Hydroponics
Group 1

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Proposed Project

Design and build a hydroponics system for the Algonquin people of Barriere Lake. Due to the lack of running water and electricity in this remote area, the greenhouse and hydroponics system must be self sufficient and easily maintained.

Needs Identification

Rank	Need
1	Easily maintained
2	Self sufficient
3	Durable enough to withstand environment (weather, wildlife, sandy terrain etc.)
4	Low cost
5	Easy to transport
6	Easy to assemble
7	Controlled water distribution

Problem Statement

The Algonquins of Barriere Lake require a three season greenhouse and hydroponics system that is entirely self-sufficient, easy to maintain, and durable enough to withstand all aspects of the surrounding environment.

Design Criteria

Benchmarking

Specifications	Hydroponic Site Grow Kit Garden Vegetable Planting System Kit (6-pipe 3-layer)	Viagrow (Deep Water Culture)	AeroGarden Farm Plus Hydroponic Garden
Cost ($CAD)	$129	$281.59	$899.95
Weight (lbs)	7.7 kg	20.5 kg	21.6 kg
Size (m)	100 cm x 50 cm x 100 cm	30.5 x 30.5 x 38.1 (cm)	91.4 x 30.5 x 86.4 cm
Reservoir Size (liters)	15-20 L	144 L	N/A
Plant Slots	54	8	24
Style	Nutrient Film Technique	Deep water culture	Aeroponic
Modularity	Very portable	Very portable	Not portable

Target Specification Benchmarking

Specifications	Importance	Hydroponic Site Grow Kit Garden Vegetable Planting System Kit (6-pipe 3-layer)	Viagrow (Deep Water Culture)	AeroGarden Farm Plus Hydroponic Garden
Cost ($ CAD)	4	3	2	1
Weight (lbs)	2	3	1	3
Size (m)	2	1	3	1
Reservoir Size (liters)	5	3	1	
Plant Slots	5	3	1	2
Style	3	3	2	2
Modularity	4	3	3	1
Total		71	44	

Engineering Design Specifications

#	**Design Specifications**	**Relation (=, < or >)**	**Value**	**Units**	**Verification Method**
	Functional Requirements				
1	Reservoir			Liters	Test
2	Water	>	20	Liters	Rainwater harvesting
3	Climate Control		0	C	Test
4	Power	>		Watts	Solar Panels
5	Submersible fountain pump	=	yes	N/A	Test
6	Channel for plants to grow	=	yes	N/A	Test
7	Starter cubes/small baskets to start seedlings	=	yes	N/A	Test
8	Return System	=	yes	N/A	Test

Engineering Design Specifications

	Constraints				
1	Weight	>		lbs	Analysis
2	Cost	<	100	$	Budget
3	Size	=	6x6	m	Analysis
4	Weather	=	Year round	C	Analysis
5	Animals	=	Yes	N/A	Analysis
6	Electricity	=	No	Watts	Analysis
7	Clean water	=	No	Liters	Analysis

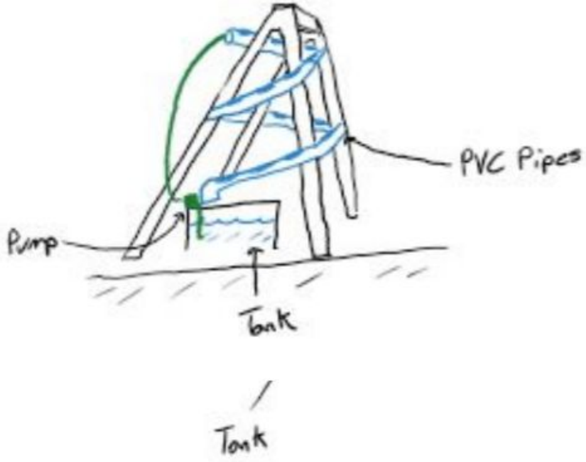
Engineering Design Specifications

	Non-Functional Requirements				
1	Easy to use	=	yes	N/A	Analysis
2	Variety of plants	=	yes	N/A	Test
3	Product life	>	5	Years	Test
4	Safety: Minimum Pinch Points	=	yes	N/A	Test

