

## **Urban Storm water management through bioretention swales in Institutional campus for Green Environment - A Case Study**

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### **ABSTRACT:**

Nature uses vegetated depressions, wetlands, marshes, etc. to clean storm water runoff by removing sediments, turbidity, heavy metals, and other pollutants. Some pollutants are removed by vegetation uptake, some by natural flocculation from decomposing vegetation, some by just slowing the flow down enough for sedimentation to occur, and some by biota consumption and ionic attraction around the root structure. Many pollutants migrate attached to soil particles and soil particles in themselves are considered a pollutant. When storm water runoff leaves a site, unless there is effective erosion protection such as vegetation, soil also leaves the site, in the forms of sediment, suspended solids, and microscopic soil particles called colloidal suspension, dissolved solids, or turbidity. The soil particulate can be clay, minerals, organic material, heavy metals, etc. Sediment usually will readily settle out. A biological filtration canal is a shallow depression created in the earth to accept and convey stormwater runoff. A biological filtration

canal uses natural means, including herbaceous vegetation and soil, to treat stormwater by filtering out contaminants being conveyed in the water.

### **INTRODUCTION:**

The bioretention swale treatment process operates by filtering stormwater runoff through surface vegetation associated with the swale and then percolating the runoff through a prescribed filter media, forming the bioretention component which provides treatment through fine filtration, extended detention treatment and some biological uptake. Bioretention swales also act to disconnect impervious areas from downstream waterways and provide protection to natural receiving waterways from frequent storm events by reducing flow velocities compared with piped systems.

**Definition:** A bioswale or vegetated swale is a form of bioretention used to partially treat water quality, attenuate flooding potential and convey storm water away from critical infrastructure.

### Study area:

SJB Institute Of Technology is housed on a vast land covering an area of 25 acres. There are catchment areas which can result in accumulation of large amount of water flowing in to the drains and not getting useful in encouraging the growth of vegetation throughout all seasons. To make use of the rain water in enriching the green environment bioretention swales could be introduced in the divider and also all along the sides of the pavement throughout the length of the campus. As project work we will be designing the swales for the campus by conducting relevant tests for the suitability of soil, hydraulic design, vegetation design and storage tank design.

### OBJECTIVES:

1. To provide a conveyance function.
2. Selecting appropriate type of vegetation.
3. Efficient removal of hydrocarbons and other soluble or fine particulate contaminants from biological uptake.
4. To provide a low levels of extended detention.
5. Provide flow retardation for frequent (low ARI) rainfall events.

### METHODOLOGY:

#### Catchment Area:



As this is the case study, the chosen area is SJBIT Campus. The catchment area of the SJBIT Campus is determined with the help of the Google Earth Map. The area which is needed is traced through the Google Earth Map and that data is imported into the AUTO CADD software to calculate the catchment area. The calculated catchment area is 4.4 hectares.

### Calculation of surface run off:

Among all the above mentioned methods, the method adopted for the further design process is "RATIONAL METHOD".

The runoff rate corresponding to this condition is given by :

$$Q=C*A*I$$

Using the above method the quantity of surface runoff is 25660800 cum or m<sup>3</sup>

### Soil Characteristics in SJBIT Campus:



The following tests were conducted to know the characteristics of the soil which is used for the growing of vegetation in SJBIT Campus.

- Core cutter method
- Liquid Limit
- Plastic Limit
- Shrinkage Limit
- Permeability Test
- Wet Sieve Analysis
- Hydrometer Analysis
- pH Test

### Core cutter method:

This method is conducted to determine the in-situ dry density of the given soil. As per this test the results for the collected two soil samples is as follows:

	LOCATION-1 NEAR PUBLIC SCHOOL	LOCATION-2 NEAR ADMIN BLOCK
BULK DENSITY(g/cc)	1.87	1.48
WATER CONTENT(%)	6.74%	6.41%
DRY DENSITY(g/cc)	1.75	1.39

### Liquid limit:

It is defined as the minimum water content at which a part of the soil cut by groove of standard dimension will flow together from a distance of 12mm under a impact of 25 blows in the device. To determine the liquid limit of the collected soil sample by using Casagrande Method. As per this test the results for the collected two soil samples is as follows:

	NEAR PUBLIC SCHOOL	NEAR ADMIN BLOCK
Liquid Limit	44%	38%

### Plastic limit:

- It is defined as the water content at which a soil just begins to crumble when rolled into a thread approximately 3mm in diameter. This test is conducted to

determine the plastic limit of the collected soil samples. As per this test the results for the collected two soil samples is as follows:

	Near Public School	Near Admin Block
Plastic Limit	23%	20%

### Shrinkage limit:

It is defined as the water content where further loss of moisture will not result in any more volume reduction. This test is conducted to determine the shrinkage limit of dry soil pat of collected soil samples. As per this test the results for the collected two soil samples is as follows:

	Near Public School	Near Admin Block
Shrinkage Limit	20.61%	25%

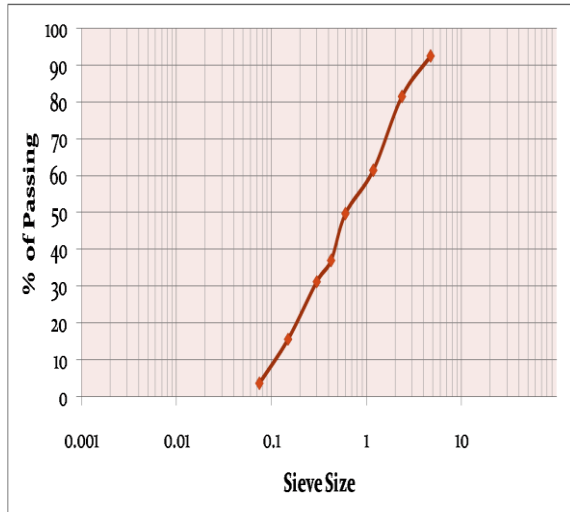
### Permeability:

It is defined as the property of porous material which permits the passage or seepage of water through interconnecting voids. This test is conducted to determine the co-efficient of permeability of the collected soil samples by constant head method. As per this test the results for the collected two soil samples is as follows:

	Near Public School	Near Admin Block
Co-efficient of Permeability (cm/s)	$2.48 \times 10^{-3}$	$1.93 \times 10^{-3}$

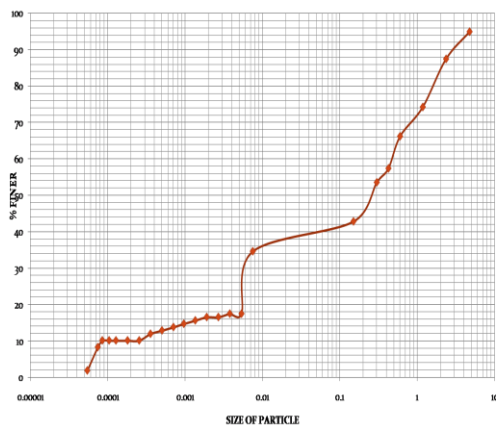
### Wet sieve analysis:

This test is conducted to determine the grain size distribution of the collected soil samples. As per this test the calculation is as follows:



### Hydrometer analysis

This test is conducted to determine the size of the particles. From the calculations the graph is plotted size of the particles versus % finer at the sample collected near school.



### pH test:

The pH test is conducted to determine that the taken sample is neutral or acid or alkaline.

	RAIN WATER	SOIL NEAR SCHOOL	SOIL NEAR ADMIN BLOCK	VERMICOMPOST	UREA
pH	8.4-8.8	6.5-7	6-7	7.8	9.3

### VEGETATION DESIGN:

Based on the pH of soil and soil types different types of vegetations can be grown in SJBIT Campus. That are as follows-

Erica carnea:, Helianthemum, avender  
Monkey flower, Rosemary, Indigofera  
Bog st. John's wort, Western buttercup



### FILTER MEDIA SPECIFICATIONS

Filter media must:

Support bioretention vegetation.

Infiltrate water sufficiently to enable design objectives to met.

Not migrate downwards through the transition layer, drainage layer, under drainage or in-situ soil.

FILTER MEDIA IS COMPOSED OF THREE LAYERS

- Sandy layer
- Transition layer
- Drainage layer



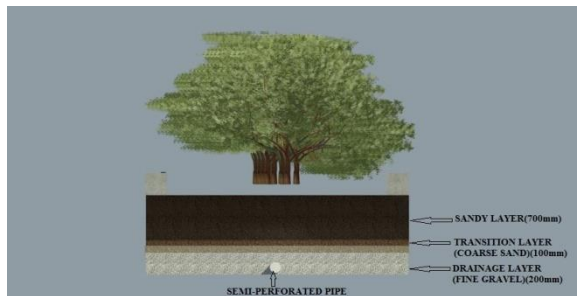
The filter media layer provides the majority of the pollutant treatment function, through fine filtration and also by supporting vegetation. The vegetation enhances filtration, keeps the filter media porous and provides some uptake of nutrients and other stormwater pollutants. As a minimum, the filter media is required to have sufficient depth to support vegetation. Typical depths are usually between 400-1000 mm with a minimum depth of 400 mm for grasses and shrubs and a minimum depth of 800 mm for tree species to avoid roots interfering with the perforated under-drain system. It is recommended that the minimum clay and silt content in filter media is 2%.

## **COLLECTION, FILTRATION AND DISPOSAL OF STORM WATER:**

- During rain, the rain water flows downwards from toll gate towards the library because there is downward gradient.
- Semi-Perforated pipe of economical diameter is placed at a depth of 0.5m from the ground surface.
- The rain water falls on median, that water is percolated through the soil and collected in the perforated pipe.
- From the Google earth map the selected path is measured as 600m.
- PVC semi-perforated pipe is used.
- In the stretch of 600m, the lateral pipes is provided at the interval of about 50m throughout.
- This lateral pipes are provided throughout the kerb length for passing rain water to the median.
- And also we can grow the vegetation beside the drains at the both sides of the road.
- At last these pipes are connected to the place where the bioretention swale can be introduced.

- The collected storm water is passed through the filter media.
- Then it is collected in the storage tank through semi-perforated pipe which is placed in drainage layer of the filter media.
- The collected water in storage tank is filtered water and that can be used for the gardening purposes.





## CONCLUSION:

- We can re-use storm water for gardening purpose.
- We can reduce the size of the treatment plant as the storm water finds application in maintaining green environment.
- Pollutants in the storm water can be easily removed.
- It reduces the burden on our municipality in constant supply of water which offers savings.
- Vegetation that grows in the filter media enhances its function by preventing erosion of the filter medium.
- Vegetation growth improves the aesthetic appearances.

## RECOMMENDATION:

- It is good to adopt on either side of the roadways such as state highways, national highways which enhances the aesthetic appearance of the road.
- It enriches the green environment by reducing global warming.
- It helps in increasing the ground water table.
- Different types of manure can be used to grow vegetation.
- For the bioretention swales different filter media can be used.

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