100 Potomac Ave. SE
Stormwater Bio-Filtration

Prepared by:

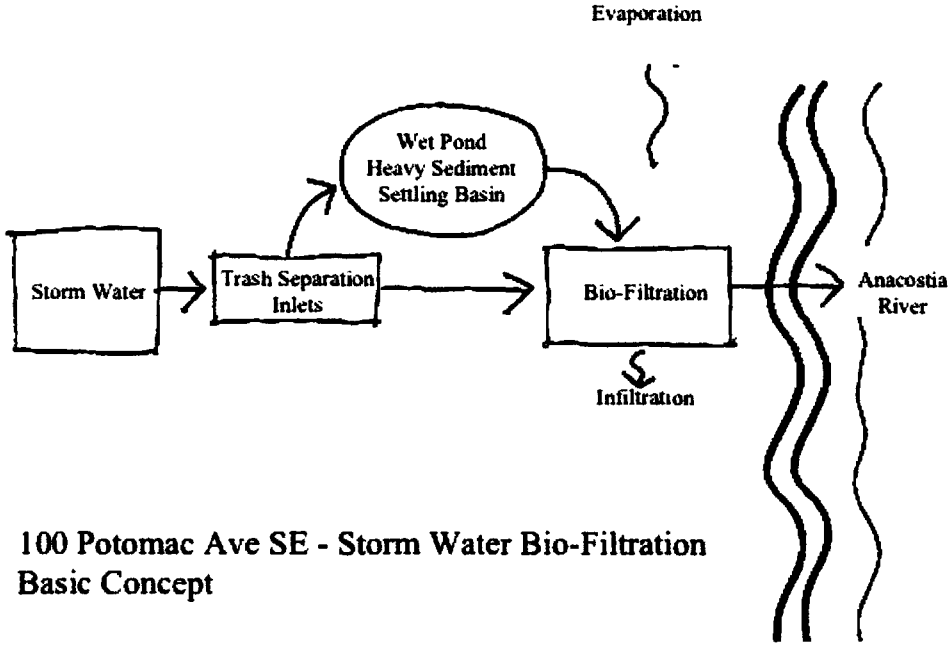
James Urban FASLA
Landscape Architecture

August 23, 2004

100 Potomac Ave SE
Stormwater Bio-filtration

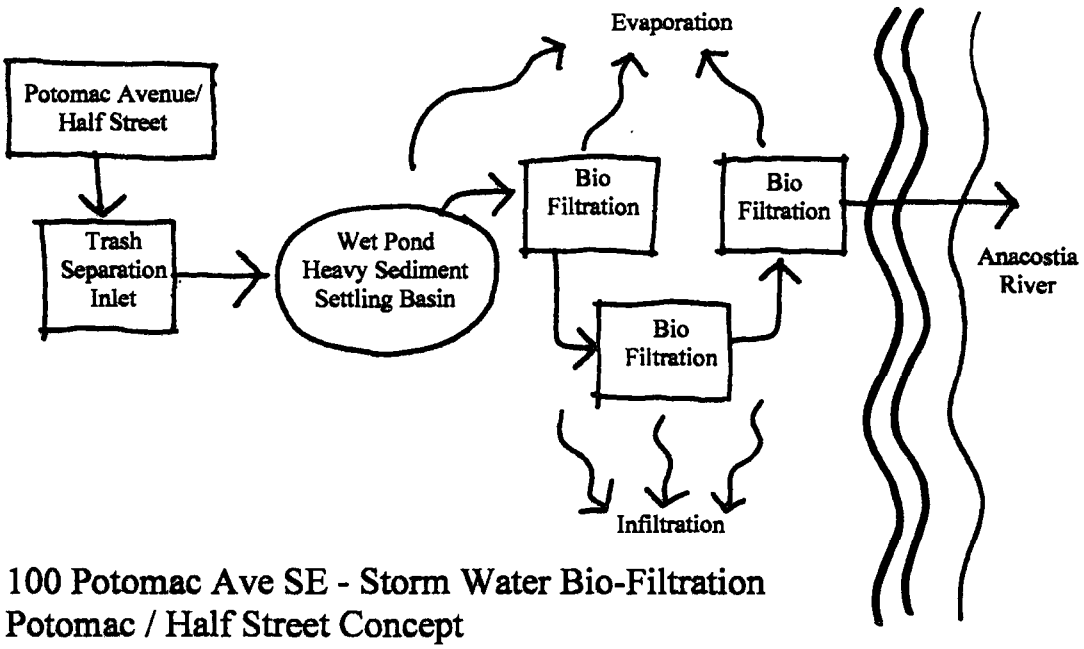
An effective and environmentally conscious method of containing, slowing down, and treating storm water runoff is found within the science of bio-filtration. Bio-filtration utilizes some of the same aspects as a traditional storm water management system, however, with bio-filtration the water is temporarily captured in shallow planted depressions that hold the water and filter out harmful substances. The plants use some of the water, some evaporates into the air and the remainder is slowly released or, in some instances, allowed to infiltrate into the surrounding soil. Bio-filtration areas can be as simple as a small area tucked into the corner of a site, or they can be constructed with multiple bays to treat the runoff in stages. Most bio-filtration areas are designed as dedicated engineering objects that contribute little to the aesthetic quality of the landscape. In the case of 100 Potomac Ave, bio-filtration is designed as an integral part of the entire site's landscape and will be designed to become the basis of the landscape aesthetic.

