Green Parking Solutions

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Executive Statement

There are a number of expenses and liabilities for Western Washington University associated with the gravel surface "C" commuter parking lots located at the southern end of campus. The primary issues are related to water quality and the expense of maintenance of the current systems. The University currently has storm water remediation measures designed to mimic the natural hydrological regime but storm water volume occasionally exceeds the capacity of the current system. These systems also require a significant amount of expense, time, and resource consuming maintenance to function to their designed potential. The surface of the lots is less than ideal for vehicle and pedestrian traffic, as well as being a constant maintenance issue. These issues have been occurring for some time, but addressing them was lower in priority than other projects. In order to comprehensively address this issue, WWU's Facilities Management through their Storm Water Management Plan (SWMP), have requested funding through the campus Capital Budget Office for Fiscal Years (FY) 2013-2015 to the Washington State Legislature to replace the gravels lots on campus and provide a maintainable surface where WWU can meet the requirements of its secondary MS4 permit.

In an effort to promote sustainable, environmentally-sound campus development, pervious concrete should be used as method to help the University meet the mandates of the SWMP. A reduction in impervious surfaces is a considered a desirable characteristic in sustainability planning. This method would help remove pollutants from parking lot stormwater runoff on campus before draining into the Taylor creek watershed. With this project, the College has the opportunity to reconsider and enhance its academic facilities and campus spaces, particularly with regards to environmental sustainability. Pervious pavement should be used for any campus paving projects. Pervious pavement is an expanding technology that has extensive environmental advantages when used effectively, including a decreased volume of storm water runoff, increased groundwater infiltration, and reduced sediment loading. The goal of this project is to evaluate pervious concrete in order to determine its ability to mimic natural infiltration characteristics, protect water quality, and provide durable, low maintenance surface at a comparable cost to traditional pavement materials.

Statement of Need

The “C” lots consist of large gravel parking areas that are drained by storm drains feeding into westerns storm water system. Pollutants, consisting primarily of sediments derived from the gravel commuter “C” lots are carried into the storm water system during precipitation events. They are then discharged into Taylor creek, and eventually Padden creek. The potential pollution inputs negatively impact water quality and could result in fines for exceeding the parameters of stormwater permits. In order to address this issue it would be wise to use the EPA has development standards and best management practices now emphasize the need to reduce the overall amount of paving that is specified in construction, as well as increasing the permeability of paved areas where practical. The impacts that the accumulated pollutants have on the Universities stormwater system present an expensive and resource intensive problem. Upkeep of the stormwater system requires the supervision of multiple departments and the material that is removed is hazardous waste and must be disposed of properly. The surface of the gravel parking lots is less than ideal, and poses a potential risk to users and their vehicles. The maintenance of the lots is a costly and constant process. Maintenance can consist of repairs of small areas to extensive re grading of the parking area. Upkeep must occur during off peak demand hours which mean high labor costs; any repairs that are used are only temporary.

Pervious concrete is frequently used in parking lots and other light traffic areas. It is being used increasing in development as a method to protect water quality. Pervious concrete is similar to traditional concrete, but it that has large aggregates with little to no fine aggregates that create the characteristics that allows water to drain through it. The concrete structure contains stable air pockets; the total void space in the concrete is between 15 and 35 percent and averages 20 percent. The void space allows stormwater to flow through the concrete and infiltrate into the groundwater instead of running into storm drains or streams.

Construction of this type consists of a surface layer of pervious concrete 4 -8 inches thick depending on application. Under the surface layer is a open graded bedding layer which usually consists of 3 - 4 inches of crushed stones typically 3/4 to 3/16 inch. This layer provides storage capability as well as well as providing a transition between the bedding and sub base layers. The third layer is a open graded reservoir layer consisting of stones lager than the bedding layer approximately 2½ inch. The purpose of this layer is water storage. The

thickness of this layer is dependent on storage capacity requirements and type of use. The drainage requirements are specified by engineer depending on site conditions. A system installed in low-infiltration rate soils may require under drain facilitates to remove water from the base and sub base. The under drain that is used is a perforated pipe that is integrated into an outlet structure. An optional geotextile may be used under the sub base if desired. This layer can be used to provide a barrier between the engineered system and un compacted sub base to prevent to prevent a migration of materials. The base layer of the system consists of un compacted soil. The infiltration capacity of the soil determines how much water can be dispersed into the surrounding soils.

