

GREEN ROOF AND WALL POLICY IN NORTH AMERICA

Regulations, Incentives,
and Approaches



ACKNOWLEDGEMENTS

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Powderhouse, Somerville, MA. Photo: Recover Green Roofs

About the Report

This report is designed as a resource for policy makers that are interested in establishing or updating green roof and wall policies and programs. It can also help Green Roofs for Healthy Cities' corporate members source supportive policies and programs for green roof and wall installation in markets across North America. For more information about Green Roofs for Healthy Cities membership opportunities for both public and private organizations and resources please visit [our website](#).

On the Cover:

2023 Jeffrey L. Bruce Awards of Excellence Winning Project Photos

Top Row (left to right): 4131 South State - Omni Ecosystems, 5665 Woodlawn - Omni Ecosystems. Second Row: Drexel University - Parker Interior Plantscape. Third Row (left to right): Javits Center Farm - Brooklyn Grange, 4131 South State - Omni Ecosystems, Javits Center Farm - Brooklyn Grange. Bottom Row: University of Hartford - Recover Green Roofs. Submit your project, policy or research leader for a future award [here](#).

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Introduction

In an era of climate change, marked by extreme heat, drought, flooding, fire and worsening air quality, policy makers the world over are looking to the roofs, and more recently the walls, of the buildings in their cities for relief. Over the past 20 years, local governments from across North America have been introducing green roof policies in order to generate a market for these technologies and achieve multiple policy objectives.

Green roofs go by many names, including eco-roofs, living roofs, vegetative roofs, and roof gardens to name a few. Green roof policy is often a key component of a larger government policy effort to implement various forms of green infrastructure, also known as ‘natural infrastructure’, in cities to address multiple challenges simultaneously. Green infrastructure measures include bioswales, urban forests and wetlands. This report focuses primarily on green roofs and green walls, which remain significantly underutilized by policy makers across North America.

A decade ago, the City of Toronto was the first major city in North America to adopt a mandatory green roof requirement for new buildings. As a result, it now boasts more than 1000 green roofs and over 10 million square feet of additional green space. Policy makers in Portland, Oregon and Chicago, Illinois were also two of the early adopters of green roofs. They provided financial incentives, regulations and procurement policies for green roofs. Each of these cities has seen millions of square feet of growth in the green roof market, with the resulting increase in employment and many other benefits. Portland, Oregon and Cambridge, Massachusetts have recently made green roofs mandatory on new buildings.

Green roofs are neither new nor exotic. In fact, they’ve been deployed elsewhere in the world for decades on modern structures, and in some cases they’ve been common practice for generations. The concept is simple and derived from “natural infrastructure”, such as wetlands, forests and prairies. They mimic such environments in terms of aesthetics and habitat. They are functionally comparable in terms of providing ecosystem services: filtering air and water, employing rainfall to support plant life, and absorbing and detaining such rainwater that would otherwise need to be managed through engineered drainage, septic, and/or treatment systems. They have the capacity to displace vast areas of negatively impacting roofs with “green infrastructure”, with the cumulative potential to avoid costly expansions of municipal water treatment systems and address challenges like the worsening urban heat island.

A decade ago, targeted green wall policies lagged behind the implementation of green roof policies, in part because of the relative newness of the green wall industry in North America, and because there was less performance data and a less-evolved universe of providers for these technologies. Since that earlier era, a growing number of cities have developed more comprehensive green infrastructure policies that capture the many benefits of green walls as well as green roofs, urban forests, bioswales and other forms of engineered green infrastructure.

Green roof policies vary considerably: some have come to include regulations which require compliance, and others offer voluntary incentive programs. Certain municipalities have adopted regulations and incentives for installing green roofs, with different agencies operating programs with complementary goals to foster deployment of these technologies.

