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Youngstown State University "Gateway Project" Rain Garden Design Upgrades and Community Engagement

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Abstract:

The Youngstown State University (YSU) "Gateway Project," completed several years ago, was a large scale grounds and facilities project intended to upgrade several campus buildings and the grounds surrounding these facilities. Many of the upgrades utilized Leadership in Energy and Environmental Design (LEED) sustainable design criteria. Included in these upgrades was the installation of bioswale and rain garden areas intended to help manage storm water runoff from new parking facilities. While the bioswales are functioning as intended, the rain garden has never maintained plant life and is not functioning to manage storm water runoff. Phase one of this research involved testing the hydraulic conductivity of the soil in the garden, sampling the soil for its pH and identifying the soil stratification in the garden by digging test pits. This document will recap the results of that research and build on those results by specifying how the rain garden can be rebuilt in order to properly manage the storm water runoff.

Phase One Research Recap and Current Conditions:

Rain gardens and bioswales are bioretention areas used to capture runoff water from impervious areas so that the runoff can be filtered through plant roots and soil which allow natural infiltration into the aquifer. The rain gardens primary intent is to decrease the amount of storm water runoff that enters the municipal system. Furthermore, rain gardens which are typically located near imperious areas (parking areas etc.) serve as media to filter runoff which is full of oil, gas, roadway melting salts and other slag. In addition to functioning as a storm water management device, rain gardens are also an aesthetically pleasing area to urban and suburban communities due to the growth of healthy, colorful plant life and the habitat that they provide for birds, butterflies and other wildlife. Water that enters the rain garden should stand for no more than 48 hours. Standing water will typically attract and breed pests such as mosquitos and other flying insects which detract from the other positive features of bioretention facilities (Strange, 2007), (Bannerman, 2003)[1,7].

Typical rain garden construction is approximately 10 feet from the foundation of any building to prevent water from getting into the building. Ideally, retention areas should be constructed in full or partial sun and consist of approximately 80% sandy soil, 15% organic compost and 5% top soil. Soils that have a lot of clay should be avoided due to slower infiltration rates. Finally, the plants included in a rain garden must be a mix of native and adaptive plants which will effectively filter the storm water that enters the area. Native plants are plants that grow naturally in the area while adaptive plants are brought in and planted to specifically filter water. Both

plants must be able to thrive in the environment listed above which contains oil, gas and road salts (Bannerman, 2003), (Dorsey, 2014) and (Seymour, 2005)[1,2,6].

The Youngstown State University (YSU) "Gateway Project," completed several years ago, was a large scale grounds and facilities project intended to upgrade several campus buildings and the grounds surrounding these facilities. One of the upgraded areas utilized several Leadership in Energy and Environmental Design (LEED) sustainable storm water management strategies including bioswales and a rain garden. The bioswale areas are functioning as intended. However, the rain garden only maintained plant life for the first few years of its existence and for the last several years has not been able to sustain any plant life.

The original research which was funded by the American Society of Engineering Education (ASEE) Engineering Technology Division (ETD) Mini-Grant included two Civil and Construction Engineering Technology faculty and two senior Civil and Construction Engineering Technology students at Youngstown State University. With this funding, three aspects of the rain garden were tested. First, the soil pH was determined to be an average of 6.5 after sampling several different locations. The pH level greatly affects how certain nutrients required for plant growth are able to dissolve into the soil. Some plants are more accepting of a wider range of pH levels, while other plants are more specific in terms of tolerable pH. The optimal soil-water pH level for plants to flourish is widely considered between 5.7 and 7.0 (Eckert et., al.,2009)(Geotechnical Engineering Bureau, 2007)[4,5]. Second, the saturated hydraulic conductivity (K_{fs}) was determined by an in-situ method known as a "Constant Head Well Permeameter" (CHWP) or Guelph Permeameter. Using this method the K_{fs} value was determined to be 4.54 in/hr which is considered to be moderately rapid. Finally, two separate test pits were dug by the students to visually ascertain the make-up of the rain garden soil. This was done to identify if the rain garden was constructed to consist of approximately 80% sandy soil, 15% organic compost and 5% top soil. After digging the pit, it was determined that the soil was basically of one type with a variety of large fissures which would cause such a rapid hydraulic conductivity.

