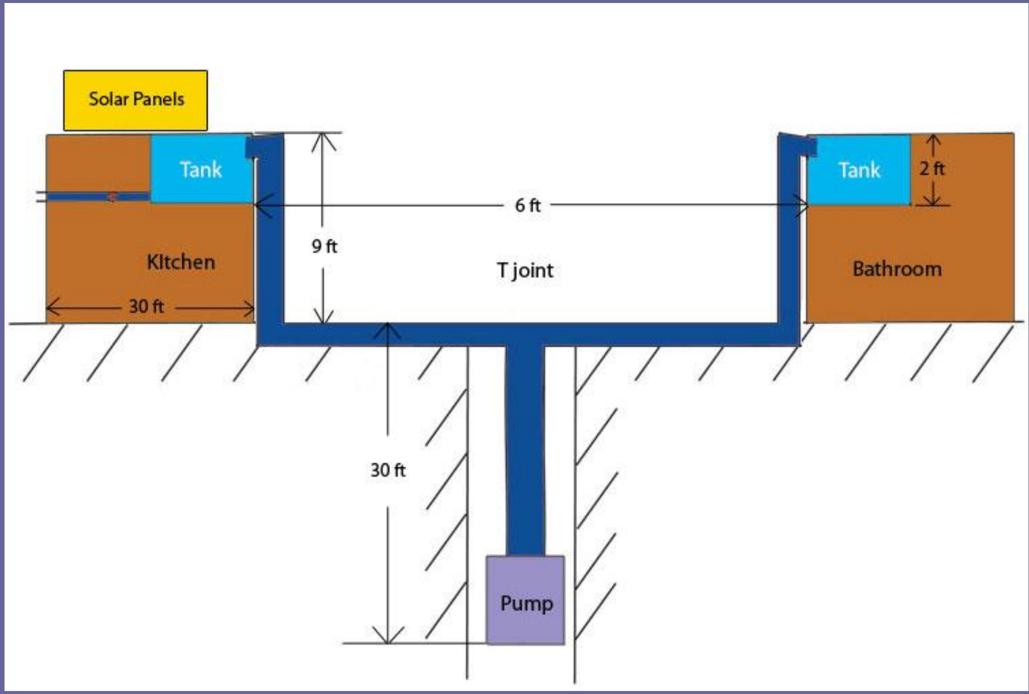


- Rural community
- Flat landscape
- 4 full seasons
- Minimal shade
- Small community
- 3 cabins

Initial Design

Internal Storage

- 260 gallon storage tanks within attic of each cabin
- Single solar powered pump
- Gravity fed system



Advantages vs. Disadvantages

- Simple Design
  - Single pump
  - Simple electrical setup
- Storage removed from environmental conditions
- Reliable system

- Limited internal space
- Limited water supply
- Low amounts of pressure
- Stress factor
- Buckling loads

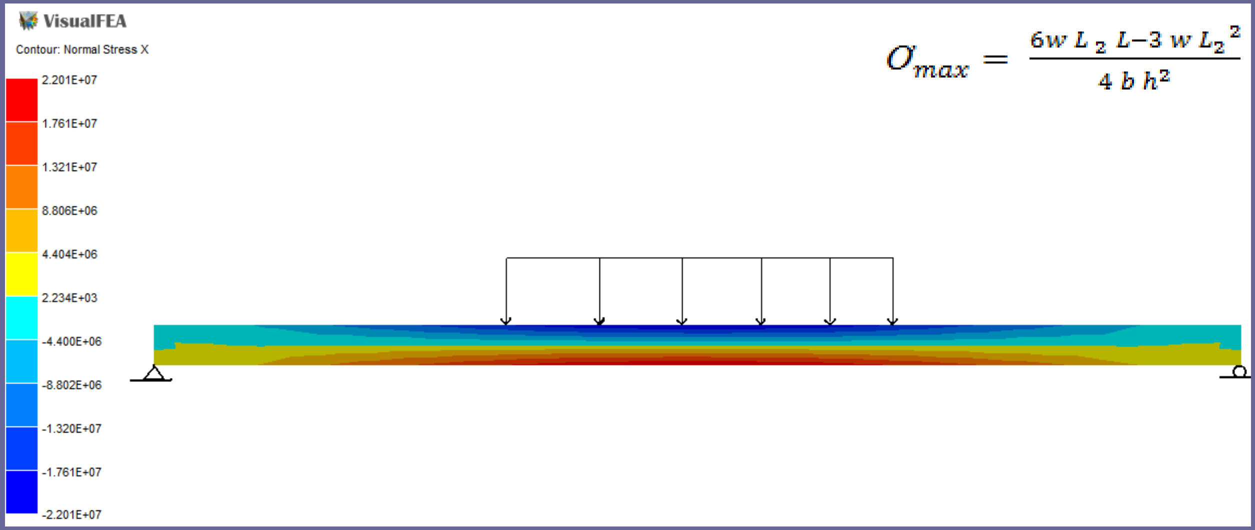
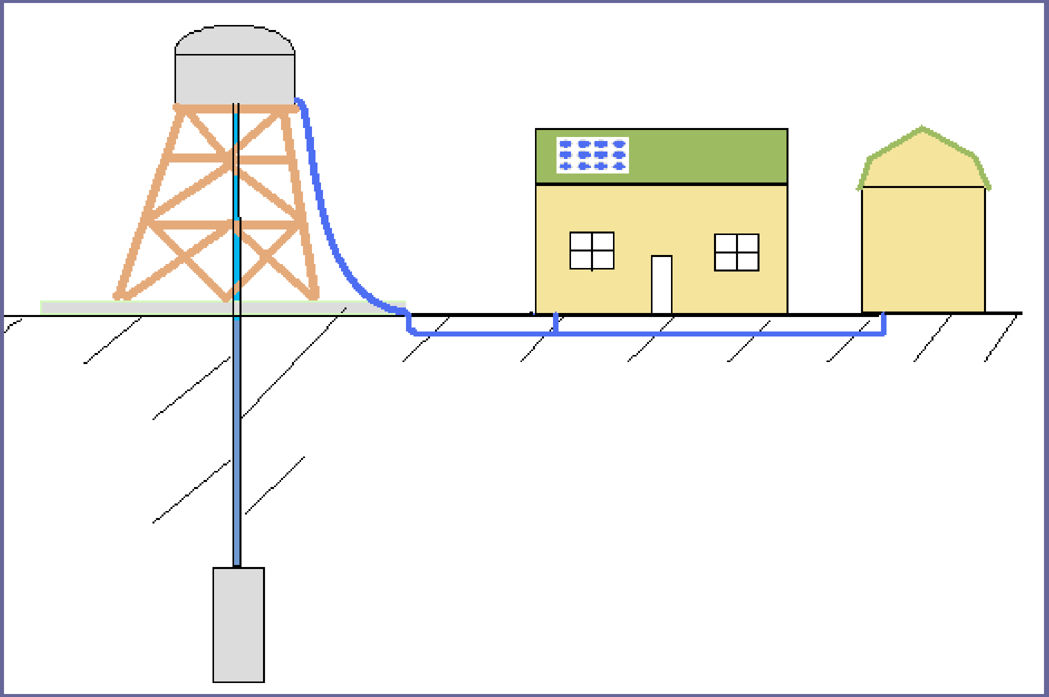


