T. Ridgway, Phillip O'Connor, Chris Tigani

For the Sustainable Solutions Challenge, our group decided that a green roof would be the best step towards achieving a more sustainable community. Of the four possible goals for the challenge, our idea aligns with the third goal of implementing sustainable practices into campus operations and services. Among the many buildings on campus, we concluded that the flat roof over the practice basketball court in the wellness center would be the best location. Green roofs come in two different styles, intensive and extensive. Intensive green roofs function similarly to a conventional garden and can support much larger vegetation like trees and bushes. This means intensive roof systems are much heavier, require increased roof stability, and require much more maintenance. Extensive systems are much simpler and would likely be the best option for the University of Richmond. Extensive systems are lightweight and are only about 6 inches deep. However, only sedums, succulents, and small hardy plants are the only plants it can support. Another benefit is that extensive green roofs can be installed onto previous structures, and do not require a total roof replacement like an intensive system would. Most extensive systems only weigh about 18 pounds per square foot and require very little maintenance. The layers of the extensive system function as thermal insulators or hydrologic filters. In general, there are many benefits from the installation of the green roof that we believe will help the University reduce energy costs and meet some sustainability goals. The two most significant benefits are reducing roof temperature and aiding in insulation. The temperature of the roofs decreasing during hot weather will reduce energy costs for the University's air cooling systems. During the summer time, this helps the HVAC system because it needs to pre-cool the air before it can start cooling, so the green roof does this in place of it and in turn, the HVAC systems will require less energy.

The insulation benefit will help during the colder months by trapping heat in the building that will reduce energy needed to run the heating system. The green roof will help save fuel costs for the heating system by 3-10%. As a bonus, these benefits essentially reduce

greenhouse gas emissions that come from the use of the HVAC equipment since energy demand will be lessened. Also, the green roof will aid in removing air pollutants through dry deposition and carbon sequestration. With the green roof, vegetation goes through the process of photosynthesis which will reduce carbon dioxide and increase oxygen production. The multiple layers of the roof will collect rainwater and help decontaminate the water by acting as a filter. The absorption of water will allow for the reuse of rainwater for irrigation. The layers will help and prevent stormwater runoffs, which can help the sewer systems on campus as well by decreasing the amount of water it takes to overflow the roof. In the winter time, the roof can retain about 25-40% of precipitation, while in the summer it can retain 70-90% of precipitation. The life expectancy of the roof if a green roof is implemented will be doubled.

Lastly, the green roof is aesthetically pleasing and will look beautiful to visitors and potential students on visits. The location of the green roof is another important factor in its implementation. Because there are very few flat roofs around the University's campus, the roof of the practice basketball court was one of the only viable locations. The roof is about 120 feet by 90 feet which gives us about 10,800 square feet of room to install a green roof. This is a similar sized area to the green roofs utilized by other colleges. The association with the wellness center is another reason why this location was appealing. The wellness center prides itself on promoting all facets of human wellness and uses many sustainable practices in its operations. Installing a green roof onto this building would further promote these ideals and raise awareness for environmental wellness and sustainability. Organic Krush, the restaurant located within the wellness center, could also benefit from the green roof because some small plants and herbs could be directly used by Organic Krush. Not only could the vegetation space be used for edible plants, but students within the science departments can use the area for research.

We estimate the garednes will cost $20 per square foot to install and $1 per year per square foot to maintain. This may seem costly upfront, but the green roofs will have better

economic value in the long run. A newly constructed or renovated roof with a green area on top can have a lifetime of up to 50 years vs. one with a standard paint which needs to be fully renovated every 15 years. University of Michigan researchers conducted a study that provided hard numbers as to the expected financial benefits of a green roof. They studied a roof area of 20,000 square feet, and the university found that a green roof area could save nearly $200,000 over a thirty year period from increased longevity, health savings, and stormwater tax credits gained (Figure 1). Other universities have taken notice of this research, and we looked at Ohio University and Williams College in particular. Ohio began the project in 2013 but completed the first green roof in 2020. They set out with three goals in mind, air quality control, economic benefits, and stormwater management. They have seen early success in all three areas. Williams College established their first roof in 2007. They have also seen results going as expected. They have expanded and built multiple on campus, and the university sustainability webpage is currently calling for more of them to be constructed across campus.

The implementation of the green roof would be quite simple, but a significant initial investment of $216,000 would be needed. Firstly, we would need to contact the universities facilities department about their available budget and just about the viability of the project in general. If the initial investment is too high, looking into potential stakeholder investments would be the next course of action. Luckily, the installation process would take less than a month, so long-term construction costs would not be a problem. For smaller roofs, this process can take only a few days, but a reasonable estimate for construction time would be around 2 to 3 weeks. And unlike intensive green roof systems, this green roof could be installed directly onto the existing roof without any need for replacement. The facilities department would also have to account for yearly maintenance costs which luckily, would only be around $11,000. Once constructed, the green roof would be fully established with vegetation within a year. When

choosing the vegetation to grow, the grounds crew, Organic Krush, and the science departments would be contacted.

We have looked at the numbers and researched other universities that have implemented the same concept. It saves money and it is better for the nevironektn, It will improve the overall well being of the campus and may even become a learning area for future biology researchers. The upfront cost is justified with the number, environmental benefits aside, and we think the university has no reason to not build a green roof atop the new Wellness center.

Appendix

Figure 1.

Figure B:

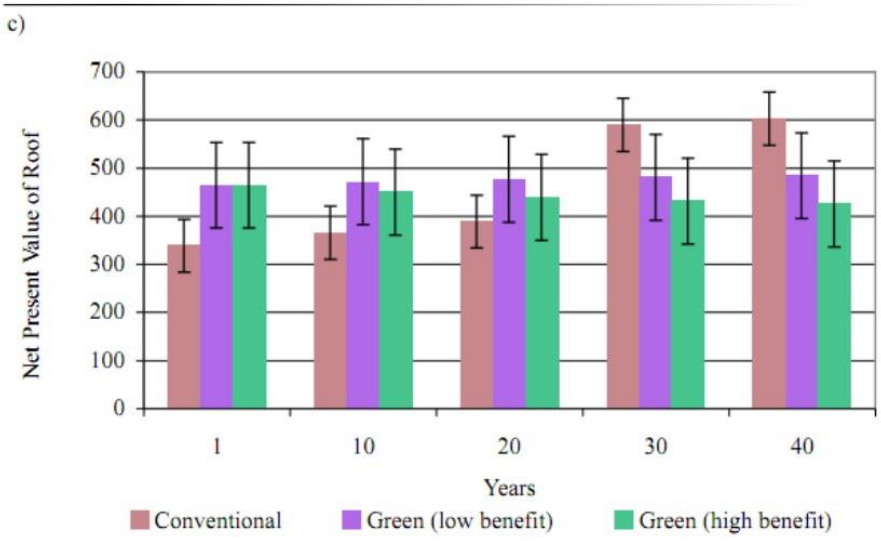

Figure taken from source: Clark, C.E. (2008) "Energy Emissions Mitigation using Green Roofs: Probabilistic Analysis and Integration in Market-Based Clean Air Policies"