UNH Stormwater Research Green Infrastructure Adaptations to Intensifying Rainfall Jessica Zielinski BS Sustainability Studie Tagliatela College of Engineering Dr. Jon Aktas

substances into nearby surface waters, where they degracteused the August ¹0 2012 flooding at UNH was aquatic ecosystemsStormwater ruroff is the main documented at the Tweed New Haven Regional Airport pollutant to U.S. waterwaytsday(EPA, 2014).Stormwater weather station as a 2.36 in that flows over impermeable urban surfaces is usually

that flows over impermeable urban surfaces is usually collected in one of twosewer types combined sewers or sanitary sewers Combined sewers collect both stormwater and sewage from residential, commercial, and industrial buildings while sanitary sewers collect sewage from buildings only without collecting stormwater Therefore, in areas that use sanitary sewers, a separate system called a stormwater sewer is equired to collect rainwater un off to prevent urban flooding most cases, when stormwater is collected separately from sanitary wasters is released untreated or with minimal treatment (perhaps straining to removed large deris) to nearby surface water ror Municipal Wastewater Treatment Systems, 2004

During heavy or prolonger precipitation events. stormwater volume sometimes overwhelms combined sewers(and even sanitary sewers that allow stormwater in through leaks), causing overflows release the untreated or minimally treated mixture of sewage and stormwater at designed seem overflow points which results in ontamination of nearby surface waternd/or lands Stress to combined sewers during intense rain events can also cause sewage to back up in basements and yards. Such contamination threatens the health and safety of local and downstream life, both natural and urbanized alike (Delleur, 2003) Economic damages also often result from such overflows given the necess closure and cleanup of recreational or fishing waters or other attractions, an example, it is reported that approximately 27 billion gallons of sewage and stormwater overflows from combined sewers near New York Harbor and the Hudson River estuanche year as a result of about 460 separate overflow sevent Given such negative outcomes, water regulatory agencies and activists are putting effort into the reduction of such overflows (Combined Sewer Overflows, 2014),ging and overburdened sewer systemare getting no help from mother nature in some areas of the world where it is predicted that climate change will result in more frequent and more severe precipitation evertusGS models project increasing precipitation patterns for the eastern sealogard the United States, indicating that stormwater runoff and sewer overflows could become more prevalent if water infrastructure is not improvedC(imate and Land Use Change Research and Development Program, 2014).

During a rain event in August 2012, attized flooding on the UNH campus inundated one building's classrooms with stormwater, resulting in excess of \$400,000 worth of property damage ocalized urban flooding, unlike large-scale flooding, is usually the result of stormwater runoff from one square mile or less of impervious surfaces that has built up and overflowed nearby sewer or stormwater systems Types of Floods and Floodplains, 200B oth the stormwatersewes for the campus and those connecting the campus to West Haen wereinsufficiently sized to handle the volume of runoff generated during the rain event causing overflow of the system of the subsequent flooding of Kaplan Hall (Aninno, 2014 powerpoin) the The rainfall that

Figure 1: UNH's hillside riprap, installed after the 2012 campus flooding event in Kaplan Hall.

Literature Review

With human populations increasingly shifting to dense urban areas, the need for reliable, efficient, and multi purpose infrastructure is growing. Urban areas hine t northeastern United Statesre being overwhelmed by greater increase in intense rainfall events as compared to all other region of the U.S. (Horton et. al, 2014) om 1958 to 2012, very heavy precipitation events in New England have increased by 71%, and this trend is predicted to continue (Walsh, J., et. al., 2014)G.I. can address these urban stormwater issues and provide additional benefits such as: groundwater recharge, reduced heat island effect, water quality treatment for sediment, pollutants, and excess nutrients, increased habitat, carbon usestration, aesthetic greenspace, potential for water harvesting and reusse, well as energy savings from roof insulation, and protecti water habitats against erosion and heat pollucome G.I. types perform better than others in any one of theseftts, thus choosing which G.I. type to utilize depends upon local and downstream goal\$Vhat follows is a brief description of some of the most popularpes of G.I.

For developedareas G.I. such as rain gardens, bioswales, and retention ponds can be added, as well as returning certain areas to preplanfottr,

materials were not sourced locally or if maintenance crews drove many miles every year to maintain the streewever, unlike tradtional infrastructure, Gl's incorporation pfants has the ability to sequester more emissions than are produced by its construction and maintenance, resulting in a carbon

site infiltration capability due to the deeper root systems typical of many native species. If sites had sufficient infiltration capability, stormwater from nearbimpervious surfaces could be routed to these are asparticular, if infiltration and/or storage feature could be placed conveniently in relation to campus buildings, the roof downspouts of these buildings could route roof runoff away from storm drains, helping to reduce the burden on campus sewer pipes Green roofs could capture this water on roofs, however these GI features require considerable material inputs that create long pay

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