The 100 Potomac Avenue project presents an ideal project to explore a new level of urban bio-filtration design. Due to the size of the project and the amount of impervious surface, coupled with the topography of the land, storm water runoff can be collected in stages at different elevations and treated to improve its quality. An even more important rationale for bio-filtration on this project is the fact that the Anacostia River is adjacent to the project site. Major rivers like the Anacostia are constantly subject to polluted runoff from large areas of land along their banks. Polluted water entering the Anacostia River flows into the Potomac and the Chesapeake Bay. Decreases in oyster and crab populations, as well as native grasses in the Bay, have all been linked to storm runoff that has been polluted with chemicals, excess silt, and high nutrient loads. The pollutant load from the urban environment upstream of this project is making a significant contribution to the pollution in the Anacostia River. The Chesapeake Bay Foundation has demonstrated that riparian buffers along bay tributaries can contribute significantly to improving the Bay's water quality. But how do we make a vibrant urban waterfront-gathering place also function as a riparian buffer, usually associated with woods, fields and marsh grass?



100 Potomac Ave SE - Storm Water Bio-Filtration
Basic Concept

Two important principles must be followed to accomplish this goal. The first is that the design team must commit to making surface storm water treatment a priority function in every civil engineering and landscape architectural design decision. The existing views of civil engineering as the manager of water and landscape architecture as the manager of site aesthetics must be fused together. The second principle is that the design must explore a critical path that creates new solutions that will be unique to this site. Standard practices and details of bio-filtration must be re-considered to fit into an urban landscape. Water must be held at as high an elevation in the landscape as possible for as long as possible. Standards of pipe flow rates, slope minimums, cleanout frequency and other maintenance functions must be developed along with the design. Standard plant selections and plant maintenance cycles must be re-thought.

