Client contact: Monique Manatch mmanatch@gmail.com

Hydroponic system - $100

Problem Statement:

- Inability to grow food (vegetables, fruits etc.)
- Everything is very far away from them
- Lack of clean water, no electricity
- Animals eat their crops (need an elevated system)
- Safety and privacy
- Snowfall (poor weather conditions)
- · Member of Algonquin (small reserve, 59 acres)
- o Barriere lake first nation (50 people)
- · Housing issues, space issues
- · Accommodate by building shelter by an airport strip
- · No running water (mercury contamination – not an issue anymore), electricity
- · The area is being clear cut by federal government
- · Long distance to buy groceries
- · Gas, propane is very expensive ($1.60-$1.70)
- · Materials must be able to last in the winter (-40C)
- · Most of the cabins are made from logs
- · Grow vegetables and fruit (sema tobacco)
- o Sweet potatoes, onions, greens
- o Difficult for them to grow due to poor weather conditions
- o **MUST BE RAISED**
- · No limitation for the size of the greenhouse (design as a big greenhouse) – 10 ft x 15 ft
- · Squirrels, bugs, bears, mice
- · Collect rainwater (not a lot of rain)
- · MakerRepo – Hydroponics
- · Polyethylene sheets, wood, PVC pipes, Galvanized steel

Project Deliverable B: **Need Identification and Problem Statement**

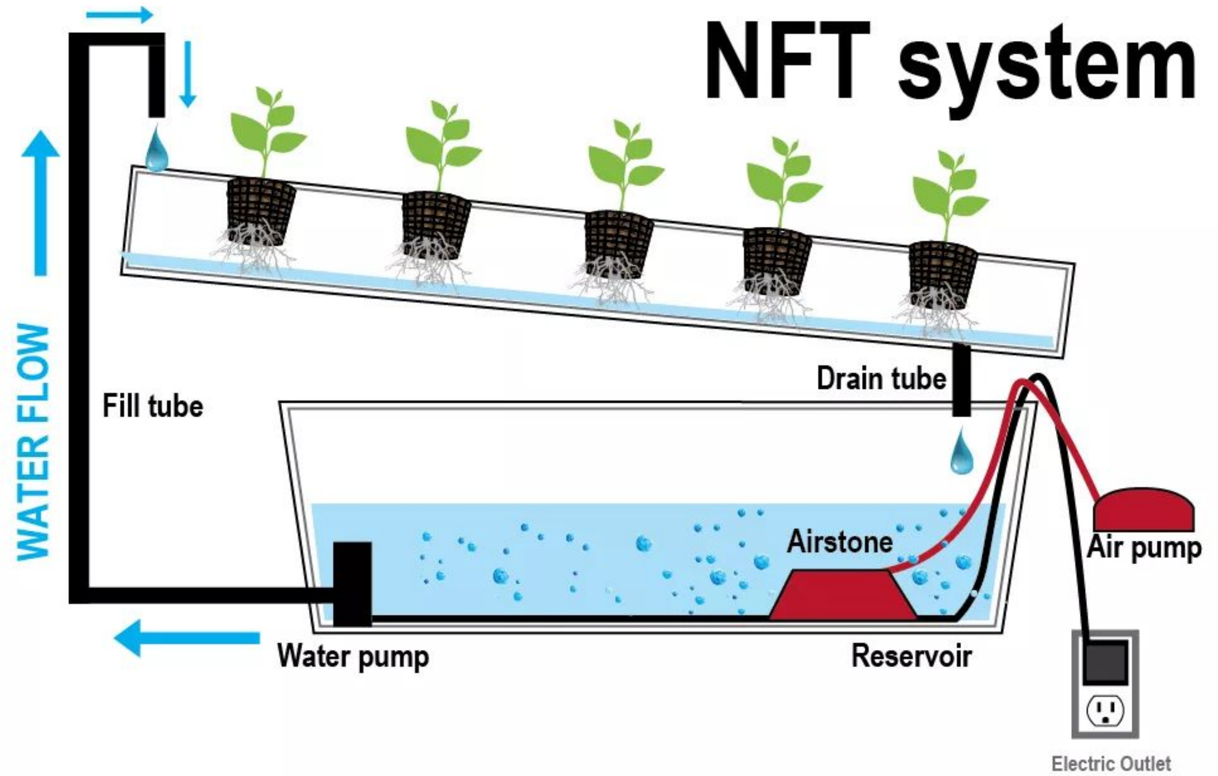
GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa

There is a small native community consisting of approximately 50 people who live close to an old airport strip located in Le Domaine QC, where the ground contains a large amount of fine sand. The community traditionally lives off of the land and many stay there year round. They currently do not have access to fresh produce, this is due to the fact that the closest grocery store is two and half hours away.

The people are in need of a solution for the production of fruits and vegetables year round. The community has no access to running water or electricity, so a self-sufficient solution is necessary. The geographic area experiences long, harsh winters therefore climate control will be central to the design. Regular gardens have not been successful in the past, due to pests such as mice and also due to the problematic soil. These people are in need of a cost efficient, reliable and self-contained way to grow an adequate supply of produce.

Based on the problems and frustrations of the client, along with the limitations of the region the ideal solution is an automated greenhouse. Due to the lack of adequate soil for growing, a hydroponic solution will be employed. Design will be inspired by the work of previous student groups as well as professional greenhouse solutions in Northern Canada.


NFT system
WATER FLOW
Fill tube
Drain tube
Airstone
Air pump
Water pump
Reservoir
Electric Outlet

Project Deliverable C: **Design Criteria**

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa

The Algonquin community has communicated their needs for an adequate year round farming solution. Based on the requirements acquired from the client, a set of design criteria must be developed. The design criteria (Table 2.0) will aid in the selection of possible solutions and will give benchmarks and goals that the team will use in the selection of a suitable system. By examining, benchmarking and ranking available standalone solutions we can test what the market currently has to offer and set reasonable goals for ourselves.

The current hydroponic solutions available that meet the requirements of ease of use and those that are self contained are outlined in the benchmarking table below (Table 2.1). Based on the values we assigned to the different criteria (Table 2.2), the Hydroponic Site Grow Kit was the strongest competitor, due in part to its low cost and high quantity of plant slots.

Our solution will aim to match the strong points of its competitors while surpassing them in other categories. It aims to offer similar benefits at a lower cost and to surpass these options in areas like reservoir size and climate control.

2.0 Translating Needs into Design Criteria

Number	Need	Design Criteria
1	Self-Contained	Power (Watts) solar
2	Climate Control	Temp (°C)
3	Cost efficient	Cost($)
4	Sustainable	Recycled materials
5	Portable/Modular	Weight (lbs) Length*width*height (m)
6	Water Supply	Volume (liters) Rainwater collection Storage tank (liters)
7	Eases of use	Simple maintenance and use

2.1 Benchmarking Data

Specifications	General Hydroponics EcoGrower Drip Hydroponic System	Hydroponic Site Grow Planting System Kit	General Hydroponics GH4720
Cost ($ CAD)	303.88	159.00	677.00
Weight (lbs)	30.8	25.8	46.3
Size (m)	.66x.58x.46	1.2x1.2	.62x.62x.62
Reservoir size (liters)	64.35	None	79.5
Plant Slots	6	72	8-12
Style	Drip	Ebb and Flow	Ebb and Flow
Modularity	No	Yes	Yes

2.2 Target Specification Benchmarking

Specifications	Importance (weight)	General Hydroponics EcoGrower Drip Hydroponic System	Hydroponic Site Grow Planting System Kit	General Hydroponics GH4720
Cost ($ CAD)	**4**	2	3	1
Weight (lbs)	**3**	2	3	1
Size (m)	**3**	2	1	3
Reservoir size (liters)	**4**	2	1	3
Plant Slots	**5**	1	3	2
Style	**2**	2	2	2
Modularity	**3**	1	3	3
Total		40	56	51

2.3 Engineering Design Specifications

#	Design Specifications	Relation (<, = or >)	Value	Units	Verification Method
	Functional Requirements				
1	Power	>	Yes	Watts	Solar Panels
2	Water Supply	>	Yes	liters	Rainwater Harvesting
3	Climate Control	>	10	^{o}C	Test
4	Reservoir	>	80	liters	Test
	Constraints				
1	Weight	>	25.8	lbs	Analysis
2	Cost	<	100	$	Budget

3	Size	>	1.2x1.2	Meters	Analysis
4	Weather Conditions	=	4 Seasons	^{o}C	Analysis
	Non functional				
1	Aesthetics	=	Yes	N/A	Test
2	Ease of use	=	Yes	N/A	Analysis
3	Product life	>	5	years	Test
4	Variety of crops	=	Yes	N/A	Test

