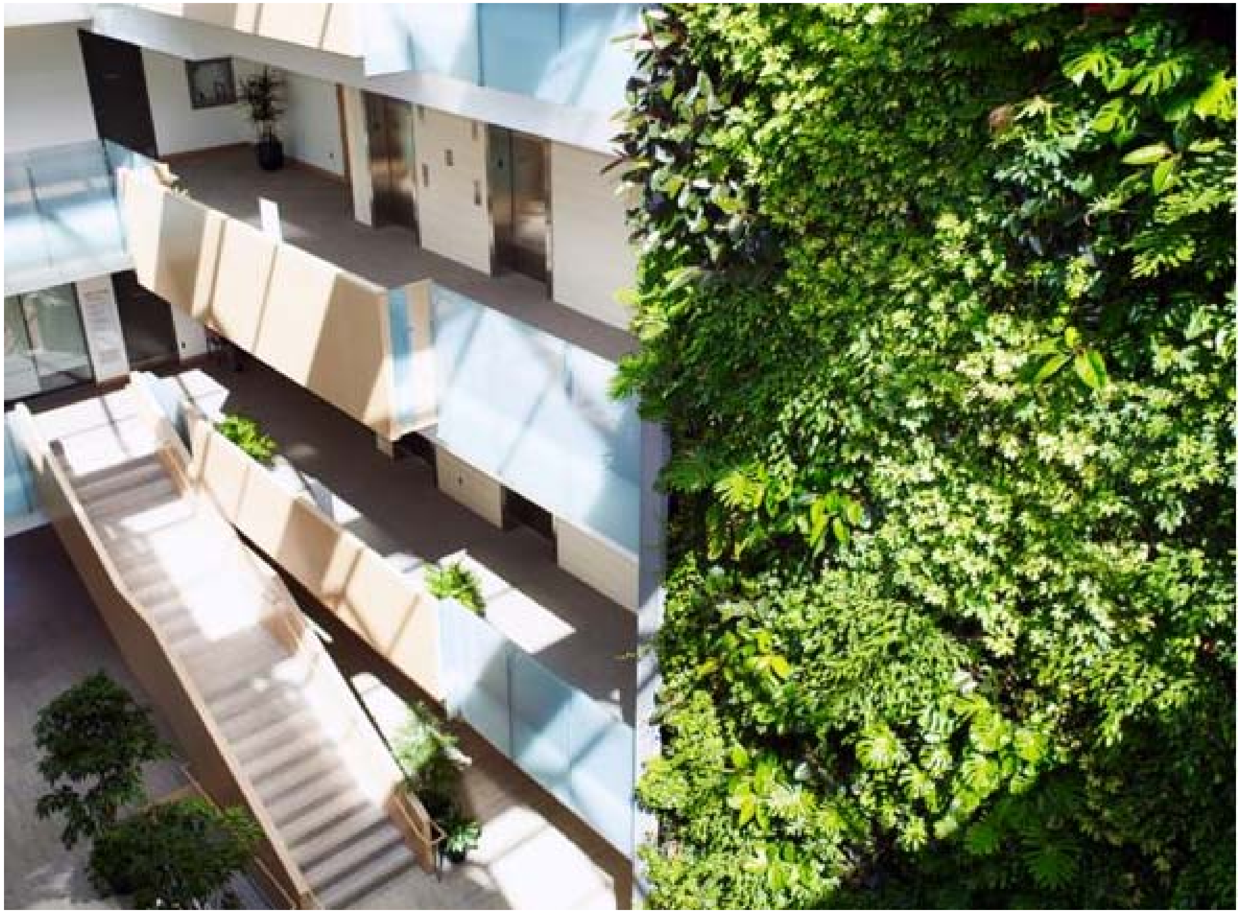
This Online Learning Seminar is available through a professional courtesy provided by:

Nedlaw Living Walls
232B Woolwich St., S.
Breslau, ON N0B 1M0
Tel: (519) 648-9779
Fax: (519) 648-3508
Email: livingwalls@nedlaw.ca
Web: www.nedlawlivingwalls.com/

START

powered by @AECDAILY www.aecdaily.com



Living Wall Biofilters: Growing Clean Air and Energy Savings

Living Wall Biofilters: Growing Clean Air and Energy Savings

Presented by: Nedlaw Living Walls
232B Woolwich St., S.
Breslau, ON N0B 1M0

Description: At first glance, a living wall biofilter appears as a vertical, hydroponic green wall of plants. However, it is an active filtration system that is an integrated part of the air handling system for a building. This course explains how living wall biofilters improve indoor air quality, enhance building performance, and create healthier, more pleasant indoor environments.

To ensure the accuracy of this program material, this course is valid only when listed on AEC Daily's Online Learning Center. Please click here to verify the status of this course. If the course is not displayed on the above page, it is no longer offered.

The American Institute of Architects · Course No. AEC911 · This program qualifies for 1.0 LU/HSW Hour.

AEC Daily Corporation is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES). Credit(s) earned on completion of this program will be reported to AIA/CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request. This program is registered with AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product. Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

This course is approved by other organizations. Please click here for details.

AEC Daily Corporation has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

RCEP

REGISTERED CONTINUING EDUCATION PROGRAM

Purpose and Learning Objectives

Purpose: At first glance, a living wall biofilter appears as a vertical, hydroponic green wall of plants. However, it is an active filtration system that is an integrated part of the air handling system for a building. This course explains how living wall biofilters improve indoor air quality, enhance building performance, and create healthier, more pleasant indoor environments.

Learning Objectives:

At the end of this program, participants will be able to:

- discuss how living wall biofilters improve the aesthetics and the physical environments of the facilities in which they are installed, and how they affect the health and well-being of the occupants
- explain how living wall biofilters remove common indoor contaminants through biological processes and deliver cleansed air into interior spaces
- discuss the impact living wall biofilters have on building performance and energy costs compared to traditional air handling systems, and
- summarize the design considerations and construction of living wall biofilters.

How to Use This Online Learning Course

- To **view** this course, use the **arrows** at the bottom of each slide or the up and down arrow keys on your keyboard.

- To **print or exit** the course at any time, press the **ESC** key on your keyboard. This will minimize the full-screen presentation and display the menu bar.

- Within this course is an ★ **exam password** that you will be required to enter in order to proceed with the online examination. Please be sure to remember or write down this exam password so that you have it available for the test.

- To receive a **certificate** indicating course completion, refer to the instructions at the end of the course.

- For **additional information** and post-seminar assistance, click on any of the logos and icons within a page or any of the links at the top of each page.

Table of Contents

Click on title to view

University of Ottawa, Ottawa, Ontario

Drexel University, Philadelphia, Pennsylvania
Photo Credit: Sean Corbett, Drexel University

Introduction

We Are an Indoor Species

We spend between 80% to 90% of our time indoors. It is too cold in the winter and too hot in the summer to venture outside. For almost our entire life, we breathe air in buildings that are sealed like airtight jars to provide a controlled environment. This separates us from the outside world.

Increasingly, links are being made between indoor vegetation and the health and well-being of occupants. Indoor vegetation is part of biophilic design, which incorporates nature into the spaces where we live, work, learn, and enjoy our leisure time. Building-integrated vegetation not only offers us a means of reconnecting with nature, but also can reduce occupant stress, improve productivity, and generally enhance an occupant's experience of and aesthetic satisfaction with a space.


Kamloops, BC

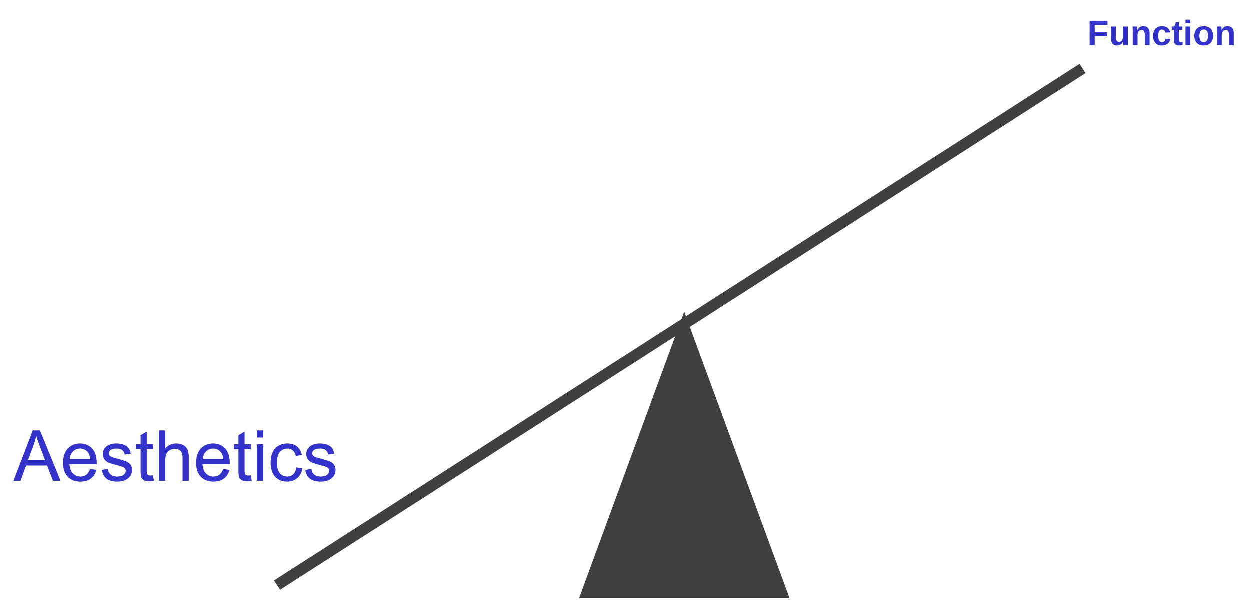

Grimshaw Architects (NYC)

We Are an Indoor Species

Studies show that people perform better in spaces with improved air quality. However, providing adequate indoor air quality to satisfy the well-being of occupants can consume over 30% of a building's overall energy consumption.

Green Vertical Walls

One of the more dramatic ways to incorporate vegetation into a building is through the use of green vertical walls or living plant walls. They are beautiful and add life to otherwise dreary environments. Their incorporation is almost entirely driven by aesthetics. The functionality of a green vertical wall is largely only a passing concern. But surprisingly, in many ways, simple living plant walls actually diminish building performance. Their labor-intensive systems require utilities such as water and power, but offer very little, if anything, in the way of improved building operations.



Living Wall Biofilters

An exception to non-functional, aesthetic, green vertical walls are living wall biofilters. These systems are beautiful plant walls that have been engineered to be integrated right into the building environment. Living wall biofilters clean air using the same processes that nature uses and succeed at improving both the aesthetics of the space and building performance.

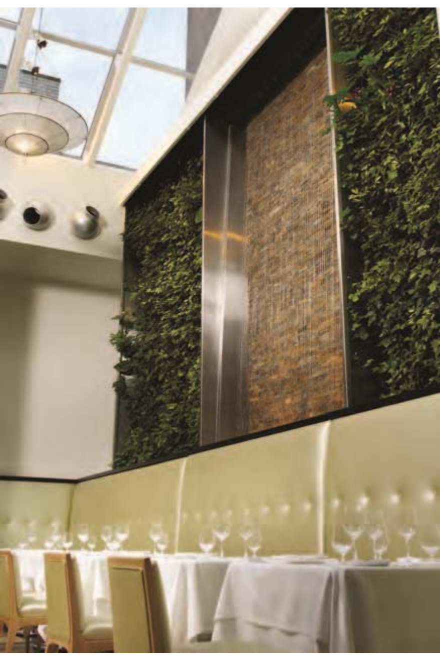
Living Wall Biofilters

A living wall biofilter is a vertical, interior plantscape of a diverse mixture of plants that effectively improve the conditions of the interior space. They remove common indoor air contaminants, provide aesthetic and acoustic benefits, and help create energy efficient, sustainable building structures.




Living Wall Biofilters

Living wall biofilters come in different sizes and while most are custom designed, developed, and installed, standard sized units for offices and homes are available. They are designed to work in spaces ranging from the factory floor to animal housing, from schools to nightclubs, and from small private offices to grand meeting spaces.



