Determination of Ideal Parking Lot Bioswale Porous Material in South Texas

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Introduction

A bioswale is a drainage structure designed to retain stormwater runoff and remove pollutants and solids from surface runoff before reaching a stormwater sewage system. This low impact development is beneficial in regards to flood management and water quality. A bioswale consists of natural materials as part of the its design, preferably of native soils that will make the drainage system eco-friendly, affordable, and feasible.

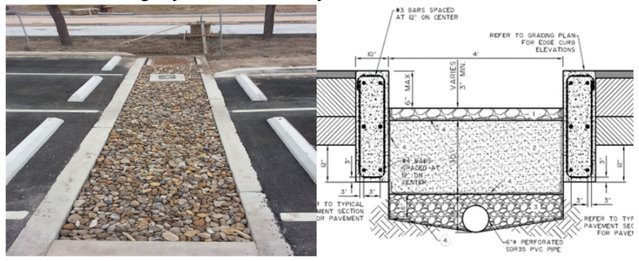
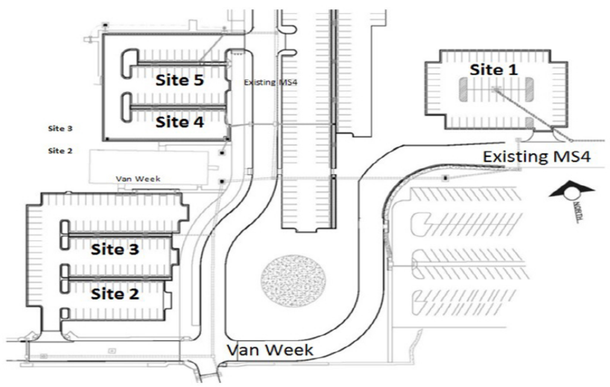


Figure 1. UTRGV campus parking lot and bioswale design.

Purpose

The goal of this project is to determine the best-performing locally available porous material for bioswales in South Texas. This will be accomplished by testing bioswales installed at UTRGV campus parking lots. A total of four bioswales were constructed, each with a different material, and a control station with no bioswale. The materials selected for this study are manufactured sand, recycled crushed glass, pumice, and natural medium sand.



Sites	Bioswale	Materials	Parking lot watershed size (acres)	Remarks
Site 1	No bioswale	No bioswale	0.24	Existing parking lot
Site 2	Bioswale 1	Pumice	0.22	City of Austin, TX
Site 3	Bioswale 2	Manufactured sand	0.23	Sinclair et. al. (2012)
Site 4	Bioswale 3	Recycled crushed glass	0.21	McAllen recycling center
Site 5	Bioswale 4	Medium sand	0.21	City of McAllen, TX

Figure 2. Bioswale sites at UTRGV campus.

Performance Monitoring

The study comprises four bioswales, each with a different material, and a control station with no bioswale. Hydrologic data was recorded using velocity-level data loggers and from local precipitation gauge stations. The parameters obtained by the Stingray data loggers were: level (height), velocity, and temperature. Level and velocity are crucial in determining the flow rate. Additionally, water samples were collected from each bioswale and control station after a rain event for nutrition and turbidity testing.

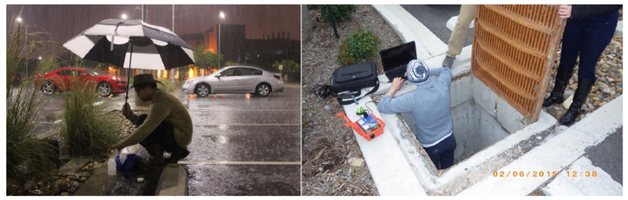


Figure 3. Water sampling and data download at bioswales .

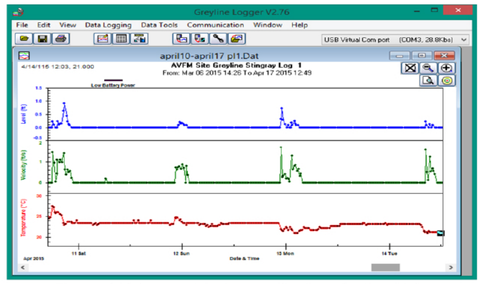


Figure 4. Stingray data logger display of rain activity.

Time	P rate	P (in)	Q (ft³/s)	Vol (ft³)
20:15	0	0		
20:20	0.16	0.013333		
20:25	0.37	0.030833		
20:30	0.38	0.031667		
20:35	0.12	0.01		
20:40	0.06	0.005		
20:45	0.04	0.003333		
20:50		0		
20:55		0	0	0
21:00		0	0.0086	2.58
21:05		0	0.007035	2.1105
21:10		0	0.010006	3.0018
21:15		0	0.005366	1.6098
21:20		0	0.004175	1.2525
21:25		0	0.003496	1.0488
21:30		0	0.004111	1.2333
21:35		0	0.004537	1.3611
21:40		0	0.00307	0.921
21:45		0	0.003393	1.0179
21:50		0	0.002709	0.8127
21:55		0	0.002451	0.7353
	1.13	0.094167	**SUM**	17.6847

Using the data recorded by the loggers and precipitation data from gauge stations, we arrive at *Table 1*. This table is used to create hydrographs and hyetographs for data analysis. We are interested in the flow rate (Q) and volume of runoff (Vol).

