Ecoroof Report

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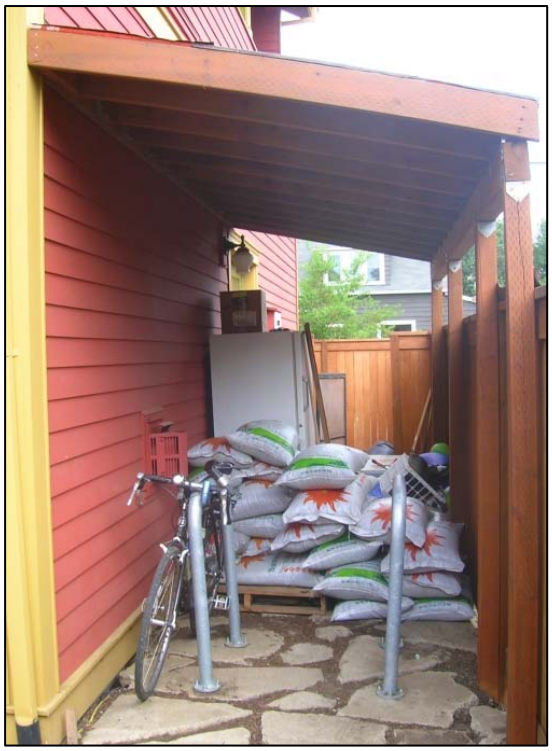
Introduction

This report explains the theories and the techniques that went into the construction of an ecoroof on the shed of a single family residence. The shed had been previously constructed with the intent of adding an ecoroof subsequent to construction. The homeowner wanted to build the ecoroof on a "common man's budget" in order to showcase the fact that ecoroofs can be done well on simple residential installations at rates that the average homeowner can afford. The grant offered compensation at the rate of $5 per square foot of ecoroof, and so the homeowner made it his goal to construct the ecoroof within that budget by using materials that may be easily obtained and installed by other homeowners. The surface to be covered by ecoroof was fairly simple to work with, and should be representative of the kinds of surfaces most homeowners would have on their property. The shed roof was a simple rectangle, approximately 6 feet wide by 14.5 feet long, with gradual slope. Details will be given below regarding the construction of the shed and the ecoroof itself.

The homeowner did a fair amount of research during the planning process for the roof, and changed a number of elements about the actual construction from what the original plan was as more information was gathered about available materials. The final result presented below is a plan for residential ecoroof construction that is easily reproducible and also very affordable. The intent of this report is to provide other homeowners with a guide for how similar installations might be placed at other residential applications.

Structure

The ecoroof was installed atop a shed that is anchored on one side to the house by 5" steel lag bolts that are anchored into the wall studs of the house. On the other side it is supported by pressure treated 4x4 posts set in concrete. Pressure treated 2x6 roof joists run from the wall of the house down to a pressure treated 4x6 header beam, with joists being spaced 16" on center, and secured by Simpson strongtie hangers at both ends. In other words, this shed was built with the intent that it would bear a substantial load on the roof. The roof decking is ½" thick OSB plywood, with 1 layer of standard roofing tar paper applied over the top. The shed roof provides shelter for the bike parking that is used by the residents of the home. It has no walls on the front or back ends of the shed, so as to allow for unobstructed passage through the shed.



System Components & Construction

The ecoroof system in this application is relatively simple. Before construction started, the roof plane consisted of OSB plywood decking covered with tar paper.

Step 1: Perimeter

The construction of the ecoroof started by placing pressure treated 2x4 boards set on edge around the perimeter of the roof. Three inch coated deck screws were used to secure the pressure treated boards to the roof. The course of boards along the lowest edge of the roof was elevated off the roof decking by ½" by placing shims under the boards. The purpose of doing this was to create a space where water would be allowed to percolate out of the drainage layer into a gutter that would catch any rainwater discharge from the roof. This elevated course was secured by means of using simple 90 degree elbow brackets that were anchored to the roof surface with screws and then secured to the boards with screws.

Step 2: Waterproofing

A standard pond liner was purchased from the hardware store for use as the waterproofing membrane for this ecoroof. This seemed like an ideal material to use for this application since it is designed to be waterproof as well as flexible and resistant to tearing or puncture, not to mention that it is affordable. The roof dimensions are 6' x 14.5' so a pond liner with the dimensions of 13' x 20' was purchased in order to ensure that a single monolithic membrane could cover the entire area, without the need to use flashing for seams or create joints in the membrane. This pond liner was laid directly on top of the tarpaper layer that was previously applied to the roof. The liner was draped over the perimeter boards with ample slack in the liner to ensure that the weight of the soil would not stretch or rupture the liner. Small slits were cut in the liner where the metal brackets held the bottom course of boards so that the brackets could protrude through the liner while also allowing the liner to lay flat on the roof surface. The bottom row of boards for the perimeter was secured to the brackets after the liner was applied to the roof.

