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Prairie rain garden design and installation project

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Summary

The rain garden described in this report was designed to provide storm-water management and was sited and configured so that native prairie plants could be used to provide the vegetation elements. It was built at the University of Washington Center for Urban Horticulture during the period between July of 2014 and March of 2015. Project objectives were 1) to manage surface runoff from a parking lot and to prevent ponding on a gravel trail downslope, 2) to convert a weedy site into a structurally and biologically diverse native prairie plant community, and 3) to collect baseline vegetation and hydrologic data to assess project results.

The garden is at the east entrance to the Union Bay Natural Area (UBNA), a lakeside landfill that is being restored. When the landfill was closed in the early 1970's, the entire site was capped and seeded with European pasture grasses. Native grasses and other prairie plants have been gradually introduced to the site, starting in 1992.

The site selected has a gradual 5.5 % slope. At the bottom of the slope, winter rains have annually created seeps that saturated a gravel trail that led to the natural area. An infiltration test was done, and results indicated that the site might function well as an infiltration pond (in which most stored storm-water is removed by movement into the substrate). To initiate the project, sod was removed from the 650 square foot rain garden site using hand tools. Four sequential pools were excavated, and a berm was placed at the bottom of the sloping site; an overflow pipe was placed beneath the trail. After winter rains began, the infiltration rate slowed and installed prairie plants were suffering from flooding. The site was re-configured as a wet swale, in which some of the pools are saturated during the rainy season. Drain rock was added to facilitate drainage, and plants were moved to a slightly higher elevation. As the installation currently functions, some runoff is stored as standing water after rainfall

events, and some is stored in saturated soils. The excess is carried off by the overflow pipes. During dry periods, pools gradually lose standing water or dry out, regenerating storage capacity.

What is the issue?

Urbanization is the consequence of the concentration of human population in urban areas. Characteristics of urbanization include the loss or fragmentation of natural ecosystems and the species that make them up, an increase in impermeable surfaces on a landscape scale, a decrease in environmental functions provided by natural systems (hydrologic control, water quality improvement, habitat), an increase in hydrologic yield (more runoff and shorter concentration times), and the introduction of pollutants into the environment. Stormwater is the runoff from urban surfaces. It is considered to be a non-point source pollutant and can contain sediment, nutrients, other pollutants and trash. It can have significant negative effects on waterways, water bodies and estuaries. When collected and placed into conveyances and discharged into water bodies, stormwater is considered a point source of pollution and is regulated by the EPA under the Clean Water Act. Municipalities must obtain permits for such discharges, and must meet performance standards or face sanctions. High volumes of stormwater flow can cause violation of permit requirements, especially in places which have combined sewer and stormwater systems (CSO's). Decreasing stormwater flows is a way to minimize the exposure of municipalities to fines and other penalties. Low impact development (LID) is one approach to decreasing the generation of stormwater at a point that is as close to its source as is possible.

Rain gardens are a design element that is often incorporated into low impact development. A rain garden is a simple planted depression, 6" to 12" deep, that collects rainwater from impermeable surfaces. The collected water may infiltrate into the soil, may evaporate, or some of it may pass out of the depression as surface flow or in a conveyance. The rain garden typically has a planted flat bottom, planted slopes, and an overflow. Water stored, evaporated or infiltrated generally results in a net decrease in stormwater flows which must be dealt with downstream.

How was the project conducted?

The site was selected because runoff from a paved parking lot was flowing down a grassy slope and surfacing at a heavily used trail. At the trail it puddled during rainy weather, and on cold mornings a sheet of ice was formed on the trail surface. Decreasing the flow down the slope would both dry out the trail and eliminate the safety hazard that was created by icing. Placement of the rain garden in a location that would intercept the overland flow would solve this problem.

The initial step was to research the construction of rain gardens and enumerate design steps for determining the necessary surface area, depth, soil permeabililty, allowable slope and other constraints. There are a number of reliable manuals that are available for the Pacific Northwest region. It was determined that the project could be carried out without obtaining a permit (in Seattle, a permit, if required, would be issued by the City of Seattle). Plant material for the rain garden was primarily in the form of plugs of the grasses *Deschampsia cespitosa, Festuca idahoensis* and *Elymus glaucus* (which had been grown from locally collected seeds).

An infiltration test was conducted by digging a hole 10" deep and adding 6" of water to it. The water was allowed to drain and another 6" was added. On the third filling the infiltration rate was timed and was 1.95 inches/hr. Sod was removed from the site by hand. Four pools were excavated, each about 6" deep. The ponding area was about 15% of the impermeable area of the parking lot, which was 1416 square feet. Mounds were built around the pools to enhance plant diversity; some prairie plants (*Deschampsia cespitosa*) are quite tolerant of flooding, while others (*Festuca idahoensis*) are intolerant. A 4" diameter outflow pipe was installed under the trail at the bottom of the rain garden, and this fed into two 4" diameter corrugated plastic pipes that were set into drain rock. When winter rains came, infiltration in ponds slowed and the modifications mentioned in the Summary were employed: trenching between pools allowed water to flow between them and out the outfall, coarse drain rock was added to facilitate this flow, and plants were moved slightly up-slope.

<u>What are the major elements of this project?</u>

The initial element of the project was the site assessment. In the case of rain gardens, the site assessment included determining if permitting was to be required. In this case, it was not. Then, a check-list was used to determine if the candidate site was appropriate. The site must not be on a steep slope, must not be within 10' of a basement or 5' of a foundation slab. Soil must infiltrate at least 0.25 inches/hour. The site must not be near septic tanks or drain fields. It must not be above buried utilities or any other structure. It must not be under the drip line of trees. It should be down slope from an impermeable surface and upslope of a street drain or natural drainage feature. It should be on a gentle (1% to 5%) slope.

The next step was to determine the permeability of the soil, as mentioned above. Then the area of impermeable surface was determined. This allowed calculation of the total surface area of the rain garden (15% of the area of impermeable surfaces). The King County Surface Water Manual states that the rain garden must store 3" of rain from the impermeable surfaces, so this volume may be calculated and from it the design depth of the ponds may be determined. If permeability of soils is low, then storage volumes should be increased.

Plant material that was installed was placed in the rain garden based upon likelihood of inundation and known tolerances of the species used. The major species were three native prairie grasses, which have known flood tolerances: *Deschampsia cespitosa* (very tolerant), *Elymus glaucus* (prefers intermediate soil moisture but not flooding) and *Festuca idahoensis* (not tolerant). A number of other prairie species were added, with placement dependent upon their flooding tolerance.

The outreach value of this installation is considerable. It is on a heavily travelled trail, and has solved a problem that trail users are well-familiar with. Signage has been place on the trail explaining the project, and it is used as an example of "green infrastructure" in university undergraduate classes. In addition this installation suggests that many other streetside or trailside rain gardens could be constructed to improve the localized control of stormwater runoff.