

# Specification of Solution

## **Introduction**

The purpose of this section is to discuss and explain the various aspects of the final solution that our team has selected, which can be seen in more detail in section 4. This includes a detailed description of the hydroponic system design, the costs of the project, instructions for implementation and use of our model, and results of the project. The detailed description will include a CAD drawing and a detailed description of our project. The cost section will explain our costs for the design, implementation, and maintenance needed for our design. The implementation section will explain how to use and maintain The Drip Hydroponics System. This section will describe the results that have been concluded from current testing, and the overall functionality of the model.

## **Design Description**

In section 4 we used team logic and the Delphi method to select a final design. Originally after the discussion PWW chose to build an aeroponic system, but after further research realized that the aeroponic system did not meet the criteria of our client. An aeroponic system would be too unreliable and require more energy than desired. The final decision for a hydroponic system was based on the fact that the system will be reliable, use very little electricity, and use a moderate amount of water.

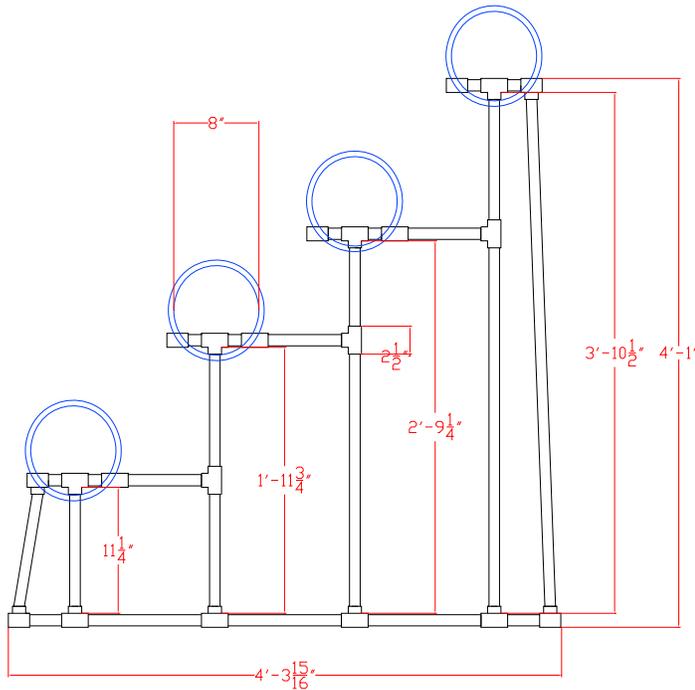


Figure 13, AutoCAD Side view of Drip Hydroponic System

Our final solution scene in figure 13, is named, “The Drip Hydroponic System.” This system’s design that will use the least amount of resources in order to produce the largest amount of vegetables or fruits. The Drip Hydroponic System is a fully functional way to grow vegetables and fruits without soil and with minimal human interaction. The hydroponic system contains a pump, nutrient solution, solution storage barrel, nutrient delivery hoses, nutrient catchment system, solution delivery rings, 8 inch PVC pipe, 1/2 inch PVC pipe, a 1 inch PVC pipe support structure, and nets to hold the plants in place. We chose to use PVC pipe for most of the structure do to the fact that it is much lighter and therefore easier to ship to New York, yet still is durable. In addition the PVC will be able to withstand the corrosive chemicals that are found in most common fertilizers.



Figure 14: A front view of solution tank draining to plants.

As scene in Figure 14, the entire support structure for our system is completely constructed out of 1 inch PVC pipe, hemp rope, and connecting PVC pieces. The project's entire support structure is spray painted in order to make all the mismatching colored pieces of PVC pipe look uniform, as seen in Figure 15. Sitting on top of the support structure is the eight-inch diameter PVC pipes that have a total of sixteen holes cut in the top for the plants to sit in. The plant's roots sit inside of a perlite and marble mixture inside of each basket.



Figure 15: View showing 1” PVC structure and 8” plant housing.

