A Reassessment of Seattle University Stormwater Infrastructure Incorporating Green Infrastructure Designs

Mid-Year Report Submitted to:
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Submitted by:

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1. Progress to Date-Seattle University's Dedication to Sustainability

Throughout fall quarter our team worked to determine what Seattle University currently does to reach its goal of being a sustainable campus, below is a summary that details what we've found and our intentions.

Seattle University is one of the nationally acclaimed universities that has put in a concentrated effort to be a green and sustainable campus. Some of the most prevalent practices visitors can see are the electric vehicles we use for campus maintenance and the NightHawk, solar panels fueling two of our buildings, and a lack of disposable plastic water bottles to cut down on waste. However, there are many other efforts SU has done to be an environmentally-minded campus. As our fellowship group focuses on creating a better system for the excess of water waste on our campus, we have discovered the many current practices SU has employed on the grounds of the campus to create not only a healthy and thriving campus, but also sustainably-minded neighborhood.

To create an environmentally-friendly campus, SU has committed to several practices that teach students in addition to accomplishing the goal of being sustainable. As a part of our campus' Climate Action Plan, they say "We believe higher education must educate students and conduct research to develop the social, economic, and technological solutions to reverse global warming and lead by example to reduce our campus's operational emissions." To accomplish these goals, the campus has purchased and installed a gas boiler to provide heating for five of our buildings, and they also have bought carbon offsets; these changes together have reduce carbon emissions by 83% from 2009. The university has also strongly encouraged classes to teach about environment sustainability, and has created an example for their students and other universities alike, like they aimed to, by hosting an annual hard-to-recycle event for students and by creating Learning Communities that focus on environmentally-friendly practices and companies.

In terms of sustainable water systems at SU, their main concern is the run-off, or stormwater, from the roofs and sidewalks around campus. When the library was redesigned, SU created two rain gardens that redirect the roof run-off. These rain gardens can collect up to 100,000 gallons of rain during a bad storm, and they hold the water as it gradually seeps back into the ground, being naturally filtered by the plants found in the garden. The campus' two green roofs also help reduce the amount of run-off from the buildings. The largest green roof on campus is over part of the Bannan Science building. The large garden absorbs most of the water coming from the upper levels of Bannan, as well as helping to insulate the building and providing a natural habitat for the wildlife. The rain garden placed in front of the Lynn building not only cleans waste water of pollutants, but also prevents flooding in the four surrounding buildings. These practices are meant to create a healthier environment for the people on the campus, but also for the wildlife that is found in Seattle.

Seattle University also has several holding reservoirs called cisterns under the campus to collect extra run-off that can then be gradually let into the combined sewer system after the rain has stopped. In a previous senior design project that also focused on run-off on campus, they were able to install a valve on one of the reservoirs so that the water being gradually let into the system can be controlled and possibly re-directed to uses on campus, such as for toilets or the sprinkler system. While the valve helped lessening the amount of water entering the sewer system, it has not been employed to its full potential. As SU considers options for expanding the campus, our group hopes to encourage water-sustainable designs that help reduce run-off even more, if not also using run-off for purposes on campus.

At the moment, the practices mentioned above, while helpful in encouraging the cleaning of waste water coming from the campus, are somewhat isolated. We hope to use our findings from our project to find a practice that can help the campus more as a whole. What we also want to do in our study is to find the places on campus that need continued attention to reduce flooding, standing water, and pollutants running into the combined sewer system around our neighborhood. Our campus has made commendable efforts at lessening the impact of run-off from our campus, but more can be done to keep the local streams and rivers, specifically the Duwamish, from further damage.

2. Progress to Date-Potential Low Impact Development Systems

Our team also focused on investigating the different kinds of low impact development systems that could be implemented to reduce the amount of peak stormwater flow off campus. A paragraph for each investigated system follows.

Bioretention is the practice of treating stormwater by using plants and a graded soil bed to filter the stormwater. It involves an optional pretreatment area if large volumes of debris are expected, a ponding area to hold the runoff, a groundcover layer, a soil layer and plants to help manage the runoff. Its ideal usage is where there is plenty of space and soils are permeable. The most significant flaw of this technology is the amount of space required and its loss of effectiveness in situations where the soil is already saturated (such as in recurring rainstorms). Seattle's long wet season (fall-spring) reduces the effectiveness of this technology due to the ground being saturated for the majority of the year. The cost is around $13.19 per square foot on average (ranging from $2.22 to $30.00).

Green roofs (also known as vegetated roofs) consist of a layer of soil and plant matter, which retains water during storm events. Green roofs come in two varieties: the first is an intensive roof, which is designed with six inches of soil or deeper, and often planted with ground covers, shrubs and trees. Intensive roofs are often designed simultaneously as public spaces. The second is an extensive roof, with a shallow soil profile, and hardy, ground cover plants. Extensive roofs are designed with a light-weight soil mixture and vegetation on top of a drainage and filtration layer, all over a waterproof membrane. Research has demonstrated that soil profiles from 3 to 4 inches in depth provide the most runoff mitigation relative to cost; however, depending on the depth of the soil, green roofs can result in loads of 15 to 50 pounds per square foot when saturated. For higher loads, the roof must be retrofitted in order to support the system. Flaws of green roofs include: they take time to establish themselves before reaching peak performance, and retain lower percentages of rainfall when rainfall distributions are more even. Therefore, green roofs are best suited to climates with intermittent rainfall. Depending on rainfall patterns, types of vegetation and other factors, the effectiveness of green roofs at mitigating storm water runoff can vary wildly. Costs of installation vary significantly, but generally fall between $10 and $15 per square foot for new construction, and $15 to $25 per square foot for retrofitting.

