The Edible Vegetative Roof:

A Design for the Plant and Environmental Sciences Building at UC Davis

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The Edible Vegetative Roof:
A Design for the Plant and Environmental Sciences Building at UC Davis

A senior project presented to the faculty of the program of Landscape Architecture
in partial fulfillment of the requirements for the degree of
Bachelors of Sciences in Landscape Architecture.

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Abstract

"The Edible Vegetative Roof: A Design for the Plant and Environmental Sciences Building at UC Davis" is a project dedicated to creating a roof farm. It is meant to enhance the university, promote sustainability, and raise awareness toward the endless abilities of an environment. It is designed as an educational and economical resource on campus that takes a unique approach at fulfilling these ideals.

This project specifically looks into the benefits of creating an edible green roof, the various methods in approaching such a scheme, and the opportunities and constraints that the site allows. The design draws from these methods and selects elements that will help to fulfill the initial goals of the project.

My hopes in this project are to present to the public a unique way of viewing unused spaces, to encourage urban farming and sustainable practices, and to expose the variety of ways of greening a roof. I hope to show that through design, a multi-functioning environment can be created and remain sustainable.

Acknowledgements

I would like to thank everyone that has made the completion of this project and this Landscape Architecture degree possible.

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Introduction

Design Intent

The Edible Vegetative Roof is a project dedicated to creating a roof garden that will provide edible vegetation, and is designed as an economical and educational resource on the UC Davis campus. It is meant to promote the production of fresh food in an urban environment, and to raise awareness on methods to become more sustainable. As a roof top farm, it utilizes unused spaces on the campus and produces fresh crops that can be eaten or sold.

This project looks into the best ways to transform the roof into a garden for the functions intended, without being too unnecessarily expensive. The garden will serve as a demonstration garden for the students and will allow them to experiment with the soil and nutrients and try their hands at composting. As well as providing educational benefits, the garden will grow produce that will theoretically be prepared and sold at a small, student-run diner on campus, which will generate income toward the project and University.

Project Site Description

Figure: i.01: Site location - PES Building adjacent to the Landscape Architecture Building and the Memorial Union.

The Plant and Environmental Sciences Building (also known as the "PES Building") is a new, three-story building on the UC Davis campus that houses the departments of Agronomy and Range Science; Land, Air, and Water Resources; Environmental Science and Policy; and Environmental Horticulture. It is located adjacent to Hunt Hall which houses the Landscape Architecture department, and to the Memorial Union which is one of the main spot to obtain food on campus (See Figure i.01).

The PES Building is an ideal area for educating the public and testing innovative ideas. One of the existing educational exhibits located here is the Field Crops of California exhibit, which displays and identifies different crops and soils during the year. This display also includes face cards to describe each planter in detail.

Along with the Field Crops of California exhibit, the "Salad Bowl Garden" created by Margaret Lloyd is housed here. The "Salad Bowl Garden" is a 600 sq. ft. edible landscape planted in the French potager aesthetic. Maintained by volunteers from various departments, this demonstration garden is open to the public for a salad lunch with washing, spinning, chopping, and dressing stations to personalize salads to their liking (See Figure i.02).

The PES Building is an ideal site because it houses and is located by the target market for the garden – students and faculty studying the Environmental Sciences and Landscape Architecture, and consumers of the products. Along with being in the center of its target market, the PES Building is also known to be a building that encourages innovation in education. Thus, it is a perfect candidate for the edible vegetative roof project.

Figure: i.02: People picking vegetables from the PES Salad Bowl Garden.

Chapter 1

What is an Edible Vegetative Roof?

An edible vegetative roof is a garden on the roof that is used to grow edible plants. It combines the characteristics of an edible landscape and of a green roof to provide produce from these usually unused roof areas (See Fig. 1.01).

Fig. 1.01: An example of an edible vegetative roof in San Francisco, entitled “Graze the Roof.”

Benefits

Edible Landscape

An edible landscape is an alternative to conventional ornamental gardens and landscapes. It is a site that has similar aesthetic qualities as ornamental ones, and additionally provides: fruits, vegetables, and other vegetation that can be eaten.

There are many benefits that an edible landscape can provide, which include: utilizing space, controlling herbicide and pesticide usage, reducing the demand for produce transportation, growing unusual varieties, and saving money in the long run.

An edible landscape utilizes space by functioning in two ways. The first way is to provide an aesthetic environment and to create an atmosphere similar to those of conventional ornamental gardens. Secondly, edible landscapes provide food in this same space. As a result, two functions are being used in this one site.

The ability to control herbicide and pesticide usage is another benefit of creating an edible landscape. Instead of purchasing produce from the supermarket that has been grown by others, edible landscapes give you the options of the quantity and kinds of pesticides used, or even the option to not use any at all (Savvy Landscaping, 2007). “This helps decrease the dependence on harmful products in food production and controls the amount of these herbicides and pesticides that are consumed” (Savvy Landscaping, 2007).

Another benefit of an edible landscape is to reduce the demand for produce transportation. An edible landscape provides fruits and vegetables on site. This promotes locally grown produce and reduces the need for ones transported from other areas. A reduction in produce transportation, in turn, reduces the ecological footprint of obtaining these goods (Savvy Landscaping, 2007).

Growing unusual varieties of fruits and vegetables is another benefit of an edible landscape. The types of produce grown on site can be chosen by preference and your liking. This ensures that “even if a supermarket does not carry a certain fruit or vegetable, you still have the ability to get what you want if it is grown on site” (Creasy, 1982).

Lastly, an edible landscape can save you money in the long run. After the initial cost of implementing the fruit and vegetable plants, money can be saved through the year by producing the crops that will be eaten, instead of purchasing them from the supermarket. By growing produce in a personal landscape, abundant fruits and vegetables can be grown year round, saving on grocery bills (Creasy, 1982).

Green Roof

Although there is debate on what a “true green roof” is, in this project, a green roof is defined as being a roof that is entirely or partially covered in vegetation. There are various types of green roofs that will be discussed in Chapter Two; nonetheless, they all have the ability to provide benefits to our environment.

One of the benefits is that a green roof reduces the urban heat island effect. The urban heat island effect is when a metropolitan area is significantly warmer than its surrounding rural areas due to urban development and waste heat contributed by humans (See Fig. 1.02). "The replacement of trees and vegetation with buildings and pavement reduces the amount of shade and evaporation, resulting in less natural cooling" (Environmental Protection Agency, 2002). A green roof reduces this effect by creating more vegetation in place of these impervious surfaces, which promotes natural cooling.

Another benefit of a green roof is its ability to utilize space. Rooftops are generally empty areas that are inaccessible to the public. A green roof can then take those unused areas and give it a function. It can provide an environment for people to enjoy, or provide cooling to the building (Green Roofs for Healthy Cities, 2005). Which ever way it is used, this nonfunctioning space is transformed and given a function.

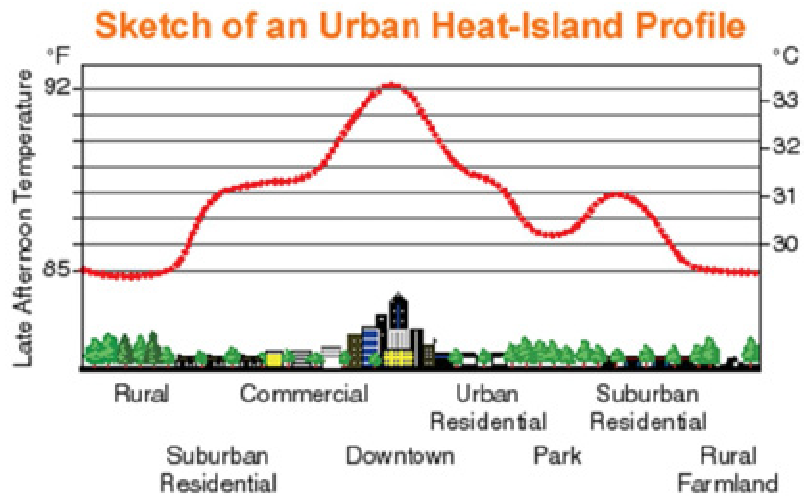


Fig. 1.02: Graph showing that an increase in built environment, leads to an increase in temperature (the urban heat-island effect).

Chapter 2

Typology

In this project, the main priorities of the garden include growing an abundance of food and allowing experimentation with the growing medium. Because of this, the type of vegetative roof chosen is important. There are three possible ways to approach a vegetative roof, and each method has its own strengths, weaknesses, and specializations.

The first approach is the typical green roof. This is the most commonly known type of vegetative roof, and comes in a variety of forms, which include: extensive, intensive, and semi-intensive. Typical green roofs have multiple layers that must be installed on the roof (See Fig. 2.01). As a result, this approach requires a great deal of time to establish, has extensive weight that may not be supported by the roof and is a more expensive way to obtain the products desired. Thus, this method of creating an edible vegetative roof will not be used.