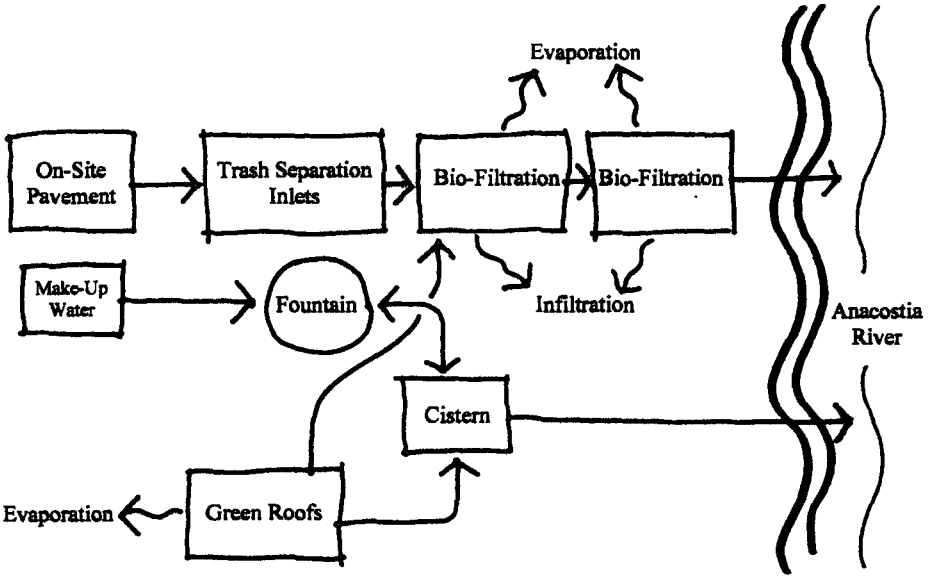


100 Potomac Ave SE - Storm Water Bio-Filtration
Potomac / Half Street Concept

Potomac Avenue/Half Street:
The bio-filtration strategy on this project will be carried out through a series of interconnected approaches or layers. The site can be broken down into two parts. The first, the Potomac Avenue/Half Street area, is subject to various contaminants from construction sites, traffic, and other functions of city life. The water flowing from this area will contribute more negatively to the quality of the storm water runoff than the area around the buildings. Storm water from the Potomac Avenue/Half Street area will be directed toward a large wet pond located in the triangular park north of Potomac Avenue. By "wet pond" we mean that there will always be water in this pond, even when it is not providing storage for runoff. Maintaining a minimum water level will allow the pond to be an aesthetic feature such as a fountain. . Fountain jets within these ponds will aerate the water to keep it from becoming stagnant. Critical to the success of this feature will be making the pool have strong architectural edges so that the rise and fall of the water does not create conflicts with edge planting. This pond will receive large loads of water that will be carrying trash debris, silt and sediment, turbidity (clay and organic material), and toxins introduced by humans. Floating trash will be screened by special trash separating inlet designs in the street prior to arriving at the pond. When the pond is providing storage for runoff, the water level in the pond will rise and fall with a minimum of 12" of difference between low and high water levels expected. Once the water enters the pond, a diverter flow system located under a pedestrian bridge will allow for any suspended sediments to settle out to the bottom of the pond. These are the first steps in improving the quality of the runoff before it flows on to the bio-filtration basins. The pond edges will have special access features to allow for easy and frequent cleanout of accumulated sediments. Maintenance will be similar to any conventional water feature.

Once the wet pond reaches its maximum water holding capacity, the excess water will flow through a pipe system down to a second, two stage, planted, filtering basin at the

east end adjacent to the project. This filter bed can also handle some of the water from First Street SE. Some of the water and the waters pollutants will be taken up by the plantings as it percolates into the special absorbing soils of the bed. The soil itself will retain much of the pollutant load. Water will be allowed to infiltrate into the adjacent soil, and subsurface drain lines within the bed area will collect excess water in the absorbing soil. The water will then be delivered to a third filter at the river's edge. The duration and intensity of the storm event will determine how much water reaches the final filtering basin before being released into the river. Water from low intensity rain events may not ever reach the river, as all of the runoff will have been taken up by the plants, evaporated, or will have percolated back into the water table. In any event, any runoff that is released into the water will have been cleaned of sediment and pollutants during the filtering process at each basin prior to its release. As in the wet pond area, attention to the edge details of the beds by providing strong architectural edges will increase the aesthetic impact of this feature.