Set of Design Criteria and Constraints

Functional Requirements

1. Power (watts)
2. Water Supply (liters)
3. Climate control (^{o}C)
4. Reservoir

Constraints

1. Weight (lbs)
2. Cost ($)
3. Size (m)
4. No water
5. No electricity
6. Weather conditions

Non-functional requirements

1. Aesthetics
2. Ease of use
3. Product life
4. Variety of crops

Project Deliverable D: **Conceptual Design**

GNG 1103 – Engineering Design

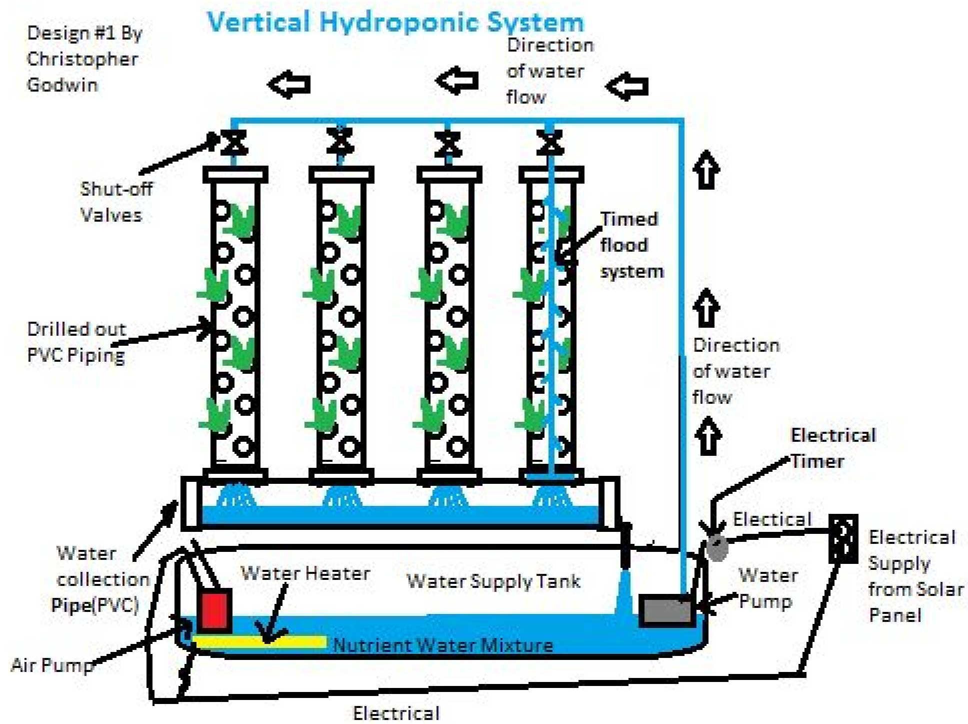
Faculty of Engineering – University of Ottawa

To solve the problem explained by the client and to address the needs that their problem presents, many candidate designs must be presented that can then be synthesised into one global concept. This document showcases designs from each team member and aims to conclude with a combined design that will best serve the needs of the client, best meet the criteria defined, and be used moving forward for testing and prototyping.

We decided on using a vertical system instead of a horizontal system in order to maximize the space we have in the greenhouse. The system we chose was based on the first design submitted by Chris, which involves a series of vertical, slanted PVC pipes with either y-joints or drilled holes to insert plants into. The idea was altered to become a horseshoe shape that fits optimally inside the construction team's proposed structure. This further increases total surface area so that our concept meets the benchmarking criteria we were aiming for. Using the selection matrix processed described in lecture and practiced in deliverable C, the team ranked the global design versus the three benchmarks and concluded that if executed correctly, it can outperform it's competition.

Chris Godwin's 3 Design Drawings

Chris' Design #1



Design #1:

For this design a nutrient water mixture is pumped from a water supply tank. Preferably painted dark red or dark blue to absorb the most about of heat from the sun and act as a thermal battery to both absorb heat and give off heat to the atmosphere. Water is also heated when the temperature drops below 10 deg. C. This could be monitored using a temperature probe if an automatic system is chosen.

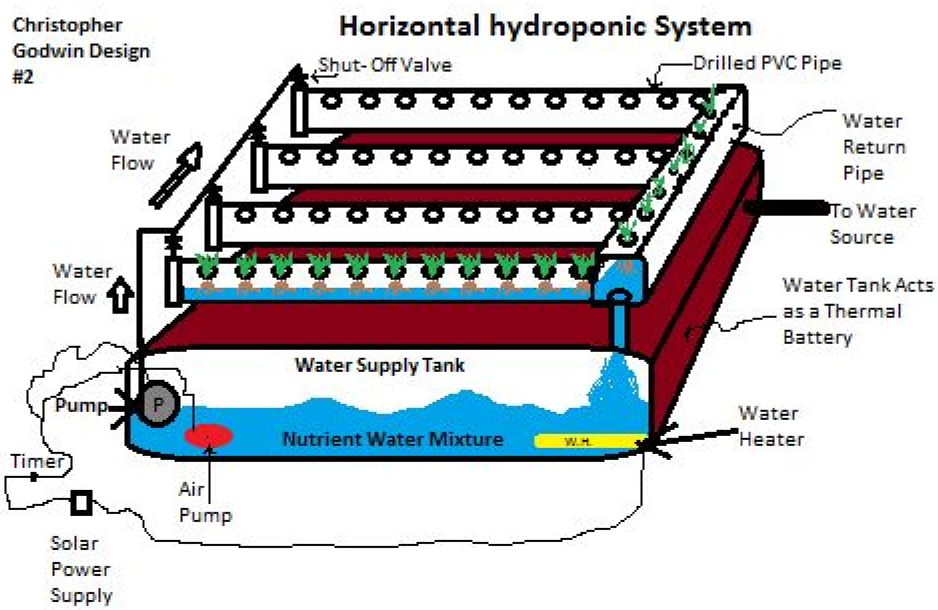
Water is injected with air using and an air pump and then a water pump would supply the water to the top of the towers. The water supply can be turned on or of manually to each tower using a gate valve. Water then flows down the tower and provides a drip of water to the roots. This supplies the roots with nutrient filled water. Any excess water flows down the tower back into the nutrient supply tank to be reused when needed. The water flow would be controlled by cycling the water pump on and off using either a manual or electric timer.

Power would be supplied to the pumps, heater and timer by use of a solar panel system using DC direct power to save cost and avoiding an inverter to convert power from DC to AC.

<u>The advantages</u> for this design are that it uses the vertical space so that you can grow more per square foot of floor space, less water due to a drip system.

<u>The disadvantage</u> is that you have to use a pump to supply water to the top of the system.

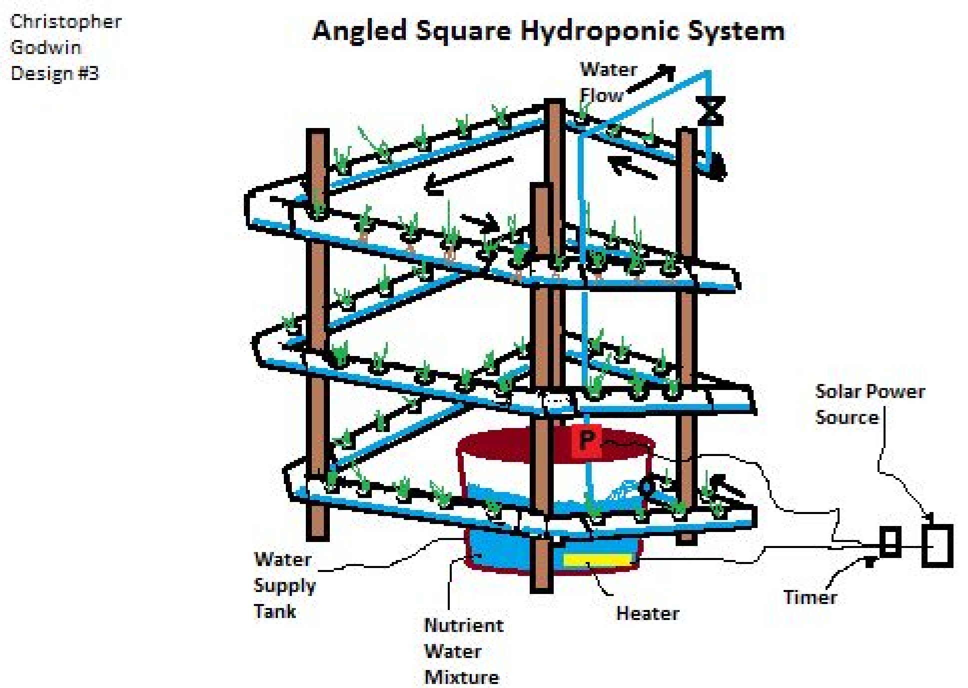
<u>Chris's Design #2</u>



<u>Design #2</u>

For this design, it uses a horizontal system and could be stacked one on top of another to add more layers. The water tank acts again as a thermal battery along with heater element in tank to heat water as needed using a temperature probe to measure the temperature and turn on when needed. Water is again injected by use of an air pump. Water then is pumped to the main piping header to supply nutrient water mixture to each horizontal hydroponic PVC pipe. The water can be controlled by cycling the pump on and off at a set increment by use of a timer. Manual valves are used to isolate each individual PVC supply pipe that hold the plants. The PVC pipes are angled slightly to use gravity to flow through the pipe. Water floods the root system supplying the plants with nutrients. The water then goes into a PVC return pipe and back into the main supply tank to be reused.
<u>The advantage</u> is that it provides easy access to grown food because it can be a waist height.
<u>Disadvantage</u> is that is uses more water and takes up more floor space so less plants per square foot.

