Developing a Hydrologically Resilient Site Plan for the Ivy Corridor: Stormwater Analysis through the Lens of Climate Change
(Technical Topic)

What Makes for a Socially Connective Gateway in an Academic Environment?
(STS Topic)

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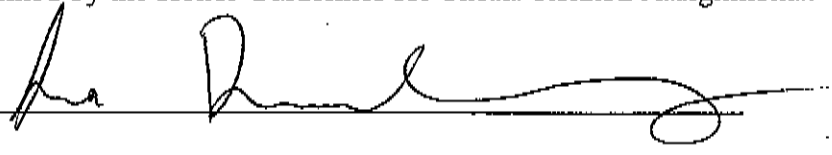
On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signature 

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Introduction

In 2018, President Jim Ryan established a special task force in an effort to determine how a critical piece of land, the Ivy Corridor located at the corner of Emmet Street and Ivy Road, could best serve the University of Virginia as it enters its third decade. With the University's plan for expansion that includes maintaining academic and societal excellence, this parcel of land is expected to become a UVA-specific fixture rivals the cultural importance of the Lawn. As Hester (2018) explains, the task force also envisions this area as the "connective tissue between North and Central Grounds" (para. 2). This connective tissue must be more than aesthetic, however, as the stormwater infrastructure embedded within the design of the parcel must be robust enough to preserve natural ecosystems and handle stormwater runoff in a changing climate with increasing rainfall frequencies and intensities. Parikh, Taylor, Hoagland, Thurston, & Shuster (2005) showed that urbanized conditions not only harm ecosystems but also contribute to flooding by "rout[ing] stormwater to streams … in greater quantities, causing higher peak flows that lead to stream degradation" (p. 134). With respect to the importance of a cohesive gateway, Jacobson & Row (1999) explained how there is a "substantial phenotypic relationship between [surrounding] environment and adolescent depression" which puts the need for environmental cohesion into a meaningful and urgent perspective (p. 927).

The glaring potential misstep, however, is if the stormwater hydrology and gateway plans are developed independently of one another: the aesthetics of infrastructure are inherently tied to the efficacy of the gateway and, therefore, designing one without the input of the other is a failure of both. With regard to the technical topic, this project will utilize aesthetic stormwater best management practices (BMPs) that augment the built environment in the site design while simultaneously treating pollutants and minimizing peak flow rates off site. To meet the criterion

of connective tissue, this project's STS research will investigate what it is about the infrastructure and landscape at UVA that makes a student feel connected to the cultural experience of being a college student to ultimately define the term gateway in the context of a university.

Technical Topic: Developing a Hydrologically Resilient Site Plan for the Ivy Corridor: Stormwater Analysis Through the Lens of Climate Change

Background on Permitting

In the state of Virginia, any stormwater that will land on a prospective project site must be routed and treated as per the standards outlined by the Virginia Runoff Reduction Method (VRRM) enforced and permitted by the Virginia Department of Environmental Quality (DEQ). For culvert and overall hydrological implications, however, the whole watershed and drainage area of a site must be considered. That is to say, for a comprehensive hydrological analysis, all water that enters the site (not just precipitation over the area of interest) must be accounted for. While water that drains over a site should theoretically not carry any pollutants, as it should come from another site in compliance with VRRM standards, it will contribute to the peak flow of the culvert (large pipe) that later carries the water off site. However, Sheffield, Goodall, & Fitch (2015) brought to light that "[n]utrient credit exchanges allow agencies to meet stormwater requirements by purchasing pollutant reduction credits from off-site sources that are equivalent to what would be treated onsite", thus negating the previous assumption that all overland flow from offsite is within pollutant standards (p.1).

How Detrimental Can Static Regulations Be?

To further muddle things, the VRRM standards deal with ecological requirements by way of converting volumes of flow to level of pollutants (specifically nitrogen and phosphorus, as they are the most ecologically damaging) that are expected to be associated with that volume, as

directly measuring pollutant levels is costly and time consuming. Yet, Rapport (1989) "identified some 18 major stresses, including nutrient loading, fishing, dredging, landfill operations … and thermal modification" that can affect ecological health, not just nitrogen and phosphorus (p.127). As most or all of these stressors are expected to worsen with climate change in the coming decades, designing a resilient structure necessitates going past the DEQ standards that were implemented in 2013. For perspective on potential ripple effects, Worm (2006) "highlight[ed] the societal consequences of an ongoing erosion of [ecological] diversity… accelerating on a global scale" (p. 790).

Aside from the indirect effect of diminished ecological health on the water cycle, the changing climate has increased both the intensity and frequency of extreme rainfall events. A case study in Piazza Armerina, Sicily by Liuzzo & Freni (2019) utilized hydrological modelling software to investigate the impact of increased rainfall on maximum flow depths and average flooded area in an urban environment. In 2050, they predict, even in conservative climate change scenarios with minimal uncertainty, "a remarkable increase of flooded areas… if compared with the same maps for the 2010 and the 2025 scenarios [which also saw increased flooding]", as visualized in Figure 1 (p.9). While Governor Ralph Northam's Phase III goals for restoring the Chesapeake Bay and its tributaries include "[a consideration for] future population growth… and impacts of climate change no later than December 31, 2025", the case study by Liuzzo and Freni suggests that this hard, distant deadline may allow behavior that will ultimately cause irreputable damage (Commonwealth of Virginia, 2019, p.1). Instead of waiting for the regulations to catch up, a resilient site plan must overdesign with respect to the current regulations to ensure that pollutant reduction requirements are met not only for today, but in the coming decades.

