



## Abstract

Lake Quinsigamond, situated between Worcester and Shrewsbury MA, is subjected to urban contaminants which enter the lake via point sources. One such source is bridge drainage pipes from the I-290 bridge traversing the lake. The runoff from the pipes contributes various pollutants, decreasing water quality.

To treat runoff drained from the bridge, a slow rate sand filtration system would be implemented to collect and filter the runoff before it enters the lake. Success will be measured by the overall improvement of water quality, cost efficiency and the sustainability of the system.

## Pollutant Impacts

Pollutants	Primary Affects
Heavy metals – Lead, Copper, Zinc Oils Gasoline and Diesel Herbicides and pesticides Chemicals – antifreeze, windshield wiper fluid Fecal Coliform	Directly Toxic to Aquatic Life
Salt Suspended solids Herbicides and pesticides	Raises pH Levels & Increases Turbidity
Heavy metals – Lead, Copper, Zinc Excess Nutrients – phosphorous, nitrogen, hydrocarbons Fecal Coliform	Lowers Oxygen Levels

## Pollution Effects on Lake Quinsigamond

### Decreased Wildlife Diversity

- Thriving populations only include hardy fish species – (i.e, bass and perch) – and certain invasive plant species.
- Fishing restrictions are upheld to protect wildlife diversity as well as human consumers.

### Limited Recreational Uses

- When water samples test positive for high levels of dangerous chemicals or bacteria such as Fecal Coliform, swimming, rowing, sailing, and beach use is restricted until the water returns to safe EPA standards.

### Low Property Value

- Due to long standing pollution and limited recreation, waterfront properties become less desirable. Therefore, the market value of these properties decreases as well.



Drainage Pipe embedded in the side of the bridge  
© UWM Groups

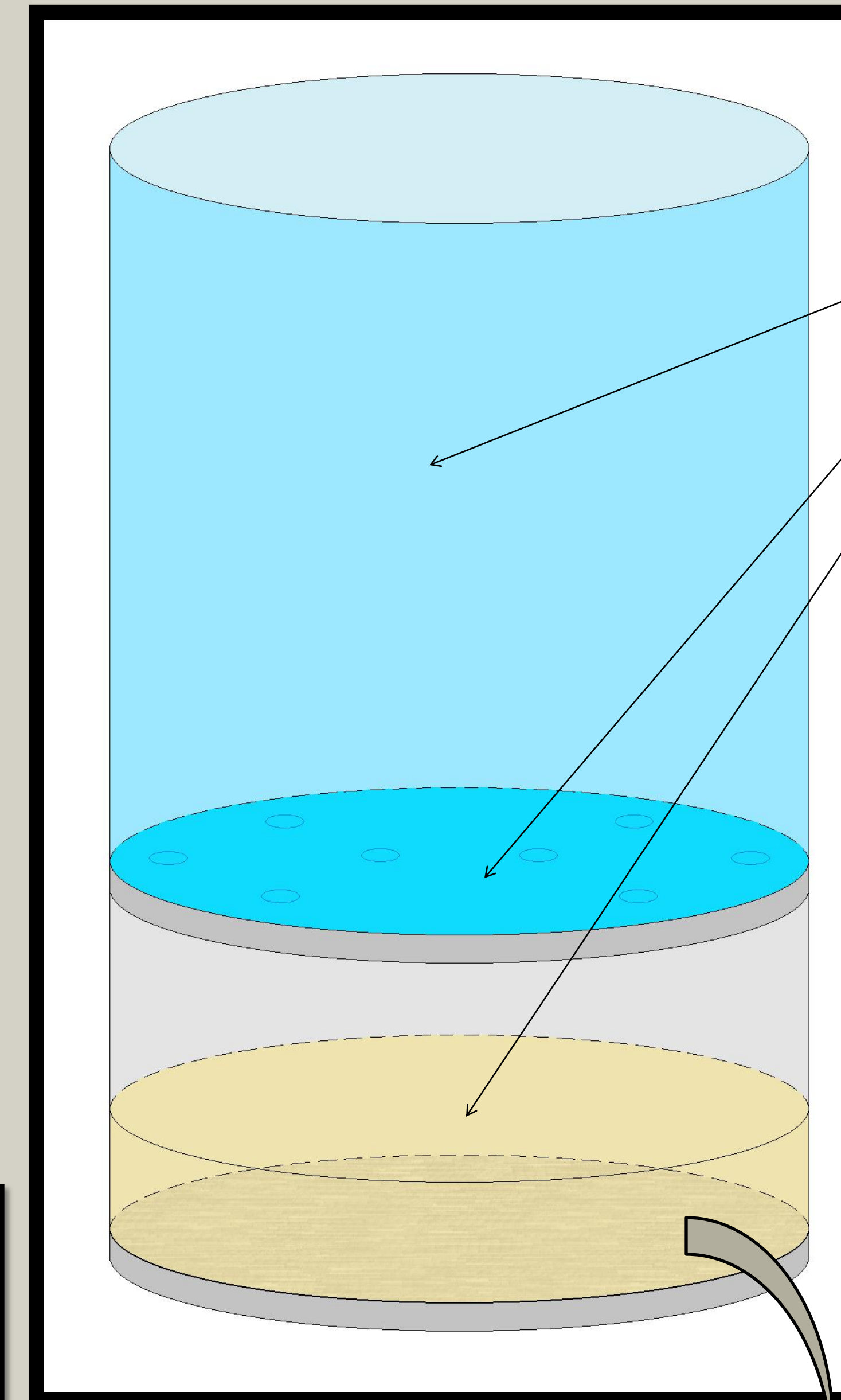


Drainage Pipe off the I-290 bridge over Lake Quinsigamond. © UWM Groups



Part of Lake Quinsigamond, near the I-290 Bridge  
© UWM Groups

“Recent record **rainfall** caused flooding and **contamination** of the lake...Please be advised to **avoid** contact with all **surface waters** including **Lake Quinsigamond...**” – Shrewsbury Board of Health (Shrewsbury Lantern 4/2010)