Chris' Design #3



Design #3

For this design, a water supply tank is located in the middle of the hydroponic system. The barrel or water supply tank is filled with nutrients, acts as a thermal battery, and can be heated when needed using a water heater controlled with a temperature probe. The water pump is located on top of the supply tank and sucks water up out of the tank to the top of system. The pump is controlled using a timer to cycle on and off the pump. The entire system has a manual shut off valve to cut the supply or manually throttle the supply of nutrient water to the system.

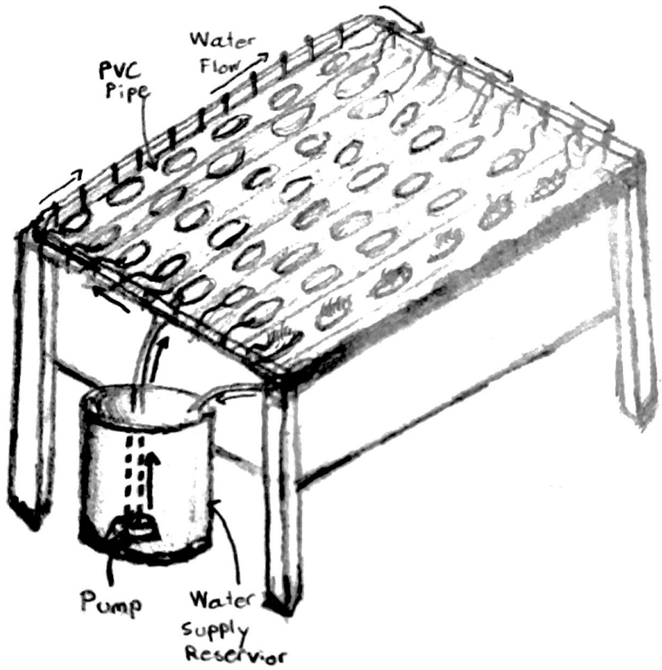
The water flows down the PVC piping that is angled around every corner from top to bottom. This allows the water to flow back into the supply tank to be reused.

<u>Advantage</u> is that it you only have to supply water to the top and it uses gravity to flow back to the tank.

<u>Disadvantage</u> is that it takes up a lot of space and water due to a flood type system.

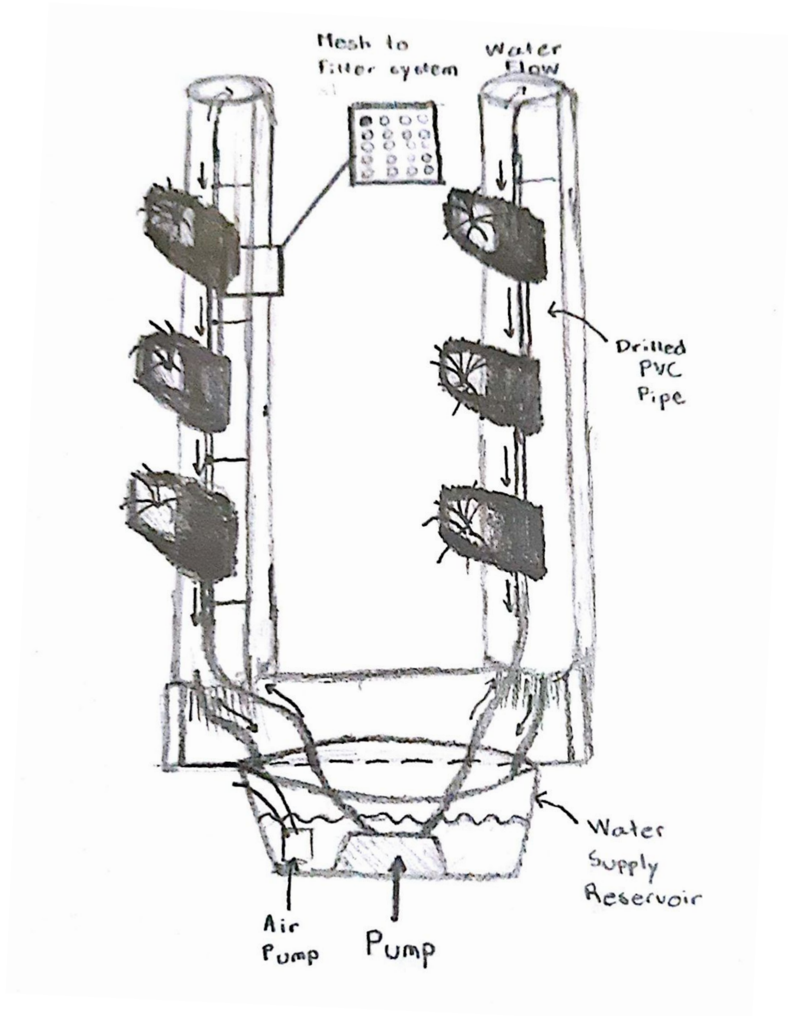
Rohit's Design Drawings

Design #1: Horizontal Hydroponic System



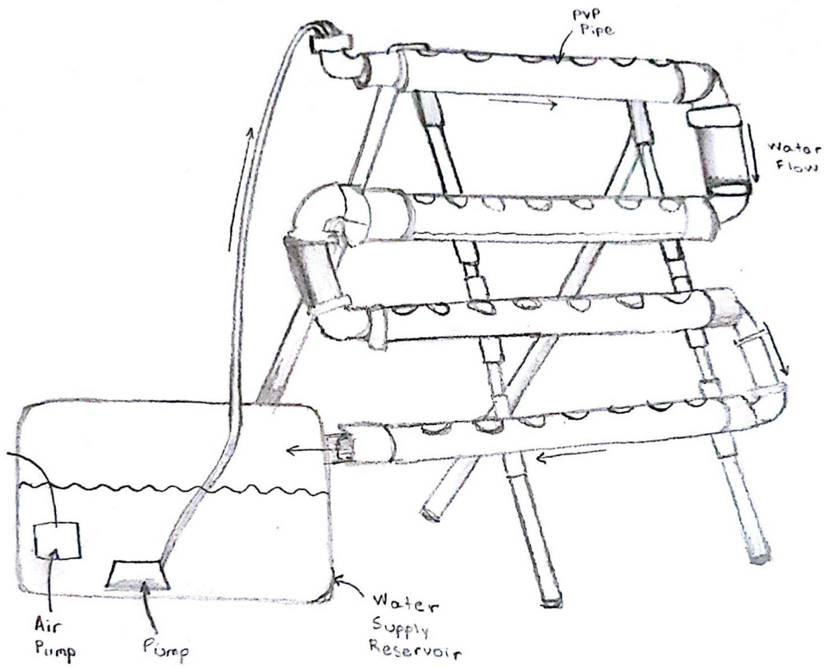
This design implements a horizontal hydroponic system with drilled PVC pipe laid side by side. There is tubing all around the border of the system that supplies water to each individual pipe. The water flows in a constant cycle returning back to the central water supply reservoir, where it gets reused. The reservoir includes an air pump that injects water into the tank. Then, water is pumped up the central piping, again supplying water to each PVC pipe. Inside the water, there is a nutrient mixture, which supplies nutrients to the roots of the plants when water enters the system. Some disadvantages include the use of space, as the design does not maximize the space of the greenhouse. Another issue would be weight and modularity as it would be hard to transport this system.