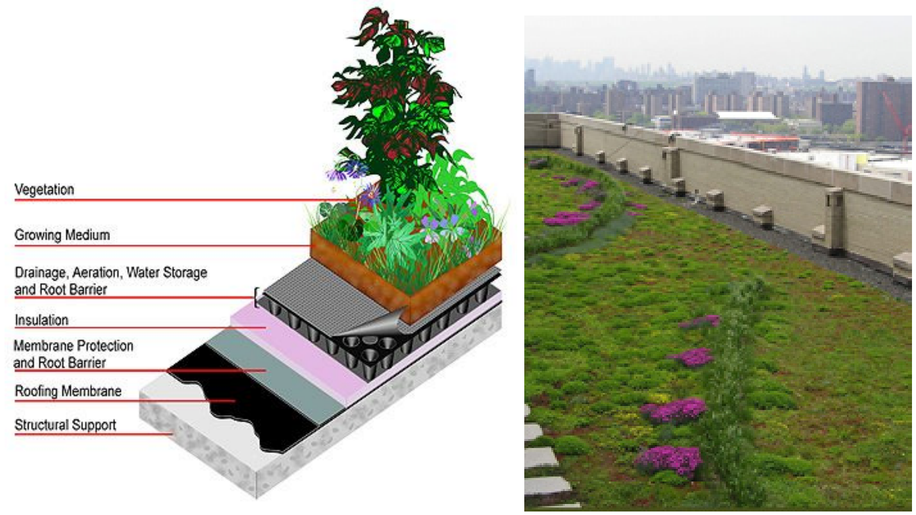


Fig. 2.01: Typical green roof layers (Left). Green roof on the Bronx County Courthouse (Right).

The second approach is to use a hydroponic system. A hydroponic system is a low soil or soil-less system that has automatic watering, and pH and nutrient control. This method produces more, better quality produce than other systems (Garden Unit, 2008). Thus, it is ideal to use in this design.

The third approach is a container garden. A container garden is exactly what it sounds like, a regular garden grown in containers (See Fig. 2.02). This is an inexpensive method that allows for experimentation and has similar qualities as normal gardens. This method is also ideal for the edible vegetative roof design.

Fig. 2.02 An example of a container garden using plastic pools as planters.

Of the three approaches, the hydroponic system and container system are best to satisfy the needs of this project. These systems will be explained in better detail as follows.

Hydroponic System

The hydroponic system is an ideal way to grow vegetation on the roof of the PES Building because it is light weight and yields higher quantity produce than other methods. Hydroponics allows for control of the nutrients that are fed to the plants, producing better quality crops (Garden Unit, 2008). Also, in this system, watering is controlled and automatic, cycling the moisture so that it starts off completely wet, then gradually dries out before it moistens the plant again. This mimics the conditions of nature, giving the plants the amount of water they need and results in less water usage and less maintenance (Autopot, 2006).

The Autopot system is the preferred type of hydroponic system because it is the most water efficient hydroponics available and has better control of the watering cycle of each plant than other systems (Thanate, 2008). Autopot has a plant driven watering system, which means that the plants decide when the pumps should work, not the growers. This gives each plant the amount it needs, as opposed to giving every plant the amount of water that the driest plant needs (like in other systems). As a result, less energy is needed to operate this system because it does not work unnecessarily (Autopot, 2006).

When it comes to the economical benefit of the edible vegetative roof, the hydroponic system is the best bet. This is because the hydroponic system is made to give the plants the exact amount of water and nutrients that they need, resulting in more, good quality food produced (Thanate, 2008). The larger amount and better quality the food, the easier it would be to sell to the masses.

There are three specific products under the Autopot name that will be used in the edible vegetative roof design. They are the smart pump set, the caplus trays, and hydrotrays. Each of which will be explained as follows.

The smart pump set is designed to water and feed the plants that are located on the caplus trays and hydrotrays. This set has three main components that keep it running: a power supply, a water supply, and a feeder (See Fig. 2.03).

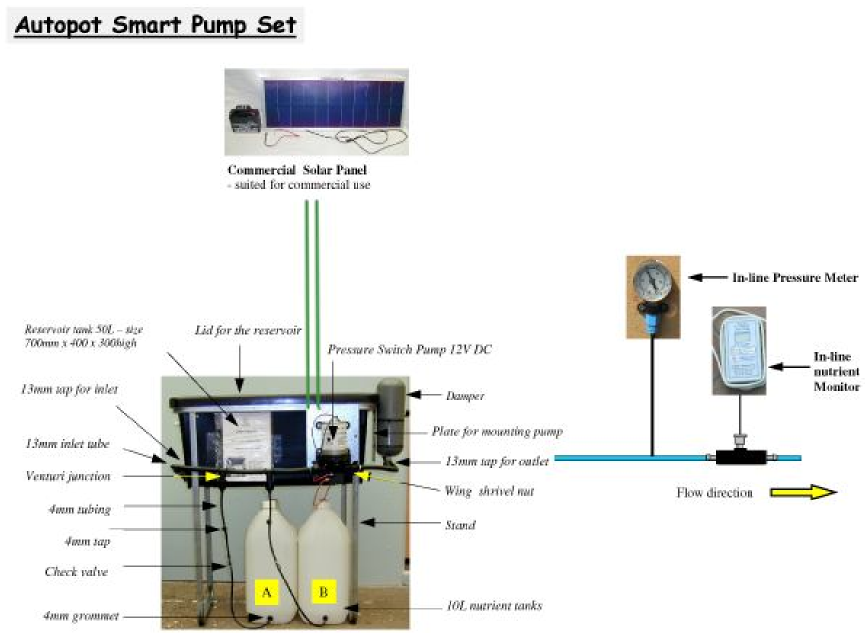


Fig. 2.03: The components of an Autopot smart pump set.

Since part of the edible vegetative roof is designed to feed the masses, a commercial sized power supply is needed. According to the Autopot website, the best energy source option is a solar panel. The solar panel is strong and long lasting, and it will be used to power a

12V DC battery. This solar panel and battery will charge and run the entire smart pump system (Autopot, 2006).

The water supply is an 11 gallon reservoir that maintains its levels with a built-in ballcock valve. From this reservoir, the water will be pumped to all the plants in the Autopot system. As the water is being pumped out, the feeder injects a calibrated proportion of part “A” and part “B” nutrients into the delivery outlet. As added features, a pressure meter and a nutrient monitor are added to the system, providing early indication of pressure problems and easy readings of the nutrient status of the delivery pump (Autopot, 2006).

The smart pump set pumps its water into the caplus tray system, which acts as an automatic capillary watering system (See Fig. 2.04). These caplus trays are ideal for raising seedlings, propagating cuttings, and growing herbs and vegetables (like leafy greens). Because of this, caplus trays can be used to start off or create clones of a plant before transferring it to a hydrotray, which will house the larger plants (Autopot, 2006). This allows a continuous growth of vegetables, where as one plant dies in a hydrotray, a clone from the caplus tray can be planted to take its place.

Fig. 2.04: An example of an Autopot caplus tray.

The smart pump set also waters the hydrotray planters. The hydrotray is a tray that holds two 12” pots and a smart valve which connects to a main feeder line. This feeder line connects to the smart pump set containing the water and nutrients. The smart valve precisely adds the nutrient rich water into the tray up to a designated level; it then closes and allows the water to drain completely. After the water level reaches zero, the smart valve waits about 30 minutes before opening and watering again (See Fig. 2.05). This hydrotray system is ideal for larger plants, carefully watering and feeding each plant up to 20 feet tall (Autopot, 2006). This system is ideal for a large range of plants, including tomatoes, melons, grapes, and cucumbers (See Fig. 2.06).

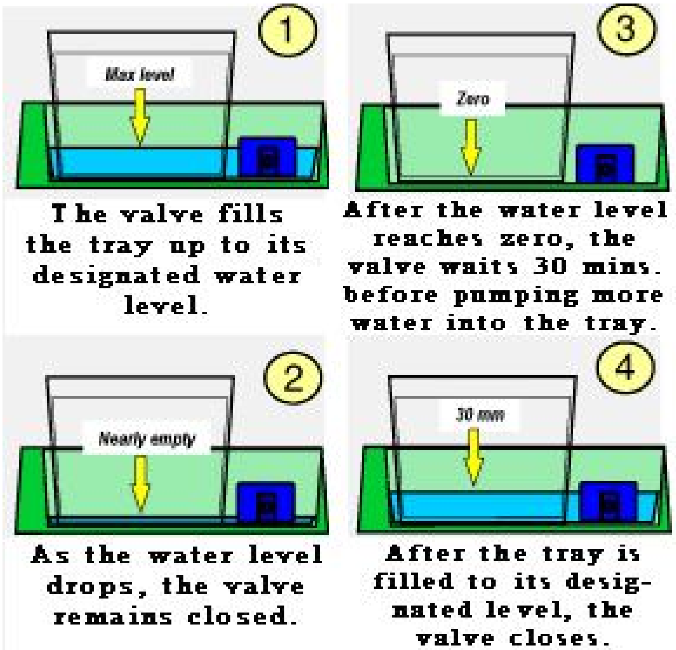


Fig. 2.05: A diagram of how the smart valve works.