The Basic Design (drawn by MHiatt)



Microscopic View of Sand Grains  
[http://www.itccs.org/so/images/sand\\_2.jpg](http://www.itccs.org/so/images/sand_2.jpg)

## Solution

Our solution is to filter the bridge run-off with a slow sand filtration system, which will effectively extract the contaminants from the water. There are three main parts to the sand filter we would use:

- 1) Holding Tank that will hold sudden storm water.
- 2) Controlled Release of water onto sand.
- 3) Sand: The sand traps the tiny particulates which contaminate the water, within successive layers of tiny sand grains.
  - Coating: For maximum efficiency, a chemical coating is applied to the grains in the filter which breaks down the particles that get trapped within the filter. A Iron Oxide coating is excellent at breaking down organic materials, arsenic and some metals.
  - Iron Filings: Mixing the sand with iron filings will help with the removal of phosphorus.

## Implementation

In order to implement this project, we would need to calculate the specific size of the unit that is required to adequately filter the runoff. Using formulas from the article, *Stormwater Sand Filter Sizing and Design A Unit Operations Approach* by Ben Urbanas, we can determine the necessary size of the filter and tank.

We first calculate the Total Suspended Solids which is the concentration of particles in the runoff.

$$L_a = 0.2265 \cdot A_c \cdot P_A \cdot E_s$$

Where,  $L_a$  = the average annual TSS amount in the stormwater from the bridge

$A_c$  = the are of the catchment / bridge in acres

$E_s$  = Event Mean Concentration of TSS OR  $\frac{\text{TSS load}}{\text{total flow}}$  < -during the event, in mg/l

$P_A$  = average annual stormwater runoff from the catchment area in inches.

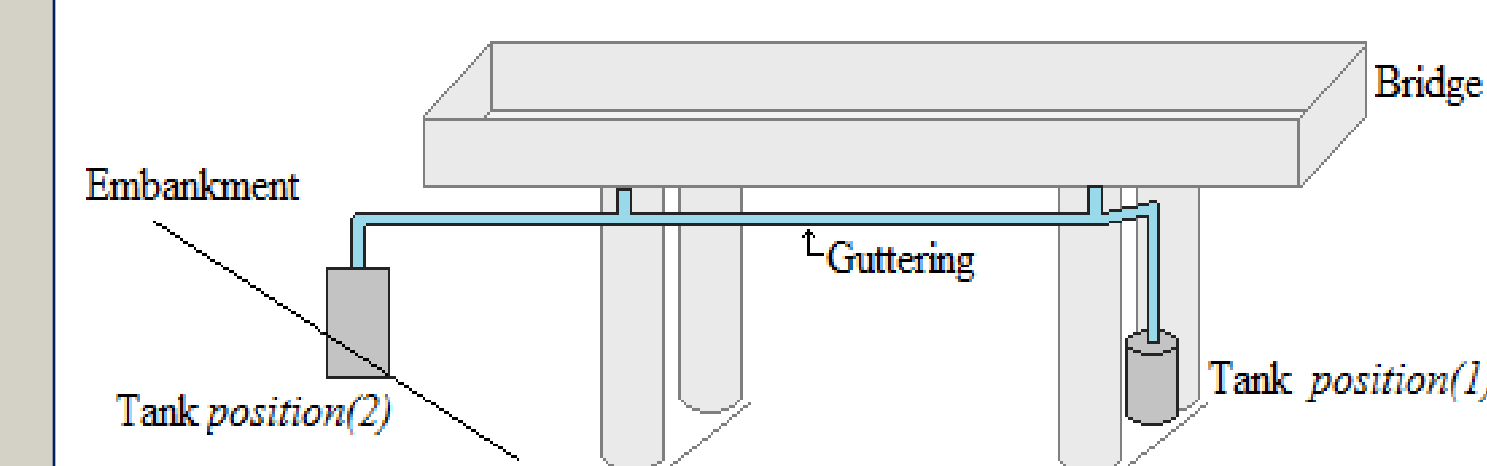
Then we can calculate the size of the sand filter.

$$A_A = \frac{L_a}{L_m \cdot M}$$

Where,  $L_m$  = the average TSS load removed, per sqft of the filter during each maintenance cycle, in  $\frac{\text{lb}}{\text{sqft}}$

$m$  = maintenance cycles per year (number of times filter is cleaned)

$A_A$  = surface area of th filter sized on the basis of TSS Load, in sqft



The sand filter and holding tank could be positioned below a bridge on one of the support pillars (fig.2, position1) or on the river embankment (fig.2, position2).

Guttering would be run from the end of the runoff drainage pipes to the top of our filtering tank (fig.2).

In the case of the I-290 Bridge, we would place the tank and filter in the soil embankment beside bridge. From our design and implementation process, we show that this project can be designed and used on other bridges as well: not just the I-290 bridge over Lake Quinsigamond.

## Acknowledgements

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## Selected Bibliography

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- Logsdon, G. S. (2008). Water Filtration Practices: Including Slow Sand Filtration and Precoat Filtration. *American Water Works Association*.
- Urbanas, B. R. (1999). Design of a Sand Filter for Stormwater Quality Enhancement. *Water Environment Research*, 71(1), 102-113.