Design #2: Vertical Hydroponic System



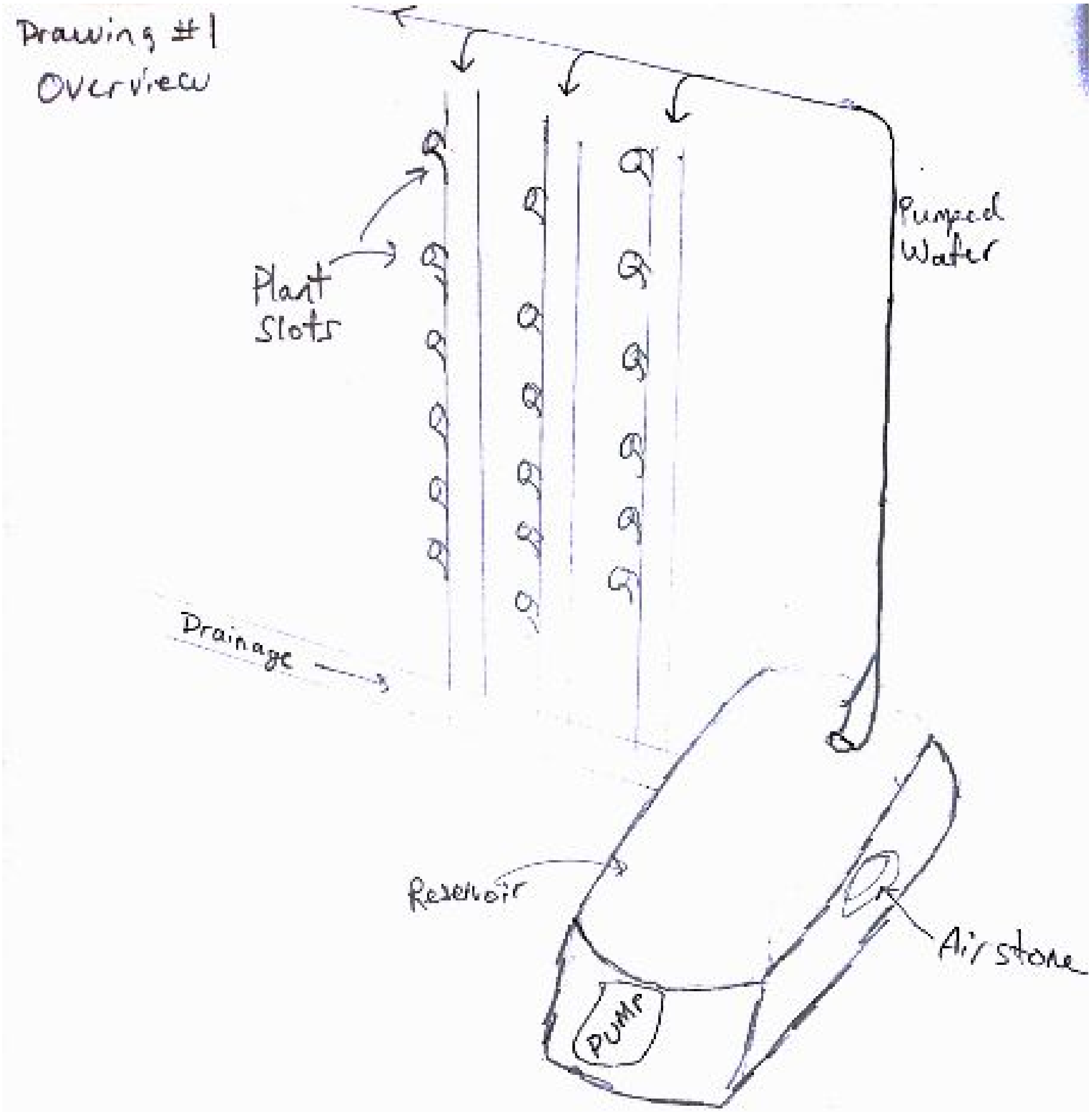
This design implements a vertical hydroponic system, which uses gravity to flow water through the system. Each pipe has multiple cutouts, each attached to a joint. Again, a nutrient water mixture is pumped from the water supply reservoir to each pipe. At each joint there is a mesh filter system, which prevents bacteria to enter the water tank. This prevents any contamination when the water is reused and supplied back. The water supply cycle will be controlled manually or automatically using a timer. As this system is vertical, I believe it less space will be taken up inside as it can be easily hung on the walls of the greenhouse. A huge advantage with this design in the ability to maximize the space in the greenhouse. The PVC pipes can be easily hung on the walls, so allow for space to walk. One disadvantage is the need for multiple pumps to supply water to each PVC pipe, highlighting cost as a huge constraint.

Design #3:

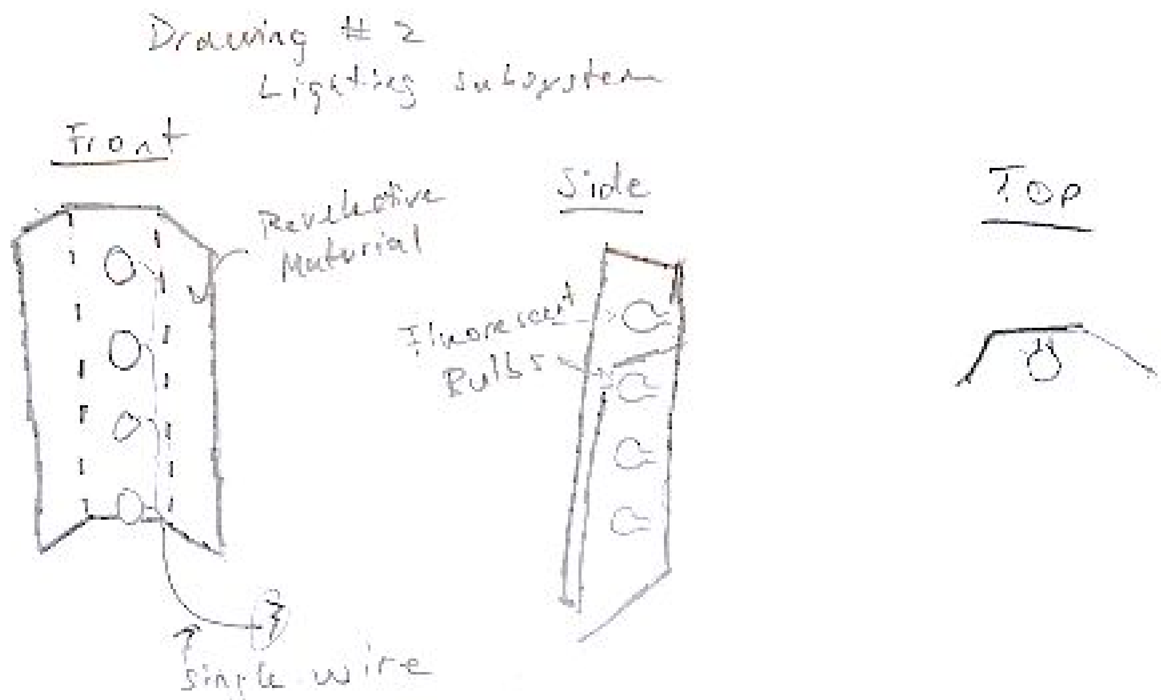


This sketch implements an angled hydroponic system, where water is supplied through the main piping and then flows down the piping by gravity. When the water reaches the bottom of the system it will return to the main water supply reservoir, where the water will be reused. Each pipe contains multiple cutouts where water floods the root system supplying the plants with nutrients. All power is supplied from the solar power source, powering the heater (to control the temperature inside the water tank), air pump and the water pump. The advantage of this design is the foldability feature which makes it very easy to transport. A disadvantage though is the ability to provide sunlight to the plants as they are going to be faced directly upwards, restricting the amount of sunlight they recieve.

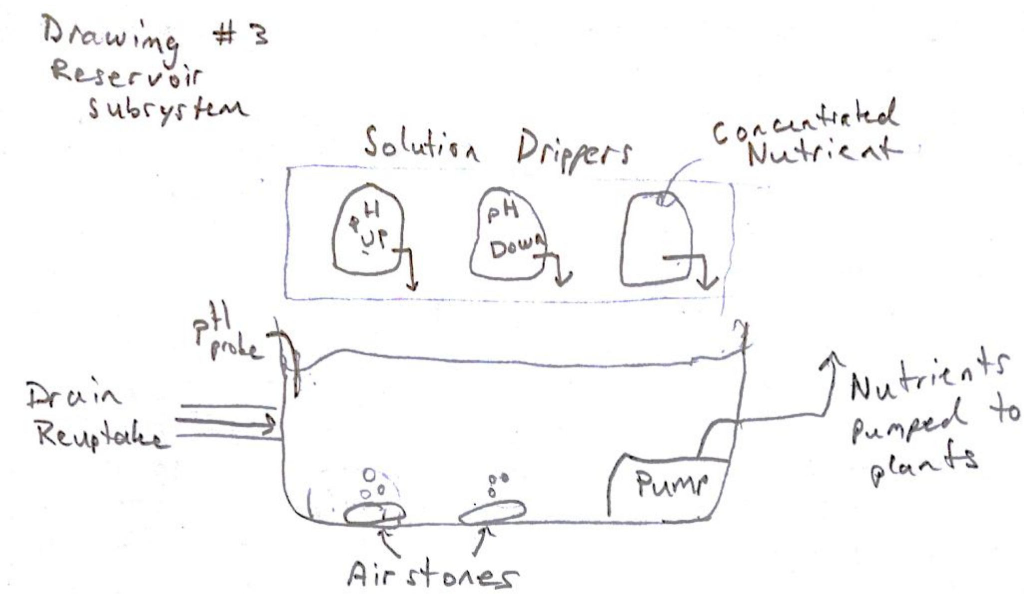
Aidan's Design Drawings



This design describes an overview of the main components of a hydroponic system. It includes reservoir, plumbing and planting subsystems. Water is pumped from the reservoir, passes through and array of vertical PVC pipes and return to the reservoir via the drain pipe. Although the sketch suggests three vertical pipes this quantity can be expanded to any quantity that fits the greenhouse enclosure. Plants are inserted into PVC Y-joints in a lattice formation to maximize surface area. This surface area maximization is its greatest advantage. It may be disadvantageous to have to pump against gravity as it will increase energy demand.