Pervious concrete protects water quality in a variety of methods. The coarse aggregates in the concrete filter the stormwater by slowing the velocity which allows sedimentation to occur. This process has been successful in Reducing TSS levels removing up to 92 % (Ruston, 2001). The characteristics of subgrade soils are a major element of water treatment. Sandy soils have more infiltration capability but less more treatment capability. Clay soils have higher treatment capabilities due to high cation exchange capacity, but had less infiltration capacity (NRMCA, 2011). The aggregates in pervious concrete provide a suitable habitat for beneficial bacteria's that aid with water treatment by reducing petroleum, metals and other pollutants in stormwater (Pratt et al., 1999).

A desirable characteristic is low impact development is restoring natural hydrological characteristics. Natural infiltration of water into the water table is far more desirable to high velocity surface runoff. Pervious concrete can dramatically alter areas from a source of stormwater into a treatment system that can effectively reduce or eliminate runoff. The infiltration rate of properly constructed pervious concrete and base is designed have the capacity function properly during the peak storm rainfall rate (Collins. Et al, 2008). Infiltration rates for a similar pervious parking area in Redmond, Washington have regularly been 99.9 % (WA&CA, 2006).

Other environmental benefits of using pervious concrete include a reduced heat island effect due to less mass due to the porosity, more sunlight is reflected due to a lighter color and the coarser aggregate. The coarse aggregates used also provide more traction to the surface creating a safer environment for motorists, pedestrians, and cyclists. Pervious concrete results in less energy use for lighting because the concretes characteristics reflect

more light providing better nighttime visibility. The porosity of the system reduces the chance that water will pool in low areas,

Resurfacing the gravel parking lots with pervious concrete could be a cost effective, low maintenance method to protect water quality on and around the Western campus. It would meet and reaffirm the values of the college while enhancing and protecting the environment and conserving resources.

Project Description

The goal of this proposal is to clarify the range of benefits and potential drawbacks and limitations with respect to the use of pervious concrete to resurface the gravel parking lots on the WWU campus. The project is designed to evaluate pervious concrete in order to determine its ability to mimic natural infiltration characteristics, protect water quality, and provide durable, low maintenance surface at a comparable cost to traditional pavement materials.

Objectives:

Physical:

- Improve water quality by eliminating pollutants from entering the ecosystem,
- Provide a an easy to maintain surface
- Decrease pollution inputs into current stormwater system

Economic:

- Delineate the potential cost benefits of using pervious concrete

Cultural:

- This project can serve as a model for implementing the technology in different locations that share similar characteristics.
- This project has the potential to demonstrate WWU's commitment to sustainability

Methods

How?

First funding must be acquired to begin this project; this is already in the process of going through Olympia and will hopefully be accepted and granted.

Second a civil engineer hired by the school will begin designing and drafting plans to install stormwater remediation and pavement options. After the school has approved his/her method and tools, construction begins soon afterwards.

When?

As soon as the school is granted funding from Olympia the project will then be designed by a civil engineer of the school's choosing.

Why?

We have chosen pervious concrete as our stormwater remediation technique because of its ability to replicate natural filtration into the groundwater system. Maintenance on pervious concrete compared to traditional methods with Western's parking lots is estimated to be less costly and less frequently needed. We recognize the challenge to install newer technologies on a college campus, more specifically the parking lots, but this method has been used in many locations and places with different purposes. Wilson motors in Bellingham uses pervious concrete and asphalt to mediate their stormwater runoff into Whatcom creek. If a car dealership can take a step towards eco-friendly materials for managing stormwater then Western Washington University most definitely can make this step.