## Design’s Function

As scene in Figure 14, the entire system starts in the solution barrel that is planned to be mounted 15 feet above the project. The barrel contains the nutrient solution and an aerator. The aerator is a bubbling mechanism that supplies the nutrient solution with enough dissolved oxygen for the plants to live. Once the solution is aerated the release valve, Figure 16, is opened at the bottom of the barrel. Connected to the release valve of the tank is a four-way splitter, Figure 17. This splitter makes it possible for each individual row to receive nutrient without affecting the other rows. After the four-way splitter there is a short section of clear tubing attached to it. After a six inch section of tubing each hose has another valve so each row will have an individually controlled flow. Once the solution flows down the 15 feet of tubing and fills up the clear hose, Figure 15, the hose will become pressurized. Once the hose becomes pressurized the solution will fill up the “halos” that are placed around each plant. Once the halos fill up there is three holes drilled in the bottom of each halo, which will let water drip into the baskets

as shown in Figure 18. Once the perlite is sufficiently saturated the excess nutrient solution will flow into the 8" PVC pipe. Once inside of each tube, due to a slate grade, the solution will drain to one side of the tube. Once on the left or right side of the tubes the solution will drain through drains that are on the bottom of each 8" pipe. The excess water collected is drained into a separate barrel located at the bottom of the system where the solution can be pumped up to the top barrel to be reused again.

\*For details on how to set up the system see Appendix B.



Figure 16: Release valve.



Figure 17: Four-way hose splitter attached to 55-gallon drum.



Figure 18: Halo ring surrounding a lettuce plant.

## Cost Analysis

### Design Cost Hours

The design costs for our project consist of the total amount of hours that have been put into our project since the beginning. The total amount of hours that PWW has put into the project is 165 hours.

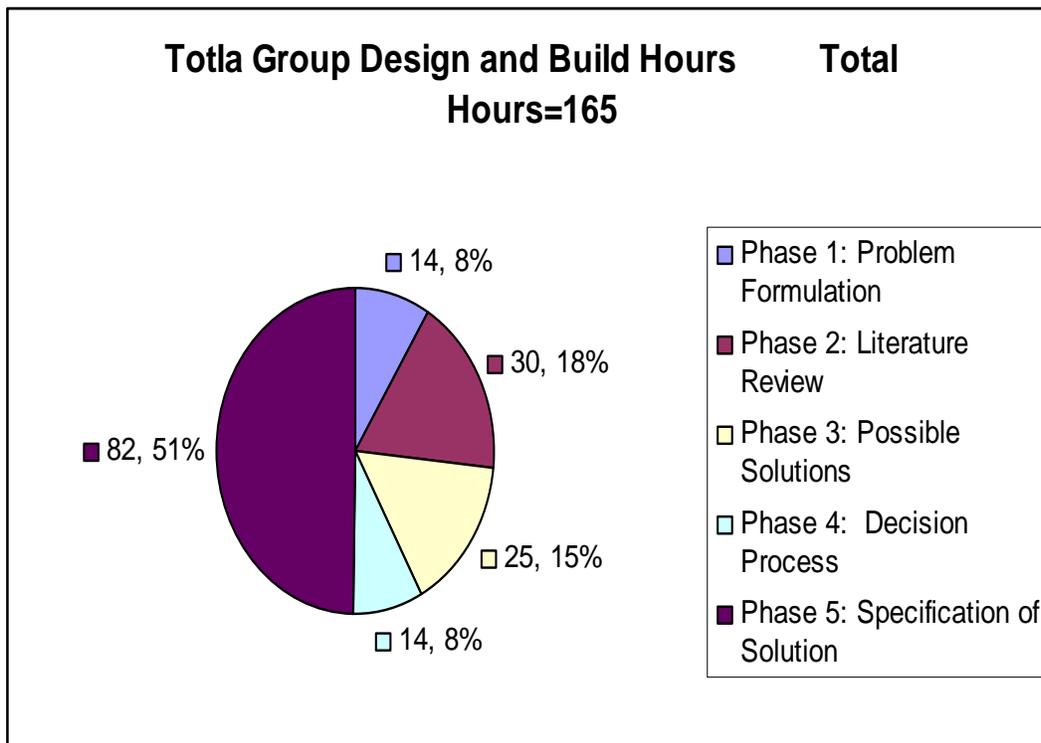


Figure 19: Chart of total hours.

### Implementation

The implementation costs is a cost summary of all the materials, listed in Table 3, that were gathered to build our project.