Conceptual Designs

Gabe’s Designs

#1



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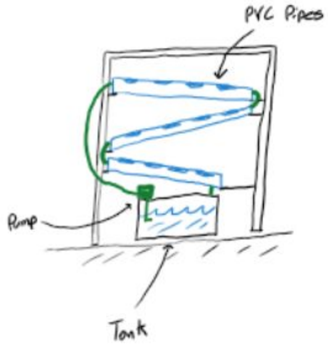

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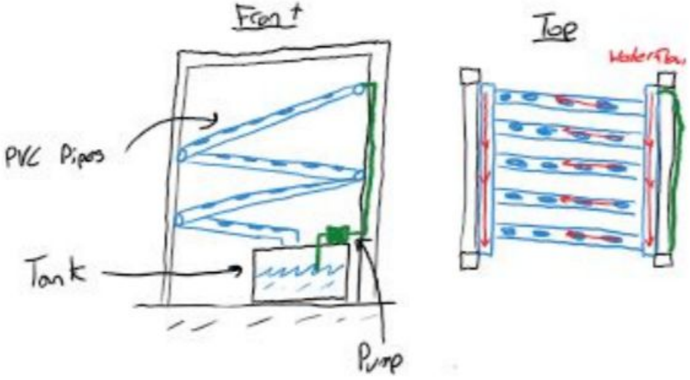
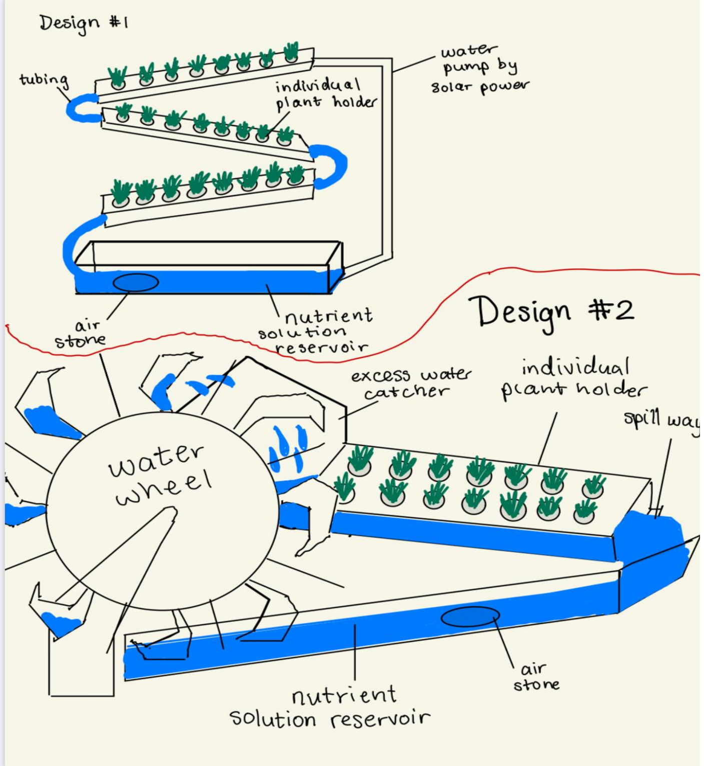
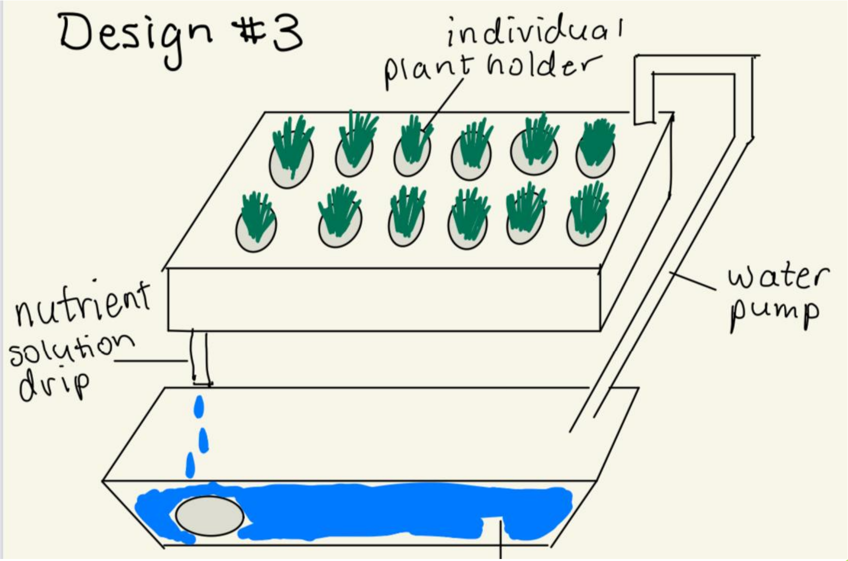