Fig. 2.06: Jim in front of his tomato farm grown in Autopot hydrotrays.

Overall, this Autopot system is ideal for this project because it grows an abundance of food, and consistently keeps the cycle of growth going. This system is water and energy efficient, and allows for quality fruits and vegetables to be sold to the public.

Container System

Along with the hydroponic system, a container garden system is an ideal way to grow vegetation on a roof top because it is more light weight and cost effective than traditional green roof systems. It also allows for easier distribution of weight on the roof to ensure that it does not exceed the structural load capacity of the building (Alternatives and the Rooftop Garden Project, 2008).

Fig. 2.07: A finished and planted square foot garden.

A square foot garden is the preferred type of container garden because it requires less water, soil, and maintenance than other container gardens (Odum, 2007). This makes the overall system more lightweight. Square foot gardens also yield more vegetables per square foot than traditional gardens which optimize the roof space (Odum, 2007).

A container garden is preferred to a hydroponic system when it comes to the educational aspect of the design. This is because it allows students to experiment with the nutrients, water usage, and compost. The container garden is more hands on and better mimics ground gardening situations.

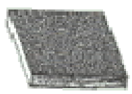
A square foot garden can be constructed and managed by anyone, ranging from faculty to volunteers to the students themselves. Below are the nine easy steps that must be followed in order to do so, provided by the Square Foot Gardening Foundation.

1. Layout the roof top in 4’ x 4’ square planting areas.
2. Build a garden box frame that is 4 feet wide, 4 feet long, and 6 to 8 inches deep (and if desired, deeper for carrots). Any 1 by 6

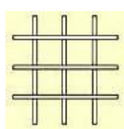
or 2 by 6 lumbar can be used for the sides, except for treated wood because it contains toxic chemicals that may leach into the soil. When fastening the boards, use deck screws and alternate corners in order to keep a square inside.

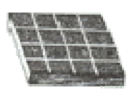
3. Place the boxes 3 feet apart from each other to create walking aisles.

4. Fill the boxes with soil and compost or whatever materials that will be tested. A recommended combination is: 1/3 compost, 1/3 peat moss, and 1/3 coarse vermiculite.



5. Make a permanent grid out of wood to place at the top of the box, making each grid one square foot (resulting in 16 total grids).





6. Select the plants that will be grown in each grid and coordinate it with the recommended plant spacing (See Fig. 2.08). One type of plant should house each grid and you can grow 1, 4, 9, or 16 plants in each. For example, if spacing is 6 inches between each plant, 4 plants will fit in each grid.

7. Make a shallow hole in the soil, plant one or two seeds in it, and cover it without packing the soil.

8. Manually water as much as needed using the harvested rainwater that has been warmed by the sun.

9. Continually harvest and replant or re-soil as needed.

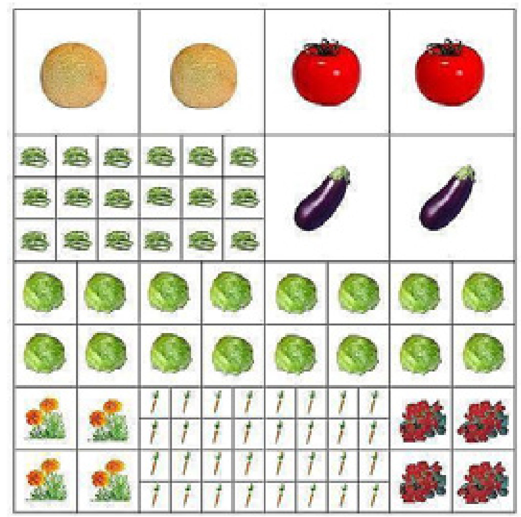


Fig. 2.08: An example of a planting plan to space each vegetable according to their recommended plant spacing.

Chapter 3

Site Accessibility

The edible vegetative roof is designed to be located on the Plant and Environmental Sciences Building (See Fig. 3.01). As mentioned earlier, this is an ideal site for the project because of its proximity to its target market (See Fig. 3.02). In order for the green roof to be built and for the target market to reach this roof top, the accessibility of the building must be taken into consideration.

Fig. 3.01: The front of the Plant and Environmental Sciences Building.

Fig. 3.02: PES Building is adjacent to the Landscape Architecture Building and the Memorial Union.

Roof Access

The existing roof of the PES Building has two main tiers. The first tier is a slightly sloped roof that houses the roof and overflow drains. The second tier holds the exhausts, house keeping pads, and mechanical equipment of the building. These areas should not be accessible by the public; thus, the first tier is the better area for access (See Fig. 3.03).

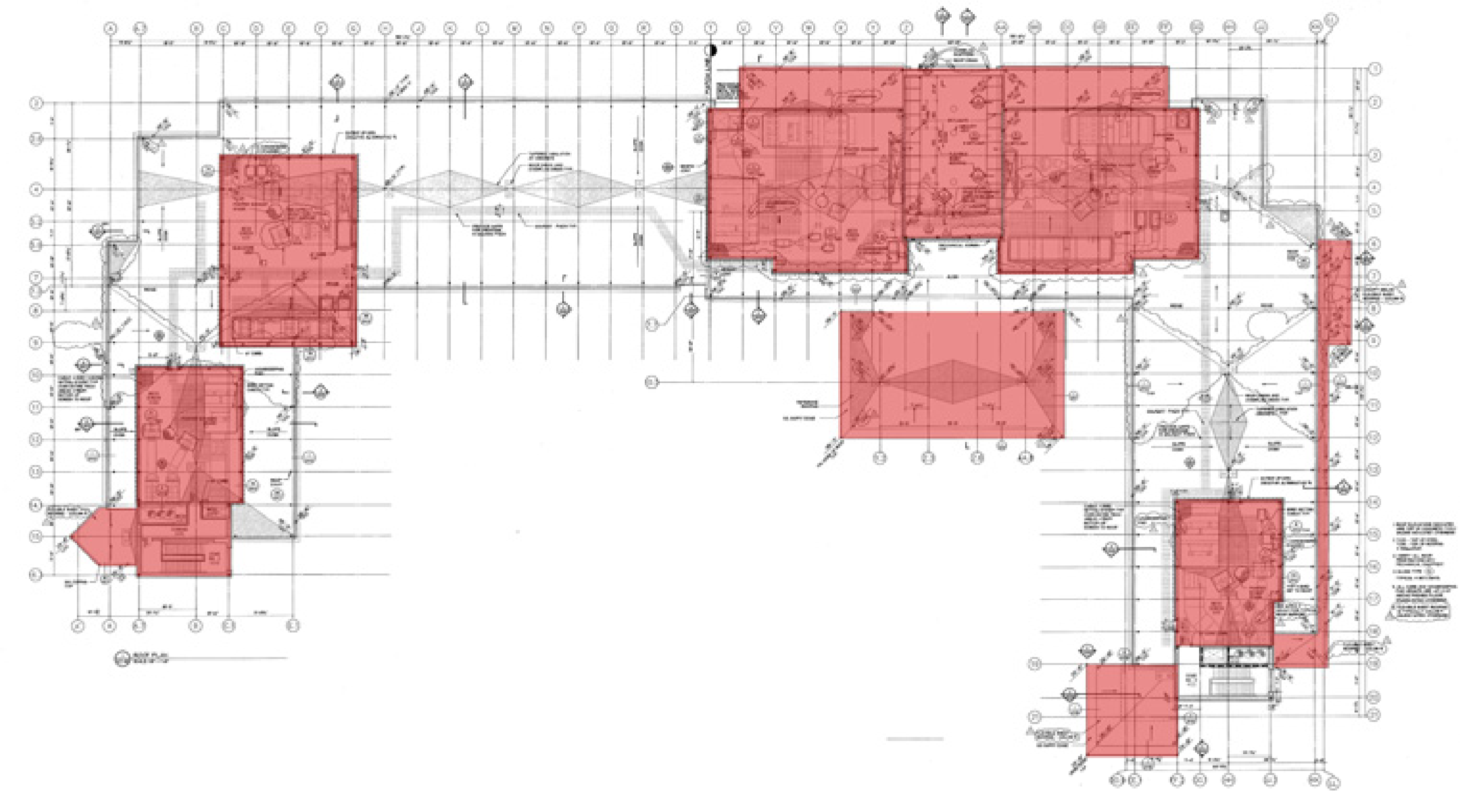


Fig. 3.03: The red areas indicate the parts of the PES Building that are not accessible by the public.

Stair Access

Currently, the PES Building has access to the roof from the inside via stairways and elevator. Since the building is occupied by many offices, it is preferred to create access to the roof from the outside. This ensures that the employees will not be disturbed by the publicly accessible roof. Also, the best external access to the roof will be areas with minimum window and utility blockage so that the offices with window views will not be disturbed and utilities can be reachable from the ground (See Fig. 3.04).