St. Gabriel's Passionist Parish, Toronto, Ontario
Project is LEED Gold®

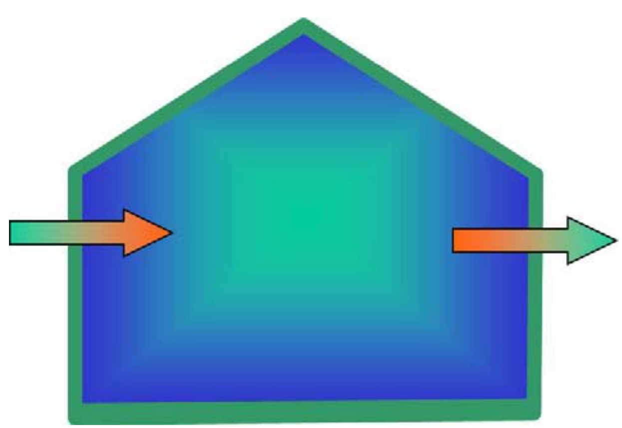
How Living Wall Biofilters Work

Indoor Environments

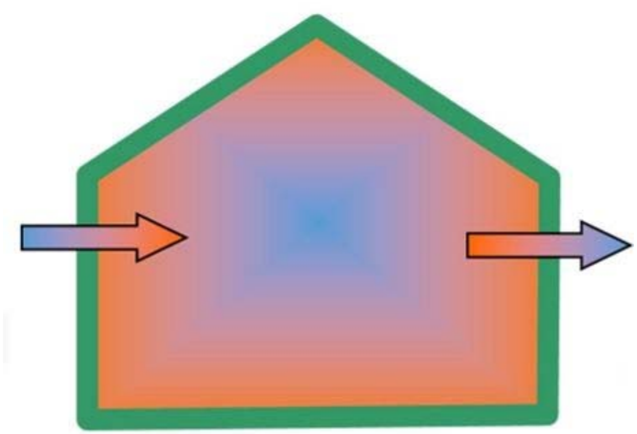
The interiors of our buildings are very artificial environments which rely on mechanical systems to provide the desired conditions. Unfortunately, indoor air is negatively affected by a number of factors including poor ventilation, improper maintenance, and the presence of a complex mix of pollutants, from volatile organic compounds (VOCs), toxic chemicals, and odors emitted by building materials and furnishings, to molds, dust, and airborne bacteria.

Traditional Method of Indoor Air Quality Control

Buildings are frequently designed to be airtight to limit the infiltration of outside air, and thereby reduce energy losses and maintain occupant comfort. But sealing a building traps all the pollutants that arise in the interior spaces, allowing them to accumulate to levels that may affect the well-being and health of the occupants. To try to avoid the buildup of indoor pollutants, buildings are ventilated with new, outside (clean) air. However, this new air frequently has to be cooled or heated before it can be used, and as mentioned earlier, this additional conditioning can represent 30% of the energy consumed by the building. If this ventilation is not done, the health and well-being of the occupants is reduced, negatively affecting productivity and increasing absenteeism, etc.



Traditional buildings rely on bringing in new, outside air into the building to maintain air quality



Traditional Method of Indoor Air Quality Control

Building occupants have a fairly narrow range of acceptable, comfortable, interior air temperatures. In the winter months, air entering the building is frequently colder than -20°C (-4°F) so it has to be heated prior to being released indoors. In the summer months, the air entering the building may have temperatures higher than 30°C (86°F) so it must be cooled. The heating and cooling of the airflow can represent a large portion of the energy demand of the building. Building designers and operators are therefore faced with the problem of trying to provide a comfortable indoor environment for the occupants while trying to minimize the energy footprint (consumption and cost) of the building.

Air Quality Control with Living Wall Biofilters

Living wall biofilters offer a means of removing indoor air pollutants without the cost of bringing in new, outside air. Through natural processes, the indoor air biofilter can generate cleansed air within the building that can be used to replace or supplement the introduction of new, outside air.

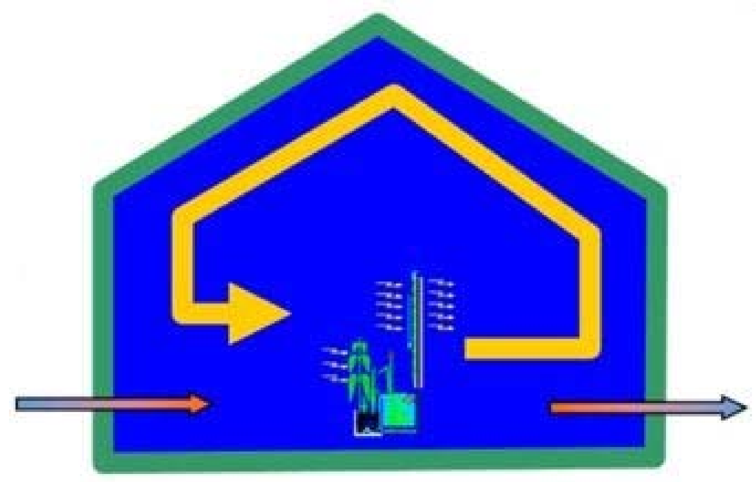
Living wall biofilters improve the indoors by integrating natural systems into an otherwise very artificial environment, and use considerably less energy than conventional systems without sacrificing air quality.

University of Guelph-Humber, Toronto, Ontario

Air Quality Control with Living Wall Biofilters

Since the air entering the living wall biofilter and the cleansed air generated by the living wall biofilter is already at the right temperature and humidity, the extra energy expenses to bring in new, outside air are avoided. One cubic meter of cleansed air requires 80% to 85% less energy to condition than bringing the same amount of air in during the heat of the summer or cold of the winter.

Biofilters improve building operation by supplying clean air without having to bring in expensive outside air.



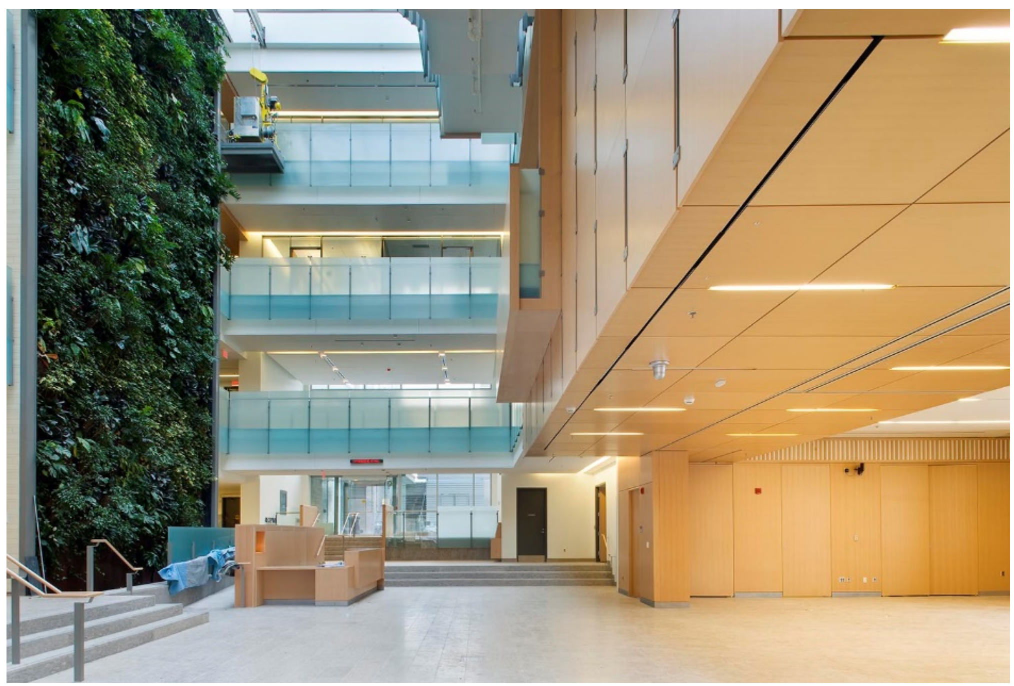
Potted Plants and Indoor Air Quality

Plants alone do very little for indoor air quality. When it is reported that potted plants can remove (some) chemicals from the air, it is not the visible green leaves of the plant but rather the complex microbial community (its biota) growing in the soil that is doing the job. Since the biota in a potted plant is surrounded by masses of soil, an impermeable pot, and even the plant itself, it is extremely inefficient at removing chemicals from dirty air.

To be biologically degraded, air contaminants must first be exposed to the biota, but both the plant pot and soil limit the movement of gases to the microbes. The surface of the soil that is covered with plant material further limits how much dirty air the biota actually accesses and how many contaminants it can remove.

Not Just Plants on a Wall

The ability to actively move dirty air directly through the plant root systems to generate and circulate clean air is one of the key differences between a living wall biofilter and a passive, vertical garden. Dirty air is forced through the plant canopy on a living wall biofilter and into its root zone where the air chemicals, such formaldehyde and benzene, are exposed to beneficial biota. The contaminants are destroyed by entirely natural processes and actively degraded into their benign constituents (i.e., carbon dioxide and water).



City of Cambridge Civic Center, Cambridge, Ontario

A Synthesis of Technologies

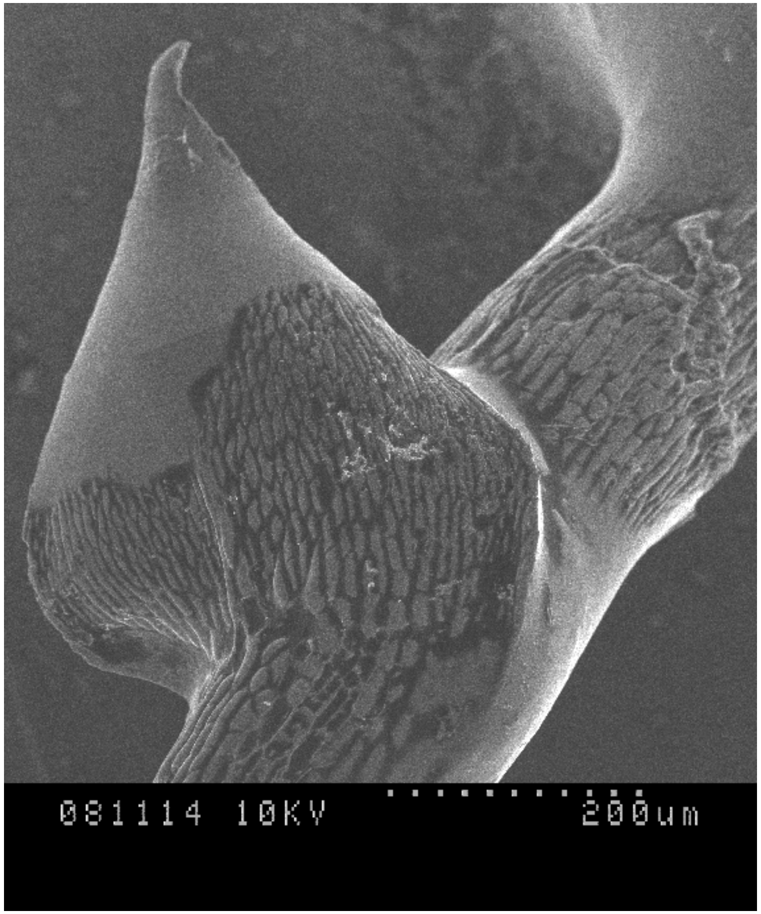
Living wall biofilters remove VOCs and other pollutants by combining the processes of three widely used technologies that have been specifically adapted for indoor application.