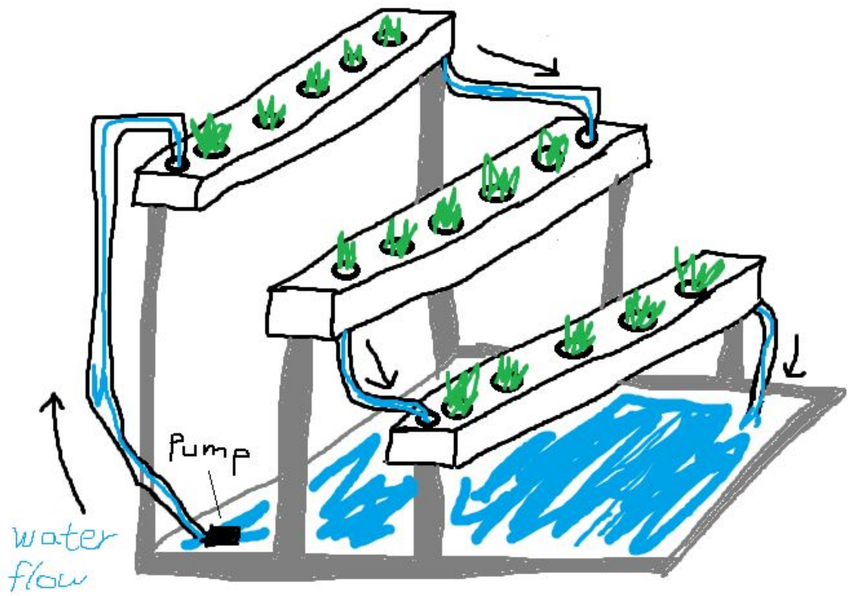


This sketch gives three views for a lighting subsystem that will be installed alongside the hydroponic system. The goal for this subsystem is maximum modularity and minimum cost. The subsystem consists of fluorescent bulbs, a reflective container and power going to each bulb. The bulbs are installed in a vertical array similar to the plants. Reflective material, preferably recycled aims to cut down on cost and maximize the efficiency lighting system. For each lighting unit, all power runs to a single plug. This fact increases modularity as the only thing require to alter the setup is an extension cord. The disadvantages of using artificial light is that it will be more expensive and demand more energy. This is more than offset by the gains made in plant growth.

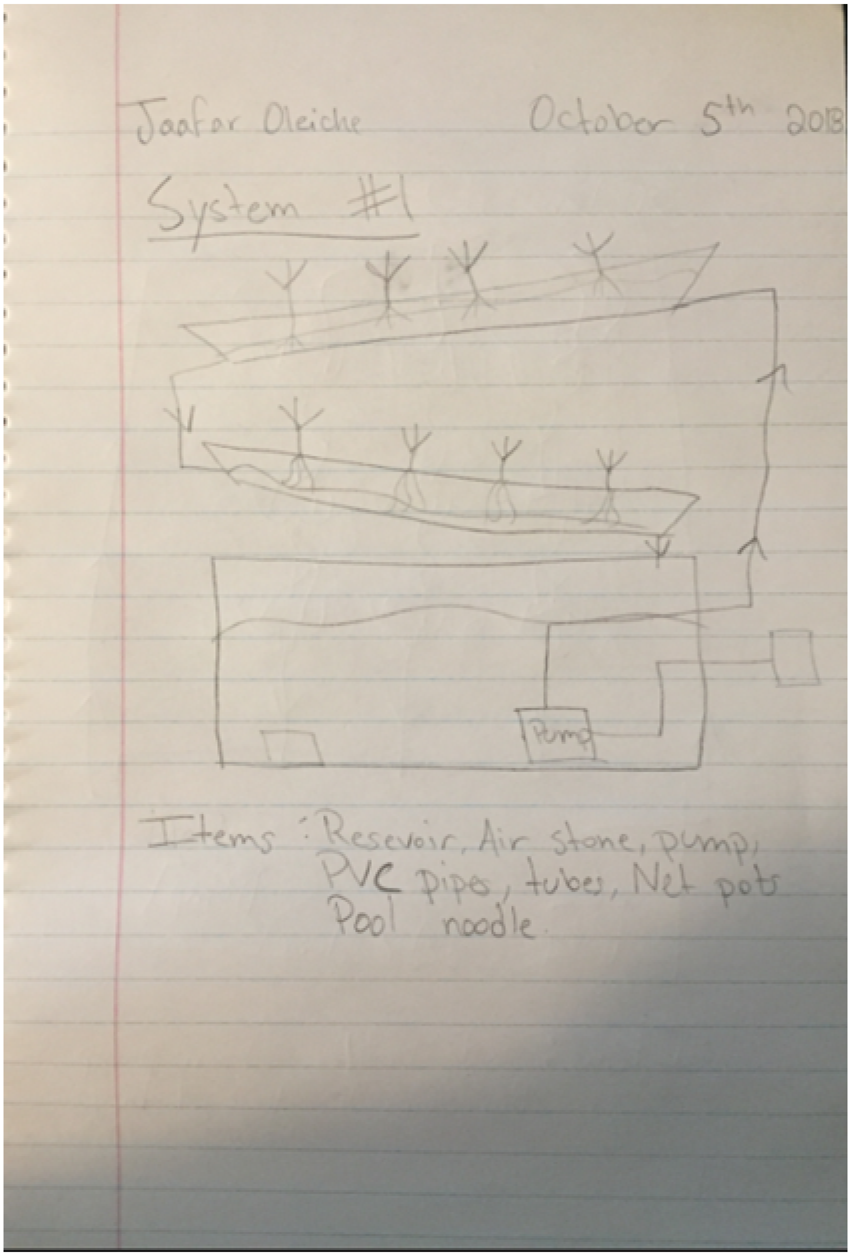


This conceptual design describes an ideal reservoir subsystem. The system aims to be entirely autonomous through the use of sensors and drippers. The only input that will be required from the user of the greenhouse is occasional addition of water to the system as the plants will slowly remove water from the system. The pH probe will give information to the various drippers so that an ideal nutrient solution can be maintained. Airstones oxygenate the water and ensure that the solution uniformly mixed. Water enters the reservoir via the drain pipe and is pumped out to the plants on the opposite side. While this system adds a great deal to the autonomy of the global concept its relative difficulty to develop and install is high. It also makes general upkeep of the greenhouse potentially require a technician that understands the automated systems, increasing the quantity of support the final product will need.

Hui's design #1



In this design, it uses horizontal hydroponic system. There is a water tank at the bottom of system. In this tank, a pump is used to transport water to the highest level of the system. Water goes from the highest level to the lowest level, which allows the water can be fully absorbed by plants.



Design 1:

A reservoir is filled with water and nutrients, it also contains an air stone and air pump in order to allow the intake of oxygen; located at the bottom of the system, a pump sends water through the tubes/pipes that leads to the first PVC pipe. It is slightly inclined in order to allow gravity to bring the water back down, and contains a holes that house a certain amount of plants using pool noodles cut in a way to keep them secure. When the water is pumped up it will follow the tubes while passing by the roots of the plants and going back down to the reservoir using gravity. The amount of floors can be changed, that is to say instead of simply having two we can increase the number to 4 or 5 depending on the vertical space allocated and on the needs.

Advantages :

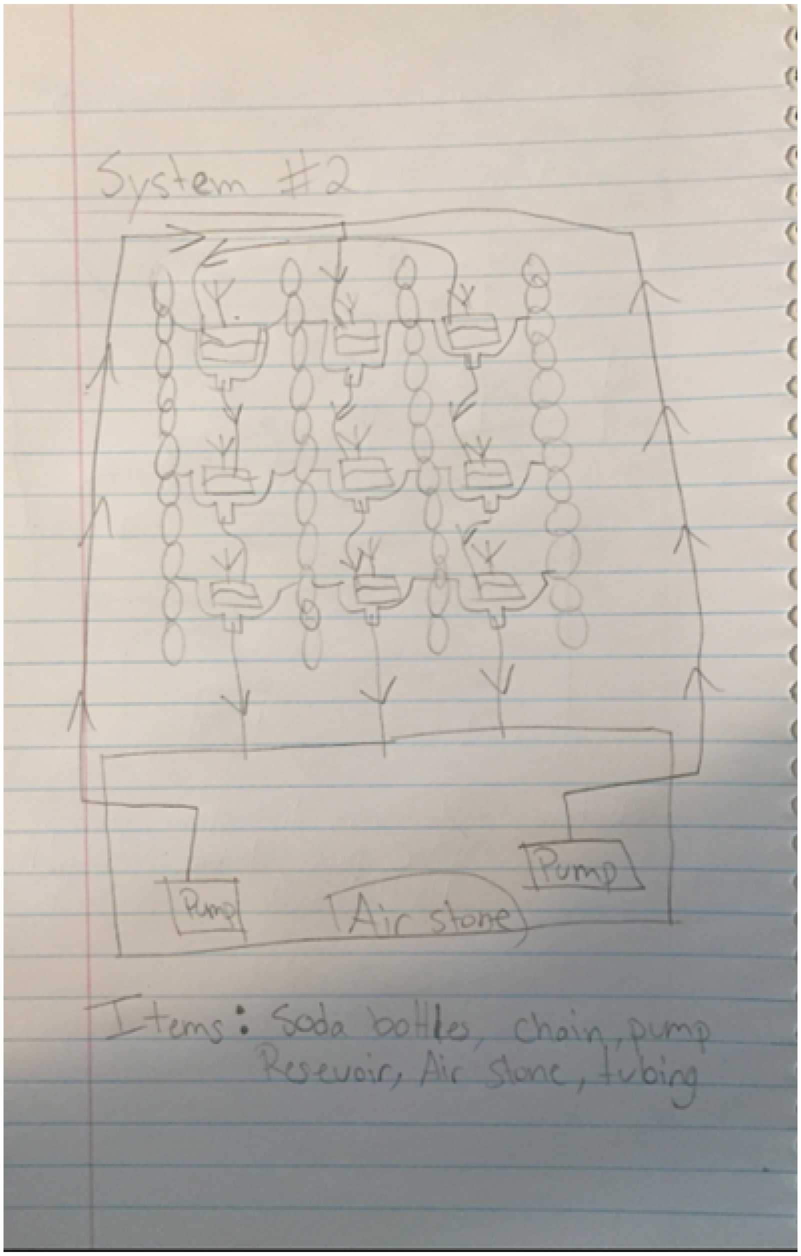
-Saves space as it will be vertical

-Can house different plant sizes depending on PVC pipe size

Disadvantages:

-Flow system means it will need a lot of water

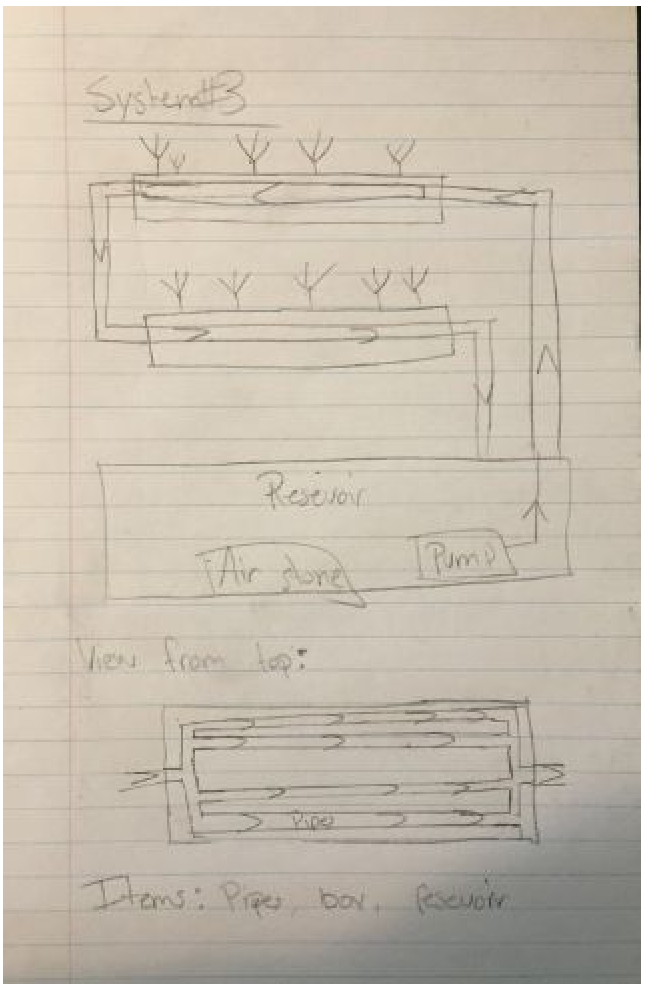
-Pump needs to work against gravity



Design 2:

This system uses chains in order to create a vertical flow. It starts with a reservoir that contains water and nutrients, it also contains an air stone and air pump in order to allow the intake of oxygen; located at the bottom of the system. A pump or two (depending on the size) is used to send the nutrient filled water to a central pipe system at the top which splits off depending on the amount of columns, from there it enters the plants pot which is housed in the bottle cap half of a soda bottle pipes leading from the cap to the next plant allow for gravity to move the water down and back to the reservoir. The number of columns and the amount of plants per column can be changed.

Advantages :
-Saves space as it will be vertical and flat on the wall
Disadvantages:
-Flow system means it will need a lot of water
-Pump needs to work against gravity
-Can only house small plants



Design 3: This resembles the first system but instead of using PVC pipes as the housing for the plants it uses a larger and wider box which contains its own piping system that feeds the plants. The boxes need to be inclined in order to allow gravity to bring the water down using a drain pipe. A view from the top/inside indicates how the piping will be made. Once again the a reservoir that contains water and nutrients, it also contains an air stone and air pump in order to allow the intake of oxygen; located at the bottom of the system will pump the water up. The number of boxes can also be changed depending on the size. This system allows for a lot more plants to be housed and also

accommodate larger plants that need bigger holes.

Advantages :

-Saves space as it will be vertical

-Can house different plant sizes depending on holes made

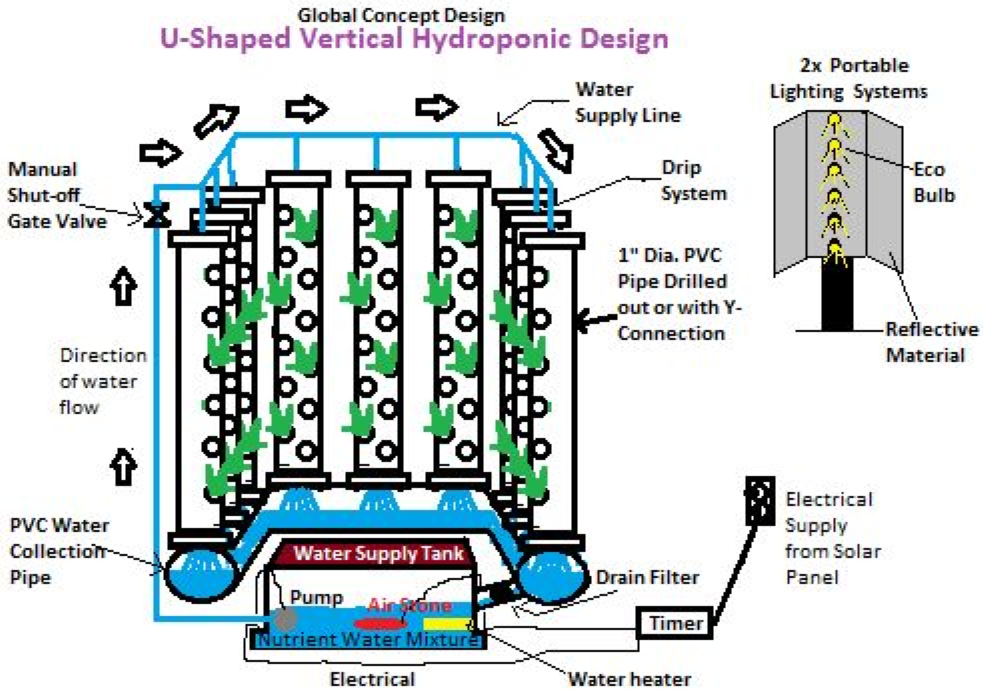
Disadvantages:

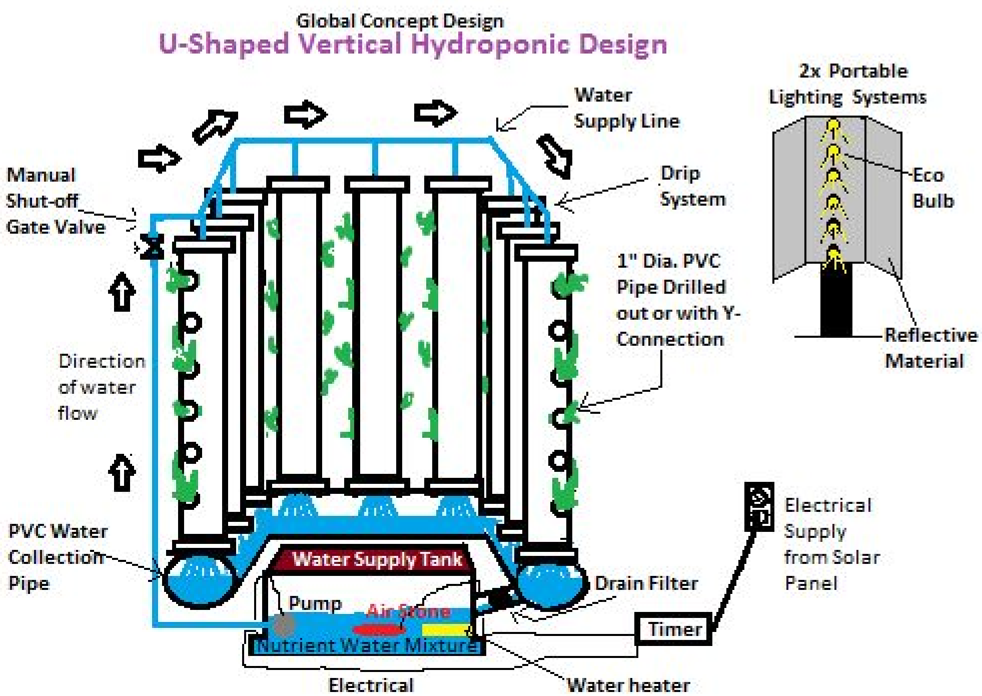
-Flow system means it will need a lot of water

-Pump needs to work against gravity

-Boxes will be heavy and need to be supported properly

Final Design:





Specifications	General Hydroponics EcoGrower Drip Hydroponic System	Hydroponic Site Grow Planting System Kit	General Hydroponics GH4720	Our Design
Cost ($ CAD)	303.88	159.00	677.00	100.00
Weight (lbs)	30.8	25.8	46.3	28
Size (m)	.66x.58x.46	1.2x1.2x1	.62x.62x.62	1x1x2
Reservoir size (liters)	64.35	None	79.5	60
Plant Slots	6	72	8-12	54
Style	Drip	Ebb and Flow	Ebb and Flow	Drip
Modularity	No	Yes	Yes	Yes

Specifications	Importance (weight)	General Hydroponics EcoGrower Drip Hydroponic System	Hydroponic Site Grow Planting System Kit	General Hydroponics GH4720	Our Design
Cost ($ CAD)	4	2	3	1	3
Weight (lbs)	3	2	3	1	3
Size (m)	3	2	1	3	2
Reservoir size (liters)	4	2	1	3	2
Plant Slots	5	1	3	2	2
Style	2	2	2	2	2

Modularity	**3**	1	3	3	3
Total		40	56	51	58

Project Deliverable E: **Project Schedule and Cost**

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa

In order to complete project deadlines in a timely manner and ensure that the project remains within budget and on schedule a series of Gantt diagrams must be created. These diagrams will be based on lists of tasks and cost estimates defined in this document. These Gantt charts illustrate a project schedule using a progressive bar chart. Our Gantt chart will be adequately planned and divided into the work required for future deliverables. Regular referencing of the Gantt chart will give the team a clear idea of how they are progressing towards the completion of the project.