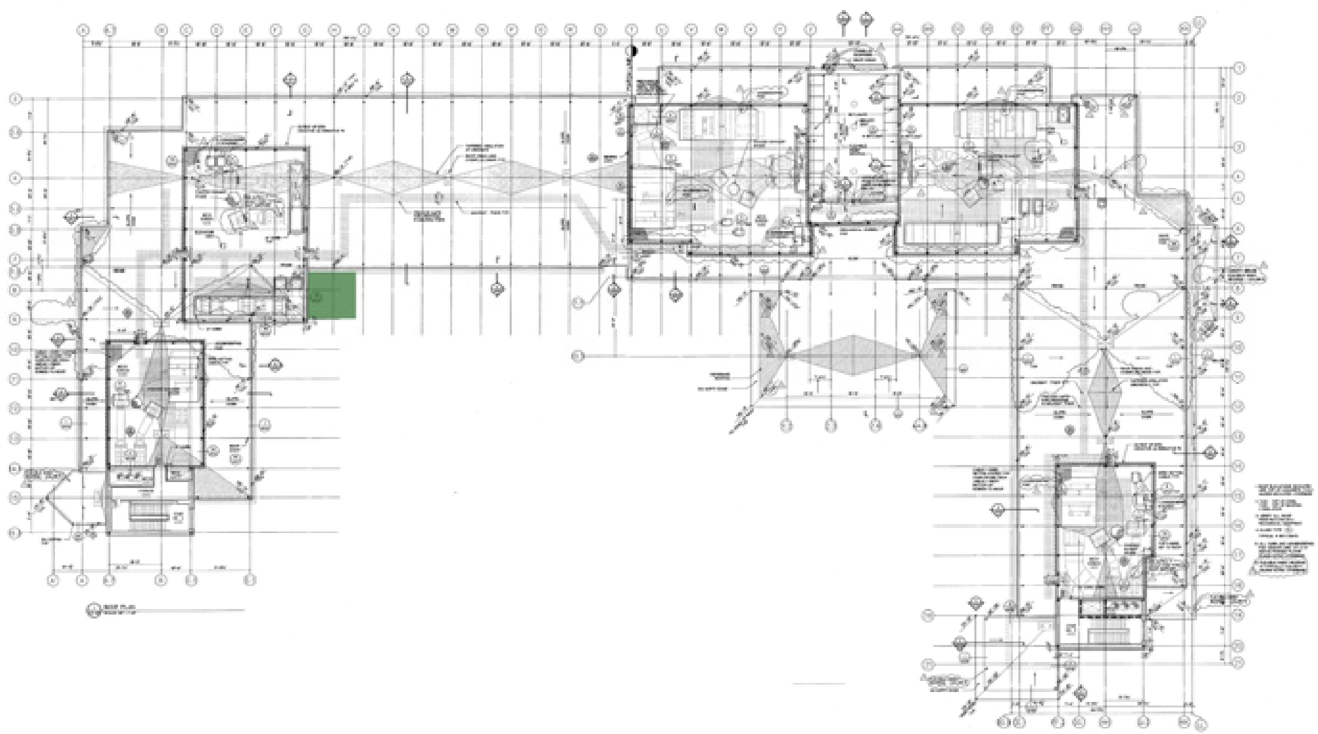


Fig. 3.04: The green area indicates the ideal place to put stairs for public access on to the PES Building rooftop.

Chapter 4

Along with accessibility, the plants chosen for the edible vegetative roof are important to the design. Since the design requires vegetation that will be sold at a student diner, crops that are easily grown to feed the masses are ideal. Also, in order to pick the best plants for the roof, the conditions for growing in Davis must be considered.

Conditions for Growing

When choosing plants to grow, it is important to know the climate zones, seasons and soil types of the environment. Since the edible vegetative roof will not use existing soil, the soil types will not affect the planting choice.

According to the Redwood Barn Nursery, in Davis, the climate zone is USDA Zone 9 and Sunset Zone 14. Davis remains frost free from March to mid-November, and usually, the frost is light enough to not affect vegetable crops.

Davis has two distinct planting seasons, which are fall and summer. Crops planted in fall and winter result in a winter to spring harvest. While, crops planted in summer and spring result in a summer to fall harvest (Redwood Barn Nursery, 2008). Because the seasons of planting and seasons of harvesting overlap with one another, the design must leave space for both planting seasons' crops to grow concurrently. This ensures that the crops will be grown year-round.

Edible Plant List

The edible plants chosen to be included in this list are a mix of vegetables, melons, and berries that would work well in the Davis environment. Fruit trees were not included because of their extensive height, weight, and their need to be grown in a different set up. Nevertheless, fruits and vegetables that are favorable to the general public and that grow in abundance were chosen, and are listed as follows.

Food Planted in Summer (and Spring)

Basil
Beets (Detroit Dark Red, Early Wonder, Chioggia)
Bell Peppers (Purple Beauty, Ivory Hybrid, Lilac Hybrid)
Brussel Sprouts
Cantaloupes
Carrots (Little Finger, Danvers Half-long)
Corn (Silver Queen, Golden Jubilee)
Crookneck Squash
Cucumbers (Burpless, Lemon, Armenian)
Dried Beans
Eggplants (Dusky, Black Beauty, Ichiban)
Green Beans
Honeydew
Hot Peppers (Chili, Poblano, Jalapenos)
Leeks
Okra (Clemson Spineless)
Peas (Sugar Snap, Oregon Sugar Pod II,Dwarf Grey Sugar)
Potatoes (Yukon Gold, Yellow Finn, Red La Soda)
Pumpkins (Sugar, Pie)
Radishes (Champion, Daikon)
Rutabagas
Strawberries (Selva, Fern, Ozark Beauty)
Summer Squash (Gold Rush , Ambassador , Sunburst)
Tomatoes (Roma, Early Girl, Champion)
Watermelon (Sugar Baby)
Winter Squash (Sweet Meat, Table Queen, Spaghetti)
Zuchinni
Beans (Blue Lake, Royal Burgundy, Tendergreen)
Tomatillos
Cherry Tomatoes (Sun Gold, Sweet 100, Patio)

Food Planted in Fall (and Winter)

Beans (Fava, Broad)
Beets (Detroit Dark Red, Early Wonder, Chioggia)
Blackberries (Boysen, Logan, Marion, Olallie)
Broccoli (Romanesco, Raab)
Brussels Sprouts
Cabbage (Green Acre, Savoy)
Carrots (Little Finger, Danvers Half-long, Chantenay)
Cauliflower (Early Snowball)
Celery
Chard, Swiss (Bright Lights, Rhubarb)
Chicory, Belgian Endive (Magdeburg)
Cilantro, Coriander
Collards
Corn Salad
Cresses
Endive
Fennel, Florence
Garlic
Kale (Russian Red)
Leeks
Lettuce (Romaine, Tom Thumb, Bibb)
Mustard Greens
Onions (Red Torpedo, Walla Walla, Welsh, Spanish)
Peas, Sugar, Snow (Oregon Sugar Pod II, Dwarf Grey Sugar)
Potatoes (Yukon Gold, Red La Soda, White)
Radicchio (Giulio)
Radishes (Champion, Plum Purple, Sparkler)
Rutabagas
Spinach (Bloomsdale, Olympia, Tyee)
Strawberries (Sequoia)
Turnips

Chapter 5

Design

The edible vegetative roof is a roof used to grow edible crops. It is designed to creatively make use of initially unused spaces to promote sustainability and urban greening. The main areas on the roof are used to allow students to experiment with water and soil, composting, and rainwater harvesting, and to provide an economic benefit from the produce. The crops grown in this design will be sold at a student diner that will earn money to further fund this project and for the university.

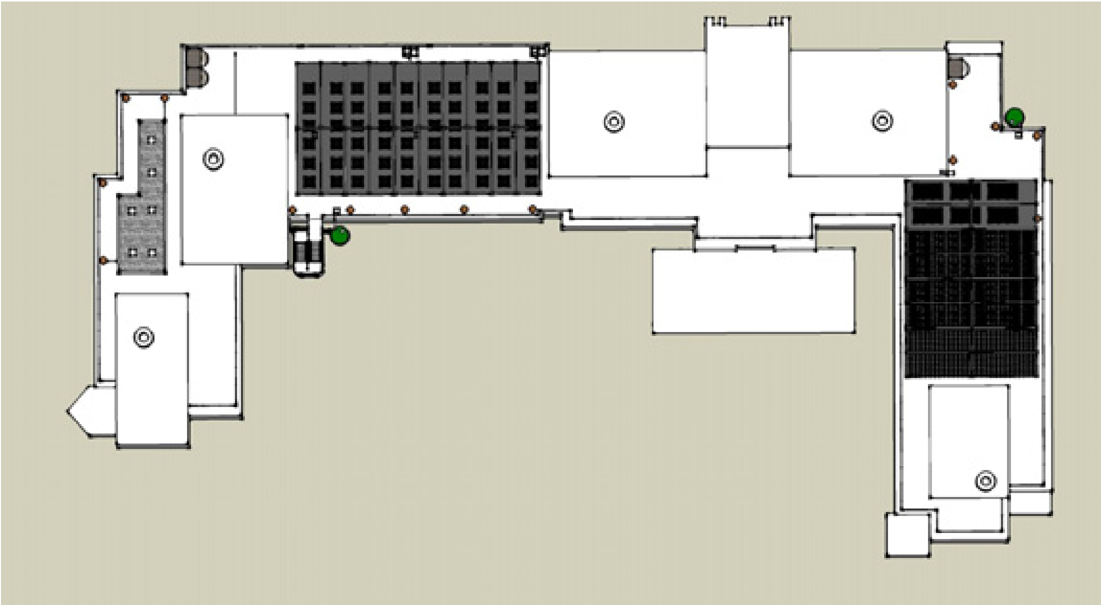


Fig. 5.01: Plan view of the entire design.