- Biofiltration - putting microbes to work
- Phytoremediation - putting plants to work
- Hydroponics - putting it all together

University of Windsor Medical Building, Windsor, Ontario

Biofiltration: Putting Microbes to Work

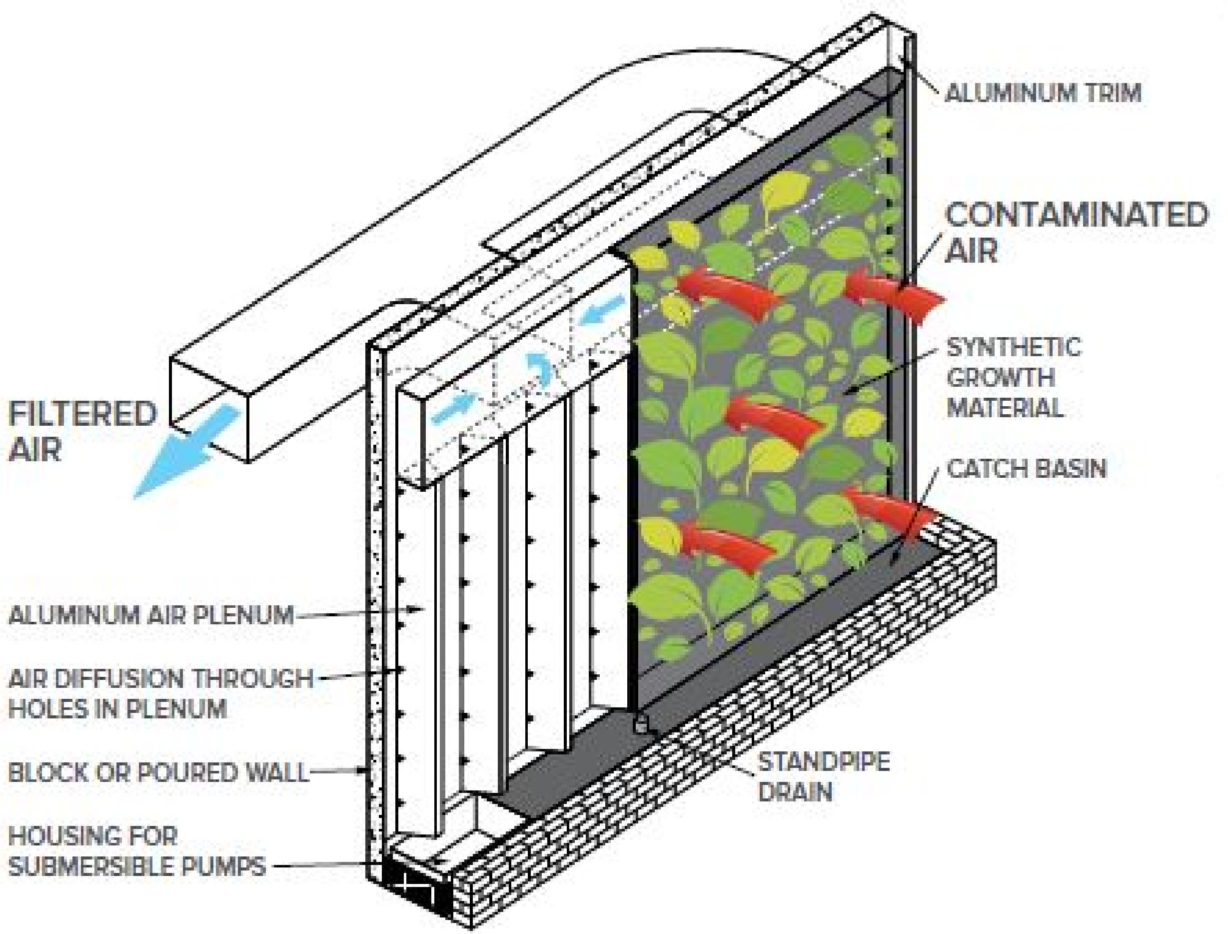
Biofiltration is an environmental technology in which a contaminated airstream is passed through a biologically active zone where a highly specialized biological community of contaminant-degrading microbes use the pollutants as a food source. Just as a colony of ants will consume and clean up a sugar spill on the ground, a biofilter's microbes will eat the chemicals in the airstream.



Tiny microbes on the roots of plants use VOCs and other contaminants as a food source and break them down into harmless compounds.

Biofiltration: Putting Microbes to Work

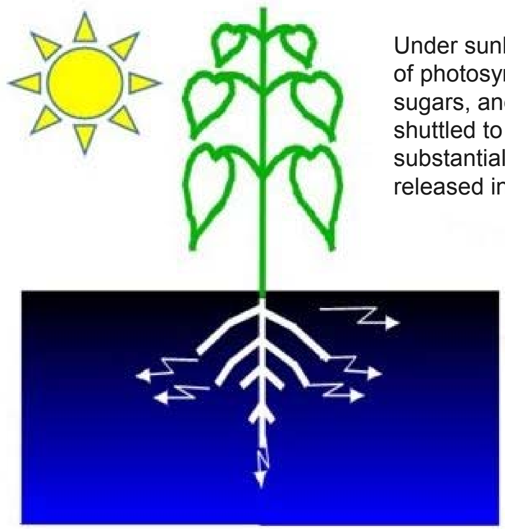
As the dirty air from the interior space comes in contact with the growing (rooting) media, contaminants move into the water phase where they are broken down by the beneficial microbes.



Phytoremediation: Putting Plants to Work

Phytoremediation describes the treatment of environmental problems through the use of plants. It is a common technique used in the recovery of contaminated soil that has been adapted for indoor use.

Living wall biofilters use green plants to create an environment that encourages the activity of specialized biota. The plants provide the range of vitamins, proteins, and other nutrients the beneficial microbes need to maintain a healthy active population that can effectively break down the contaminants passing through the system. Through the process of photosynthesis, plants synthesize nutrients in their leaves and then translocate some of the produced carbohydrates (sugars) to their roots. Once in the root system, the nutrients are released to the surrounding area in the soil, creating a zone of enhanced biological activity.



Under sunlight, the products of photosynthesis (oxygen, sugars, and proteins) are shuttled to the roots where a substantial amount is released into the soil.

The increased nutrient availability leads to enhanced microbial activity.

Hydroponics: Putting It All Together

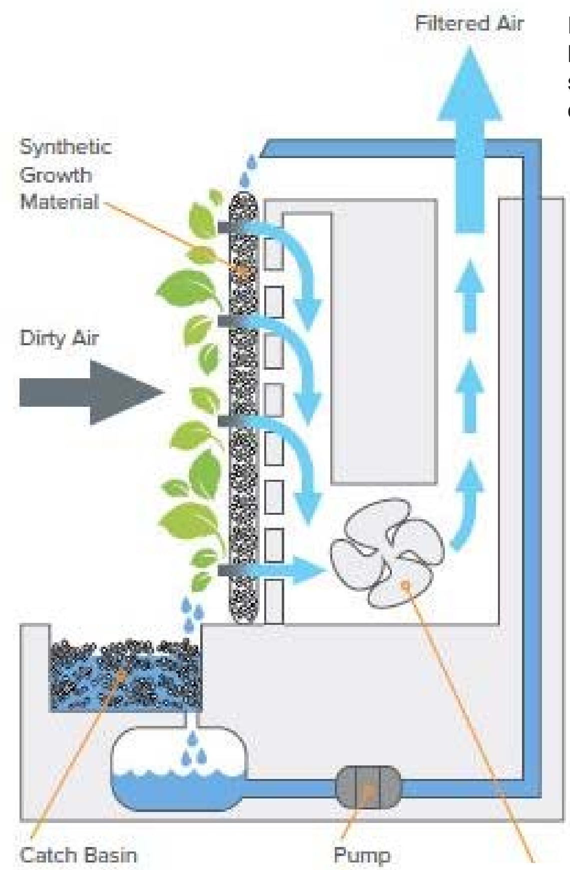
Hydroponics is a technique of growing plants without soil. It has long been used in horizontal installations in greenhouses to grow agricultural crops. Plants are grown in an inert rooting material and all of their nutrients are supplied by irrigation water. Hydroponics facilitates better control and monitoring of a plant's growing environment.

Conventional, horizontal hydroponics

Hydroponics: Putting It All Together

Living wall biofilters combine biofiltration and phytomediation in a vertical, hydroponic system.

Green plants, growing in the vertical hydroponic media, encourage the growth of the beneficial biota in the root zone. The media is connected to the return airstream of the building's air handling system so that room air is drawn through the media and brought in close contact to the biota. An array of air diffusors behind the media ensure even airflow, presenting the contaminants to the microbes in adequate concentrations, for the right amount of time.



Filtered air is drawn into the building's air circulation system or circulated using onboard fans.

Fan draws dirty air through plants and into the growth material where microbes eat the pollutants as a food source.

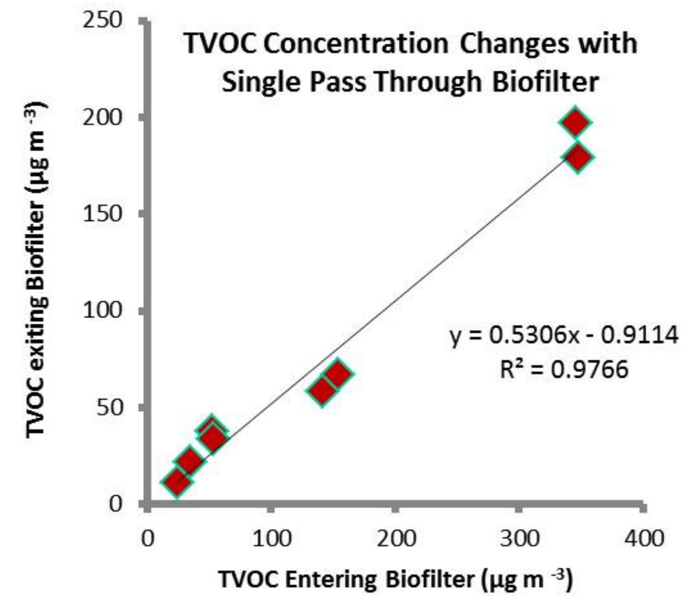
Toronto Regional Conservation Authority (TRCA), Toronto, Ontario

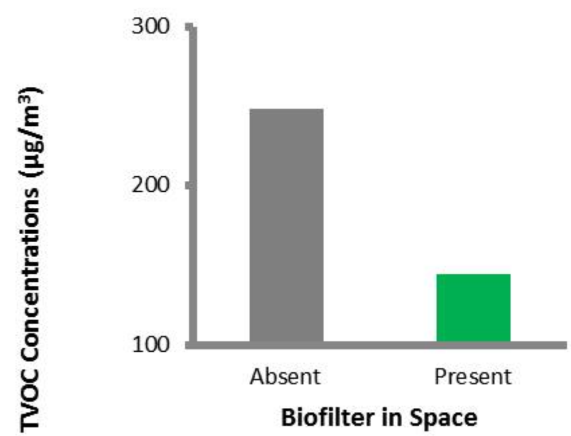
Biofilter Impact on Air Quality and Building Performance

Biofilter Impact on Air Quality

In a recent university study, living wall biofilters were tested under real world conditions. When placed in typical indoor spaces, the airborne pollutant/total volatile organic compound (TVOC) concentrations were reduced by close to 50% by a single pass through the biofilters. The extent of contaminant removal was very consistent over a wide range of air qualities.

A biofilter's overall impact is determined by both the quality of the air generated and the quantity of the air treated. So, given the amount of air treated by the biofilter and its cleaning power, the biofilters in this study generated the equivalent of over 25 liters of virtual outside air every second, or over 50 cubic feet per minute (cfm). What is the impact of this cleaned air on the indoor space? The presence of the biofilter in the indoor space reduced the pollutants by over 40%.





Biofilter Impact on Air Quality

Other studies looked at actual installations in a wide range of venues. The biofilters ranged in size from a few square feet to over 17 m (50′) high and covering an entire wall. They ranged in age from a few weeks to a decade (10 years).

The performance of the biofilters was consistent and predictable, despite their range in age and size. The amount of clean air generated by the biofilter could be easily calculated based on its size and the rate of airflow. The ability to remove pollutants was clearly seen in almost brand new biofilters and remained consistent for years.

University of Windsor Medical Building, Windsor, Ontario

Biofilter Impact on Air Quality

The study found the cleansed air generated by the biofilters to be akin to bringing new, fresh, outside air into the indoor space. It is virtual outside air.

Some biofilters were capable of generating up to 100 liters of virtual outside air per square meter, every second.

One Kids Place, North Bay, Ontario

Biofilter Operation

The biofilter can operate two ways.

First, the virtual outside air from the biofilter can be added to the interior without changing any of the building operating parameters. While this approach results in little change in the energy consumption of the building as a whole, the occupants can enjoy a cleaner, better indoor environment as the biofilter reduces chemicals and smells in the air by up to 40%. This is the most common use of biofiltered air.

John Deere Financial, Oakville, Ontario

Biofilter Operation

Alternatively, if the current indoor air quality is adequate, the virtual outside air can be used to replace up to two-thirds of the normal makeup air coming into the building. This would reduce the size of the air handling system and reduce the amount of energy required to operate it.

The two methods of biofilter operation need not be exclusive. A building's operation can easily fluctuate between the two approaches depending on the current conditions.

Corus Quay, Toronto, Ontario

Biofilter Impact on Building Performance

Proving that biofilters can remove harmful chemicals from a contaminated airstream is only half of the equation. To be truly effective, the living wall biofilter must provide clean air more efficiently than traditional systems.

In other words, do biofilters require less energy than traditional air handling systems to deliver the same fresh air?