Alana’s Designs

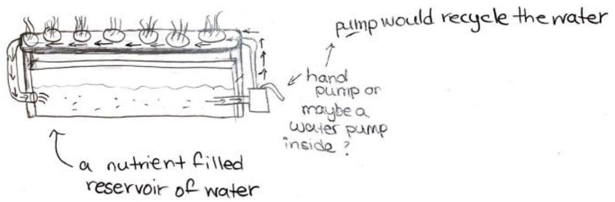




Weeda's Designs

Concept #1

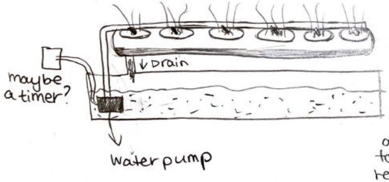
NFT



- water running through tubes on the sides
- A water reservoir that rests at the bottom and is full of the nutrients needed for the plants.
- A hand pump or maybe another type of pump is used to pump the water up into the pipe that holds the plants. The plants are placed in a pipe with holes. the bottom roots/stems of the plant in the pipe are touching the constant nutrient water solution passing by
- The water is then re-entering the water reservoir from the other side, and the cycle continues.
- can create rows of plants and add more pipes connected to the water flow to grow even more plants.

Concept 3

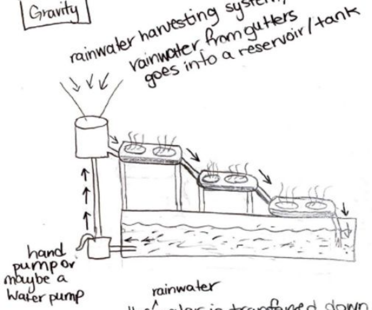
Drip System



- a tube runs at the top of the pipe containing the plants and has a dripping spout at each plant
- the nutrient water solution is pumped using a water pump from its reservoir up to the plants and then drips into each one
- the pipe containing the plants and solution will then have another pipe working as a drain to avoid overflow → drain leads to reservoir
- may be a timer could be placed with the pump so that its pumping the solution at certain intervals...