Step 3: Drainage Layer

A layer of filter cloth was applied over the top of the water proof pond liner. The cloth was stapled to the interior surface of the perimeter boards. This was especially critical along the bottom row of the perimeter in order to make sure that the cloth functions in such a way as to hold back the dirt from falling out of the ½" gap that was created under the bottom row by the shims, while also allowing water to percolate out of the soil at that point and subsequently into the gutter that catches any rainwater discharge from the roof. The gutter subsequently directs water into a downspout that empties into a 55 gallon rain barrel that sits on the ground below the shed. The water level in the barrel may be monitored in order to learn exactly how much water is being discharged from the roof. Moreover, the captured water may be used on site to water other vegetation and landscaping.

Step 4: Planting

After all necessary layers were in place, the really exciting part could begin: Planting. After hoisting all of the soil atop the roof, the planting media was scattered in small increments around the roof. The planting media was delivered to the site in bags, which made it fairly convenient to get it up on the roof. This system also made it easy to move systematically across the roof by cutting open only one or two bags at a time, and then placing plants in that same area. The entire planting process only took a couple of hours because it was so easy to start in one corner of the roof and gradually move to the opposite corner while spreading media and placing plants at the

same time. This method eliminated the need to walk across the media after it was laid out, and thus resulted in no compaction of the soil for the plants. (Note: See the soil specifications below).

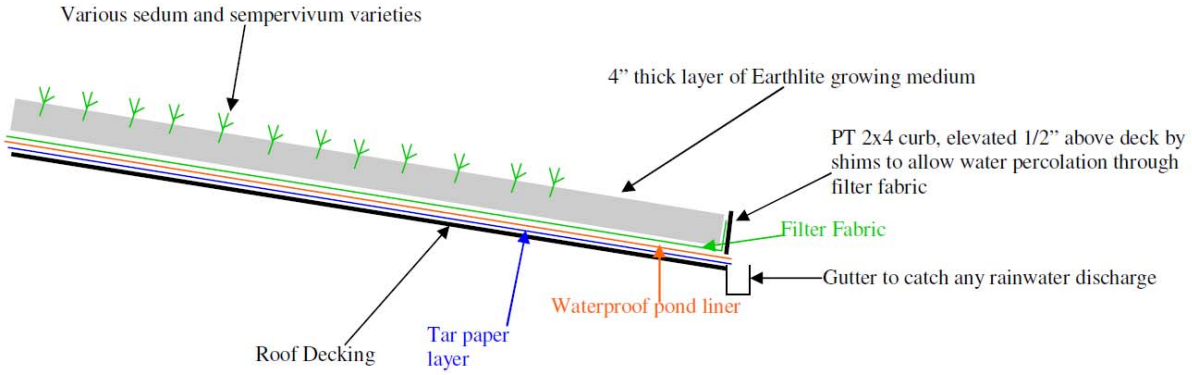
In this particular application, the homeowner had been cultivating a large quantity of sedum plants elsewhere on the property prior to the planting of the ecoroof. Therefore the vast majority of plants installed on the roof were simply transplanted from other parts of the property. There were 20 other plants that were obtained from a local nursery in order to provide a greater variety of plants on the roof.

Two trays of sedum were purchased, while the rest of the sedum were transplanted from the homeowner's

Step 5: Irrigate

This ecoroof has no built-in irrigation system. The irrigation plan is simply to spray with a garden hose from the ground when roof appears dry. A second story balcony allows for easy viewings to check for dryness.

Fully planted ecoroof



Construction Diagram

Soil Specifications

The growing medium for this project was obtained from Sunmark Environmental Services LLC (503-241-7333), which is a local company whose operations are based out of Gresham. The name given to the particular soil blend used here is "Earthlite". The composition is as follows:

Earthlite Vitrified Lightweight Media	35%
Green Choice Ecololgy Blend Perlite	12%
Green Choice AraBiotics Recycled Fiber	26%
Green Choice Axis Diatomaceous Earth	2%
Green Choice Organic Compost	12%
Green Choice Dakota Organics	12%
EcoLive™ Organics w Mychorrizae	0.5%
EcoBiotics™ Microbiological Organics	0.5%

This soil blend is ideal for ecoroof applications. It is designed to be light weight (12.3 lb/sqft at 4" in depth, dry) and it also contains a number of ingredients that stimulate root growth for quick coverage by newly planted plants. It is also a relatively absorbent growing medium which is conducive to retaining rainwater and allowing more of it to be absorbed by the plants, thus reducing discharge.

With a cost of roughly $90/cuyd (not including bagging or delivery fees), this growing medium was the most expensive component of the whole ecoroof. However, a few considerations justify the expense of this medium. While there are other less expensive mixes available that would be adequate for an ecoroof application, the total volume of media required for this project was so small that the net difference in cost was not substantial, so why not go with the superior product? Furthermore, the cost savings from other aspects of this project (such as growing one's own plants on site and using standard hardware store materials in construction) create room in the budget to splurge on the best growing medium. The growing medium is the most important component to a successful ecoroof, so any improvements to this component will be well worth it.