The project prototypes will logically build on one another. The first prototype we build will be a simple proof of concept for vertical pumping and drip nozzles. The water will flow down a makeshift tube that will be made of recycled plastic piping. in the final design this will be replaced by PVC.

Prototype 1:

1. List of Tasks
    a. Plan build of precise prototype (Team)
    b. Acquire purchased components
        i. Pump (Aidan)
        ii. Drip emitter (Chris)
    c. Acquire recycled components
        i. tubing (Aidan)
        ii. Reservoir (Jaafar)
    d. Multiple members meet to build (STEM?) (Team)

2. Cost Estimate
    a. Pump (20$)
    b. Recycled pvc pipe (0$)
    c. Tubing (7$)
    d. Drip emitters ($1ea) Option #2 adjustable emitter ($6.25/50 pack)
    e. Reservoir, household or recycled (0$)
    f. timer($8)

Prototype 2

1. List of Tasks
    a. Power subsystem (solar power)
        i. Power provided by construction
    b. Reservoir subsystem (airstones, pump, pH balance, nutrients)
        i. Standalone system
    c. Plumbing/tubing
    d. Expand to multiple towers (3 towers)
        i. Incorporate drainage
    e. Planting prep
    f. Lighting
2. Cost Estimate
    a. Airstone ($17)
    b. Recycled tubing ($0)
    c. Solar circuit supplies($12)
    d. Poolnoodle ($1)

Prototype 3

1. List of tasks
    a. Research and plan for prototype 3
    b. Frame planning
    c. Frame build
        i. Expand to 9 towers
    d. system integration
    e. Crop planting
    f. Heating
    g. ventilation
2. Cost estimate
    a. Lumber for build ($3.65 per 2*4*8)
    b. Recycled fan ($0)
    c. heating($13)

Total Cost Estimate

Pump	$33
Tubing (recycled)	$0
Drip emitters (9)	$8
Airstone	$12
Solar circuit supplies	$12
Timer	$14
Pool noodle	$1
Lumber	$0
Fan (recycled)	$0
Water heating	$13
Nutrient & pH Balance Kit	$0
Total	$93

Team Dynamics Debrief

Purpose & Guidelines

This is an opportunity for team members to reflect on their teamwork competencies. Team debriefs are a valuable development opportunity because team members who set goals for behaviour change and vocalize their commitments to the team are more likely to take action on them. The following sections will offer a framework for successfully facilitating the debrief.

Before beginning the team debrief discussion, all team members should review their feedback and record their development goals for each of the 5 teamwork behaviours. Make sure that all team members bring their report to the meeting for quick reference.

Remember that peer feedback reports are designed to be anonymous and private. Team members are NOT required to show their scores or any written comments. Each team member will share only what they are comfortable sharing with the team.

The debrief is most effective when discussions are future-oriented, focusing on forward-looking agreements with minimal discussion of problems occurring in the past.

Development goals should be as specific, actionable, and quantifiable as possible. After each member presents their development goal, the team should offer strategies to support that member toward goal accomplishment.

Follow these steps for debriefing results:

1. **Choose one member of the team to facilitate the debrief. The facilitator's role will be to keep the conversation on track and make sure that the guidelines outlined above are being followed. Have the facilitator read the Purpose and Guidelines to the team at the beginning of the meeting.**
2. **Ask each team member to share one personal strength that emerged from their feedback report. Identify how each individual can leverage their strengths to enhance the team’s overall performance. Have someone record each team members’ strength in the space provided below.**
3. **Team members recorded one development goal for each of the 5 teamwork competencies on their individual reports. Now each member should select one or two of these goals to become their primary development objective. Have someone record each team member’s commitment in the space provided below.**
4. **Wrap up the session by summarizing themes involving the team’s overall strengths and development areas, and record the themes in the space provided below.**

Name	*Perceived Strength*	*Development Area*
Jaafar	**Continue my communication during team meetings and giving my ideas.**	**Learn more regarding the project and do personal research in order to facilitate team meetings.**
Chris	**Continue my commitment to the team by being prepared for team meetings, sharing ideas and meeting team project deadlines.**	**Remain focused on the project and help to anticipate problems and work with the team to keep on track with project deadlines.**
Aidan	**Time commitment to the project, availability and willingness to put in work.**	**Personal research into PV system to alleviate that general stress from the team.**
Rohit	**Ability to acquire new skills/knowledge, improving overall team's performance.**	**Try to gain more knowledge of each team member's role, and dedicate time to learning crucial skills and abilities that will increase my technical skill set.**
Hui	**Exchange information with teammates in a timely manner.**	**Takes on a fair share of the team's work, prepared for team meetings.**

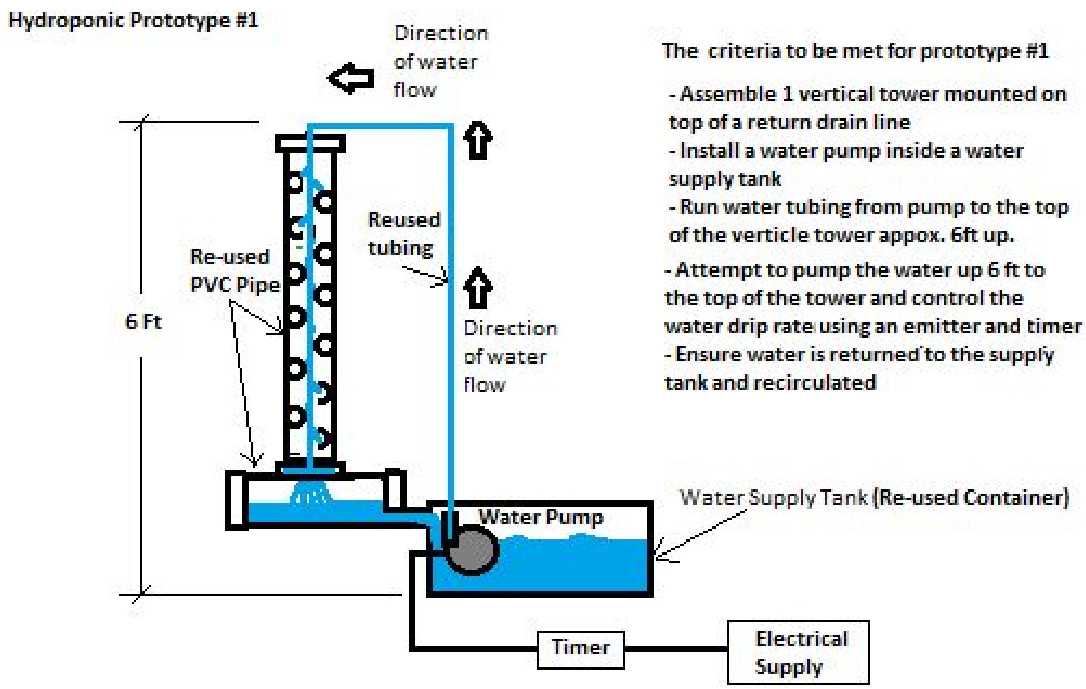
Themes

Strengths	*Development*	*Others*
Scheduling, commitment, communication, Knowledge	Workflow needs to be balanced and divided for more efficient production of work.	More personal research done Deadline awareness is good but we should try to submit earlier.

Project Deliverable F: Prototype I and Customer Feedback

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa



The initial prototyping process allows us to create a basic proof of concept for the core system we wish to execute. We will be able to analyse some elements of our current system, allowing us to improve what is lacking and guaranteeing some basic capabilities.

The goal was to obtain actual flow rate GPH (Gallons per hour) that the pump will produce and determine which rate is needed and how to control it. We also wanted to test out the drip emitters and their drip rate by doing so we also evaluate the capabilities of the pump to go through the tubing and make it back into the reservoir.