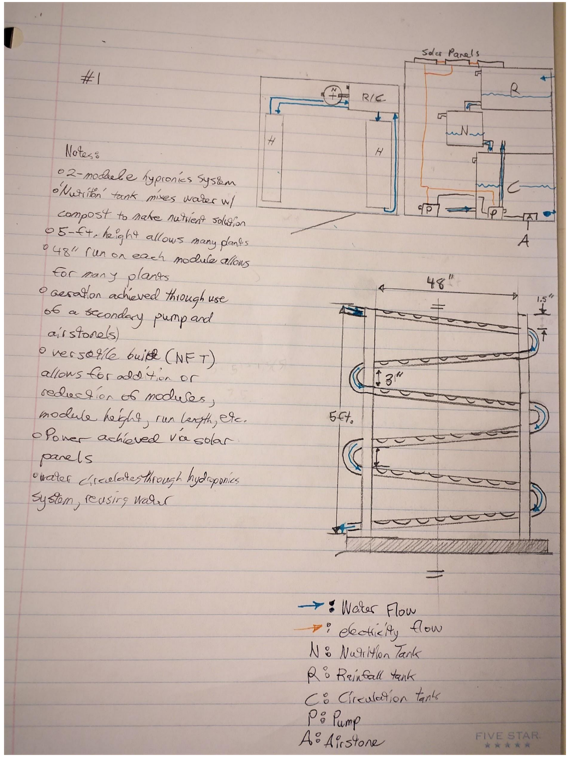
Concept #2

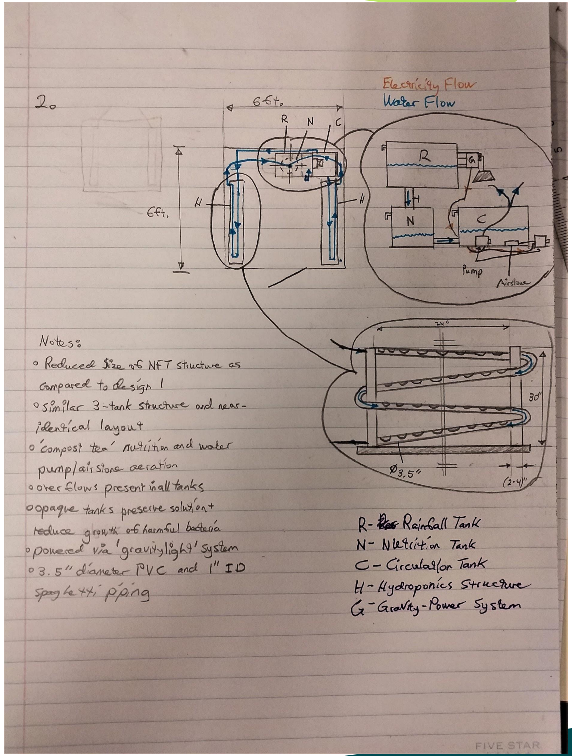
Gravity

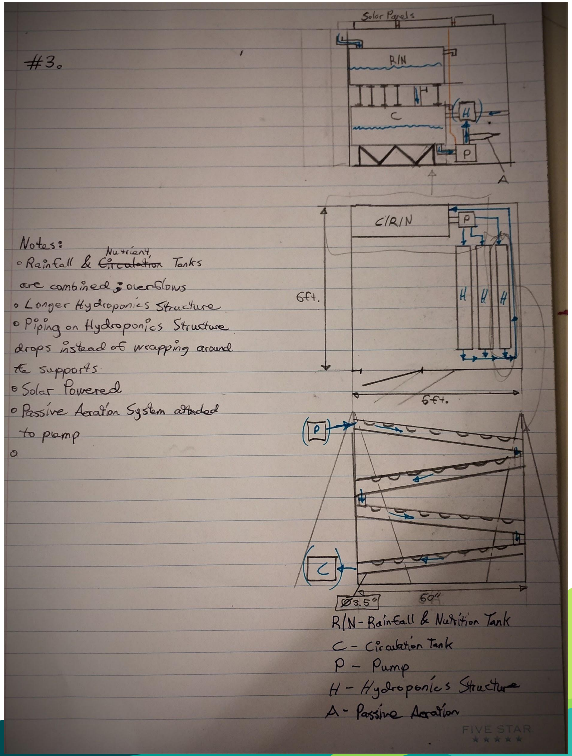


- the rainwater water is transferred down with gravity through multiple rows of pipes that contain the plants → look like steps
- eventually the rows lead to a nutrient filled water reservoir
- a pump then pumps the solution back to the rainwater reservoir where it is recycled again through the system...
- tubes connect all things to one another and transfer the water

