

# Hydroponics Group 1

## TEAM:

Joseph Francis

Gabriel Goad 300138333

Alana Leung 300111051

Lucas Piazza 300122443

Weeda Wardak 8171970

# 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.

The background features a central teal-colored area with the text 'Design Criteria' in white. This teal area is framed by dark teal and lime green geometric shapes that create a layered, mountain-like effect. The overall composition is clean and modern.

# 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
<b>Cost (\$CAD)</b>	\$129	\$281.59	\$899.95
<b>Weight (lbs)</b>	7.7 kg	20.5 kg	21.6 kg
<b>Size (m)</b>	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
<b>Reservoir Size (liters)</b>	15-20 L	144 L	N/A
<b>Plant Slots</b>	54	8	24
<b>Style</b>	Nutrient Film Technique	Deep water culture	Aeroponic
<b>Modularity</b>	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
<b>Total</b>		<u>71</u>	<u>44</u>	

# Engineering Design Specifications

#	Design Specifications	Relation (=, < or >)	Value	Units	Verification Method
	<i>Functional Requirements</i>				
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

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

# Engineering Design Specifications

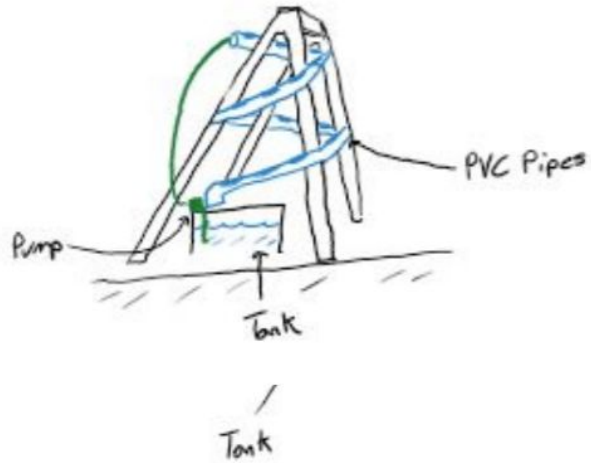
	<i>Non-Functional Requirements</i>				
1	Easy to use	=	yes	N/A	Analysis
2	Variety of plants	=	yes	N/A	Test
3	Product life	>	5	Years	Test
4	Safety: Minimum Pinch Points	=	yes	N/A	Test

The background features a central teal-colored area with the text 'Conceptual Designs' in white. This central area is framed by dark teal and light green geometric shapes that create a layered, mountain-like effect. The overall composition is clean and modern.