Swales are either dry (providing volume and quality control by facilitating infiltration) or wet (using time and plant growth to limit peak discharge and to treat runoff). The type to be used is determined by the type of soil, with dry swales requiring infiltration rates between 0.27 and 0.5 inches per hour. Fatal flaws are situations where the soil infiltration rates are poor. Similar to bioretention, Seattle's long wet season (fall-spring) reduces the effectiveness of this technology due to the ground being saturated for the majority of the year. Cost is around $89.52 per linear foot (ranging from $24.70 to $385.00).

Permeable pavement is used to take the place of the common, traditional, impermeable pavement on parking lots, sidewalks, driveways, and residential roads. Unlike some other LID technology, it is appropriate for climates with heavy rainfall such as the Pacific Northwest. Permeable pavement consists of porous material that allows for water to infiltrate and be collected at the aggregate base, which provides structural support and acts as a storm water reservoir. The infiltration rate of the soil below the pavement is what determines the amount of surface runoff being reduced. To maintain the infiltration rate, surfaces of the permeable pavements should be cleaned and inspected annually, while the surrounding soil erosion and sediment areas should be kept from exposure by mixing it with compost or mulch. Permeable pavement must also not be built on steep slopes that are prone to deliver erosion, and where water cannot be controlled by detention structures. If guidelines are not met, the pavement will have long-term excessive sediment deposition. The cost per square foot of the pavement can range anywhere from $2.00-$6.50.

3. Other Activities and Future Plans

Finally, our team used previous data collected by Seattle University students for a senior design project to determine which areas of campus are in the most need for treatment. Figure 1 is a map of campus which highlights the amount of untreated surface area per each section of campus. Notably, blocks A, E, I, J, N, S, and U have the highest percent of untreated area. However, not all buildings in these areas are under Seattle University domain, this occurs most prominently in blocks A, I, J, and N. Thus, sections E (Ignatius chapel, Lee center, and parking lot), N (Rianna Building, School of Law Annex, and the O'Brien center), and U (Connolly center and adjacent parking lot) will be our prime candidates for changes to be made, though other areas with above average untreated area will be investigated secondarily. In the coming months we hope to determine a selection of projects that could have the most change in peak flow off our campus.

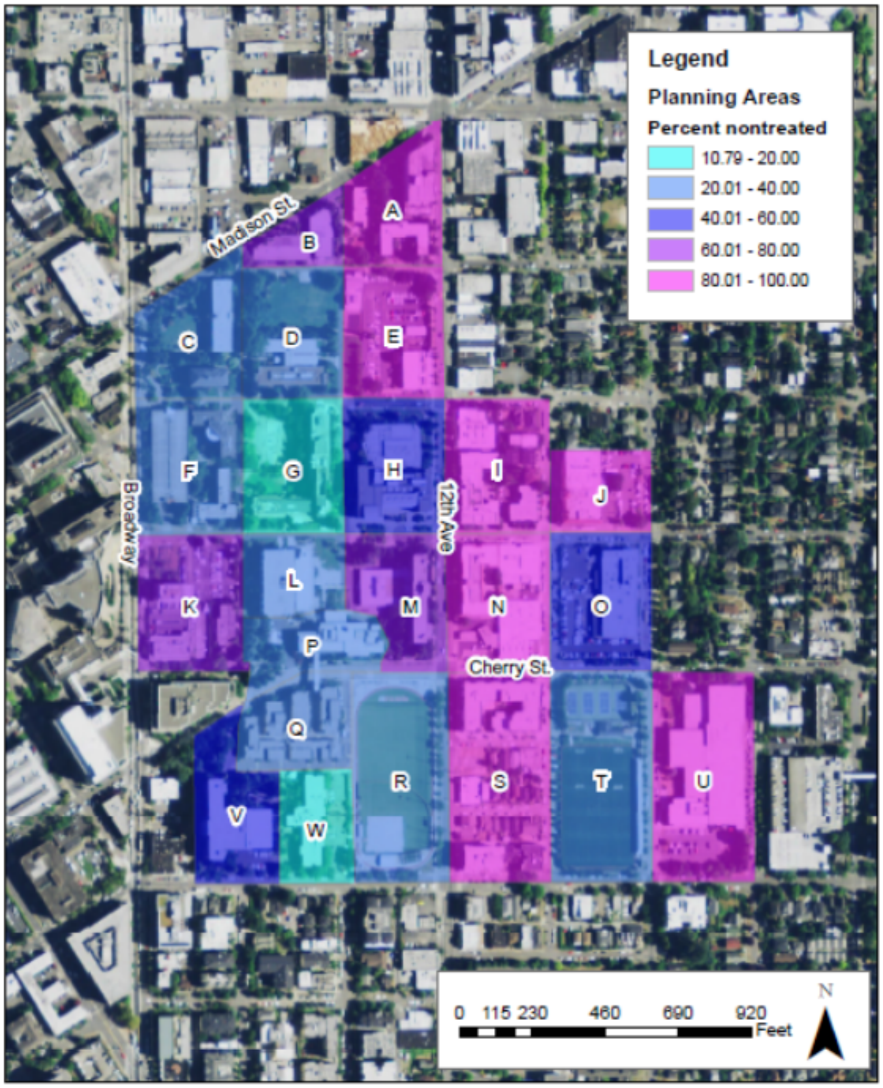

Figure 1: Map of Seattle University campus split into treatment sections each overlaid with a color corresponding to the percent of area untreated by either a detention tank or pervious area.