The specific construction requirements of mandated and incentivized green roofs also vary, from simple roof coverage and media depth requirements, to more complex construction standards which include items such as leak detection and minimum maintenance standards. Over the past five years, Green Roofs for Healthy Cities and the Green Infrastructure Foundation have worked to develop a comprehensive performance rating system for green roofs and walls called the Living Architecture Performance Tool (LAPT). The LAPT is intended as a readily implementable standard for municipalities to assert a consistent set of design, construction, maintenance, and performance requirements. A number of different projects, from simple sedum roofs to more complex intensive roof gardens have been certified under the LAPT. In some jurisdictions, where such policies and regulations have been considered, initial costs for a green roof have – unsurprisingly – proven to be a political challenge as development constituencies have reacted to first costs rather than considering life cycle costs. However, in a variety of markets, geographies, and bioclimates, the life cycle value and financial return of green roofs has been demonstrated to be consistently robust, resulting directly in the increasing number of cities establishing mandatory requirements typically focused on new buildings.



Plants growing naturally along the sidewalk, some leaning in. Photo: Phipps Conservatory and Botanical Gardens

Regulations catalyze maturing markets. Requiring developers to implement green roofs provides a certain green roof economy that allows the most rapid and successful emergence of local product and service providers. Such deployment also consistently results in an early and dramatic reduction in installation costs, thus furthering the cost-efficacy of these systems.

Cities that have recently established green roofs to address green building goals and/or stormwater management objectives include: New York, Seattle, Toronto, San Francisco, Cambridge, Gatineau, and Washington DC. This layered approach tends to produce greater results such as in Devens, Massachusetts. Stormwater regulations, viewshed overlay requirements and greenhouse gas mitigation work in concert to support green roof implementation.

These cities each have a combination of green roof regulations for new buildings and incentives for existing buildings to substantially, directly, and effectively manifest new development that cost-efficiently contributes positively and remedially to the built environment.

Benefits Overview and Policy Options

Each municipality and governing entity needs to determine the drivers for green roof policy appropriate to its particular circumstances. There is something for everyone up on the rooftop. Green roofs have an extraordinary ability to generate both public and private benefits. The composition of the benefits is largely a function of the type of building, the type of green roof deployed, and the environment in which the green roof is located, i.e., need for green space, air quality, and stormwater management. Here are some of the many benefits of green roofs:

Biodiversity Focused Roofs

Green roofs can provide much needed habitat for invertebrates and birds as well as rare and endangered plants, particularly if they are designed and maintained for this purpose. Green walls can also support insect and bird habitat when employed outside. Portland, Oregon was one of the first municipalities in the United States to install a green roof to enhance biodiversity. The European Union is pushing a strategy to promote biodiversity through vegetated roofs. The City of Toronto has developed biodiverse design guidelines to encourage more biodiverse green roof development.

A proposal for legally binding EU nature restoration targets to restore ecosystems and help to increase biodiversity, mitigate and adapt to climate change, and prevent and reduce the impacts of natural disasters. The European Commission proposed a [Nature Restoration Law](#) and in that framework it proposed unprecedented legally binding urban biodiversity targets. Such targets are intended to boost a systematic integration of vegetation into urban planning, including in public spaces, infrastructure, and in the design of buildings, in particular of their roofs and facades, and their surroundings. England adopted a new policy in 2022 requiring new development to provide a net gain or improve biodiversity over existing conditions. Vegetated roofs will play a starring role in this effort.

Carbon Sequestration Strategy

Plants and soils/engineered growing media, sequester carbon and produce oxygen. Green roofs can play an outsized role in a communities' climate action, mitigation and adaptation plans when deployed in the aggregate. Green roof mandates begin to address the need to achieve wholesale deployment of this important tool. The more types of vegetation and deeper growing media deployed, the greater the carbon sequestration impact.