Leamington Municipal Office, Leamington, Ontario

Biofilter Impact on Building Performance

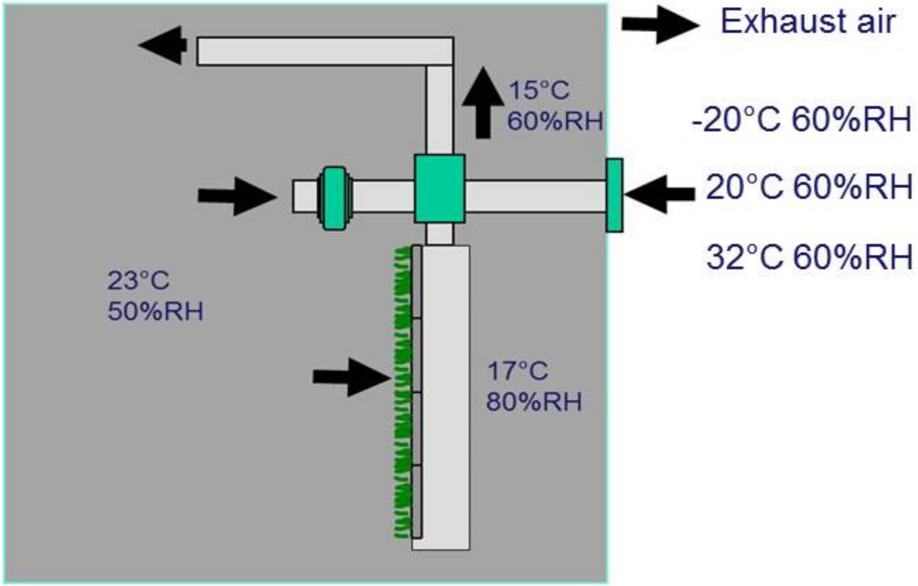
In most modern buildings, air is circulated by the heating, ventilation, and air conditioning (HVAC) system. To maintain ideal occupant comfort levels, these air units take air from the indoor space (e.g., 23°C [73.4°F] and 50% relative humidity [RH]) and condition it (e.g., to around 15°C [59°F] and 60% RH) before returning it to the interior.

To avoid the accumulation of contaminants, a portion of the circulating air is exhausted outside and an equal amount of new, outside (fresh) air is introduced. This new, outside air is commonly between -20°C (-4°F) and 32°C (89.6°F) in North America and as such, has to be heated or cooled before being used. This requires energy.

The conditioning of this new, outside air can represent a substantial energy cost to building owners: under normal operating conditions approximately 10% to 20%, and during temperature extremes over 30%. Because of these expenses, there is little incentive to provide the interior living space with little more than the minimum amount of required fresh air.

Biofilter Impact on Building Performance

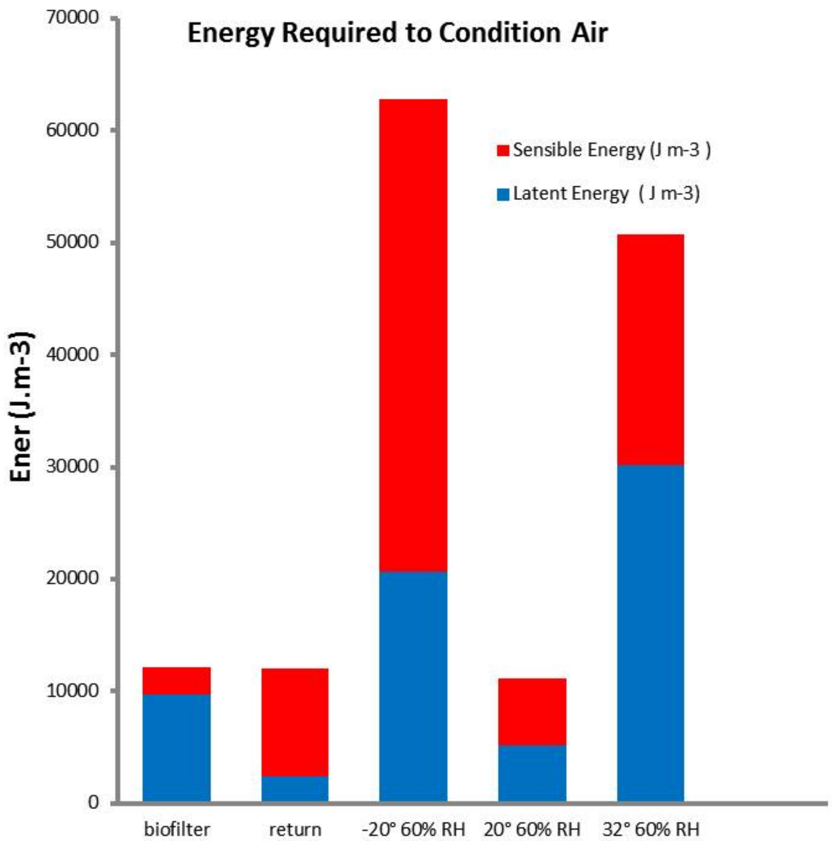
The biofilter's virtual outside air is an alternative to bringing new, outside air into the building. In this graphic, air circulating in the interior space passes through the biofilter and is stripped of chemicals before reaching the air handler. The biofilter naturally cools the air passing through it by roughly 5°C (41°F) and increases its humidity to around 80% RH (due to evaporative cooling).



Energy Required to Condition Air

To condition normal return air, an HVAC system must adjust its temperature (sensible energy) and its humidity (latent energy). Being from the same air mass, the absolute amount of energy to condition air from a biofilter is almost the same as that of normal return air. However, because the air has been cooled, it requires little temperature adjustment, but it may require energy to adjust its humidity.

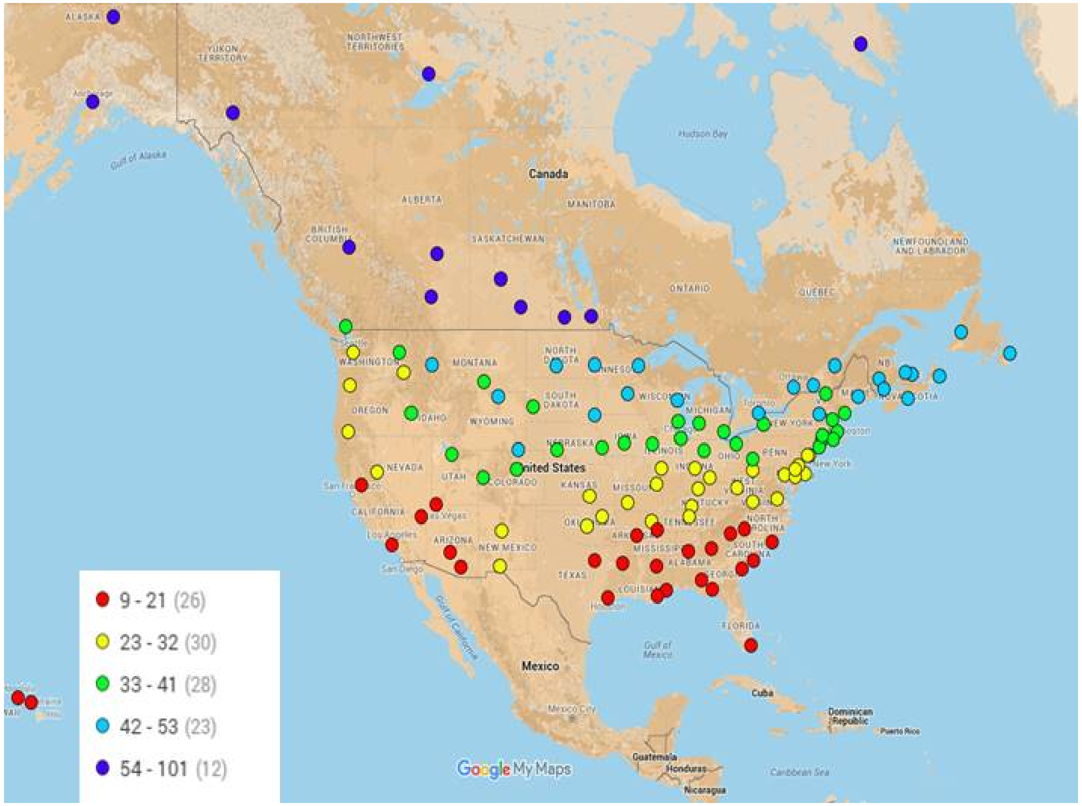
When outdoor conditions are mild, little energy is required to adjust its temperature and humidity. However, under cold outdoor conditions, the air must be heated and humidified prior to use, and in the summer, outside air must be cooled and dehumidified prior to use. These processes require considerably more energy.



As seen in this bar graph, five to six times more energy is required to condition a volume of air brought into a building during the cold of winter and heat of summer compared to treating the same volume of cleansed air by the biofilter.

Biofilter Impact on Building Performance: Total Energy Saved (GJ per year)

RETScreen is a clean energy management software system used to evaluate the impact of different energy strategies on buildings. RETScreen building performance software was used to determine the energy savings associated with introducing 100 liters per second of virtual outside air from the biofilter into the space compared to bringing the same amount of air in from outside for 100 different (theoretical) buildings across North America for an entire year.

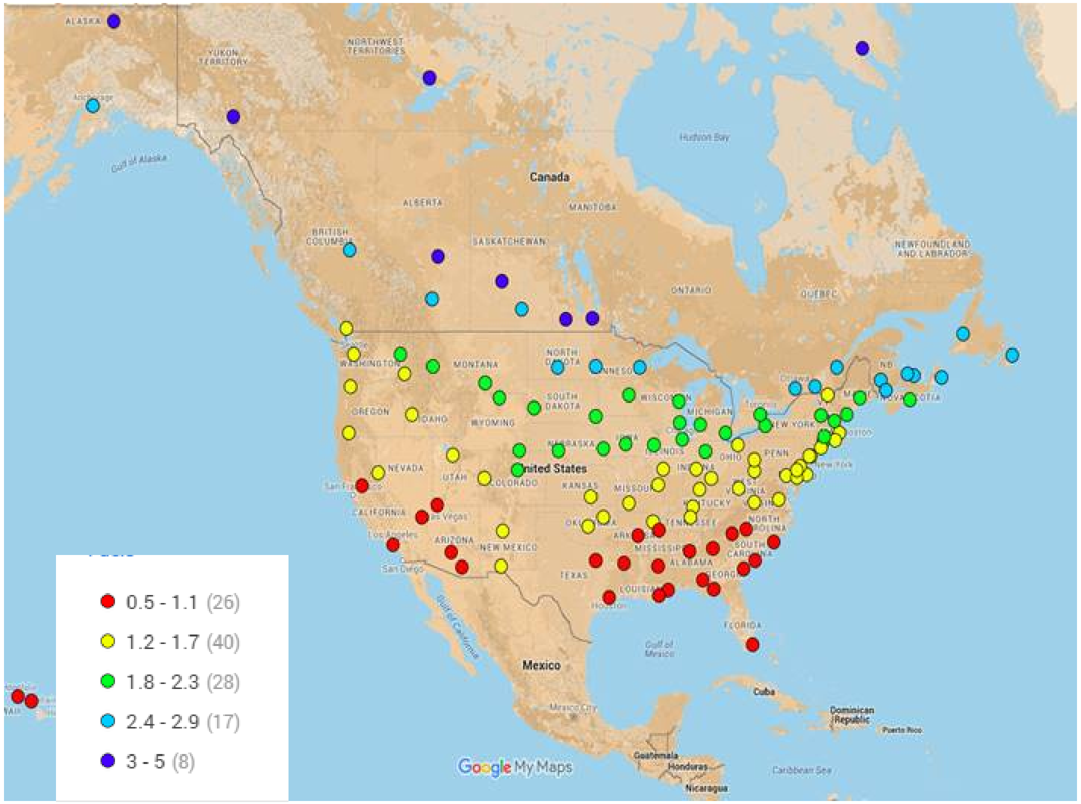


GJ savings (range) per 100 liters of air from the biofilter per year (by location). Example based upon instantaneous conditions (a cold day in winter and a hot day in summer).

This energy model indicates that using biofiltered air takes between 10 and 100 GJ (Gigajoules) less energy than introducing outside air into the building at the same rate.