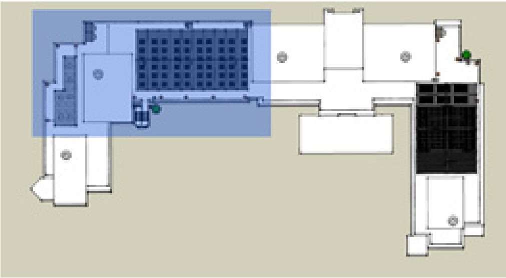


Fig. 5.02: Close up, plan view of the edible vegetative roof (West).

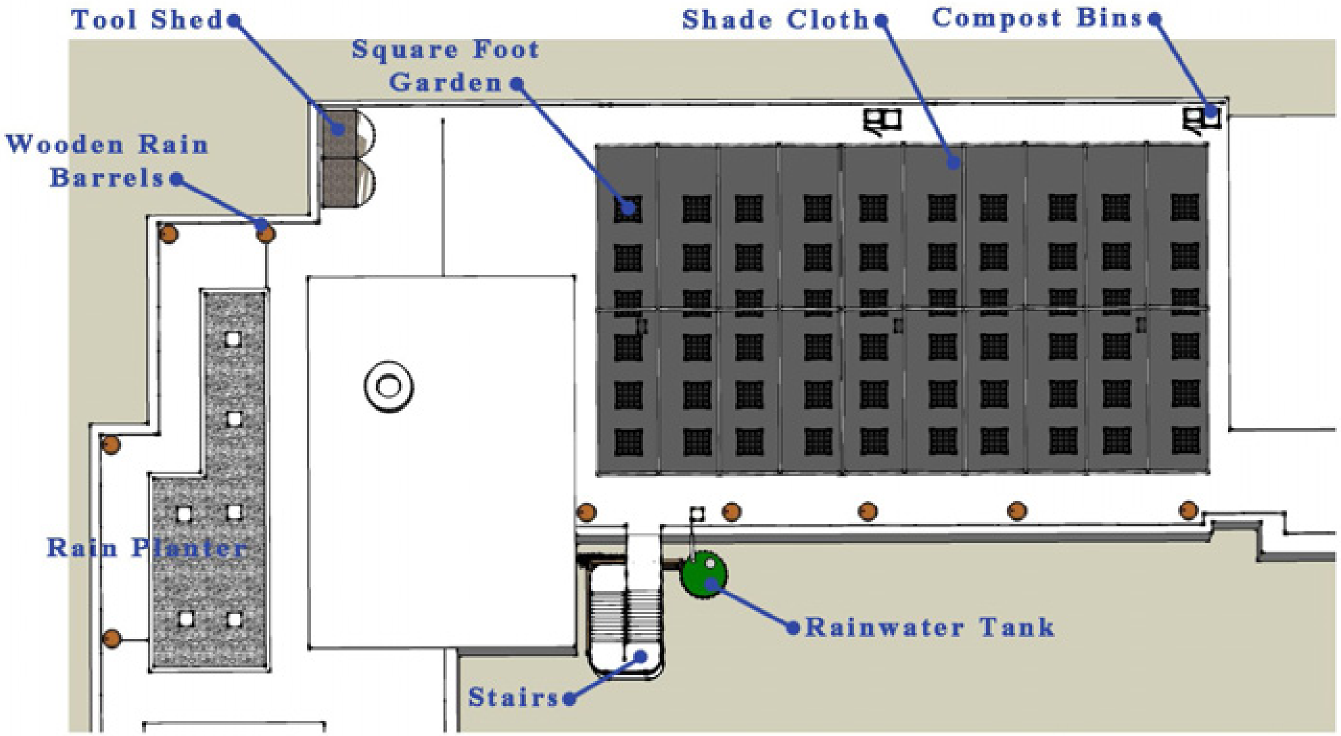
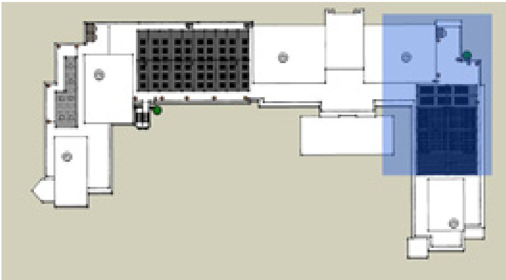
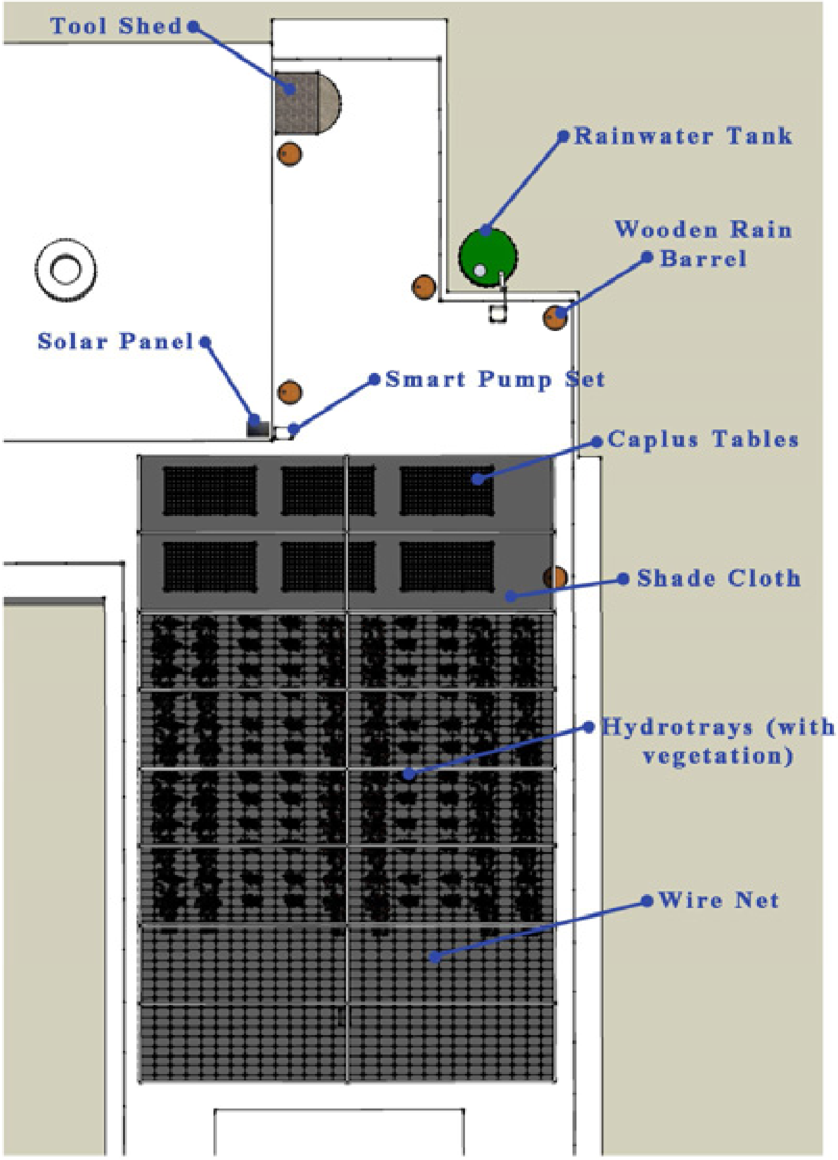


Fig. 5.03: Close up, plan view of the edible vegetative roof (East).





Safety

For the initial steps in creating this design, safety is the first concern in making the roof open to the public. Since the slopes on the accessible areas of the roof are so slight, they do not have to be tampered with. The roof is lined with guard rails to allow the public to access it safely (See Fig. 5.04). The existing roof drains and back up drains are secured with wire caging, allowing water to still be able to flow into them. The caging will also prevent people from tripping on the drains and will protect the drains from damage. After these safety modifications were addressed, the design focused in on making the primary goals of the project plausible.

