Mainpat Refugee Camp

MAHB Inc.
Team Members:
Jason Hertzberg
Garrison Becher
Hasan Mansouri
Jaber Aljuaidi

Overview of Presentation

- NAU's history with Mainpat and Project Purpose
- Background of Mainpat Refugee Camp
- Clients and Stakeholders
- Existing Conditions at Mainpat Refugee Camp
- Design Options
- Final Design
- Sampling Protocol
- Cost Analysis
- Acknowledgements

NAU'S Involvement with Mainpat, India

- For the past two years, NAU's Department of Civil Engineering, Environmental Engineering, and Construction Management has been involved with the Mainpat Refugee camp in Mainpat, India.
- Last December, NAU student Cheryl Dilks traveled to Mainpat refugee camp and discovered two overarching problems at the camp.
  - An outbreak of typhoid fever at all seven camps.
  - No wastewater containment for the Monastery at Camp 3.

Our team was tasked with addressing these two problems and implementing a solution.

Project Purpose

Two primary tasks of the project:

1) Wastewater Component

Design an on-site wastewater treatment system for the Monastery at Camp 3.

2) Drinking Water Component

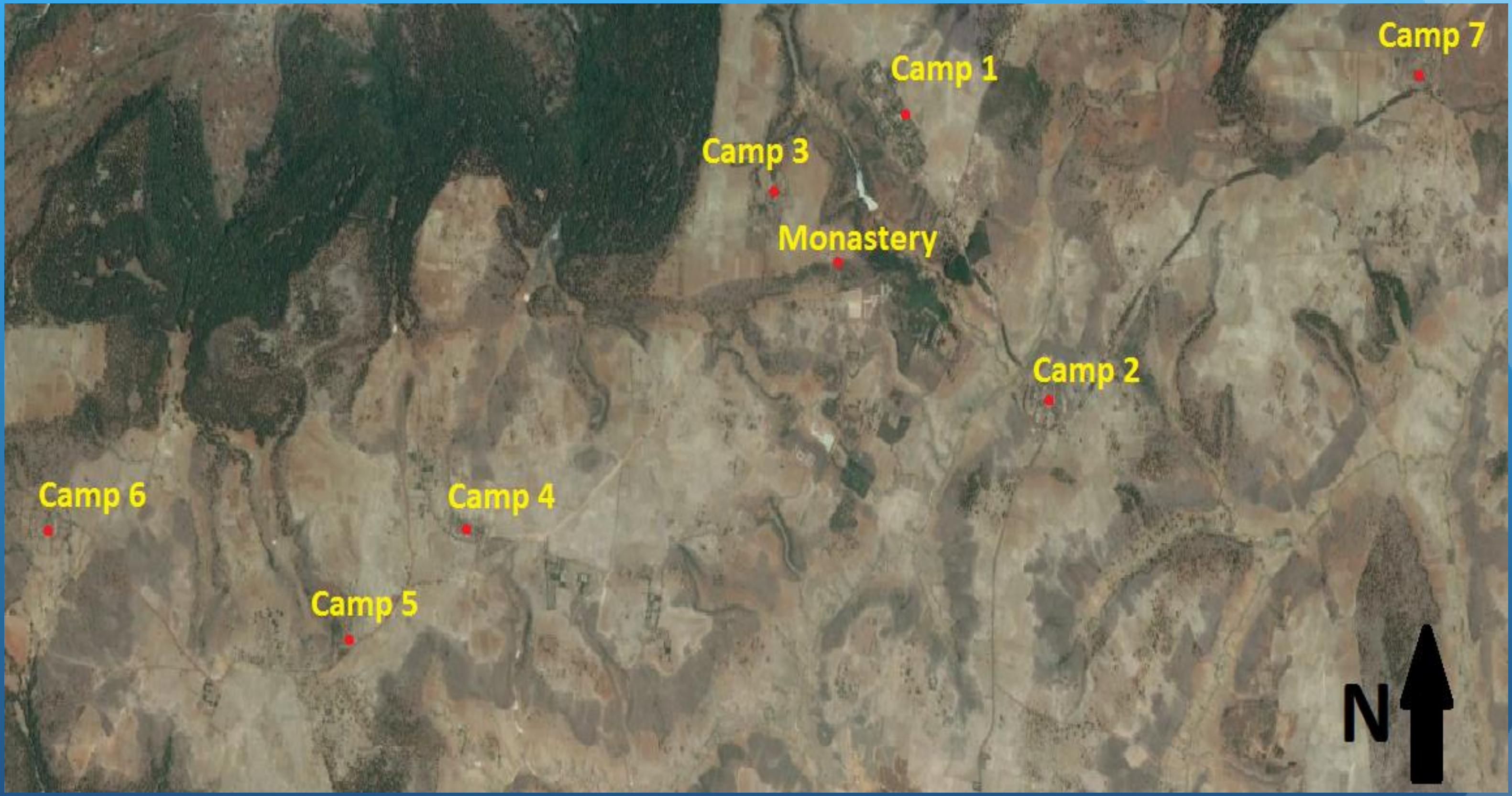
Create a Sampling Protocol for the four field samplers going to Mainpat this month. They will be testing at the wells and households at *all* seven camps.