Biofilter Impact on Building Performance: Tonnes of Carbon Saved

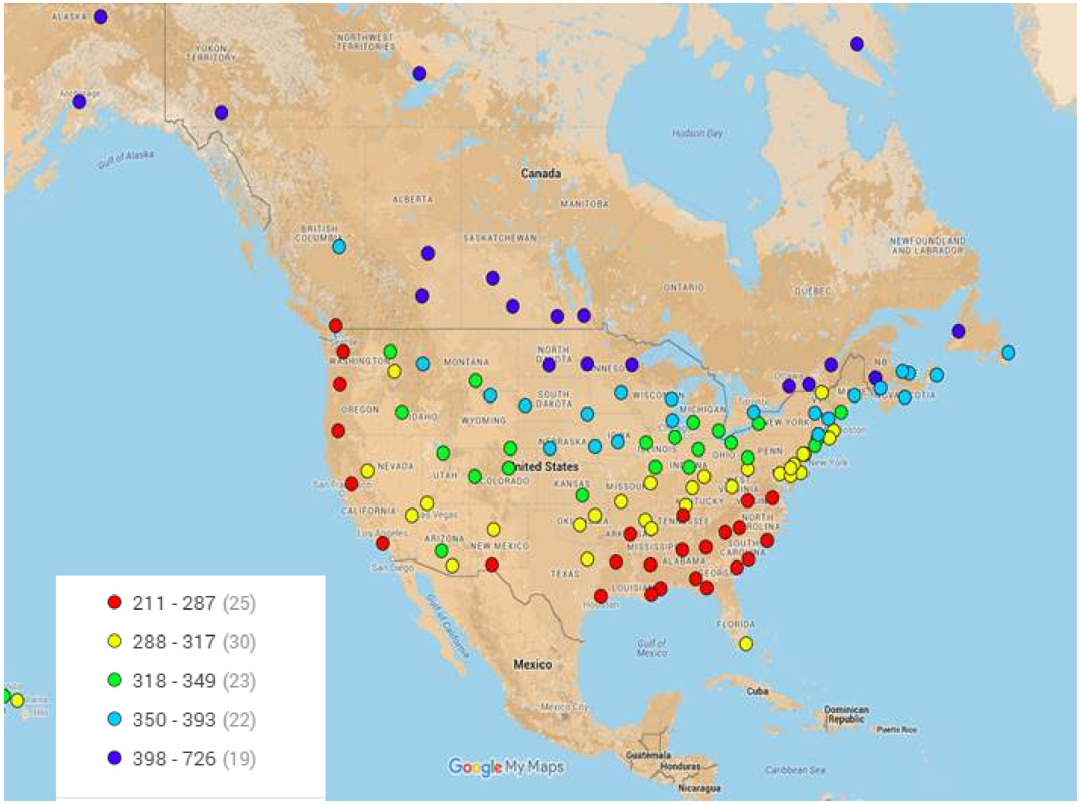
Assuming that the typical buildings are heated by natural gas and cooled by electrically-driven heat pumps, RETScreen calculated the number of metric tonnes (2200 lb) of carbon that would potentially not be released (by using virtual outside air from a biofilter instead of bringing the same volume of air in from outside). The software indicates that 100 liters per second of virtual outside air from the biofilter (released into the space) avoid the release (over the year) of carbon of between 0.5 to almost 5 tonnes.



Tonnes of carbon saved per year (by location). Example based upon instantaneous conditions (a cold day in winter and a hot day in summer).

Biofilter Impact on Building Performance: Potential Dollars Saved per Year

Heating and cooling a building costs money. To a certain extent, the energy required to heat and cool the building can be thought of as a surrogate for dollars. So it is not surprising that, as well as demonstrating the biofilter is a more energy efficient way of supplying clean air to the building, the model also predicts that using biofiltered air is a substantially less expensive alternative to traditional air systems.



Potential cost savings (dollars) per year (by location). Example based upon instantaneous conditions (a cold day in winter and a hot day in summer).

Although energy costs are variable geographically and temporally across North America, the software predicts that using 100 liters of fresh air generated per second by the biofilter would cost less than traditional air systems by between \$200 to over \$700 per year.

Biofilter Impact on Building Performance: Unexpected Results

Buildings tend to be heated by natural gas (a relatively cheap energy source) and cooled by electricity (an expensive energy source). So it was surprising to see the RETScreen energy model predict that replacing outside air with biofiltered air had the greatest impact in more northern locations.

The following two factors combine to make cold climate buildings expensive to maintain:

- When it is cold, it is very cold. In northern North American cities, it is not uncommon to have outside temperatures of -40°C (-40°F). Since indoor temperatures are typically between 20°C (68°F) and 23°C (73.4°F), this means the temperature of the outside air needs to be changed by over 60°C (140°F) before it is released into the interior living space. In southern locations, the difference between the inside and outside conditions rarely exceeds 15°C (59°F) to 20°C (68°F), and much less thermal modification to the air is required.
- Buildings are heated by natural gas. The model assumed a 90% efficiency of the gas furnace; so for every kilowatt (kW) of heat of natural gas added to the furnace, 0.9 kW of heat was generated (10% loss of energy up the chimney). Conversely, buildings are cooled using electric heat pumps. This means for every kW of electricity used to power the heat pump, 3 kW or 4 kW of cold was generated.

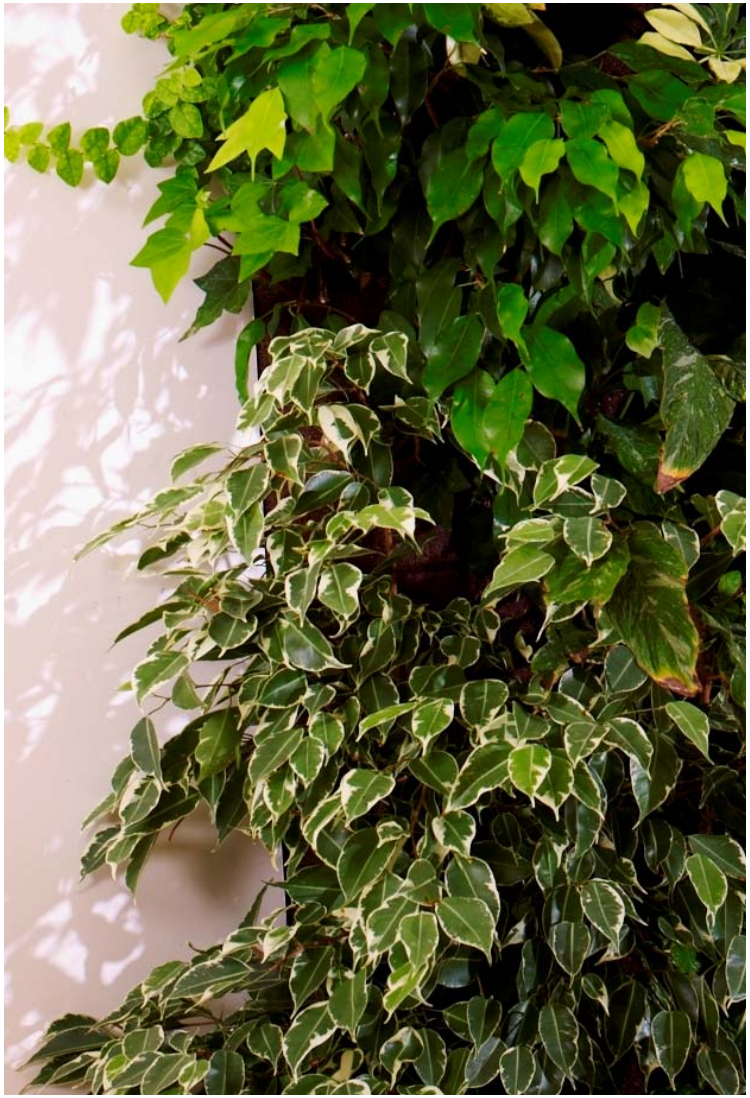
The biofilter can compensate for climatic extremes.

Green Plants

Did you note that the RETScreen model results are presented in terms of the amount of air that passes through the biofilter rather than the number of green plants present?

Remember, it is the microbes growing in soil that are capable of cleaning the airstream, not the plants themselves. The plants optimize the performance of the beneficial microbial population.

A living wall biofilter uses plants that are readily available from local and international suppliers. This ease of access improves the long-term sustainability of the living wall biofilter.



Plant Selection

The types of plants used in a living wall biofilter must have the ability to grow in vertical hydroponics, and are expected to have about a 90% survival rate from year to year. However, this is largely dependent on the choice of plants and local conditions.

Rather than trying to duplicate a particular outdoor ecosystem, living wall biofilters are designed for each unique indoor environment. The plants used are selected for their adaptations to the moderate temperature, humidity, and light conditions typically found indoors. Only management practices and biological controls that are organic in nature are emphasized.

Plant Selection

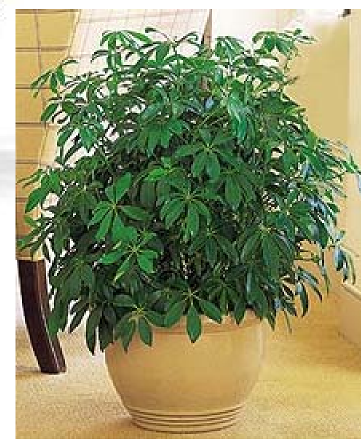
Although some are exotic and unusual plants, most are quite common. Species diversity gives the system ecological stability. This is very important in order to give the ecosystem the ability to deal with the challenges of the indoor setting.

Ficus elastica

Dracaena spp.

Philodendron spp.

Ficus benjamina



Shefflera arboricola

Hedera algeriensis

Plant Selection

Despite the broad geography, the indoor climate is very consistent, meaning that although location may be a factor, micro-conditions within the building, such as light and water quality, have a greater influence on plant selection. This is where plant selection takes advantage of generations of botanical know-how.

Arboricola bush
Ficus benjamina
Philodendron sp.
Hedera algeriensis
Ficus elastica
Dracena

Size and Performance of a Wall as a Biofilter

The quantity and quality of the biofiltered air dictates the impact of the wall on the overall quality of the indoor air. For any given size of biofilter, the quantity of air generated is governed by the flux (rate of flow) of air through it. There is a balancing between the flux and quality of air generated. Basically, the longer the contact time between the dirty air being drawn through the wall and the wall itself, the greater the amount of contaminants removed.

Size and Performance of a Wall as a Biofilter

For a given wall size, drawing the air through at a slow rate (lower flux) means a smaller volume of air is generated, but it is of a higher quality. Increasing the size of the wall means that the decrease in volume of treated air can be compensated for. The modeling of flow rate and performance is complicated by the lack of linearity between removal rates and airflow; in other words, doubling the flow rate does not cut the percentage removed per pass in half. Removal is less dependent on the airflow rate. This means the absolute amount of contaminant removed over time increases with higher fluxes.

Factors such as aesthetics, design and capital, and operating factors should also be taken into account but generally, for a given amount of air required, a smaller wall means higher air velocities.

Sizing the Wall

There are at least three ways to calculate the size of the wall for a particular application.

The first, the quickest, and the simplest is a simple 1:100 ratio for the size of the biofilter to the area of floor space being treated by the biofilter. A 200 m^2 space would require 2 m^2 biofilter. The second is the size based upon the number of people to occupy the area being treated by the biofilter. Typically, one square meter of biofilter will provide enough virtual outside air for five people. In other words, a space holding 10 occupants would require 2 m^2 of biofilter. Both of these methods assume air fluxes of approximately 50 liters per second through each square meter of biofilter (air flux of 0.05 m/s or roughly 10 cfm per square foot) and 60% removal efficiency by the filter. These two methods are approximately the same since most commercial spaces use 20 m^2 of floor space per person occupancy density.

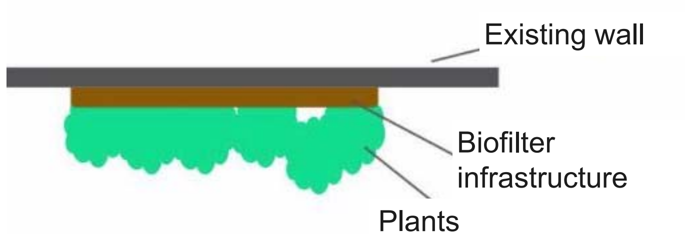
The final method of sizing is to use the mechanical requirement of the space for clean air to dictate the size of the system. Here, the mechanical consultant supplies the designer of the living wall biofilter with the amount of makeup air required to meet their needs. The number of square meters of biofilter and air flux required to meet the mechanical need is then calculated.