Suggestions for Testing of first Prototype:

- Obtain actual flow rate GPH (Gallons per hour) that the pump will produce by filling a pail or container of known measurement (ie. measuring cup) over a specific time (such as seconds, minutes). Online converter below.

http://aqua.ucdavis.edu/Calculations/Flow_Rate.htm

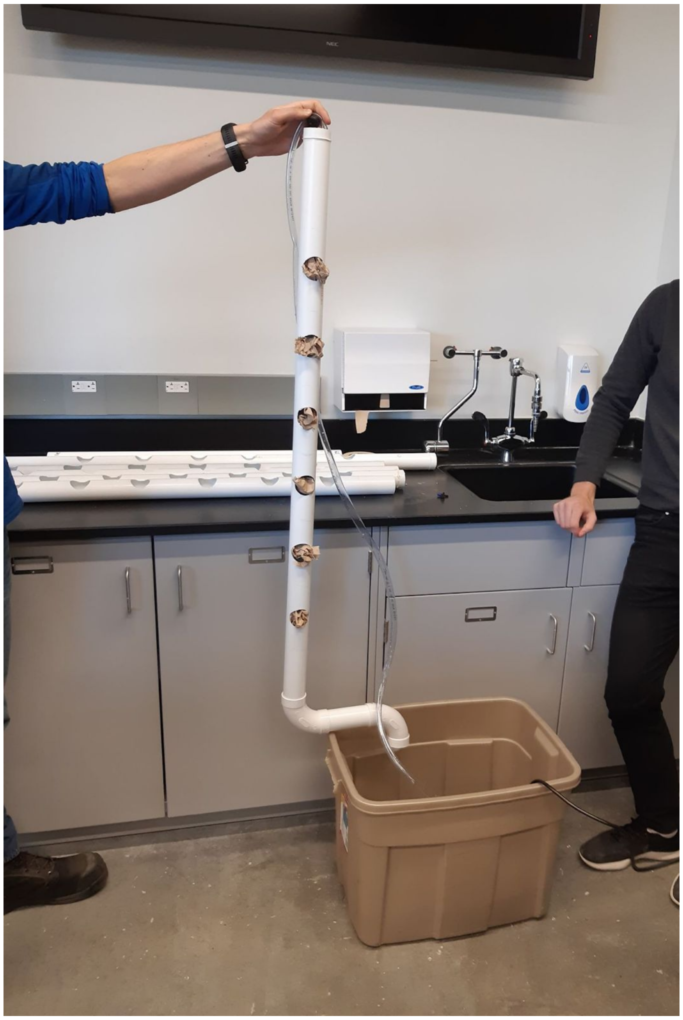
Determine which rate is needed and if we can control this by using a valve?

- Obtain drip rate using the same concept as above while using drip emitters.
- Obtain proper angle of vertical tower and positioning of drip emitters to flow down and adequately water locations of where roots would be located. Since we would not have plants, we could fill the holes with paper towel or something that we know would absorb water to know if the water is making it to all the desired areas.

Testing done:

- Gallons per hour = 396
- Water pump was able to get the water up to the 6ft mark
- Good water pressure throughout 3 different tubes
- Drip emitters were able to keep up with the pump and give off 2 gallons of water per hour
- Water reached the paper towels

Photos:



List of items for prototype 2:

-Frame

-Drip emitter attachments

-Drainage pipe

-Reservoir modifications

-Tubing

-

Budget

Pump = 33$

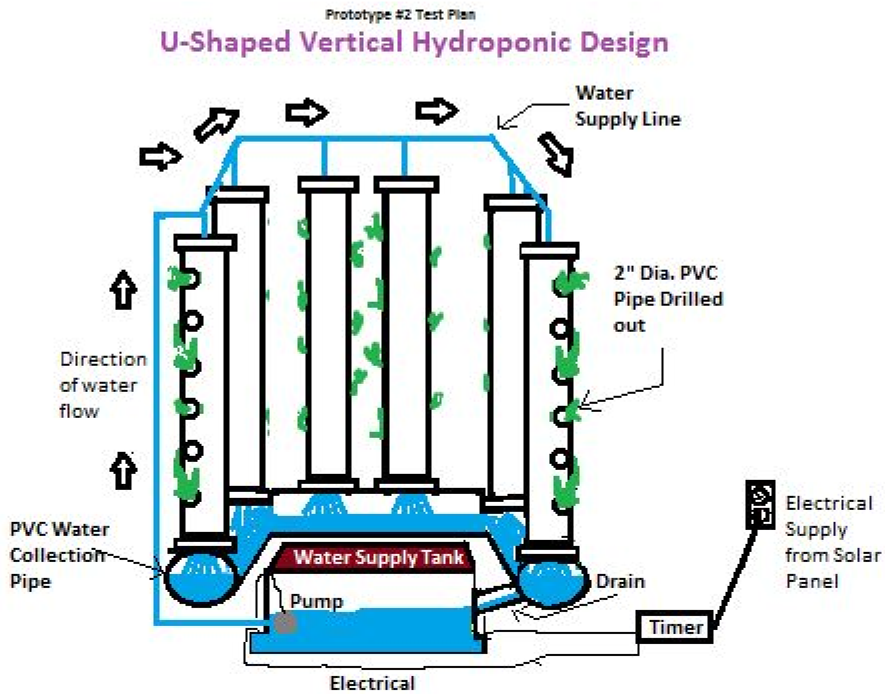
Drip emitter pack= 4$

Timer = 11$

Project Deliverable G: Prototype II and Customer Feedback

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa



The purpose of prototype II is to build on what was learnt from our first prototype and to further prove our concept by expanding our system from the original 1 tower to 6 towers (which will be the final amount needed for the final product). For this phase of our testing we want to ensure that adequate water flow is received to the top of all 6 towers at approximately 6 ft up from the pump and that we are still achieving the same GPM to all towers as received in the first prototype.

Criteria to be met for prototype II.

- Build 6 PVC towers and attach to the PVC return drain.
- Place pump in reservoir and pump water up 6 ft through tubing and out of 6 tee connections, which will supply water to each tower, then measure water flow out of each tee.
- Test the manual timer to ensure that it will start and stop the pump as needed.

- Determine structural integrity of the PVC piping towers once assembled and define what is needed for the frame design.
- Ensure that the measurements of our final system will fit in both greenhouses and will be modular in design.

Testing done:

- Gallons per hour = 396
- Water pump was able to get the water up to the 6 ft mark once again.
- Good water pressure throughout 6 different tubes.
- Manual timer was able to turn on and off the pump at desired times.
- Assessed PVC tower structure and determined that we will need to build a bottom frame to angle the water back into the top of the water reservoir approx 11 inches from the ground and that added support at the top will be needed to hold all towers in place and support the weight of the plants.

Customer Feedback:

- The customer feedback on the design and prototype was mostly positive. One concern from the customer was leaking of the system out the holes in the vertical PVC towers. This will be an item to be tested during the next prototype to ensure that the foam inserts used for holding the plants, will create the desired seal needed to prevent leakage in the system.
- Heating was another concern for the customer, in which we will look at the possibility of implementing a thermal battery into our design along with a water heater to control temperature.
- One proposed idea that we presented to the client was building a manual generator using a bicycle to convert mechanical energy into electrical energy. This would be created using a bicycle to manually turn a motor or alternator to generate power and store the energy in a battery. This idea was well liked by the client.

Photos

-

Project Deliverable H: **Prototype III and Customer Feedback**

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa

The purpose of prototype III is to continue to improve on the design from the first and second prototypes and to finalize plans for completing the project. For this phase, we wanted to focus on the design and building of the support frame in which the hydroponic system would rest on. This frame would bring the drainage pipe to the proper height and make sure that the water from the PVC drain pipe would flow back to the reservoir above the resting water level in the tank. This would be the final testing needed for the prototype.

Criteria to be met for prototype III:

- Design and build a wood support frame.
- Design and plan for the upper support needed.
- Draft a bill of materials needed to complete the hydroponic system.
- Do a physical fit test to ensure that the measurements of our final system will fit in both greenhouses and will be modular in design.

Testing performed:

- A wood support frame design was completed and the frame was constructed so that the drain would empty at a height of 11" from the bottom of the reservoir.
- A design was created for the upper support to hold the 6 towers in place.
- The final bill of materials needed to finish the project was created.
- A physical fit test of our actual hydroponic system was performed and it was confirmed that it will physically fit in both greenhouses.

Conclusion of testing from Prototypes I, II, and III.

From the work performed during our 3 prototypes, we have proved that we were able to pump water to a height of at least 6 ft and to the top of all 6 of our PVC plant towers equally and circulate the water back to the reservoir tank. We also determined that we had enough pressure and water volume to provide an adequate water source to each plant and that we were able to control the amount of water using a manual valve, pump and a manual timer.

The design that we have chosen provides for a maximum yield of plants per square foot due to using the vertical space. The u-shaped design makes for this to be compact in size, but able to be expanded by adding additional towers as needed based on the actual space or desired yield.

Due to the fact that this is a remote area, we wanted to make sure that the components we selected were easy to maintain, were reliable, easy to find replacements and be low tech, so that a computer wouldn't be needed to troubleshoot and fix any problems should they arise.

Photos:

Bill of Materials to complete the design:

- 3ft of ¾" ID tubing **Chris**
- 1 ea. ¾" 90 deg. Tube fitting **Chris**
- 10 gear clamps
- 1 tube of silicone sealant **Jaafar 13$ per tube**
- 1 pool noodle **Jaafar 2$**
- 1 pack of white cable ties **Jaafar 1$**
- 2 ea. ¾" plug. **Chris**
- 1 piece of plywood **In class**

Budget

Pump = 33$

Drip emitter pack= 4$

Timer = 11$

Sealant = 13$

Pool noodle = 2$

Pack of white cable ties = 2$

Total = 65$

35$ left for the tubing and clamps