Background Information

- Mainpat is located in northeastern India, 45 km outside of Ambikapur.
- Population of approximately 900 people, divided into seven refugee camps.
- Each camp is served by a well.
- Monastery located at Camp 3 of Mainpat.

Source: Google Earth

Map of Mainpat



Source: Google Earth

Clients and Stakeholders

Cheryl Dilks: Former NAU Student

Source: http://www.cefns.nau.edu/capstone/projects/CENE/2014/WaterFiltration/

Dr. Bridget Bero. Department Chair

Source: http://nau.edu/CEFNS/Engineering/Civil-Environmental/Directory/Bero-Bridget/

Residents of Mainpat Refugee Camp

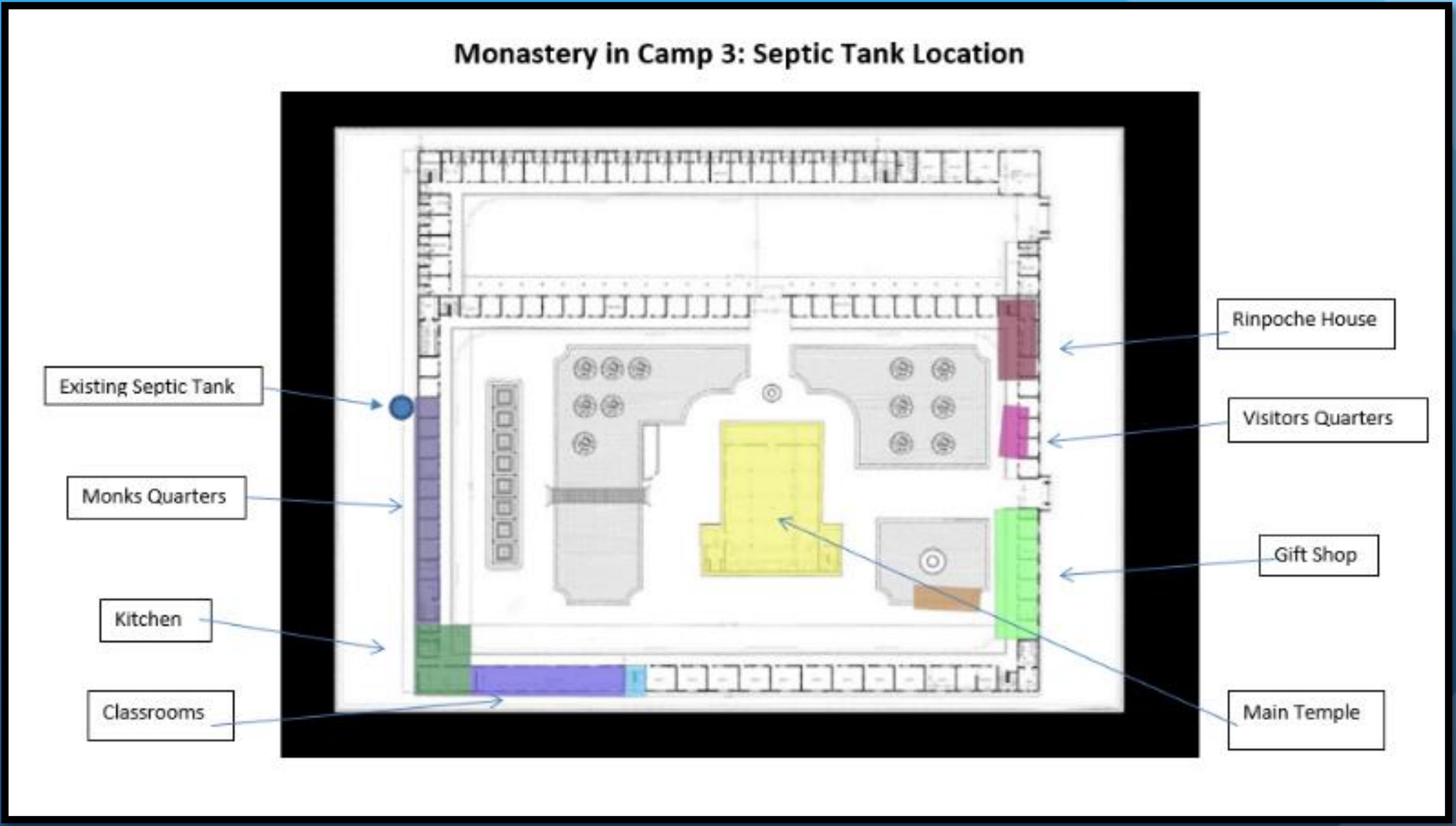
Source: Cheryl Dilks

Existing Conditions at Monastery

Toilet at Monastery.
Source: Cheryl Dilks

Unconnected Pipe releasing human waste
Source: Cheryl Dilks

Basic Layout of Monastery



Monastery Blueprint.
(Souce: Cheryl Dilks)

Primary Decision Matrix

Criteria weighting	Option 1: Composting toilet	Option 2: Incinerating Toilet	Option 3: Septic tank	Option 4: Constructed wetlands	Option 5: Aerated lagoon
Initial cost (25%)	3	1	2.5	1.5	1.5
Ease of maintenance (20%)	3	1	2	2	2.5
Effectiveness (20%)	3	3	2	1	1