Robertson Building, Toronto, Ontario

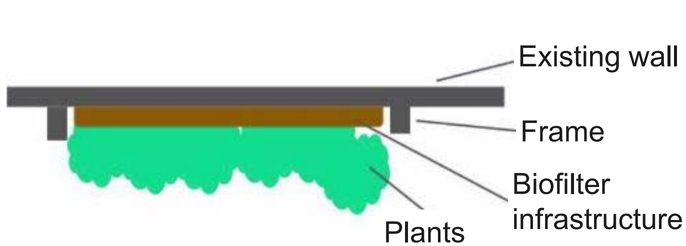
Construction of Living Wall Biofilters

Mounting Options

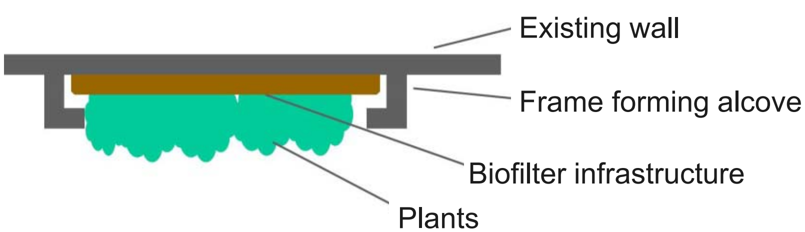
Living wall biofilters can be integrated into a building's interior as a one-sided system or as a free-standing, two-sided structure in the middle of a space. One-sided systems may be mounted directly to a wall, within a frame structure, or in an alcove.



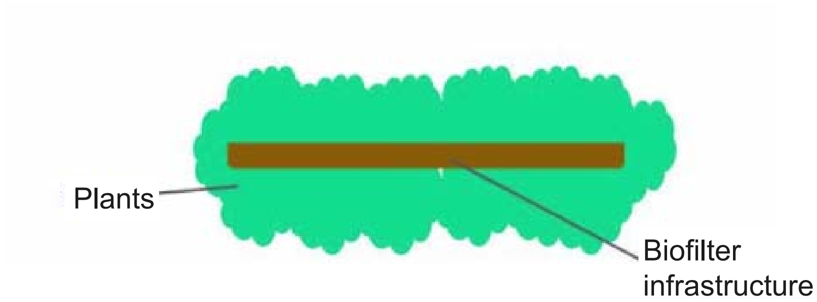
Mounted directly to a wall
Very straightforward, simple design



Mounted within a frame structure
Infrastructure is hidden, sealed from view



Mounted within an alcove
All lateral views are obscured by the wing walls and front of the alcove



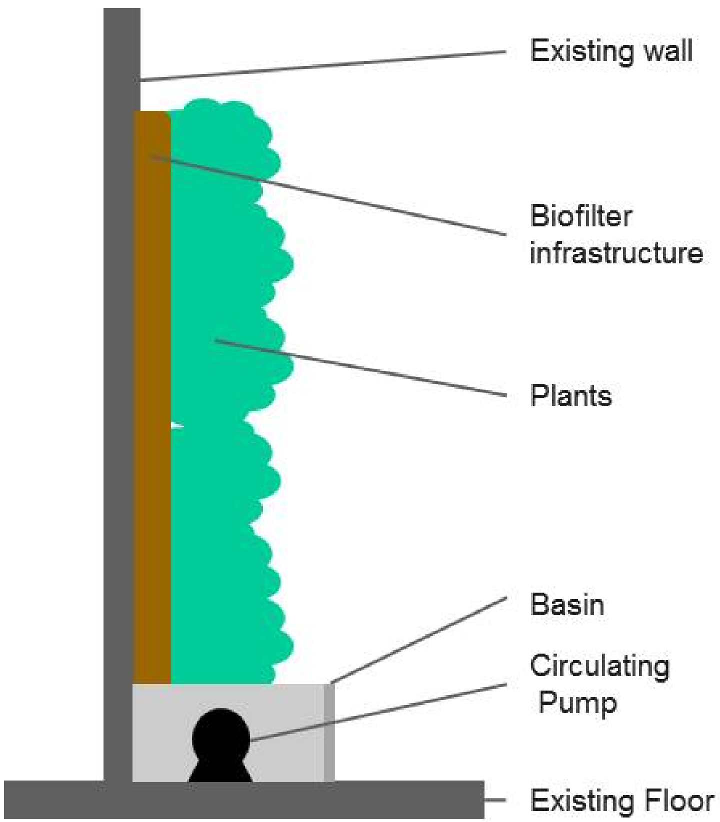
Free-standing structure
Plants completely surround the infrastructure

Components of Construction

Construction of a living wall biofilter is easy for both new construction and renovations.

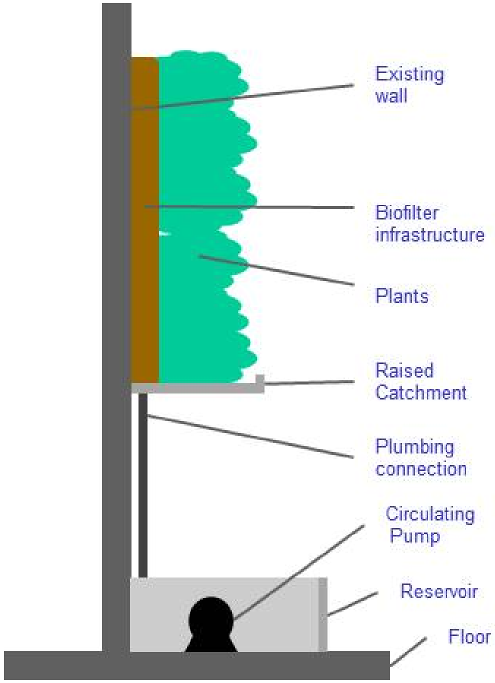
The construction of a living wall biofilter has three major components, the:

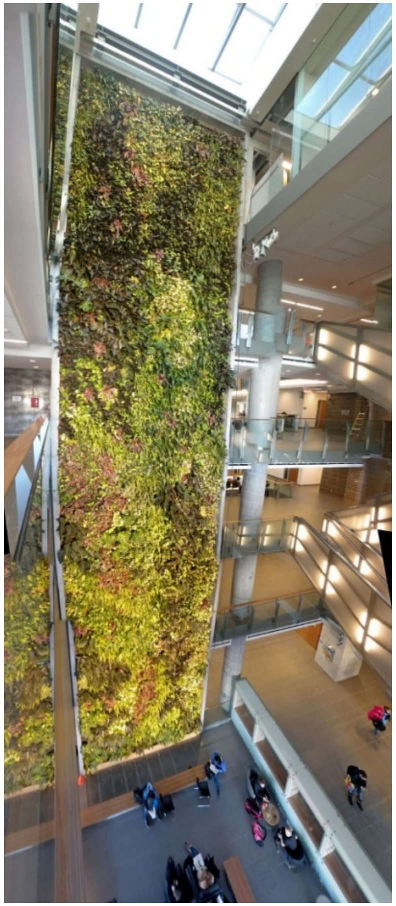
- basin
- infrastructure, and
- plants.

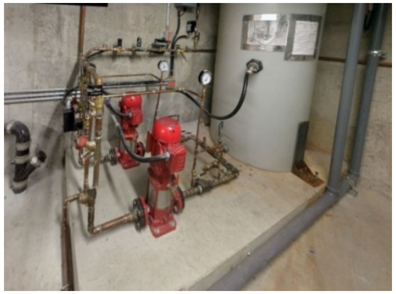


Basins

Simple in design with a wide range of design choices, the basin at the base of the living wall biofilter functions as both a catchment for the circulating water and a reservoir. These two functions can be separated by locating the reservoir and the pumps remotely from the biofilter. Removing the pumps from the area allows for easier access and quieter operation.

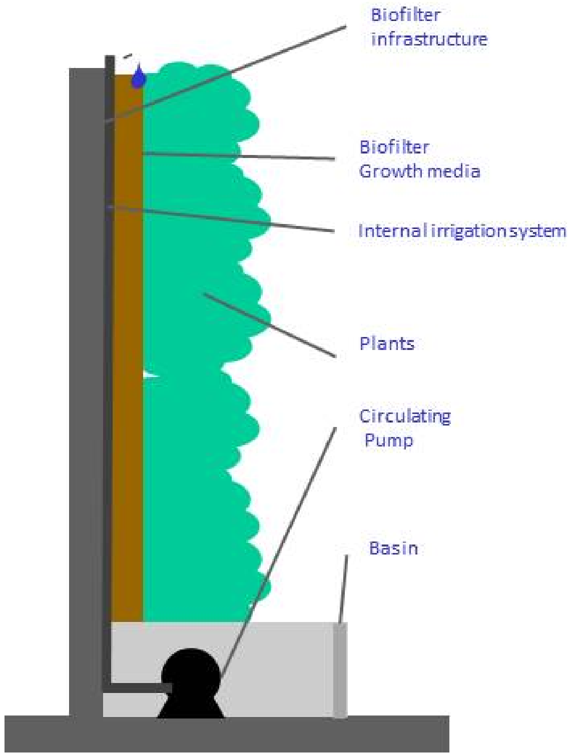


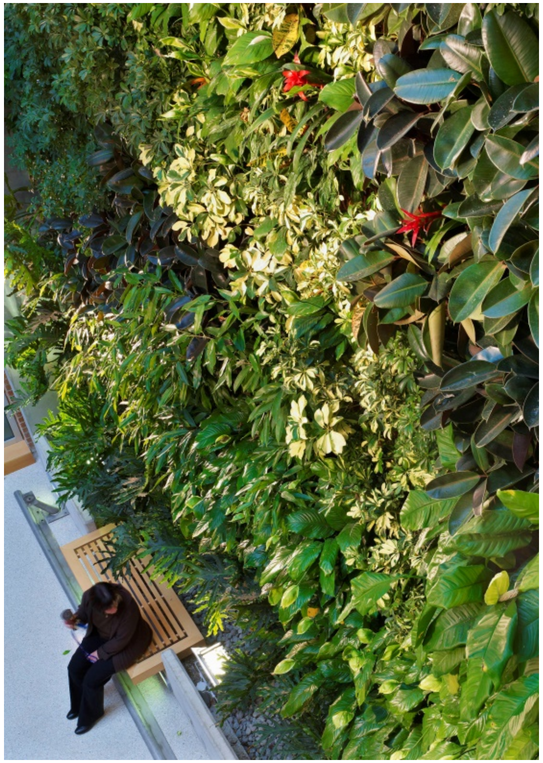




Basins

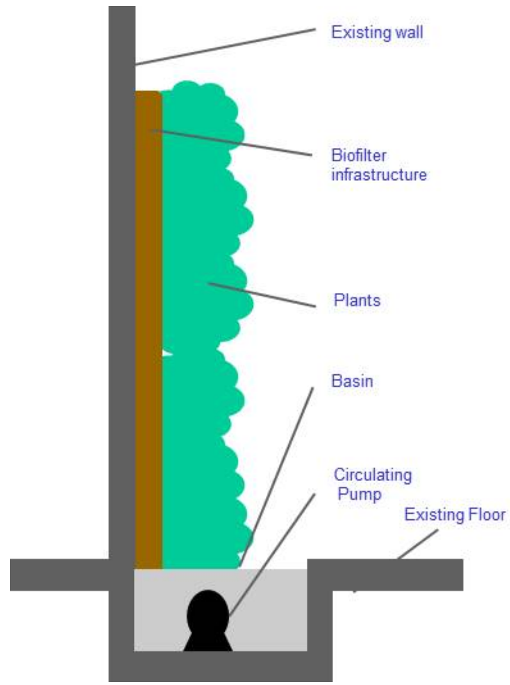
Basins can be designed as seating areas, drawing the occupant to the focal area.





Basins

Basins can also be recessed into the floor, thereby reducing the biofilter's footprint, and creating a clean sight line that invites the occupants to "Please touch the plants."

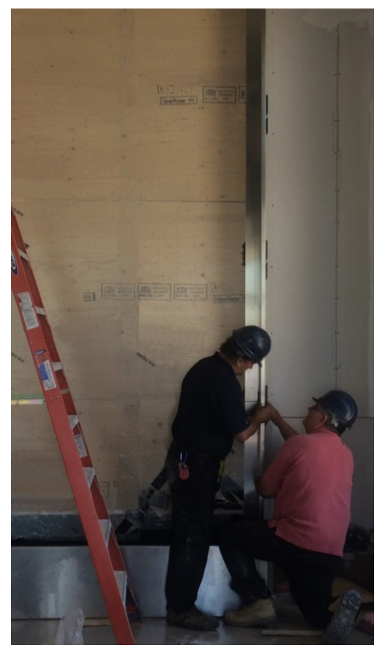


Infrastructure

To protect the supporting wall of the biofilter, it is covered with a high-quality vapor barrier. This barrier is applied as a self-adhesive membrane and will provide the system with decades of protection.