Figure: stress analysis of pine cross beam under distributive loading.

Final Design

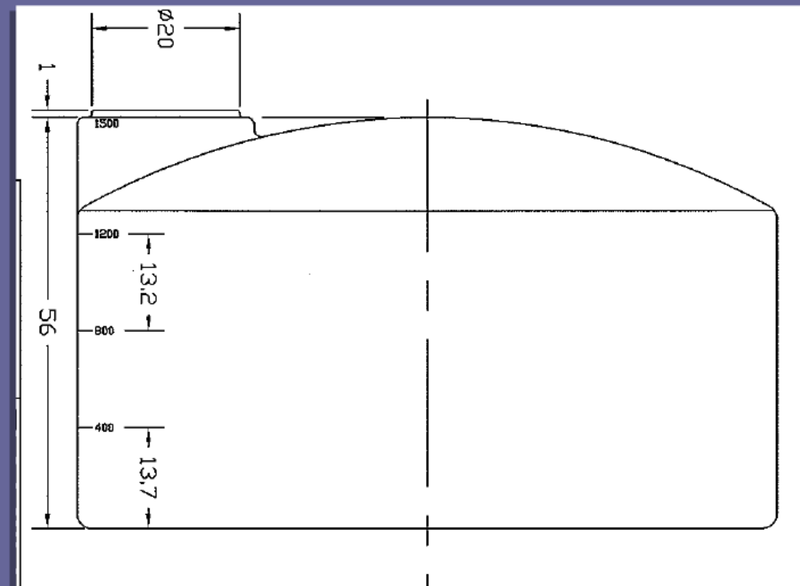
- •Elevated Water Storage
- •Single Pump Design
- •2-Phase Construction
  - ➢Well Construction
  - ➢ 15 ft. Elevated Storage
- •Easily Expandable System
- •Reliable System



Final Design

<u>Storage Tank:</u>

- External Tank
- 1500 gallon high density polyethylene tank
- Gravity fed system
- Raised 15 ft. above foundation
- Insulation for year-round use



<u>Pump:</u>

- Submersible pump
- Lorentz PS200 HR-14
  - ➢Max. flow rate: 11.8 gpm
  - ➢Max. head height: 65 ft

<u>Solar Panels:</u>

- 48 V solar panel array
- 4 BP 350J panels
  - ➢ Power: 50 watts
  - ➢ Nominal Voltage: 12 Volts

Future Tasks

- Break ground in Kankakee
  - Start with phase 1
    - Drill well
    - Install Pump
    - Pour cement for tower base
    - Install storage tank
- Mexico
  - Begun legal process of government approval in Mexico to install the system

Conclusion

- Problem
  - Need for potable water in rural communities
- Methodology
  - Broke up group
    - Farr Hall
    - Kankakee
- Future Tasks
  - Kankakee
  - Mexico
    - Future IPRO semesters

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