Based on these results, it was determined that the garden was not constructed properly due to the type of soil present which lends itself to high saturated hydraulic conductivity values. Based on this, the plants originally in the garden did not grow as expected and after a short period of time died off entirely.

Redesigning the Garden
Soil Upgrades:

Due to the fact that the infiltration rates were determined to be moderately rapid (4.54 in/hr) and that soil stratification was found to be inconsistent with the original design parameters, it was determined that in order to give the new plants the best chance to survive and adequately manage the storm water runoff, the top layer of the soil be removed and new soil added.

Davis et al. contends the following with regard to rain garden soil design. "Selection of a suitable soil mix and depth includes consideration of a number of different objectives and parameters which include the following:

1. Ability to support and sustain the selected vegetation
2. Ability to dewater the ponded water in 24 Hr.
3. Ability to remove the projected hydrologic and pollutant load;
4. Life cycle and durability of the media; and
5. Media cost."

With this in mind the following amendments should be made to the rain garden. The top 3-4 inches of soil must be amended with a mixture of peat moss and top soil and rototilled together to ensure that the new plants will have a solid foundation in order for the root base to take root and expand. Finally, after the plants are added, mulch will be added around all plants to ensure that the soil remains moist which will benefit the plant growth and assist in slowing down the infiltration rates. Lastly, according to Davis et. Al. "maintaining groundwater recharge is not an issue that is exclusive to bioretention design, but rather it is an emerging issue in storm-water management. It is used to recharge or restore both the base flow and groundwater components of the hydrologic cycle" (Davis et. Al., 2009)[3].

Also, the low area of the garden will be raised slightly with riverbed stone to enhance infiltration at the location where the water enters the garden. Furthermore, the overflow catchment which was originally installed too low will be surrounded by existing barn stones to ensure the water has time to infiltrate the ground and not go immediately into the catchment after a significant rainfall event.

Rationale for Selection of Plant Life:

The following are some general considerations which can help one select the most appropriate types of plant life in any size raingarden. The selection of plant life for a garden is dependent on several factors. Each of these factors plays a crucial role in the rain gardens ability to manage storm water runoff. First and foremost, each type of plant life selected must be researched to ascertain if it will thrive in the environment/climate that the garden resides. Moisture tolerances, seasonal considerations, salt and grease/ automobile fluid tolerances fall under this category. Second, different types of plants require differing amounts of sunlight to properly grow and manage storm water runoff. Third, plant size and plant selections that attract certain desirable wildlife (birds/butterflies/insects etc.) should also be considered (Schmidt, 2010)[8].

The YSU "Gateway Project" Raingarden has a special set of circumstances that must be considered prior to selecting plants. First, we will consider moisture and salinity tolerances. Based on prior research conducted on the site, it was found that the infiltration rate moderately rapid (4.54 in/hr). Due to this issue, the top layer of soil must be changed and plants must be

selected which can soak up water quickly and retain water for longer periods of time. Also, due to the climate in NE Ohio and the drastic changes in temperature from season to season, plants that can survive hot, humid months (June through September) with little water as well as extremely cold months (January through March) must be considered. Furthermore, this raingarden receives water from a parking facility. Parking facilities in cold climates are treated with deicing salts during the cold months. Parking facilities also contain oil and grease. Therefore, the plants in the lower region of the garden must be able to survive in water high in salinity and grease/automobile fluids. With regards to grease/automobile fluids Davis et. al. contend that laboratory studies have indicated that motor oil and hydrocarbons can be readily absorbed from incoming simulated storm-water flows by a layer of composted leaf mulch (Davis et. al., 2009)[3].