Next, the raw edges of the biofilter are sealed with metal trim. The trim also creates the air spaces that will be connected to the building's air handling system.

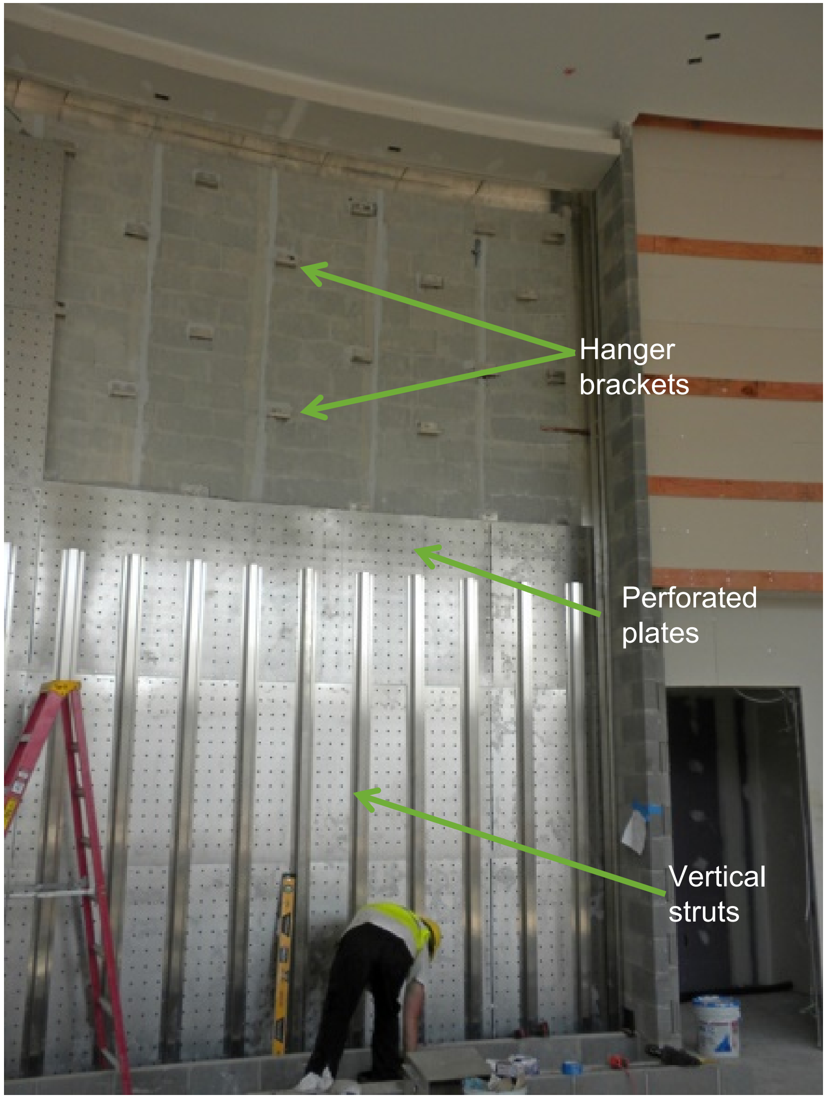





Infrastructure

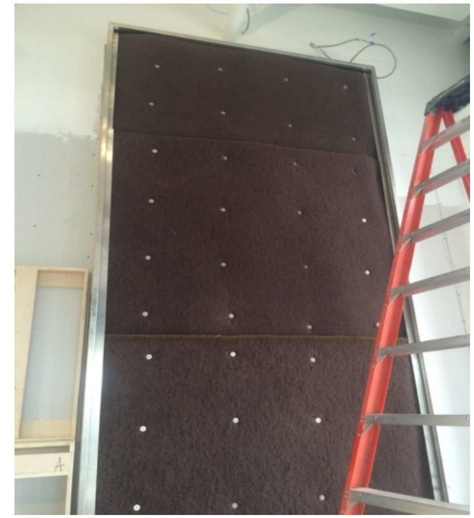
Hanger brackets are used to support perforated plates and create an inner plenum (space) between the back wall and the plates. The plenum collects the air that has been pulled through biofilter growth media and directs it to the building's air handling system (connection point not in photo). The perforated plates ensure the airflow is uniform across the entire face of the wall.

Vertical struts are used to create a second plenum between the biofilter media (not yet installed in photo) and the perforated plates.



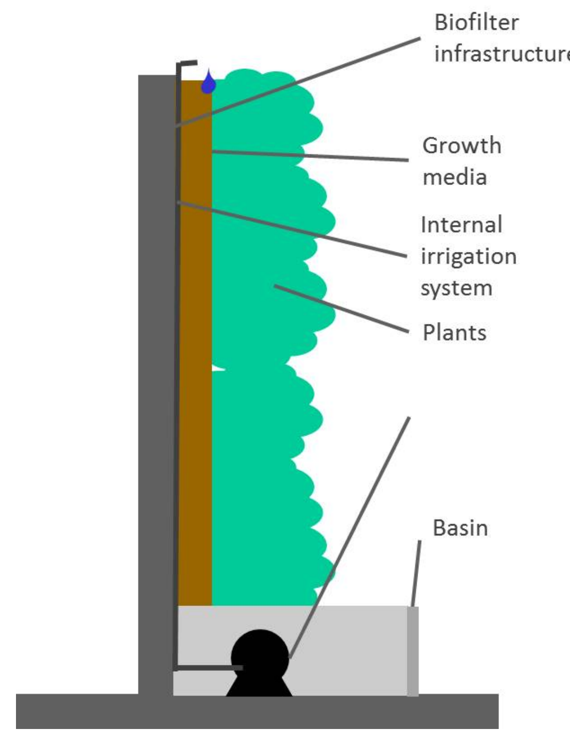
Infrastructure

The soft part of the living wall biofilter's infrastructure is the growth media. This porous mat material is fastened to the vertical struts in two layers, where each layer is roughly 2.5 cm (1 in) thick. The plant roots grow in and through the growth media, but the open nature of the material easily allows air to be pulled through it, allowing the dirty air to be in close contact with the thriving biotic community.



Infrastructure

To facilitate the biofiltration process, the growth media is under constant irrigation. A pump (typically located in the basin) lifts water to the top of the media where it disperses across the top and between the two layers of growth media by an emitter system. The water then slowly percolates down through the media to the basin where it is then circulated to the top again. A small amount of new water is required to account for evaporation and to control salts; otherwise, the system operates with little input of new water.



Plant Installation

A living wall biofilter uses full-size, ready-to-go, commercially produced plants. Unlike other plant wall systems, a living wall biofilter is soil-free, so the plants must be bare-rooted (have their roots cleaned of soil) before being inserted into small cuts that are made in the outer layer of the growth media. The roots of the plant are slipped into the pocket so that they are situated where the water flows between and through the two layers. The media holds the plant tightly in place until new roots grow, firmly anchoring the plant into the wall.

Photo credit: Sean Corbert, Drexel University

Photo credit: Sean Corbert, Drexel University

Plant Installation

Planting the living wall biofilter is an exciting time in which everything in the design and planning process comes together. Within a few hours of starting the planting, the beauty of the system becomes clear. Even for large walls, the planting process is completed in a matter of days. Because the finished product is ready for use, planting is usually scheduled to occur just before occupancy. And, because full-sized plants are used, a living wall biofilter looks great on day one.

Typically, the system is allowed a short period to adjust before being activated as a biofilter. But once air is drawn through the system, the beneficial biota begins the biofiltration process almost immediately.

Air Handling

To function as a biofilter, air must be actively drawn through the living wall. There are three options for air handling associated with a biofilter system:

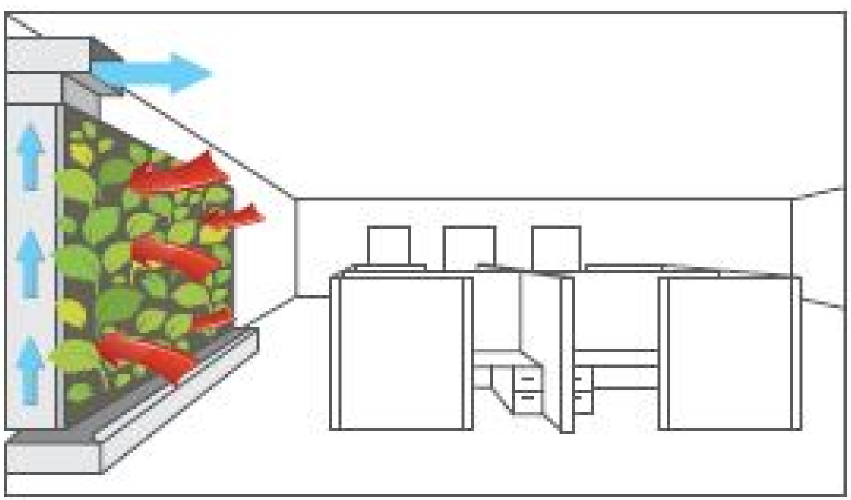
- independent air handling
- independent air handling with distribution, and
- integration into the building's air handling system.

★ Please remember the **exam password LIFE**. You will be required to enter it in order to proceed with the online examination.

Air Handling

Free-standing system – Independent air handling

In this instance, clean air generated by the living wall biofilter is not connected to a central air system. Although air is actively drawn through the biofilter by its fan system, the clean air relies on diffusion and natural airflow within the space to be distributed. A free-standing design is ideal for room-sized applications such as smaller entranceways, boardrooms, waiting areas, offices, and residences. It can be added wherever there is power and water. It’s an ideal format for retrofitting into office buildings, schools, and retail or commercial spaces for a quick and impactful upgrade.

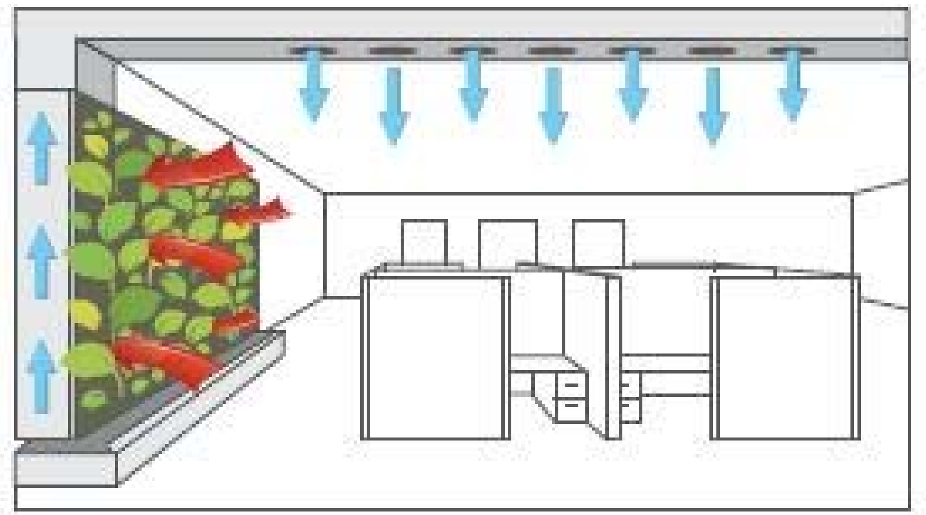


On-board fans draw air into the front of the biofilter and release it back into the space.

Air Handling

Hybrid system – Independent air handling with distribution

A hybrid installation involves tying the biofilter's fresh air return into the air handling system of a defined area by using a built-in fan system connected to a custom duct system to distribute clean air throughout the space. Hybrid systems are used in atriums, or for one unit or floor of an office building, school, or commercial space. Their flexible installation allows for maximum air quality improvement when access to the entire building's HVAC system is not possible.