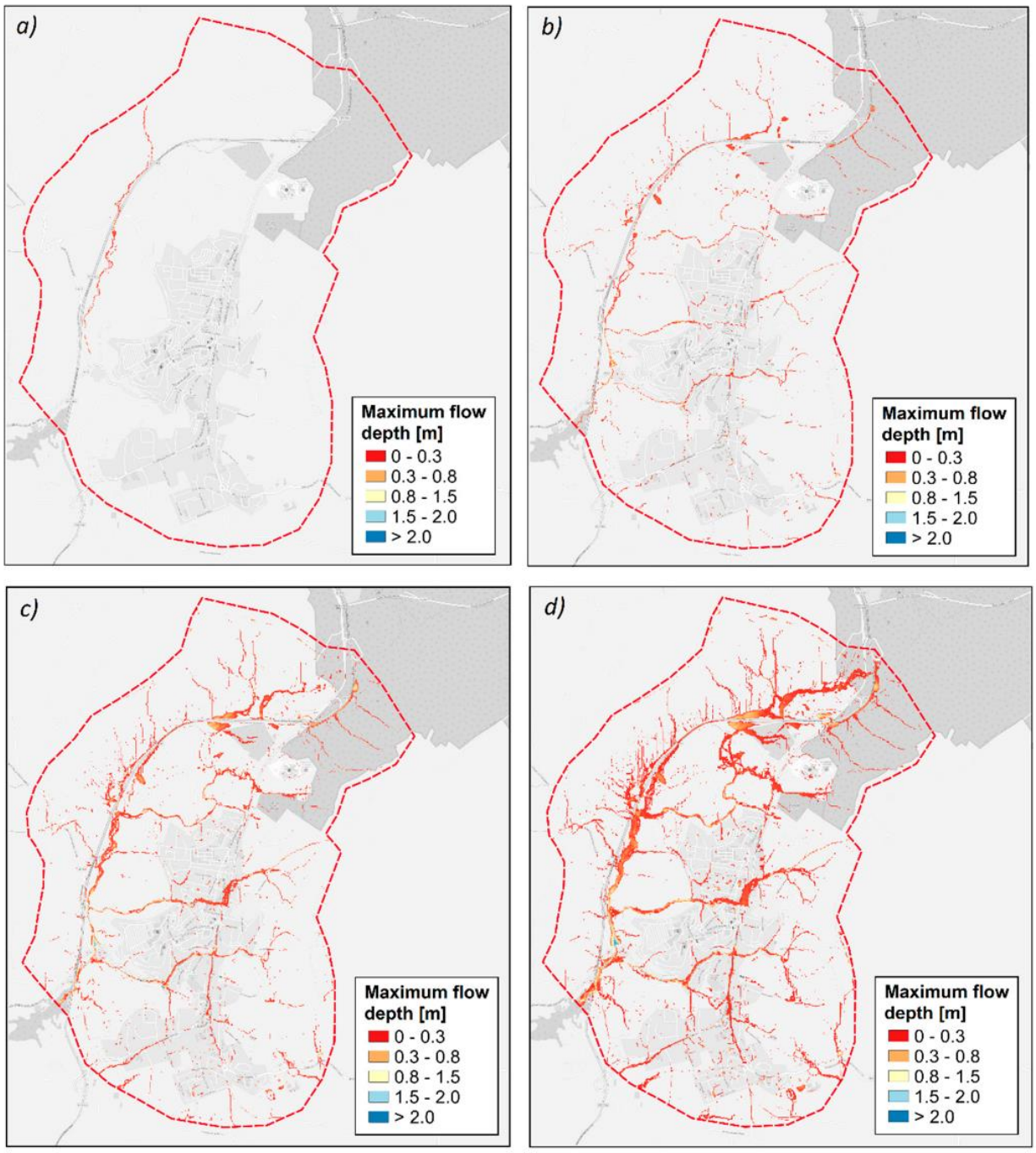

Figure 1. Maximum flow depth for the 2050 scenario: (a) T = 2 years; (b) T = 5 years; (c) T = 10 years; and (d) T = 20 years [where T is the return period of the rain event]. The larger the maximum flow depth, the more significant the flood event. As this case study is on urban flooding, we would expect to see a similar relationship in Charlottesville (Liuzzo & Freni, 2019, p.8).