Aesthetic Appeal and safety (10%)	2.5	2	2	3	2
Cultural Acceptance (25%)	2.5	1.5	3	2	2
Total	**2.83**	**1.63**	**2.38**	**1.78**	**1.78**

Secondary Decision Matrix

Criteria Weighting	Option 1 (Community Composting Unit)	Option 2 (Individual Composting Units)
Initial cost (25%)	2.5	1.5
Ease of maintenance(25%)	3.0	2.0
Aesthetic Appeal and safety(20%)	1.5	2.0
Cultural Acceptance(30%)	2.0	1.0
Total	**2.28**	**1.58**

Mass Balance of Liquids and Solids

Assumptions:

- 100 people.
- Solid Waste is 75% Liquid.
  (2 lbs waste/person/day).
- 0.5 gal/flush.
- Flushing twice a day.
- 1 lb. solid waste/person/day @ 2 times a day.
- Produce 0.125 gallons liquid/person/day @ 3 times a day.

Source: Britannica Encyclopedia

% Solids	3.80%
% Liquids	96.20%

Mass of Solids Produced (lb/day)	Mass of Liquids Produced (lb/day)
50	1293

Determination of Liquid Evaporation

Mass transfer calculation used to determine amount of liquid waste evaporating from tank.

Assumptions:

- Q = 300 cfm (fan/blower)
- Vent opening = 4” diameter
- Length of Tank = 4 ft
- Width of Tank = 3 ft
- Temperature = 8 degrees C
- v_{air} = 1.50*10^{-4} ft^2/s
- $D_{H20,air}$ = 0.282 cm^2/s at standard conditions