Fig. 5.04: Aluminum railing added to a building for public safety.

Water

To obtain water to use on the roof, two different approaches were used, both using rainwater harvesting.

In the first approach, a wooden, shallow planter area is created to catch the rain water and funnel it into the wooden rain barrels (See Fig. 5.05). The bottom of the planter is covered with a thin layer of rocks to help filter the rain water before it enters the barrels. The planter sits on pedestals located along the support beams of the building to maintain the weight of the planter. Also, the wooden barrels are located along the edges of the roof where there is strong beam support to hold up their weight when filled.

Fig. 5.05: Shallow planter used to collect and filter water for rainwater harvesting.

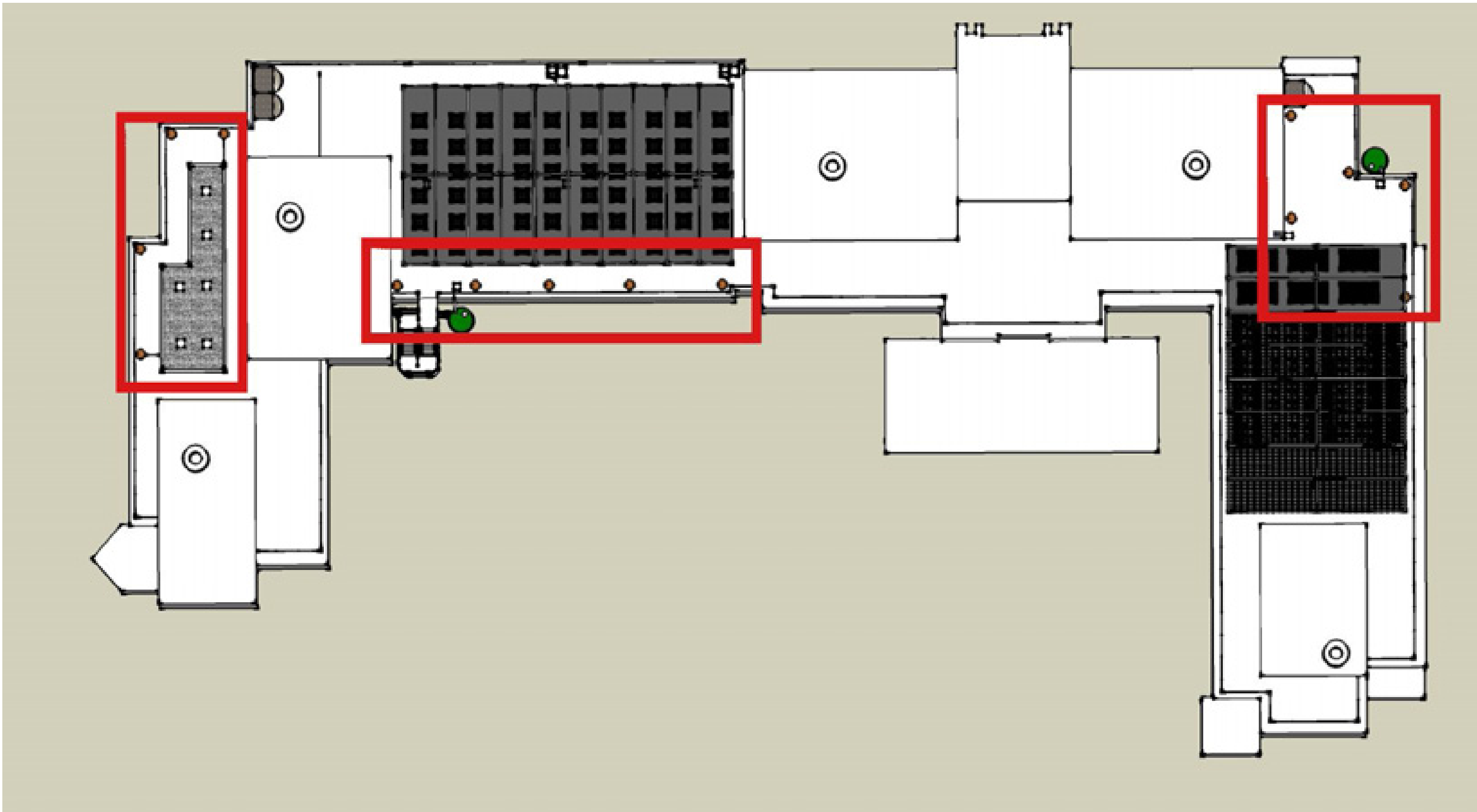


Fig. 5.06: Red areas mark the location of rainwater harvesting.

In the second approach, rain is collected from ground level and is transferred up. In two different areas, a 423 gallon tank is located next to one of the roof downspouts of the PES Building to collect rainwater from the roof. During dry seasons, this tank is filled with a water hose from ground level when the water supply is low. An 1100 watt steel pump located inside of the 423 gallon tank can provide enough pressure to run the water from the tank up to 147 feet in height. Because of this, the water will have enough pressure to reach the roof top, which is approximately 48 feet from ground level. A hose will run from this tank, up to the roof top, where wooden barrels are located to harvest this water and provide the water needed for the plants (See Fig. 5.07).

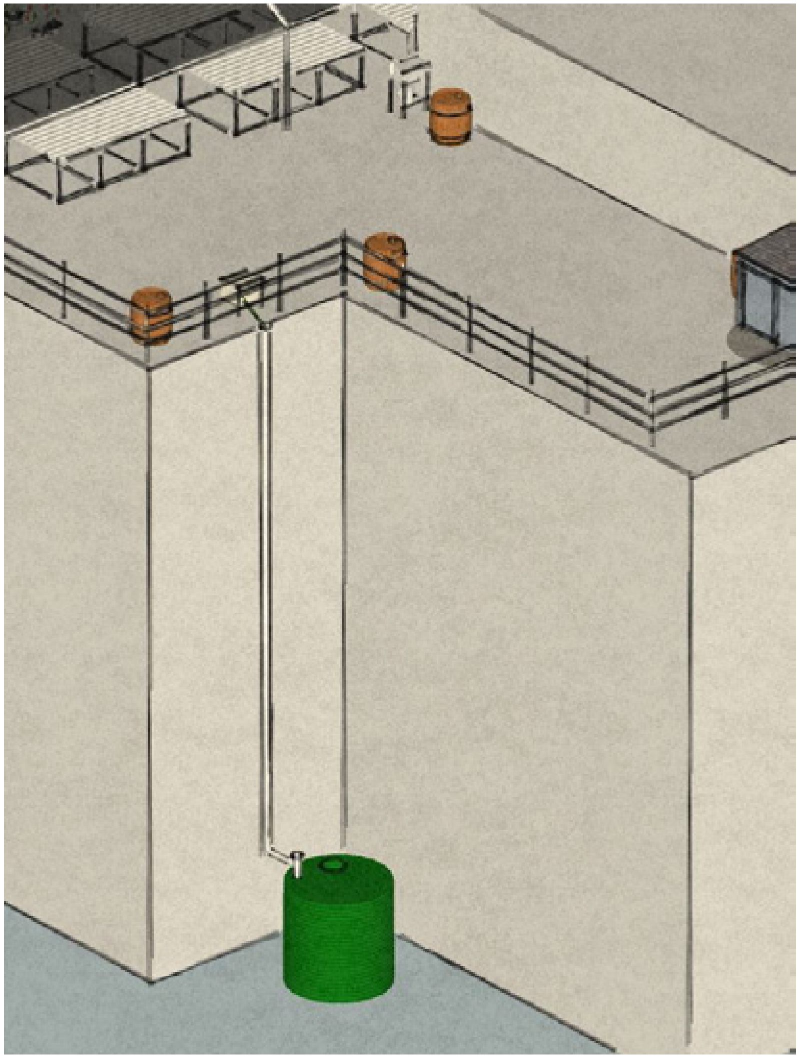


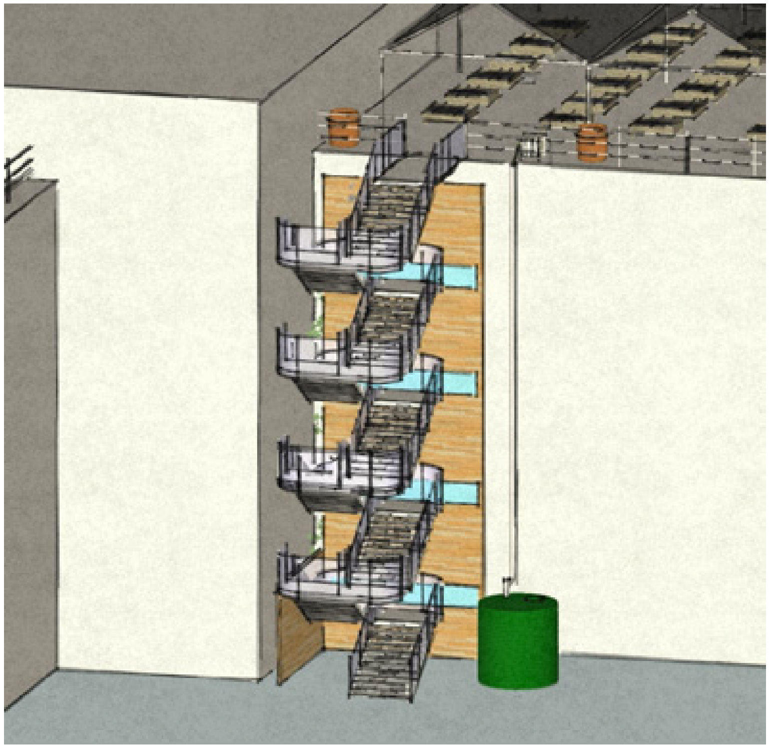
Fig. 5.07: Rainwater harvesting system using a Hercules tank on the ground level (Middle), powered by a 1100 watt pump (Right) to bring the water to the roof.