This project will build on existing research by Didona (2007) that investigates how "if beauty is incorporated into [stormwater BMP] design, [those BMPs] will become preferred water

landscapes" that add aesthetic utility to the site (p.2). The final deliverable will be a comprehensive site plan with a rough construction cost estimate, completed VRRM calculations, storm water management model (SWMM) calculations for hydrologic performance, and a detailed culvert analysis of water being routed offsite. Also included will be a detailed design for at least two BMPs of our choosing, explicitly giving us the opportunity to be creative with type of BMP, material choice, and overall look and presence within the site. As mentioned previously, a crucial aspect of this project is establishing a cohesive gateway. If a connective gateway, in the context of site design, is defined as augmenting the natural environment while simultaneously emphasizing the overall flow of the parcel by way of controlling the placement of buildings and aesthetic BMPs, then, by maximizing natural open space replete with such BMPs, we ostensibly lay the framework for a connective gateway.

STS Topic: What Makes for a Socially Connective Gateway in an Academic Environment? What Is the Ivy Corridor and Why Is It Disconnected?

The current route from North to Central Grounds is conspicuously lacking a certain UVA-esque look and feel such that a student walking this path feels disconnected to the university. Instead of seeing familiar buildings, shapes, or colors, a passerby instead sees a dilapidated hotel on the left and a string of drab, half vacant administrative buildings on the right. As both North and Central Grounds are important aspects of UVA, aspects that will only become more important with UVA's inevitable expansion, this is an oversight that is begging for some semblance of cohesion. For perspective, the aforementioned dilapidated hotel is shown in Figure 2.

Figure 2. Rundown Hotel on Emmett Street. This once-hotel is directly across the street from the Ivy Corridor, serving only to detract from the student experience when taking a trip down Emmett (Created by Author).

In working off of the previously stated definition of a connective gateway, it becomes obvious that a gateway is inherently a product of the site itself. That is to say that a gateway is only a gateway in its native location thus, transplanting a gateway to some other location deprives it of its integration into the environment and therefore its connectivity altogether. This creates a problem, mainly in that there is no precedent for creating a gateway on a site that is being redesigned and rebuilt from the ground up, as the in-situ environment is necessarily different than what is designed which renders any previously connective fixtures outdated. One way to counteract this it to find some gateway in a location with a similar environment, identical cultural requirements and overall need for refurbishment as an analog for how to create a gateway in a new location, but the odds of finding a site that meet all of these criteria are entirely improbable. Therefore, for a successful design in the Ivy Corridor, one must look at the student's needs and desires as an individual being connected to an institution of an established culture and persona bounded by the nuanced environmental confines of the parcel of land itself. This project's STS research will attempt to uncover how it is that the layout of a site is able to elicit an emotional response out of students and what discrete physical components of a gateway make those students feel connected to the university at large. The research following this prospectus will potentially build off the research done by Bales & Lindley (2013) in which they explored "how artifacts, both digital and physical, were found to support a sense of connectedness with home" to see how this sense of connectedness with home, in the context of physical environment, may impede the student's sense of connection to an institution (p.1142).

What is Lost in Disconnection?

If a university such as UVA purports to care about the health and well-being, mental or otherwise, of its student body, the overall feeling of connectedness to the university and fellow

students must be considered with paramount importance. Kitzrow (2003) explained that "Columbia University reported a 40% increase in the use of counseling services since 1995; MIT experienced a 50% increase between 1995 and 2000…" (p. 170). Whether this is due to environmental triggers or a predisposition to increased psychopathological disorders, the effect remains the same- a record number of college students are in a delicate mental state. In such a stress ridden state, students begin to disassociate and feel isolated from their school, and it is an engineer's duty to respect this mental state and take social connectedness and isolation into account when developing a site plan.

Perhaps it may seem like a stretch that physical infrastructure is a valuable component in the mental health of a student, but I would say that this train of thought is severely underestimating the amount of time that a student spends walking and/or observing her surroundings. As a student is walking across campus, she sees several different actors, living and nonliving. The living actors are the easiest to quantify and therefore seem the most important: professors, fellow students, visitors, parents, and even pets. It is the nonliving actors, however, that lurk under the surface and set the stage on which the student sees the living actors: weather, shape/size of buildings, plant life, open space, and recreational hot-spots are all nonliving actors that affect the college experience. Some nonliving actors, such as weather and to a certain extent plant life, are out of the control of a university, yet actors such as infrastructure fall directly under the purview of the institution. The entire college experience is viewed through this lens of background noise and it is that noise that, I believe, is responsible for the demeanor and tone of social interactions therein and this project's STS research will help UVA better understand what we talk about when we talk about a connective gateway.

Conclusion

When discussing mental health and well-being in the vernacular of connectivity in a college setting, the knee-jerk reaction for solution may be subtractive: remove outdated components of a system that have been unanimously deemed disconnected and assume that whatever is left is de facto connective. While this idea is the only option for some actors, namely the community actors who have little to no control over the design/construction/implementation of a redevelopment site, design engineers are given the unique privilege of drafting additive solutions that consider how a design makes the user feel. The fact that UVA has created a capstone group of students to draft ideas for a fixture that will be enjoyed by future students shows that the University is seeking input from the end user, placing tradition tantamount to embracing change. The organizational entities have voiced their goals, now it is the engineers who have the choice to bring those ideas to fruition.

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