Joseph's Designs







Benchmarking/Optimal Design Choice

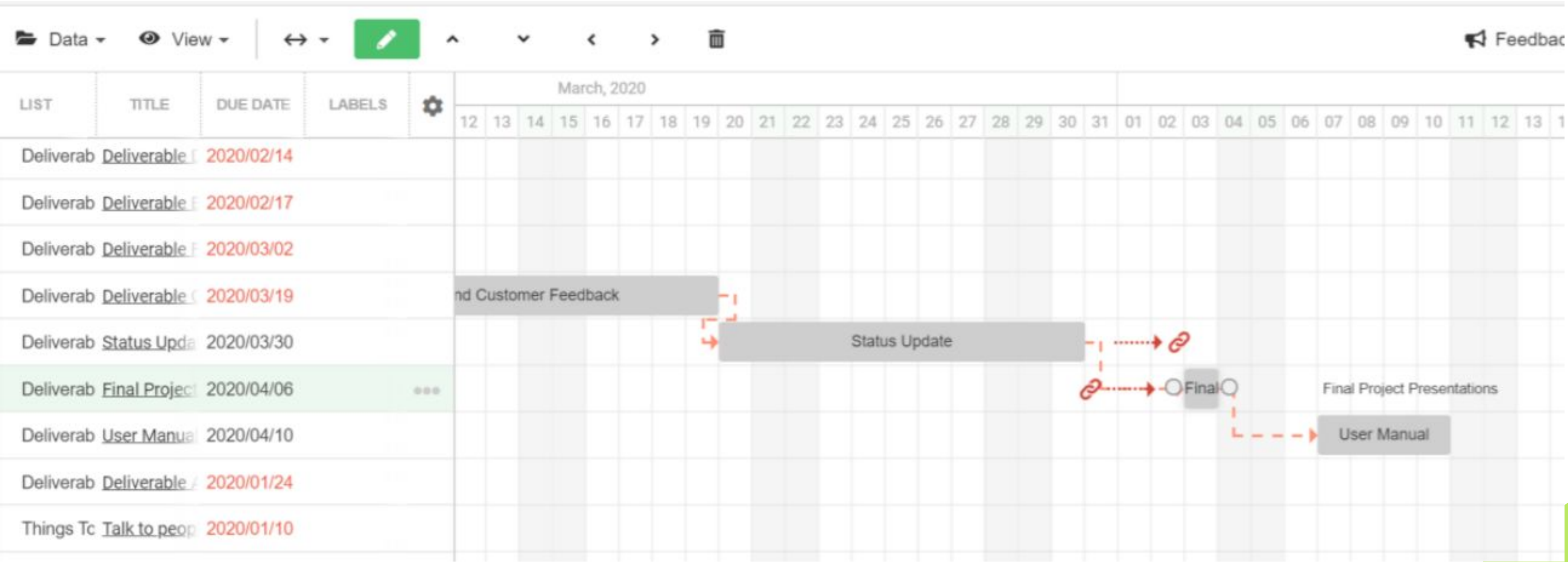
Specifications	Joe's Design 1	Weeda's Gravity Design 2	Gabe's Design 2
Cost ($CAD)	≈ $126.90	$195.99	$330
Weight (lbs)	≈ 28 lbs	≈ 33 lbs	≈ 25
Size (m)	1.5 x 1.2 x 0.25	6 x 6 x 4	1 x 0.5 x 1.2
Reservoir Size (liters)	≈ 18 L	≈ 20 L	≈ 19
Plant Slots	48	24	36
Style	NFT	Gravity fed	NFT
Modularity	Portable	No	Portable

Benchmarking/Optimal Design Choice

Specifications	Importance	Joe's Design 1	Weeda's Gravity Design 2
Cost ($CAD)	4	3	2
Weight (lbs)	2	2	1
Size (m)	2	3	1
Reservoir Size (liters)	5	2	3
Plant Slots	5	3	1
Style	3	3	3
Modularity	4	3	1

Project Plan and Cost Estimate

Project Plan (Currently)



Cost Estimate

1. Zip ties ($11.69)
2. Step up converter ($37)
3. Clay pellets ($26.45)
4. Water containers ($21.02)
5. Seeds ($5.00)
6. Solar panels (funded by construction team)