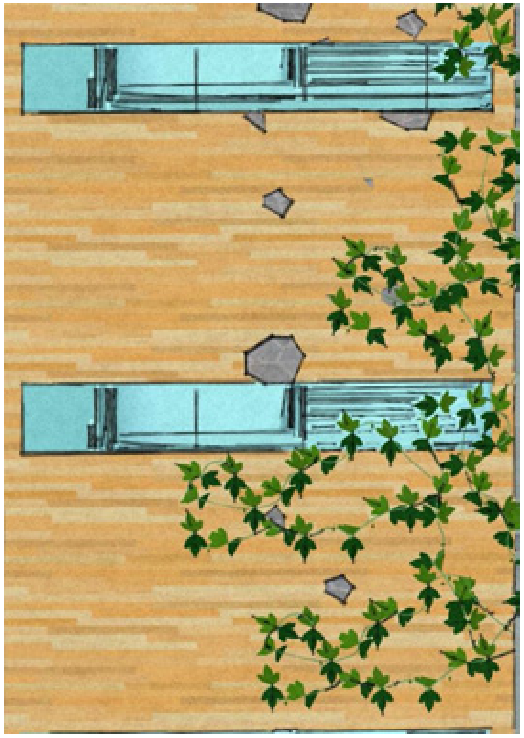
Stairs

Stairs are added to the outside of the building to ensure that the staff, faculty, and students are not disturbed by the public accessing the roof from inside the PES Building. These stairs also encourage the public to visit the demonstration gardens and see edible landscaping and rainwater harvesting in action. The stairs are located in an area with low window blockage to minimize the disturbance of those who gained window office privileges (See Fig. 5.08). For those four windows that are in front of the stairs, a wall of art, vegetation, and light will cover the view of the stairs and present a pleasant blend of beauty and nature in its place (See Fig. 5.09).

Fig. 5.08 (Left): Stair access located in secluded corner.

Fig. 5.09 (Right): View from the window offices in front of the stairs.





Experimentation Garden (Container Garden)

The first thing seen when entering the roof top is the experimentation garden. The experimentation garden is dedicated to be a demonstration garden and to allow students to experiment with water, soil, composting, and rainwater harvesting. In the experimentation garden, there is a tool shed to lock up and store equipment, wooden rain barrels to store water for the garden, composting bins to create compost from the student diner and garden waste, shade cloth to prevent crop heat stress, and square foot gardens propped up on pedestals to allow uninterrupted water to flow into the roof drains and to act as the planters used for growing the edible plants. Together, these elements create a crop producing and educational environment reserved for the classes and students.

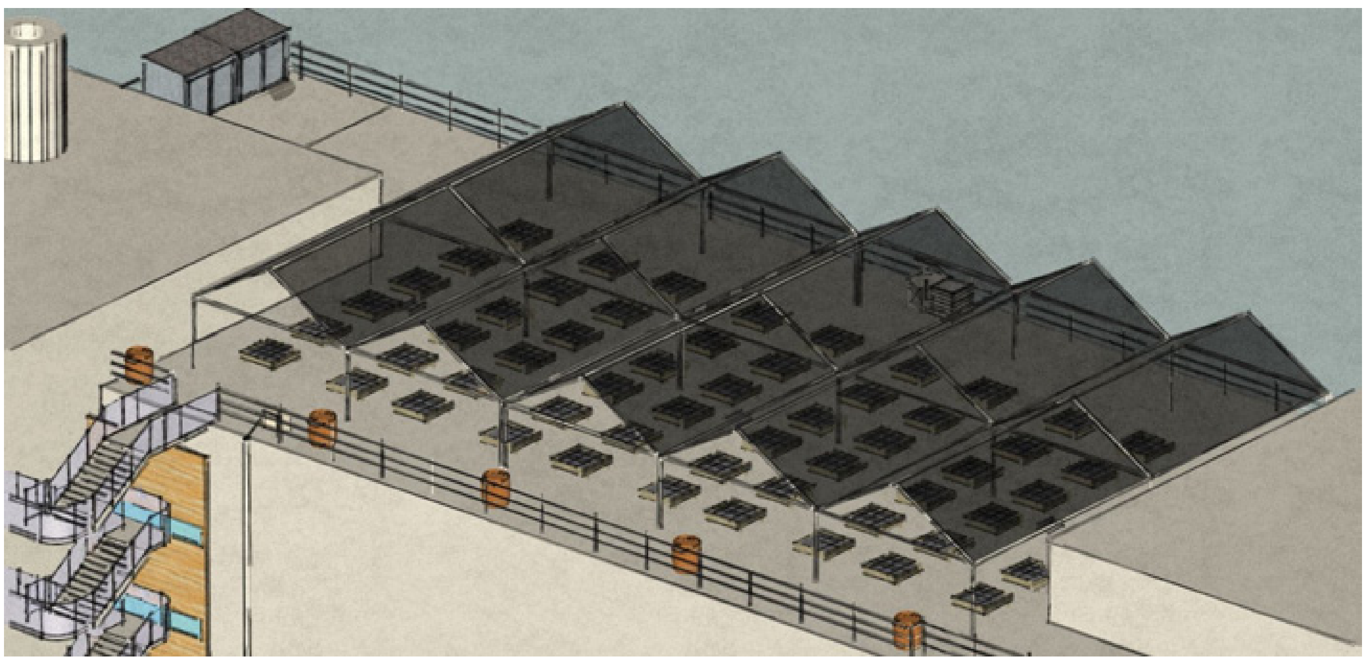


Fig. 5.10: Perspective view of the container garden, tool shed, work space, and rain barrels.