Liquid In = 155 gallons/day

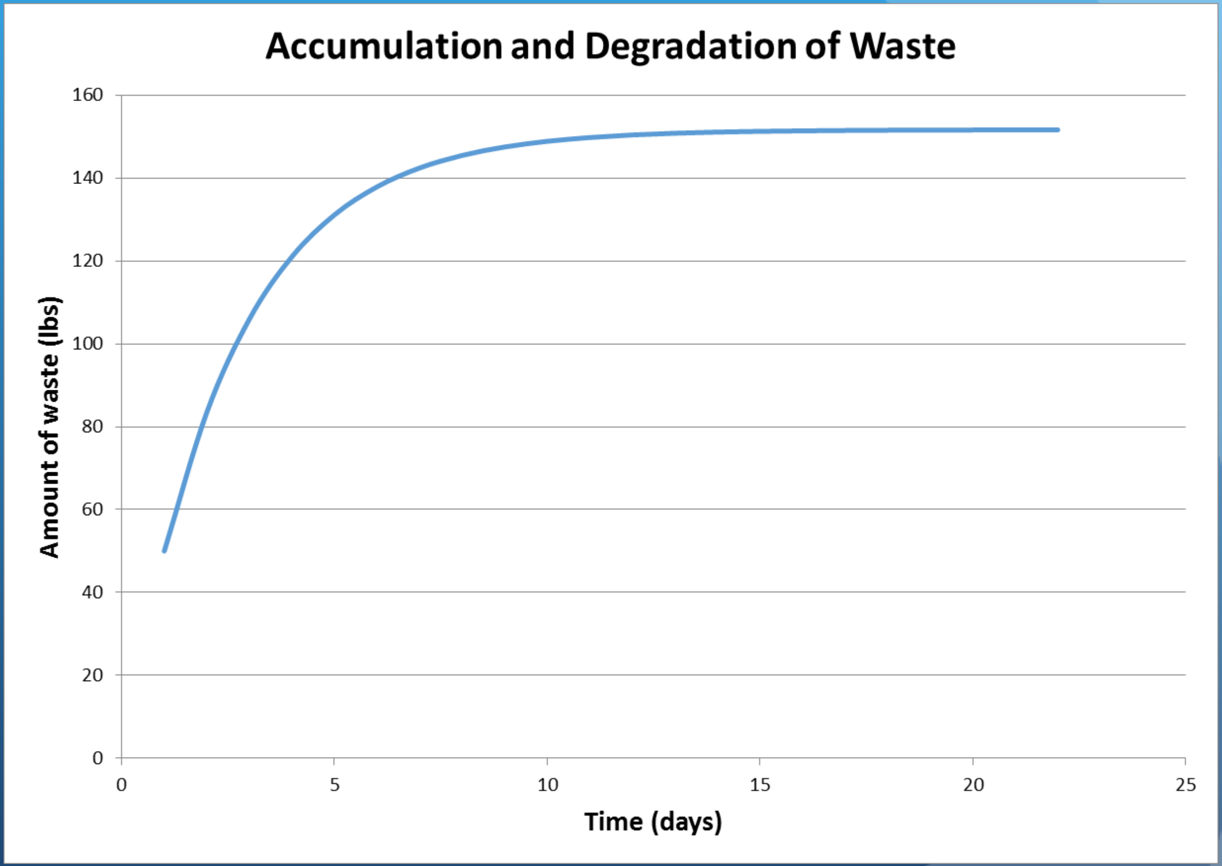
Liquid Evaporated = 5.25 gallons/day

A leach field is required as the amount of liquid waste evaporated is not sufficient, given that 155 gallons are added each day.

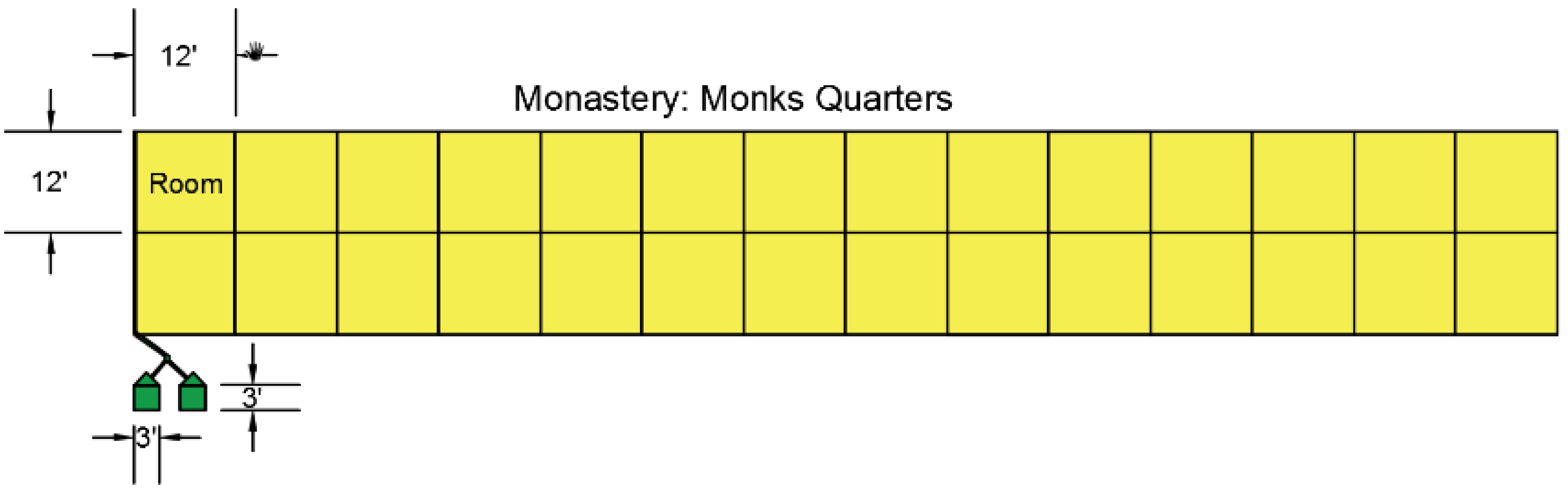
Accumulation and Degradation of Solid Waste