Table 3: Implementation Costs

Materials	Amount	Location	Team Cost	Potential Cost

Support Structure				
1" PVC Pipe	20 feet	Arcata Salvage	\$16.00	\$40.00
1" PVC Pipe	20 feet	Pat's House	\$0.00	\$40.00
PVC T joints	32 pieces	Ace Hardware	\$16.12	\$16.12
PVC Elbow Joints	28 pieces	Ace Hardware	\$20.00	\$20.00
Spray Paint	4 cans	Ace Hardware	\$20.00	\$20.00
Hemp Rope	20 feet	Ben's Dorm	\$0.00	\$10.00
PVC Pipe Glue	1 jar	Ace Hardware	\$2.75	\$2.75
Solution System				
55 gallon barrel	1 barrel	Resale Lumber	\$35.00	\$65.00
Pump	1	Let it Grow	\$55.00	\$62.00
Solution Delivery Hose	20 feet	Ace Hardware	\$20.00	\$20.00
Solution Retrieve Hose	10 feet	Let It grow	\$10.00	\$10.00
Teflon Tape	1 role	Ace Hardware	\$.75	\$.75
Release Valve	1	West Coast Plumbing	\$2.35	\$3.75
Five way Splitter set up	1	West Coast Plumbing	\$9.25	\$11.50
Bung Hole For Barrel	1	West Coast Plumbing	\$3.50	\$5.00
Spray System				

1/8" hose	10	Ace Hardware	\$15.00	\$20.00
1/8" T connector	16	Ace Hardware	\$5.00	\$6.00
Metal Fence Nails	16	Pat's House	\$0.00	\$1.00
Corks	4	Pat's House	\$0.00	\$1.00
<b>Plant Containment System</b>				
8" PVC Pipe	20 feet	Resale Lumber	\$32.15	\$120.00
8" PVC Caps	8	West Coast Plumbing	\$116.00	\$180.00
Plant Baskets	16	Let It Grow	\$26.00	\$40.00
Perlite	5lb bag	Let It Grow	\$8.00	\$8.00
Marbles	½ lb bag	Pat's House	\$0.00	\$3.50
<b>Total</b>			\$406.87	\$711.37

### **Implementation and Maintenance Costs**

This system was designed to withstand use for a total of six continuous months. The project was designed to be physically sound, but does need maintenance. The maintenance and implementation costs are the same because the implementation costs for starting the project, throughout the project all of these project necessities will have to be bought again. These maintenance and implementation costs include electricity, nutrient solution, and water. The rest of the materials were designed to last throughout the six months.

Table 4: Maintenance Costs

<b>Supply</b>	<b>Amount</b>	<b>Costs</b>	<b>Location</b>
Electricity	1 pump cycle	\$0.00	generator
Water	12 gallons per day	\$0.00	rainwater collection
Nutrient Solution	2bags	\$100.00	New York store

## **Instructions for Implementation and Use of Model**

### **Hydroponic Assembly**

The system will be shipped to the client disassembled to lower shipping costs. Each section of the PVC support structure will have a color-coded male end that fits into the corresponding female end. By following these color codes in combination with Table 2, the structure will be easy to construct. Instead of just inserting the two ends together, place PVC cement on each adjoining side then connect them. After joining the sides make sure that each section stands straight and is square. The 8" PVC plant holders along with the 1/2" spray section will be shipped already assembled. Each of the four sections needs to be placed on one of the color coded tiers. The plant holding section will be color coded to what tier it should be placed on. After placing the section on the tier, secure it with the straps provided. Once the initial structure and plant housing is secure attach the numbered houses, that come out of the pump, to the numbered nipples on the left side of the plant housing. Next connect the drainage tube to the right side of the bottom 8" plant housing and place the other end in the nutrient solution reservoir.

### **Implementation and Use of Design**

The hydroponic system should be set up in an area that has regular temperatures that hover between 55-70 degrees Fahrenheit. Nutrient solution will have to be bought and then mixed with the correct ratio of water to fill the fifty-five gallon drum. Once the pump has been fully submerged into the solution container it will sit on the bottom. Then place the desired plants in the sixteen holes on the 8" plant

housing. Once the plants have been placed and pump has been plugged in with the timer, turn the pump on and watch the plants grow.

The solution will have to be changed out, on average, every 7 days and a new solution batch mixed up for the plants. The solution may be need to be changed either more or less frequent due to different outside variables that can affect how fast the plants use the nutrient Solution. These variables include humidity, temperature, and size of plants. The only part of the project that needs to be watched is the nutrient solution drum. The Ph and Temperature inside of the drum should be checked regularly in order for the plants growth not to be stunted.

## **Results**

The Drip Hydroponic System, after some alterations, works perfectly. During tests runs the system grew tomatoes, strawberries, and lettuces for a week. Growth was noticed and no leaks were discovered. All together the system is functional and meets the client criteria. The Drip Hydroponic System uses very little water, uses very low electricity, and is shippable