100 Potomac Ave SE - Storm Water Bio-Filtration
Building Perimeters Concept

Building perimeters:
The pedestrian and vehicular spaces around and between the buildings present a slightly less challenging filtering problem. The water flowing off of these areas will be cleaner and the water volume smaller due to smaller drainage areas. The surfaces in this area will receive regular cleaning and better maintenance than can be expected at Potomac Avenue and Half Street. There will be no upstream construction or large truck traffic, and winter accumulations of sand and grit will be lower and expected to be removed.

All planted areas around the buildings will have some absorbing and filtering function. And grades are designed to avoid the use of conventional inlets wherever possible. Planted bio-filtration basins will provide for the collection and treatment of runoff through similar methods as described above. Two small wet pools, one adjacent the Hotel Plaza and the other at the south end of the Pedestrian Allee, will provide for initial sediment control. Water plants in contained areas within the pools will allow for them to appear as planted pools and still allow periodic cleaning of sediments. Fountain jets within these pools (similar to the wet ponds above) will aerate the water keeping it from becoming stagnant. These pools not only treat the water and allow for sediment to settle out, but also provide a visual amenity to the project. Some of the rainwater from the roofs will be directed to a pair of underground cisterns. The water can then be recycled back into the two fountain ponds as needed during times of low water levels.

Along the river walk, large filtration beds receive all the water from the spaces around the building and excess roof runoff. This filtered water provides water for the trees and plants and percolates into the soil under the beds. Excess runoff is returned to the river. During low-level rain events, all of the water that flows into the river will be filtered, and during large storm events, the first and last portions of the storm will be filtered with water that exceeds the capacity of the system bypassed directly into the river.

Green roofs provide environmental benefits such as holding capacity and filtering for rainwater, as well as improved efficiency of building performance during winter and summer months.

Green Roofs: The other major component of bio-filtration in this project will be the utilization of green roofs. Green roofs are widespread in Europe and are now gaining popularity in the United States. They consist of anywhere from 2"- 4" of growth media placed directly on the roof's waterproofing membrane with a layer of drain board and styrofoam between the membrane and the growing media. Low maintenance plants such as sedum are planted in the growing media. There are hundreds of varieties of sedum and other plants that can be planted.

A green roof provides several benefits, not only to the environment but also to the building itself. The water holding capacity for storm water and treatment of that water by plant uptake means that there is less water exiting the roof. In the case of this project, the water that does drain through the green roof and exits at grade has had some pre-treatment before entering a cistern or another bio-filtration basin located along the bike/pedestrian path. The water is again treated in the basin before being released into the river.

Green roofs also serve the purpose of protecting the building's roof which results in a longer than average lifespan of the roof. They also insulate the building, which lowers heating costs in the winter, while lowering cooling costs during hot months. Finally the plants and the evapo-transpiration of the stored water reduce the heat island effect created by most city buildings, which has a cooling effect on a wider area. Some of the green roof areas will be actual roof gardens where building occupants can go out on upper level

terraces. These areas will have thicker soil volumes and be planted with different types of shrubs including small trees. While roof gardens have significantly higher maintenance requirements than green roofs, they provide equal or higher environmental benefits.

Hundreds of available varieties of sedum produce year round interest and color to a green roof installation.

Capacity: The levels of filtration and retention provided by this system are designed to treat the maximum amount of water possible. It is expected that this will far exceed the current legal requirements for treatment. Providing for maximum capacity rather than legally minimum capacity provides three important benefits. The first is the obvious environmental benefit of cleaning as much water as possible. The second is that the larger capacity will spread out sediment concentration over a wider area reducing the frequency of maintenance and problems with the system. The third is that the larger capacity tends to even out the high and low water periods, which will allow the use of a wider range of plant types.

Storm water runoff from large areas of paving can be treated by bio-filtration beds.