k = -0.4/day

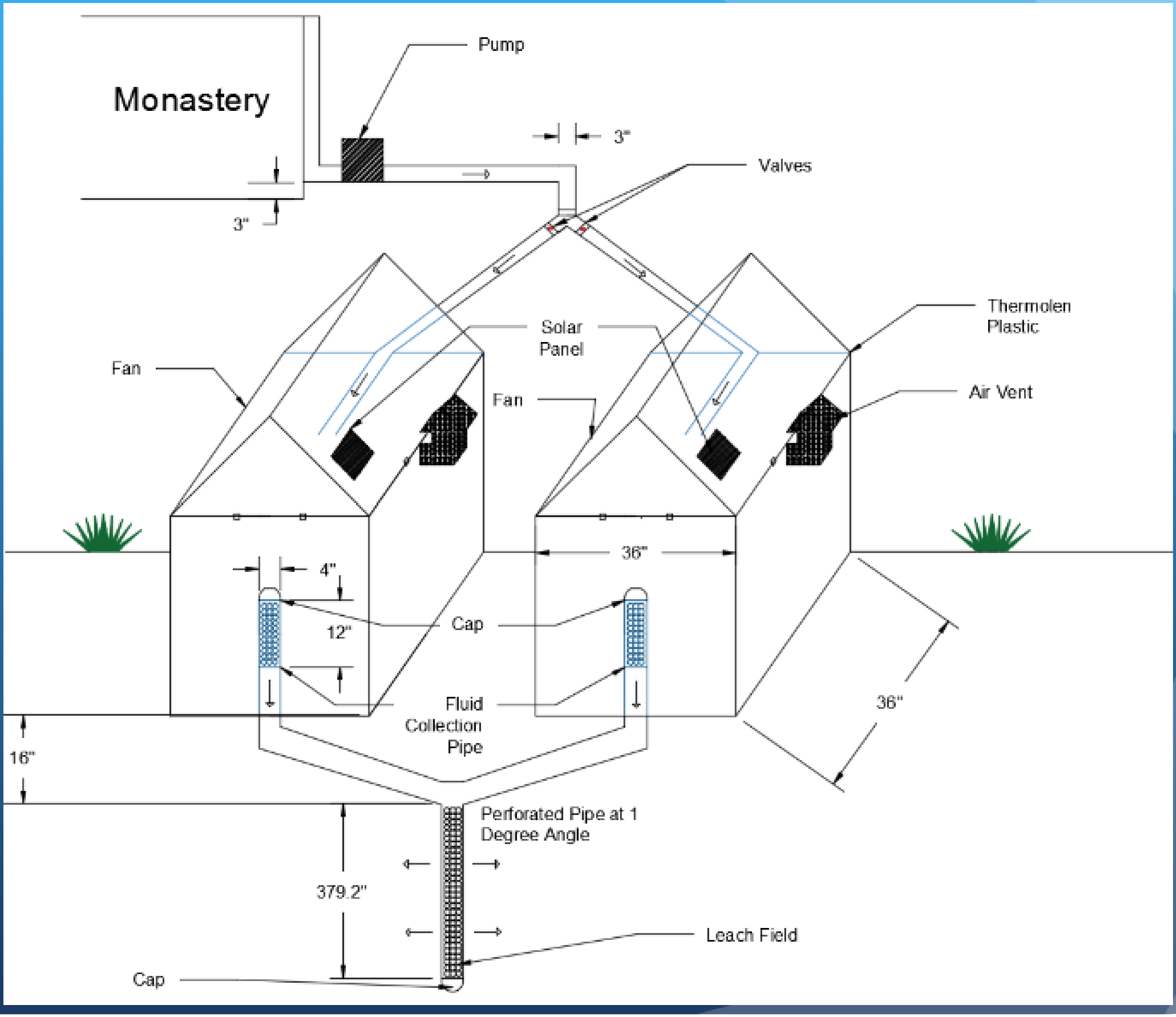
Day	Solid Waste (lbs)
1	50
2	83.5
3	106.0
4	121.0
5	131.1
6	137.9
7	142.4
8	145.5
9	147.5
10	148.9
11	149.8
12	150.4
13	150.8
14	151.1
15	151.3
16	151.4
17	151.5
18	151.5
19	151.6
20	151.6
21	151.6
22	151.6