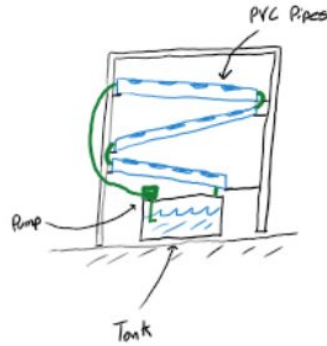
# Conceptual Designs

# Gabe's Designs

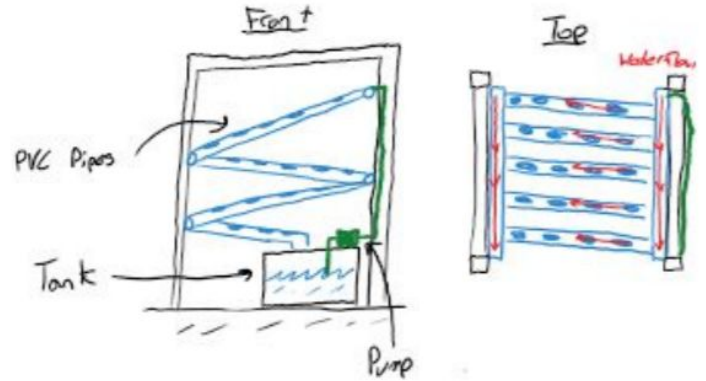
## #1



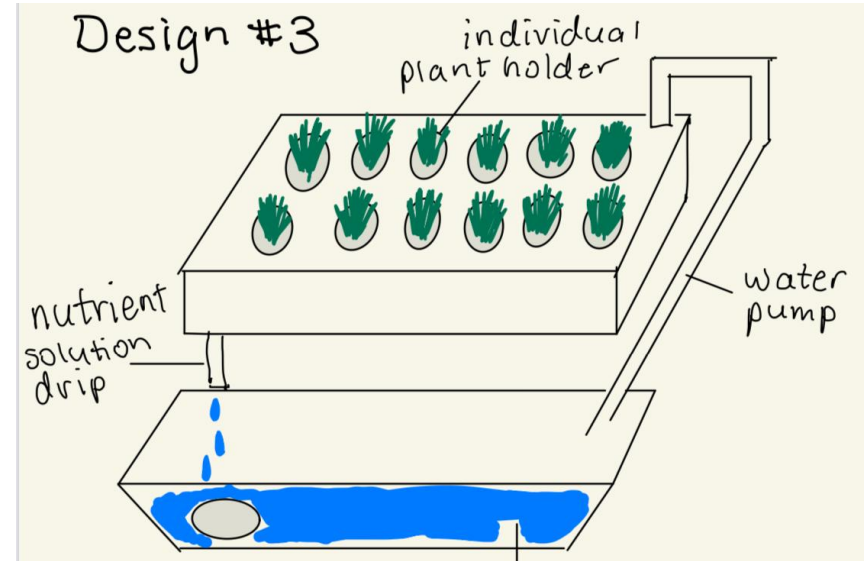
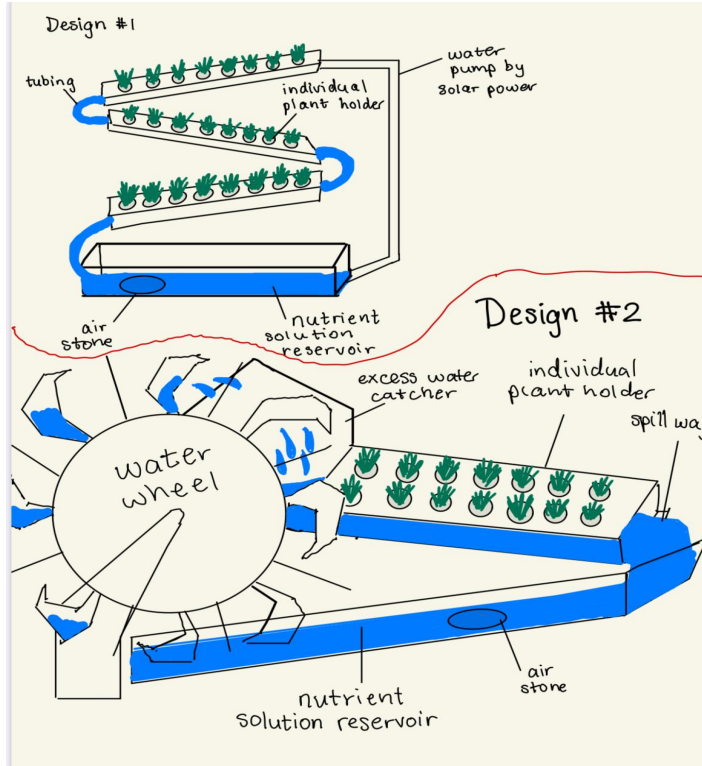
## #2



## #3



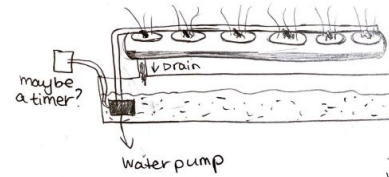
# Alana's Designs



# Weeda's Designs

## Concept 3

### Drip System

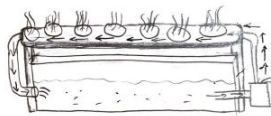


- a tube runs at the top of the pipe containing the plants and has a dripping spout at each plant
- the nutrient water solution is pumped using a water pump from its reservoir, up to the plants and then drips into each one
- the pipe containing the plants and solution will then have another pipe working as a drain to avoid overflow → drain leads to reservoir

- maybe a timer could be placed with the pump so that its pumping the solution at certain intervals...