Evaluation

Evaluation will be determined by the effectiveness of the pervious concrete. The civil engineer and maintenance crews on campus will be able to determine if this material works by simply testing the ability to filter stormwater at rates comparable to storms in Bellingham. Maintenance costs will be determined by the amount of times the parking lots must be swept and as long as this is maintained frequently enough the pervious concrete can properly be evaluated after 1 year.

Sustainability

This material is long lasting just as traditional cement and can withstand the same amount of weight. It does not require as much maintenance as a gravel parking lot would need. Pervious concrete will reduce if not eliminate stormwater runoff (which is full of particulates, toxins, and pollution) into Taylor Creek or other bodies of water.

Budgeting and Cost Information

There are a number of variables that can impact the overall cost involved with a construction project of this type. This type of work requires the utilization of specially trained and certified contractors. Site conditions can vary considerable potentially limiting accessibility by construction equipment. Excessive slope can limit the types of land use. Existing geologic conditions such as the characteristics of sub-grade soils may result in additional base material being required. Stormwater management requirements such as the level of control required for the volume or rate of stormwater discharges will impact the volume of treatment needed. Project size and scope can dictate costs; larger pervious concrete areas tend to have lower per square foot costs due to construction efficiencies.

- Estimates for cost of installing pervious concrete range from $4 - $9 per square foot. This compares to estimates for traditional pavement installation which ranges from $3 - $11.24 per square foot.
- This data was provided by; Chris Webb, PE, Puget Sound Partnership, Blue Chip Construction, and the City of Sammamish.
- Evergreen State College estimates installing pervious parking solutions to cost the same as installing traditional pavement if not less.
- Estimates for traditional concrete installation does not include costs for maintenance in the form of stormwater catch basins, piping, detention, and treatment, which adds considerable cost.
- With permeable concrete there is no need for these structures, which will save a lot compared to the nightmare of stormwater management that occurs because of the current runoff situation from the gravel lots, including being dinged by the DOE for runoff entering the watershed.
- The Environmental Protection Agency estimates the cost of maintenance for pervious concrete as $200/acre per year.
- Western has the potential to receive LEED credits to aid in funding the project through various credits such as Innovation in Design, Stormwater Management, and Reduced Site Disturbance.
- Wilson Toyota in Bellingham saved ~$500,000 by installing pervious pavement for their parking lots by no longer having to spend money on stormwater management
- Size of lots we propose to pave with pervious concrete: 460,000 sq. ft/10.55 acre, which contains 1064 parking spots.

Installing pervious concrete is likely to cost either the same or a bit more than traditional pavement alternatives. Pervious concrete, however, bypasses the need for expensive stormwater management and maintenance costs, and therefore will save money. Potential LEED credits are available to Western as a result of this installation decision as well. Estimates developed by our project indicate the costs to resurface the 10.55 acre commuter C lots on Westerns campus may vary from $ 1.8-$4.05 million based on the $4 and 9$/sq. ft. costs provided by our research.

Conclusion

In an effort to promote sustainable, environmentally-sound campus development, pervious concrete should be used for resurfacing the gravel parking lots on Westerns campus. Pervious concrete has been proven effective at protecting water quality while being durable and cost effective in comparison to traditional building materials. With this project, the College has the opportunity to reconsider and enhance its academic facilities and campus spaces, particularly with regards to environmental sustainability. By using sustainable building practices the University serves a model for the community and lives up to its reputation as being at the forefront of sustainability and environmental protection.

Limitations/Future Works

With a large construction project like this there may be a number of variables and unknowns that may become more apparent as the project progress and the question of how to deal with them. Some potential issues that may need to be addressed include;

- Time/Logistics, a large project may be difficult to implement at one. If necessary or desired the project could be implemented in stages. The benefit of this method would be that the completed lot could serve as a test/demonstration area.

- Site conditions could potentially affect project costs and timing. Comprehensive analysis of site condition would take place in the preliminary stages of the project. Any specific problems will be addressed and mitigated during the design process.
- For future study, a combination of best management practices (BMP) would most likely be the best solution. The EPA storm water management modeling software (SWMMS 5.0) provides a platform to determine the best BMP's based on specific site conditions as well as regional climate data.

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