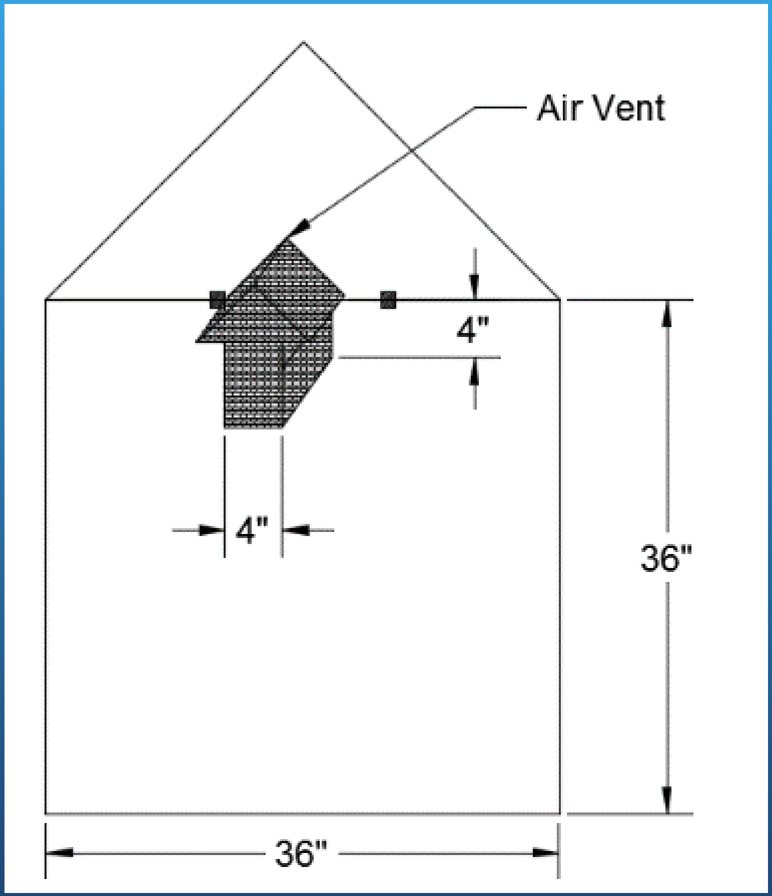
Side View of Monastery with Composting Tanks