Reflections & Lessons Learned

After completing the construction and installation of the ecoroof, a few reflections and lessons learned may be articulated for the future benefit of others who might undertake a similar project:

1) One aspect of the ecoroof that took on greater and greater importance as more knowledge was gained was the growing medium. Initially, it seemed that the plants were so hardy that any soil would be adequate. However, it quickly became clear in doing research that not all soils are created equal when it comes to ecoroofs. The importance of finding a light weight and absorbent soil quickly eliminated many soil choices from the menu. The growing medium is such a critical component to the success and function of the roof that it is justifiable to allocate most of the roof budget to that one item.
2) The great news for homeowners is that a very good ecoroof can be done for $5/sqft or less on simple residential installations. There are some rather elaborate and high-tech systems out there that would run $25/sqft and higher. It became obvious early in the researching phase that those systems were better used for large commercial and industrial installations. This installation proves that smaller scale residential installations can perform just as well with homegrown plants and simple hardware store components. Therefore, the cost of such installations is relatively low. In this case, 90 sqft of roof area was covered for under $400, and it could have been done for even less if someone wanted to use a lower grade planting medium.
3) Portlanders are especially fortunate to have all of the support industries necessary in their back yard. For example, it took very little effort to identify a local vendor who sold the kind of plants required for the roof. It also took very little effort to find a local vendor who could supply a specially formulated planting medium. It is not uncommon in construction to have to ship in highly specialized materials from other non-local sources, but that is not the case with ecoroofs in Portland. Everything Portlanders need for their ecoroofs exists in their own back yards, so to speak. Furthermore, if technical knowledge is considered as one of the resources necessary to build an ecoroof, then that resource also exists in abundance in our locale. At every juncture along the way in this project I kept meeting knowledgeable people were more than happy to share their knowledge and assist in the evolution of this ecoroof project.
4) The common barriers to entry for residential ecoroofs are really very easily overcome (e.g. cost, concern for structure, complexity, sourcing material, etc.). The sense that often emerges from conferences, classes or exhibits designed to inform the public about ecoroofs is that many people are interested and willing to do them, but feel intimidated by some of the known and unknown barriers. There may be common assumptions that ecoroofs are expensive or involve a lot of technical knowledge, and so people too easily become discouraged before ever really knowing enough about it to realize that it is not expensive or complicated. If the project described here does anything it should be to prove that a do-it-yourself homeowner is able to install a high quality ecoroof on a very minimal budget. Many thanks are due to the City of Portland for its efforts to encourage people to do projects like this and then to share the knowledge gained from those projects with others who are interested in doing an ecoroof. This project is one of many that should inspire homeowners to act on their interests in ecoroof and just do it. Really, anyone reading this report has a step-by-step instruction manual for installation and a full guide for sourcing all materials necessary for a similar installation. A person could easily work from this

template to start an ecoroof one weekend and finish it the next weekend (maybe sooner if they lure friends over with beer and pizza).

5) This design described in this report is easily reproducible and can be replicated on a variety of residential applications. It can be scaled up or down to fit the particular dynamics of other installations. The same layering technique, materials, growing medium and plants could be installed on the roof of a chicken coop or the roof of a whole garage. Anyone who has a tool shed, wood shed, or outbuilding of any kind could take the same design and materials presented here and do the same thing, and I hope they do.
6) Subsequent to the completion of this installation, some people proposed some other ideas that could even further improve this design. Those ideas seemed worthy of consideration for any future iterations of this design:
    a. The design given above includes the use of a standard rain gutter to route rainwater discharge to a downspout and into a rain barrel for later use. One suggestion to further improve upon this design is to install a small pump in the rain barrel in order to pump the captured rainwater back up to the ecoroof. Certainly this would add cost and complexity to the project, but the advantage of it is that the ecoroof can essentially function as a closed system that can handle 100% of the rainwater that falls on it. In other words, if the rainwater isn't absorbed when it first falls on the roof, then the roof gets a second chance to absorb it when the water is pumped back up onto the roof.
    b. Slow drip irrigation hoses could be buried within the planting medium for irrigation. This could be accomplished by spreading out the first 2" of planting medium across the whole surface area, and then laying the drip hoses in serpentine fashion across the roof area. Then the top 2" of planting medium would be added over the top of the hoses, and the plants added to that. The inlet of the drip hoses would have to be left accessible at the perimeter of the roof so that a garden hose could be hooked to it in order to deliver water through the hoses. This drip hose idea could even be combined with the previous idea of pumping captured rainwater discharge back onto the roof, with the drip hoses being the vehicle of delivery of that water.

All things considered, residential ecoroofs can offer their many benefits while also being very simple and affordable. There are many options available to homeowners for products to use and design features to build in. Ecoroofs can range from the very complex and high-tech to the simple homegrown version. That is part of what makes them fun and interesting. The benefits are many and the obstacles are few, so let's all do an ecoroof.