Aesthetic considerations: Typically, infiltration and bio-filtration basins have somewhat of an unkempt appearance. The reason for this is that they are usually planted with native species; those plants that will grow and thrive within the environment in which they are normally found in the wild stream edge environments the bio-filtration system is trying to mimic. Most of the existing bio-filtration systems have been developed in suburban environments. There cost and maintenance expectations are lower, space is more abundant and aesthetic expectation is lower. Many of the current designers of these systems have embraced the appearance of a naturalized aesthetic of native plants mimicking wild stream edge landscapes. To some viewers this is considered unkempt and unattractive while other consider it to be wonderful, beautiful, ephemeral visions. The advantages of a naturally wild system are that there is a much lower maintenance requirement. The water regimes in a low maintenance bio-filtration system are extreme from highly saturated soils at some points in the year to very dry soils at other times. Native plants when they are permitted to grow and respond to these conditions will survive. Pruning, pesticides, herbicides, and fertilizers are unnecessary, allowing the runoff to remain cleaner. Irrigation systems are not required, as native plants have the ability to adapt to drought conditions. But that adaptation is that often portions of the plant loose its leaves or die back during dry periods with rapid wild growth during wet seasons. The idea of plants that adapt and are more successful certain times of the year than others is acknowledged and accepted. The natural system has the ebb and flow of seasonal change.

There are designers and other urban land stakeholders who feel that a wild landscape image is inappropriate in an urban environment. The creation of a more formal urban aesthetic presents additional challenges to the long-term success of the bio-filtration portion of the project. It requires a high level of seasonal uniformity of the plants. It also promotes the idea that the uniformity, size and density of the plants are controlled. Achieving this goal requires more uniform seasonal water levels in the soil, and requires an increase in maintenance levels. Pruning, plant replacement, the application of fertilizers, herbicides & pesticides, and supplemental watering result in increased costs and lower environmental benefits to maintain this seasonal aesthetic uniformity.

Fortunately there are ways to achieve a high level of plant uniformity and a reduction in wide swings in water levels. As soil volumes are increased, the water fluctuations will decrease. Adequate knowledge of the dynamics of soil type, soil compaction and drainage allow for a better balancing of the water levels. The increased use of walls and curbs to retain and direct water can facilitate a more even distribution of water in the beds while contributing to a cleaner more architectural appearance. Matching plant selections to both water and aesthetic expectations can permit tighter, and more formal urban landscape appearance. Restraining the plant palette to a few plant species will achieve a more uniform image. Increased maintenance can repair and replace plants where water imbalances create less uniformity than can be accepted. Finally, occasional supplemental watering will be required to avoid the widest soil moisture swings during periods of extreme drought.

By grading paved areas toward bio-filtration beds, storm water quality can be greatly improved before it reaches the river.

A stone edge collects and conveys runoff from the adjacent paved area to be conveyed to a bio-filtration bed.

Collection trenches convey water to filtration beds.

Surface elements like this water garden can be created through the reuse of runoff captured in underground cisterns. Ponds also treat runoff by allowing heavy sediment loads to settle.

Fountains provide additional water quality improvement through aeration.

Summary: The 100 Potomac Avenue project can be a study in water quality improvement and reuse. The design will serve several functions, all of which will improve water quality within the limits of the project site, but also contribute to ecological improvements of the river and the Bay. Overall storm water quality will be improved through the removal of trash, silt and sediment, clay and organic material (turbidity), human introduced chemicals and toxins, and nutrient loads. The design will also capture and harvest water to be utilized for on-site amenities such as fountains and provide for the reuse of water to plants without active irrigation. Finally, the introduction of green roofs on the buildings will improve the efficiency of the roof membrane and the buildings heating and cooling systems resulting in less wasted resources. Green roofs will also decrease the urban heat island effect by reflecting heat, which will lead to an improved microclimate for the site to the benefit of the occupants of the buildings and its public spaces as well as the wider region.