Air Handling

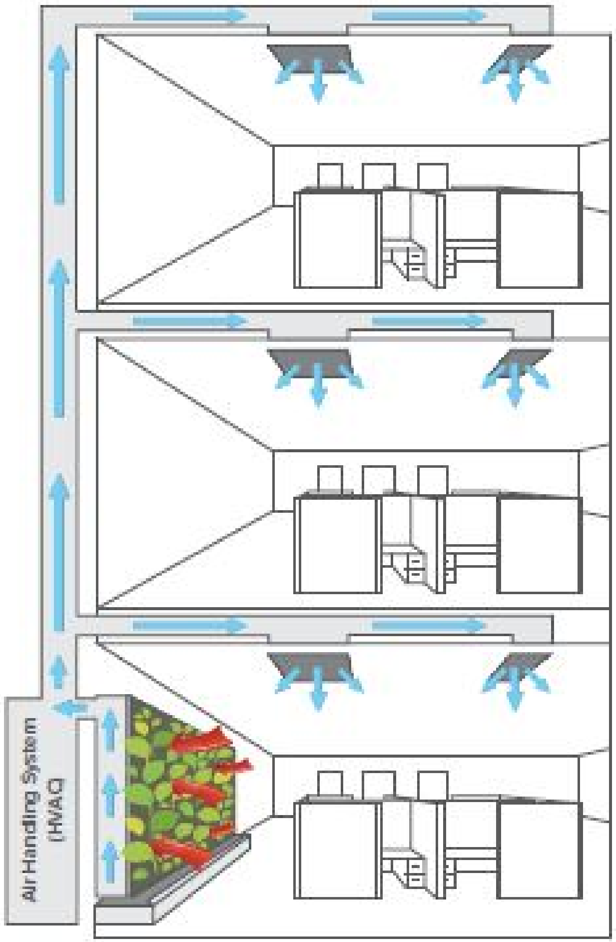
Installations that emphasize the onboard fans by making them visible remind the occupants that the biofilter is more than just a wall of pretty plants.

Grimshaw Architects, Manhattan Office,
New York City, New York

Air Handling

Fully integrated system – Connected into HVAC system

The fully integrated option involves a complete tie-in to the building's HVAC system where air is drawn through the biofilter by connecting it to the return air (intake) of the HVAC and is then dispersed throughout the building. This approach is advantageous for a couple of reasons. First, integrating into the HVAC system means the biofilter piggybacks onto the existing fans in the HVAC system to move the air rather than duplicating this movement with its own fan. This makes the approach considerably more energy efficient. Second, since the cleansed air is dispersed throughout the entire building, the entire building benefits from the effect. It is not a localized effect. While this is an obvious fit for new construction, this installation is also feasible for retrofit designs.



Air Handling

When integrated into an HVAC system, the biofilter performs similarly to an inline particle filter, but the biofilter is green, aesthetic, and exposed, and removes harmful chemicals instead of just particles. The connections to the HVAC can be subtle or conspicuous.

University of Guelph-Humber, Toronto, Ontario

RIM (Research in Motion), Waterloo, Ontario

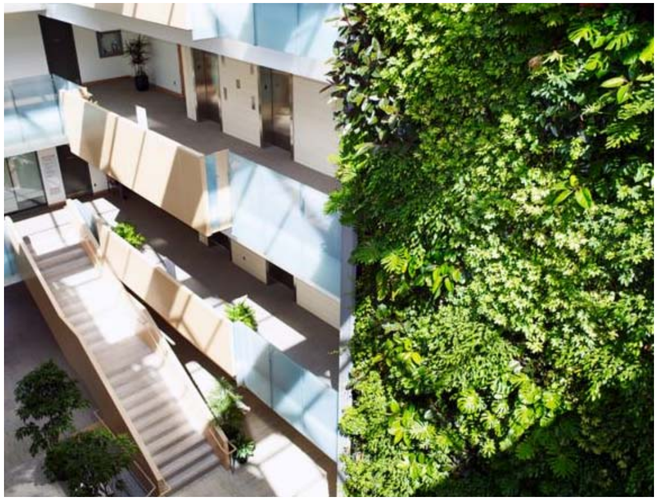
W.G. Johnson Pool, Cambridge, Ontario

Additional Considerations

Lighting

Lights are often the largest utility expense for the system. This can be minimized by taking advantage of natural light and if required, proper design of the lighting system. If supplemental lighting is required, operating expenses can be minimized by careful control of when the lights are on.

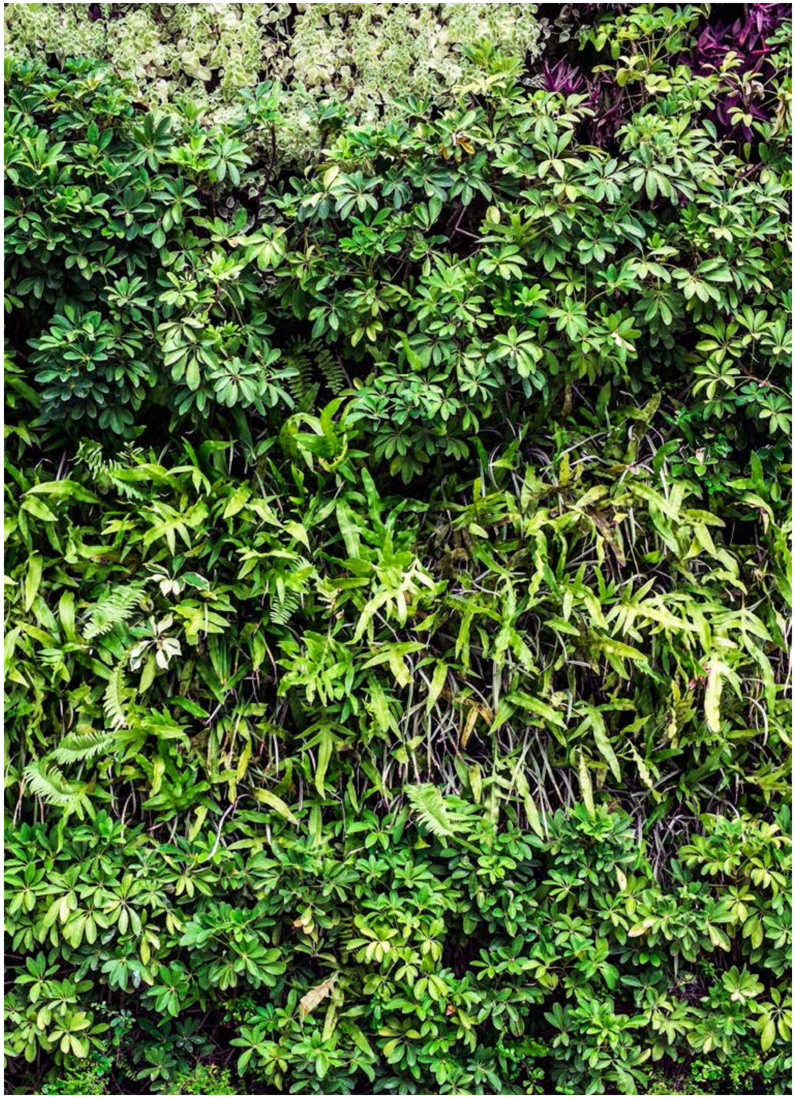
Some systems use sophisticated control protocols to minimize electrical expenses. The light output from some lamps decreases substantially with time. Depending on the hours of operation, halide lamps may need to be replaced in as little as two or three years. Although more expensive initially, LED lamps require far less frequent replacement.



Plant Life Expectancy

Once the plants are established, one can anticipate roughly 10% of the plants will fail each year. This is an average number and is dependent on the plants selected and their growing conditions. Hardy (more utilitarian) plants can be selected if survival is a concern.

Poor light conditions are the most frequent factor associated with poor plant survival rates. The cost of routine plant replacement can usually be included as part of a plant maintenance contract.



Ongoing Maintenance

A biofilter living wall will provide many years of service, but it is a combination of mechanical and biological components that must be properly maintained, and as such, requires a continued commitment to the biofilters by the owner.

Maintenance of the system requires understanding of plants and associated mechanical systems. This could be in one individual such as a plant person experienced with water features (ponds) that share many similar components. Alternatively, the expertise could be supplied through different departments (horticultural/grounds and the building mechanics), or supplied through the manufacturer or another outside party.

Living wall biofilters higher than 3 m may require a system to access the plants for routine maintenance. These can include library ladders, bosun chairs, mechanical swing stages, and scissor or boom lifts.

Summary of System Requirements

Air handling: Consider where the clean air from the living wall biofilter needs to go. The air handling options are free-standing, hybrid, or fully integrated.

Water supply (in and out): The system can tolerate a wide range of water sources: rainwater (gray water), recovered water condensate, and potable water. A sanitary drain is required for excess water.

Power and light: Power is needed for the pumps to circulate water and for any artificial lights. While natural light is ideal for energy savings, the biofilter can function on 100% artificial light. In terms of light energy, budget for 100 watts per square meter of biofilter. Separation of the power circuits is recommended.

System weight: The only structural consideration is the weight of the wall.

- Wall: 110 lb/50 kg per square meter
- Basin: As little as 220 lb/100 kg per square meter depending on the design

Finishing the area: The area around a living wall should be tolerant of moisture. Like any plant system, humidity is generated along with an occasional drip or splash of water.

Operating cost: Clean air can be supplied to occupants for as little as 24 watts per person (a substantially reduced cost compared to traditional systems).

LEED® Green Building Certification Program

In practice, active living wall biofilters have been shown to generate clean air using only 20% of the heating/cooling energy of a conventional HVAC system. That's why they are integrated into many projects registered under the LEED® green building certification program.

The inclusion of a living wall biofilter in a building project may contribute to earning points in the areas of design, environmental quality, and energy and atmosphere. Please consult individual manufacturers for specific details regarding the LEED® green building certification program.

Drexel University, Philadelphia, Pennsylvania
Project is LEED Gold®

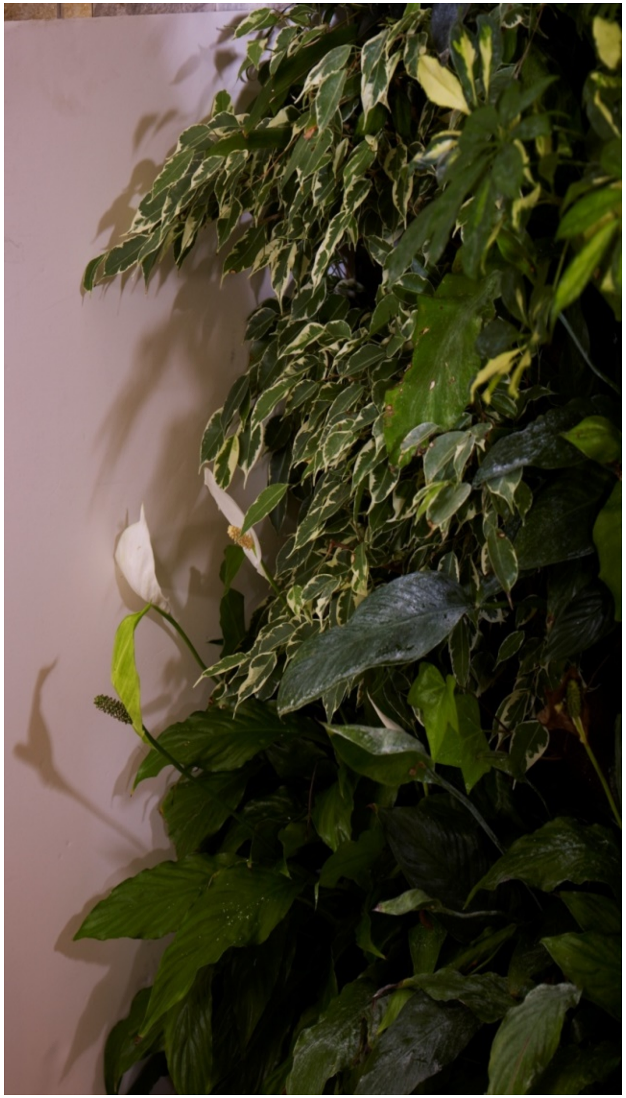
Delaware North, Buffalo, New York
Photo credit: Marcus Mitanis

Course Summary

In Summary…

Living wall biofilters:

- offer a beautiful balance between the aesthetics of indoor plantings and the need to improve building performance
- make indoor vegetation a functional element as well as an aesthetic design feature
- are indoor adaptions of established technologies proven effective in a wide range of settings
- improve indoor air quality by removing harmful chemicals
- can generate clean air at a fraction of the cost of traditional approaches, and
- can be easily adapted and constructed to suit a range of venues.



Conclusion

If you desire AIA/CES, state licensing or CE credits for another organization, please click on the button to commence your online examination. A score of 80% or better will allow you to print your Certificate of Completion; you may also go to your AEC Daily Transcript to see your completed courses and certificates.

For additional knowledge and post-seminar assistance, click on the Ask an Expert link above.

If you have colleagues that might benefit from this seminar, please let them know. Feel free to revisit the AEC Daily website to download additional programs from the Online Learning Center.

MORE ❯

powered by @AECDAILY www.aecdaily.com

NEDLAW LIVING WALLS
Rejuvenate with science.

Questions?
Ask an Expert – click here

Click Here to Take the Test

Exit