Sunlight requirements and the type of wildlife that the selected plants attract must be considered. Each plant for this site must be selected judiciously based on the site-specific conditions. Plants at this site will grow best if they can survive in a mix of sun and shade. This is a very large subset of plants. However, when you combine the moisture tolerances of each plant species selected with plants that do not require all sun or shade allows us to prioritize our selections. The plants that will be eventually selected must be able to retain water for longer periods of time due to the infiltration rates and some plants in the lower section must also thrive in water with high salinity (Schmidt, 2010)[8].

Finally, all plant species attract different types of wildlife or insects. This also plays a key role in the plants selected. Rain gardens that are in public places are best designed with plants that do not attract insects that are considered "pests" or are the type that bite or sting. For rain gardens that are not in public places it is not as critical as to what type of insects that the plants attract. The rain garden in question is on a college campus which obviously experiences a lot of foot traffic from students, faculty and visitors. Therefore, the plants selected should not attract insects such as ants, bees, mosquitos or other "pests". The plants that will ultimately be selected will attract butterflies, humming birds and humming bees (Schmidt, 2010)[8]. The paragraphs below describe the selected plants.

Partnering with campus and community stakeholders:

The plants for this garden are still in the process of being selected. This is due to the fact that the garden will be replanted in the Spring of 2017 with the assistance of the Youngstown Environmental Sustainability Society (YESS). YESS is a student organization containing faculty and students primarily from the Department of Geology and Environmental Science at Youngstown State Univeristy that will help solicit donations of plants, top soil, peat moss and mulch. They will also assist with the labor in planting the garden.

This is a key aspect of The Youngstown State University (YSU) "Gateway Project," raingarden redesign/rebuild. YSU is the centerpiece of the renovated, culturally revitalized downtown area

of Youngstown, Ohio. With this in mind, we desire to make this project an entire community project where donators and benefactors of the project are recognized for their assistance and partnership in sustainable storm water management.

We are considering a variety of plant including the following:

The botanical name for a yellow cone flower is, Ratibida Pinnata. These specific types of plants tend to thrive in lots of sunshine, easily seed and require little maintenance. Cone flowers tend to bloom in the summer and fall seasons. Furthermore, the botanical name for purple cone flowers is, Echinacea Purpurea. These species bloom from June thru August and can tolerate clay and alkaline soils. They are also low maintenance and grow easily. Yellow cone flowers as well as Purple coneflowers attract several insects including butterflies, goldfinches, and several other song birds. Coneflowers also attract bees (Schmidt, 2010)[8].

The botanical name for black eyed Susan's is, Rudbeckia Hirta. These plants bloom from June thru September and thrive in dry, average, or poor soils. Black eyed susan plants are ideal for rain gardens due to the fact that they require substantial amounts of water during their early growth phase. Black eyed susans tend to attract butterflies and birds which enhance the beauty of the garden (Schmidt, 2010)[8].

The botanical name for cardinal flowers is, Lobelia Cardinalis. They bloom from July to October. Cardinal flowers grow well in moist or rich soils and just like black eyed Susan's once established require little maintenance. The cardinal flower probably attracts hummingbirds, butterflies and bees which are both beneficial to the appearance of the rain garden. Their only drawback is that they have shallow roots and may require replanting in a few years (Schmidt, 2010)[8].

Due to the fact that the plantings for the garden are a work-in-progress, we have selected several other plants that may be added depending on availability. These include marsh milkweed, rose turtlehead, daylilies, blue flag iris and prairie blazing star.

In conclusion, the Youngstown State University (YSU) "Gateway Project," raingarden analysis and redesign has been a YSU student problem/project based learning success. It has evolved into an inter-departmental research and beautification project that will involve community stakeholders. We expect the redesigned garden to be a University showpiece indicating the relationship between faculty and student research and community engagement.

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