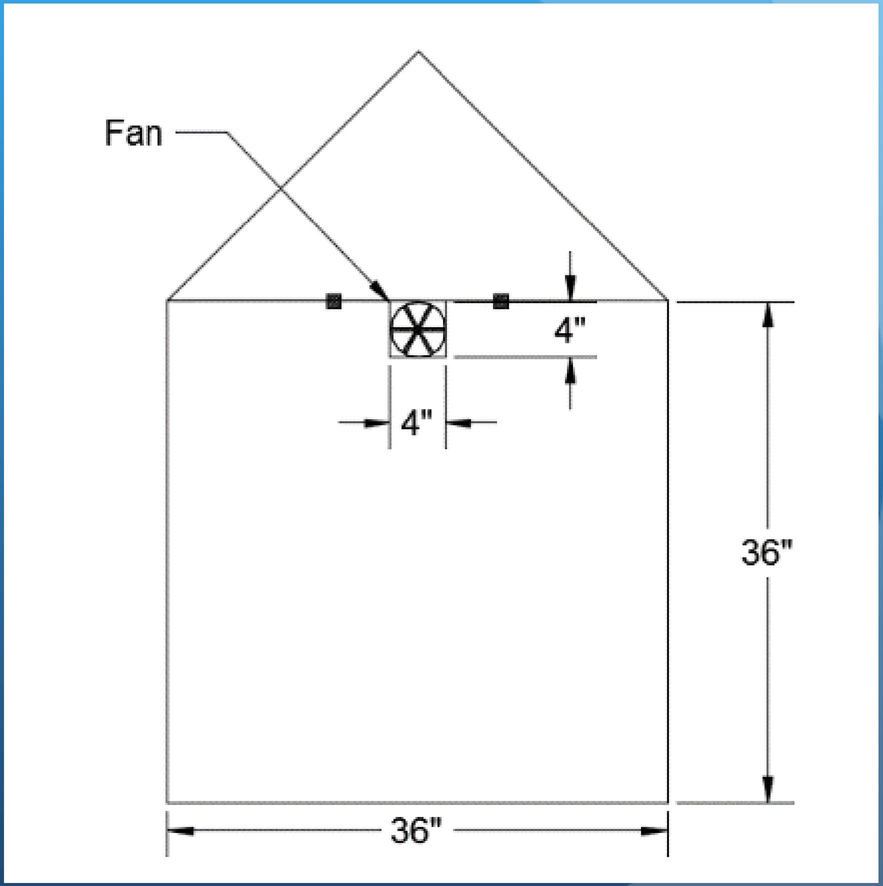
Final Design



Side View of Final Design



Front View



Back View

Sampling Protocol

- Consists of:
  - Sampling Plan
  - Health and Safety Plan
  - Quality Assurance and Quality Control (QA/QC) Plan

  - To be used by field samplers traveling to Mainpat.

  - No samples will be brought back to the university, only data collection sheets.

Water Quality Procedures

1) Total Coliform Count
2) Turbidity
3) Nitrates
4) Arsenic
5) Lead

Equipment and Supplies

Parameter	Testing Kit	Number of Tests per Kit	Number of Testing Kits
Total Coliform	LaMotte 4-3616	1	130
Turbidity	LaMotte Model 7519-01	50	3
Nitrates	LaMotte Model 3615-01	50	1
Arsenic	Econo-Quick Model 481298	1	1
Lead	First Alert	1	40

Table: Water Quality Testing Kits

Additional Supplies

- Water sampling bottles
- Labels for sampling
- Alcohol wipes
- pH strips

Naming and Location Scheme

- 21 tests required for Total Coliform and Turbidity for statistical significance.
- Name of Sample will include:
  - Type of test
  - Camp Location (I – VII)
  - House Number (Samplers will assign numbers to households)
  - Duplicate Number (1 or 2)

House Locations

Source: Google Earth

Data Collection Sheet for Samplers

Sample ID	Date	Time	Test					If Pb or TC P/A?	If NTU, NO_3, or As record value (ppm)
			TC	NTU	NO_3	As	Pb		

United States vs. India Water Quality Standards

	United States	India	Detection Limit of Kits
Total Coliform	<5% samples TC +	<5% samples TC +	1 CFU/100mL
Turbidity	1 NTU	1 NTU*	5 JTU*
Nitrates	10 ppm	10 ppm	0.2 ppm
Arsenic	10 ppb	10 ppb*	0.3 ppb
Lead	15 ppb	10 ppb	15 ppb

Source: United States EPA. Bureau of Indian Standards

*1 JTU ~ 1 NTU

*India's Turbidity standard, if no alternate water source is available for 5 NTU is acceptable.

*For India's Arsenic standard, if no alternate water source is available, 50 ppb is acceptable.

Cost of Engineering Services

Position	Billable Rate ($/hr)	Billable Hours (Hours)	Cost
Intern	40	93	$3720
Engineer	75	297	$22275
Sr. Engineer	135	157	$21195
TOTAL		**547**	**$47190**

Total Cost Of Project

Service	Cost
Engineering Services	$47,190.00
Implementation of Final Design	$3,825.47
Sampling (Labor and Equipment)	$3,651.09
Total Cost of Project	**$54,666.56**

Acknowledgements

- Dr. Bridget Bero, Department Chair and Client.
- Alarick Reidbolt, Head Field Sampler and Technical Advisor.
- Mark Lamer and Dr. Charles Schlinger.
- Cheryl Dilks and Alan Francis.

Questions?