## Concept #1

### NFT



pump would recycle the water

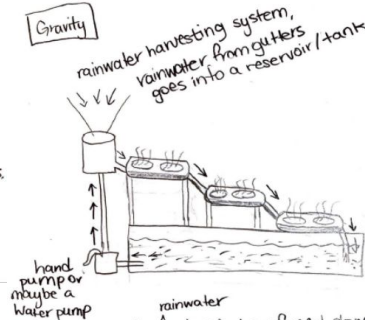
hand pump or maybe a water pump inside?

a nutrient filled reservoir of water

- 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 the bottom roots/terms of the plants. The plants are placed in a pipe with holes 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 #2

### Gravity



- the 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

#1

Notes:

- o 2-module hydroponics system
- o 'Nutrition' tank mixes water w/ compost to make nutrient solution
- o 5-ft. height allows many plants
- o 48" run on each module allows for many plants
- o aeration achieved through use of a secondary pump and airstones
- o versatile build (NET) allows for addition or reduction of modules, module height, run length, etc.
- o Power achieved via solar panels
- o water circulates through hydroponics system, reusing water

48"

5ft.

15"

3"

Water Flow

Electricity Flow

N: Nutrition Tank

R: Rainfall tank

C: Circulation tank

P: Pump

A: Airstone

FIVE STAR

2.

Electricity Flow

Water Flow

6ft.

6ft.

3"

Notes:

- o Reduced size of NET structure as compared to design 1
- o similar 3-tank structure and near-identical layout
- o Compost tea, nutrition and water pump/airstone aeration
- o over-flows present in all tanks
- o opaque tanks preserve solution, reduce growth of harmful bacteria
- o powered via 'gravity/light' system
- o 3.5" diameter PVC and 1" ID spaghetti piping

R - Rainfall Tank

N - Nutrition Tank

C - Circulation Tank

H - Hydroponics Structure

G - Gravity-Power System

FIVE STAR

#3.

Solar Panels

R/N

C

P

6ft.

6ft.

Notes:

- o Rainfall & Nutrition Tanks are combined over-flows
- o Larger Hydroponics Structure
- o Piping on Hydroponics Structure drops instead of wrapping around the supports
- o Solar Powered
- o Passive Aeration System attached to pump