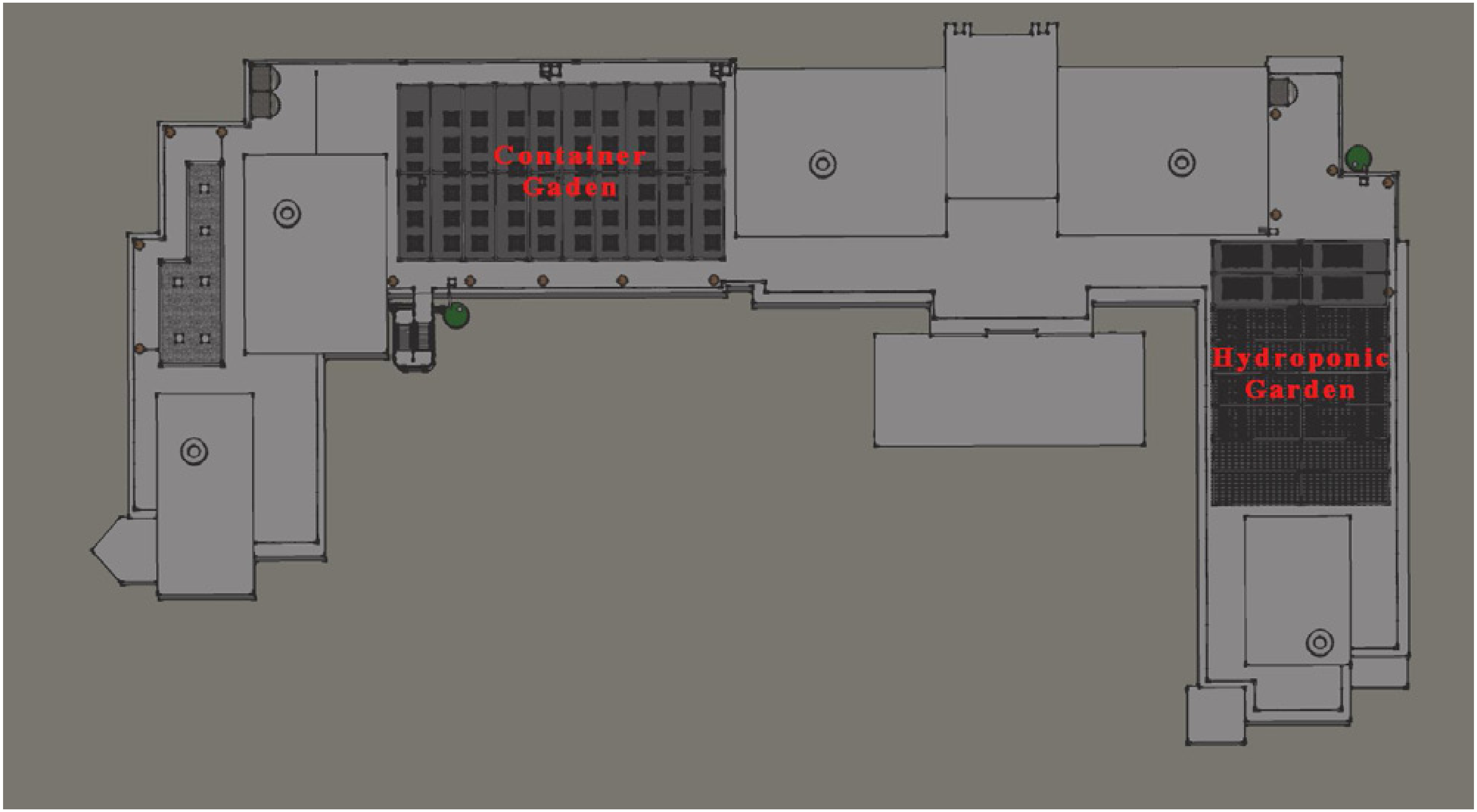


Fig. 5.11: Locations of the container garden and hydroponic garden of the PES rooftop.

Production Garden (Hydroponic Garden)

Further away from the stairs and past the experimentation garden, the production garden is located (See Fig. 5.12). This limits the foot traffic entering the area so that the produce is not disturbed. The production garden is the space dedicated to growing crops to feed the masses. The fruits and vegetables from this garden are to be prepared and sold at a student diner located in the Memorial Union. In this production garden, there are two types of hydroponic systems used to grow a high abundance of crops, a tool shed to store equipment, rain barrels to hold water for the garden, and shade cloth to protect the crops from heat stress. This garden works to produce an abundance of fruit and vegetables year round to be sold in the student diner and to generate funds to keep the project going.

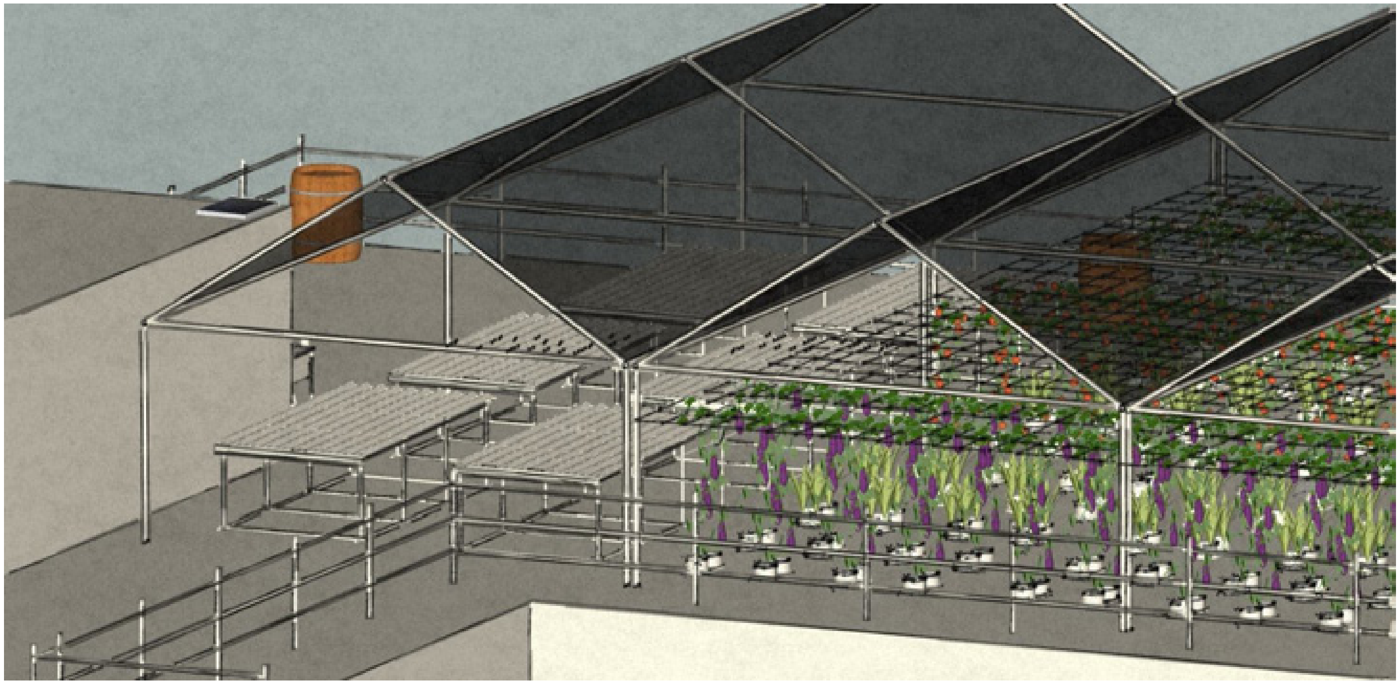


Fig. 5.12: Perspective view of the hydroponic garden, displaying the Autopot caplus tables and hydrotrays.

Conclusions

"The Edible Vegetative Roof: A Design for the Plant and Environmental Sciences Building at UC Davis" is designed to be active with the student population. In order to make this project successful, students must be hired to run the student diner and to take care of the hydroponic crops. The diner should be located inside the Memorial Union next to all of the other food service places so that it can be recognized by the student, faculty, and staff population, and give them a healthier and organic food option. The success of the diner and the hydroponic system will ensure that the university will receive economic gain from this project. Also, to better the use of this project, classes should take advantage of the work space provided by the square foot gardens. This will not only give the students hands on experience in working and experimenting with plants, but it will also further their knowledge in rainwater harvesting and composting and create food that they can either donate to the diner or be kept for themselves. As an optional addition to this project, bins should be located by the student diner to collect the leftovers, paper products, and meatless trash to use in the rooftop composting. This will remind people to take small steps to help the environment and be just a little more sustainable.

If "The Edible Vegetative Roof" is implemented, it will leave a lasting impression on the UC Davis campus. It will increase awareness of sustainable practices, promoting urban farming, rainwater harvesting, composting, and roof greening. It will give students an on campus example of things that they are learning in the classroom and bring them to life. It will also give them hands on experience with working in the garden. It will provide economic benefits to the university. It will serve as an exemplary, multi-functioning use of initially unused spaces. Overall, this project will open people's eyes toward innovation and will let them see what can be done to better our environment.

References

Alternatives and the Rooftop Garden Project. Guide to Setting Up Your Own Edible Rooftop Garden. 2008. 23 January 2009. <http://rooftopgardens.ca/files/howto_EN_FINAL_lowres.pdf>.

Autopot. Hydroponics Made Easy. 2006. 18 April 2009. <http://www.autopot.com.au/default.aspx?PageID=3a2245a5-cb2a-4f1e-89d3-58713cac0871>.

Creasy, Rosalind. 1982. *The Complete Book of Edible Landscaping*. San Francisco, CA: Sierra Club Books.

Environmental Protection Agency. EPA Urban Heat Island Pilot Project. 2002. 13 January 2009. <http://www.epa.gov/heatisland/pilot/archives/Sacramento.pdf>.

Garden Unit. Advantages and Disadvantages of Hydroponics. 2008. 18 April 2009. <http://gardenunit.com/growing-tips/advantages-and-disadvantages-of-hydroponics/>.

Green Roofs for Healthy Cities. Green Roofs – Roofscapes. 2005. 22 January 2009. <http://www.greenroofs.org/index.php?option=com_content&task=view&id=26&Itemid=40>.

Odum, Sally. Suite 101. Create a Roof Garden. 2007. 22 May 2009. <http://vegetablegardens.suite101.com/article.cfm/create_a_roof_garden>.

Redwood Barn Nursery. Food Gardening Is Back!. 2008. 23 May 2009. <http://redwoodbarn.com/DE_foodgardening.html>.

Savvy Landscaping. The Advantages of Edible Landscaping. 2007. 20 March 2009. <http://landscaping.savvy-cafe.com/the-advantages-of-edible-landscaping-2007-01-07/>.

Square Foot Gardening Foundation. How to Square Foot Garden. 2009. 22 May 2009. < http://www.squarefootgardening.com/index.php/The-Project/how-to-square-foot-garden.html>.

Thanate. Hydroponics – Soil-less Gardening. Why Plants Grow So Well in the Autopot System. 2008. 18 April 2009. <http://hydroponics-fine.blogspot.com/2008/03/why-plants-grow-so-well-in-autopot.html>.