Table 1. Final data for a rain event

Data Analysis

Many parameters were monitored during the data analysis. The focus of the analysis was to find the runoff volume reduction, peak rate reduction, peak time attenuation, and filtration efficiency. This was achieved by using the final data created for each rain event as shown in *Table 1*. Filtration efficiency was found by comparing the turbidity of water samples from the bioswales to the one from the control station. Once these parameters were determined, we can compare each bioswale and establish which is the best-performing material for implementation.

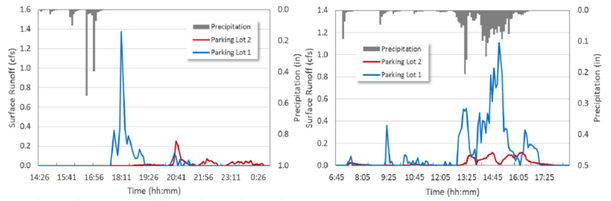


Figure 5. Parking Lot 2—Pumice

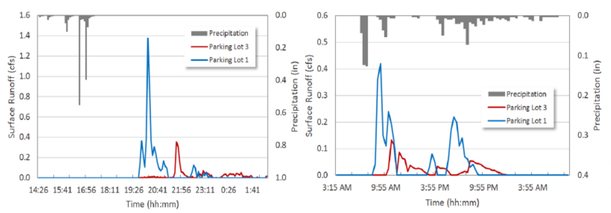


Figure 6. Parking Lot 3—Manufacture Sand

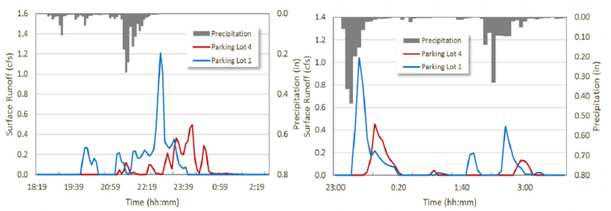


Figure 7. Parking Lot 4—Recycled Crushed Glass

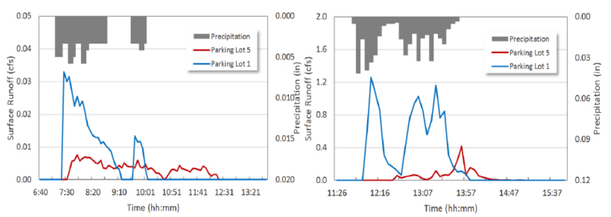


Figure 8. Parking Lot 5—Medium Sand

Laboratory testing was conducted to measure the turbidity and nutrient concentration of water samples for each bioswale after a rain event.

Figure 9. Spectrophotometer - testing of water samples.

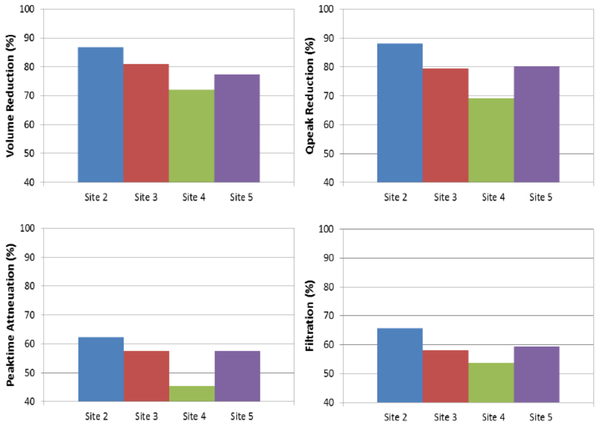


Figure 10. Hydrologic Performance

An SWMM numerical model is being developed to validate the results of our study and to simulate rain events. With this, we will be able to investigate further into the performance of our materials. We hope that the information found from this model will help us gain more knowledge on bioswales and the selected materials.

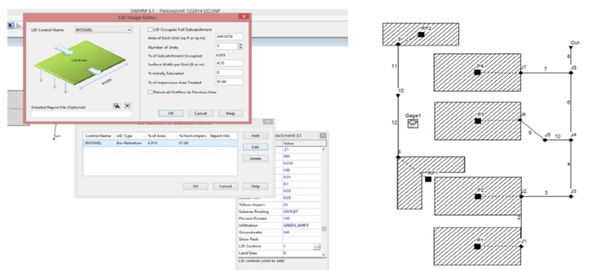


Figure 11. SWMM LID Function Modeling

Conclusion

From the results of our data analysis, we can say that pumice is the best-performing locally available material for implementation of bioswales in South Texas. As the numerical model is developed, we should be able to understand the bioswales bettr, and provide further information on the performance of the materials.