R/N - Rainfall & Nutrition Tank

C - Circulation Tank

P - Pump

H - Hydroponics Structure

A - Passive Aeration

FIVE STAR

# 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



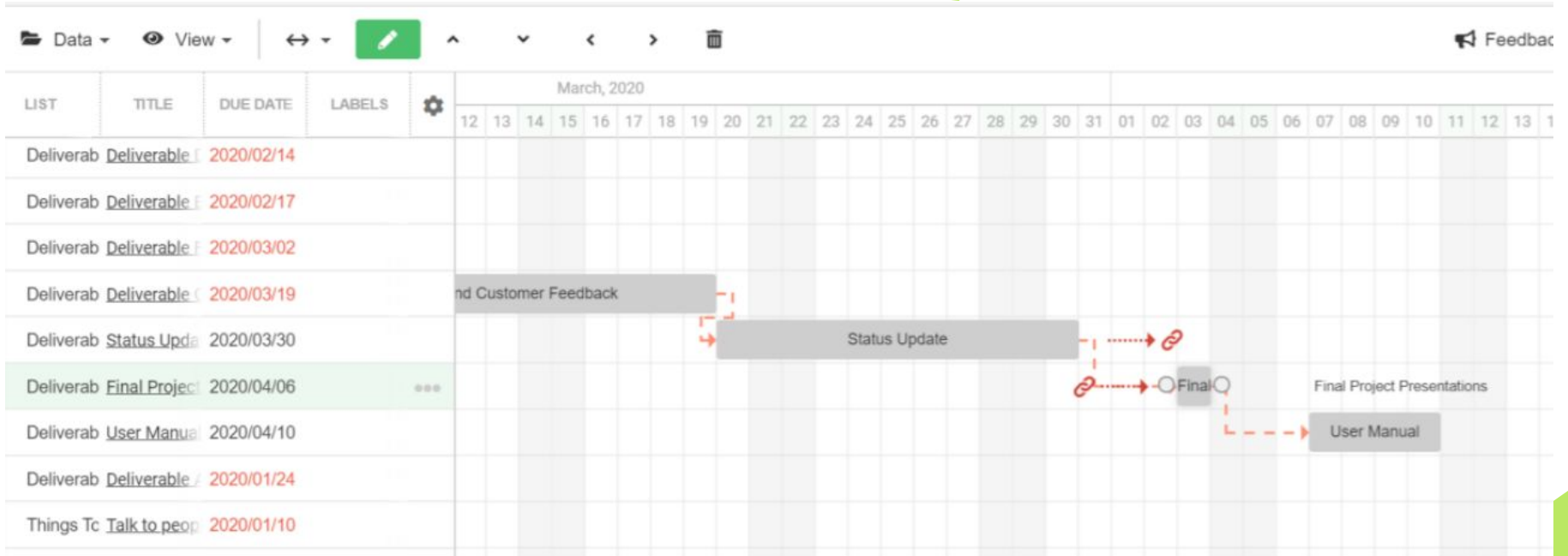
# Benchmarking/Optimal Design Choice

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

The background features a central teal rectangle with white text. This rectangle is set against a larger, irregular shape composed of overlapping layers of light green and dark teal. The overall composition is modern and geometric.

# 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

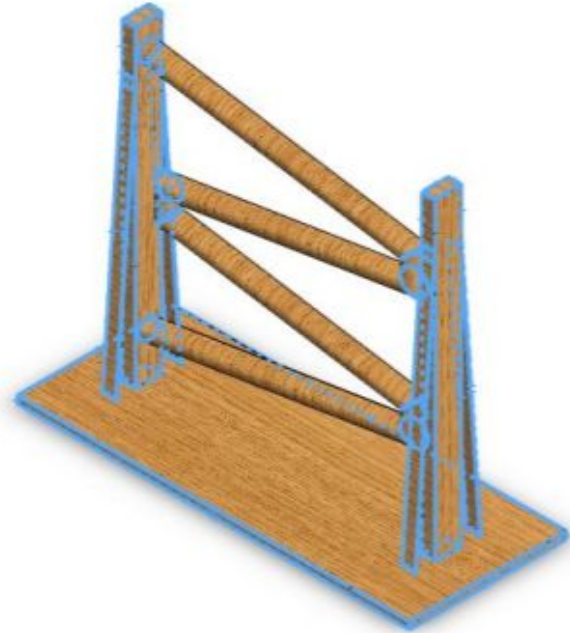
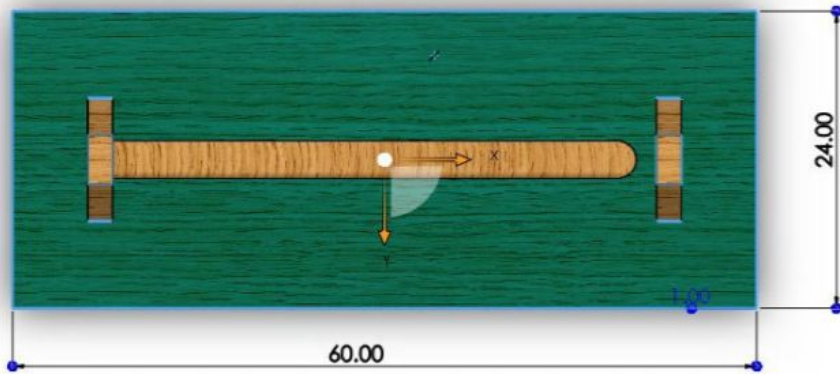
# Prototype I



# 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:  $3.5^{\circ}$
    - ◇ Angle used:  $5.7^{\circ}$
  - ◆ 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](http://www.homehydrosystems.com/hydroponic-systems/nft_systems.html).
- ◆ “Basic Hydroponic Systems and How They Work.” <https://www.simplyhydro.com/system/>



**Questions?**