Total: $101.16

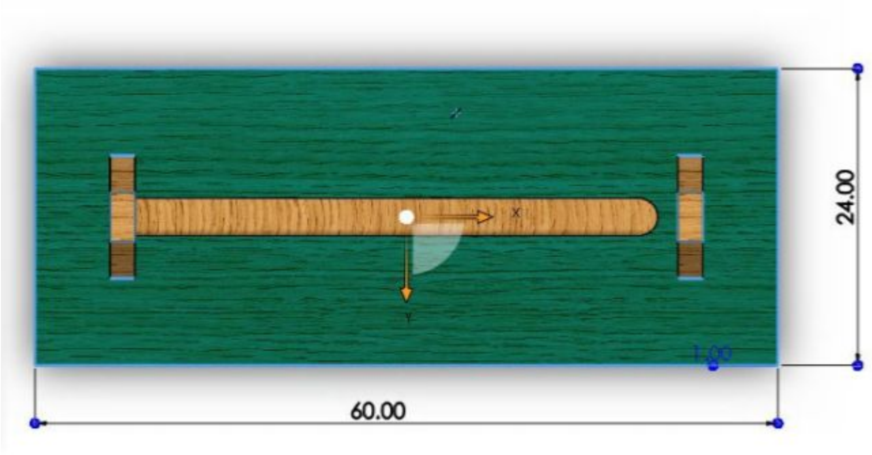
Prototypes & Client Feedback

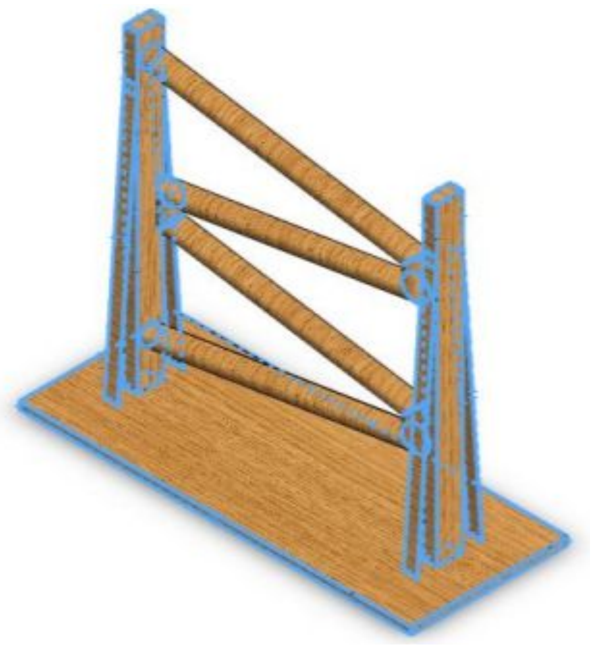
Prototype I

Client Meeting and Feedback

- Client was impressed with the compost-based water nutrition system
- Client suggested a guide on how to effectively compost
- Client thought minimizing costs to budget for solar panels was a good idea

Prototype II





Test Plan

- Pumps
  - What is the greatest height that the 120V pump can supply water to using a 110V step up converter?

    Test heights:
    - 3’6”
    - 4’
    - 4’6”
    - 5’

Test Plan

- PVC pipe angles
  - What is the smallest angle that the PVC-pipe pots can be placed at to control water/nutrient flow and to have the greatest number of plant rows possible?
    - The ideal angle was determined using Solidworks to model the orientation of the PVC pipes
    - Smallest angle: 3.5°
    - Angle used: 5.7°
- The 1.2 degree increase from the smallest angle was added to account for any error, ensuring water flow

Next Steps/Future Work

- Would have:
  - Used client's feedback to implement into our last and final design
  - Made final purchases for our final design
    - The plants, pipes, buckets, etc.
  - Built final prototype/design using all of our purchased items
  - Presented at Design Day

Summary of Project

The hydroponic system fulfills:

- Affordability
- Portability
- Maximum plant plots

Prototype II

- Includes 32 plots for plants per system
- Water/nutrient solution has a controlled flow through system

References

- “N.F.T. (Nutrient Film Technique) System.” *Hydroponic N.F.T. Systems*, www.homehydrosystems.com/hydroponic-systems/nft_systems.html.
- “Basic Hydroponic Systems and How They Work.” https://www.simplyhydro.com/system/

Questions?