Praying Mantis on Basel's biggest green roof on Stüchi Shopping mall. Photo: Andreas Hofstetter

Climate Mitigation

Green roofs are able to provide additional thermal insulation benefits for many roofs, thereby reducing energy consumption associated with space heating and cooling. Portland State University and Environment Canada established an [Energy Calculator](#) which provides base levels of energy savings in multiple climates across North America. Many of the energy savings benefits to buildings depend on their age, with older buildings often lacking sufficient insulation the benefits are greater.



Photo: Brodie Kerst. The Old Chicago Post Office in downtown Chicago

Reduce Urban Heat Island

Impervious surfaces and a lack of vegetation, often widespread in poorer neighborhoods, contributes to the urban heat island, which is the term used to describe the higher temperatures experienced in urban areas relatively to the surrounding countryside. The implementation of a significant amount of green roofs in a given area, has the potential to lower the urban heat island effect, which contributes to improved air quality and the reduction of energy consumption associated with air conditioning. While traditional roofs will heat up the surrounding environment, green roofs act as outside air conditioning and cool their surroundings through evapotranspiration. [See here](#) for detailed papers on energy, climate and green roofs.

Membrane Durability

Green roofs protect waterproofing membranes from the wear and tear associated with solar radiation exposure, temperature fluctuations, and mechanical damage, thereby extending the life expectancy of most membranes by two times or more. This results in significant savings associated with future membrane replacement costs as well as reducing the need for removal, disposing and recycling of worn out membranes.

Hail Protection and Reduced Insurance Rates

The proof is in the track record. Denver experienced a particularly punishing hail storm which damaged numerous roofs across the city: green roofs were undamaged by the event. The anecdotal evidence was translated into empirical data and the author concluded:

“Similar to current UL 2218-rated hail resistant roof materials, with the Class 4 rating, it is my hope that green roofs will be approved as a roof choice qualifying for the same insurance premium discounts. Roofs that use UL2218-rated materials enjoy up to 35 percent savings on their insurance premiums.”¹

¹Leila Tolderlund, *Living Architecture Monitor* Winter 2019 19-20. “Green Roofs Stop Costly Hail Damage to Roof Membranes



Photo: Scott Shigley. The Old Chicago Post Office in downtown Chicago

Green Roofs, Walls and Jobs

Job creation is a factor in leveraging political support for green roof and wall policies. Assessing the local green roof industry to illustrate the new jobs that adopting a green roof policy would generate, both in terms of installation, growing plants and maintaining the systems once installed provides a powerful case to politicians. Linking job training programs to the initiative can broaden support.

Public Health and Equity

In communities where there is a correlation between asthma, ozone pollution and other particulate matter respiratory issues, green roofs and green infrastructure can play an important role in crafting public policy to protect the public health of the community. Vegetation fixes particulate matter and can therefore reduce the impacts of air pollution. Policies such as directing Community Development Block Grant funding to the installation of vegetated roofs, walls, urban street trees and other green infrastructure provide multiple benefits to the community and its residents. Public health benefits include the reduction in urban heat island, energy conservation, reduction in combined sewer overflows and better stormwater management. , [see here](#) for more details on the public and private benefits of green roofs.

Numerous studies have clearly illustrated the role vegetation can play to fix particulate matter (one of the major factors in asthma). A recent study shows green wall plants can reduce indoor air pollution as well. A team at the University of Washington has compiled over forty years of academic studies documenting the benefits of green roofs and green infrastructure at the web site [Green Cities: Good Health](#). Exposure to nature in urban environments through Green Infrastructure has been shown to reduce stress levels, reduce recovery times in hospitals where patients have a view of nature, and provide many other co-benefits. Learn more about the benefits to nature specifically for children [here](#). Green walls, in particular, have an advantage over green roofs in that they contribute visually while conferring direct health benefits, including adding moisture to - and removing pollutants from - indoor air.

Public Art/Aesthetics

The Devens Enterprise Commission in north central Massachusetts adopted a viewshed protection ordinance to protect the view from the nearby Museum of the New England Landscape. Views from the museum must be mitigated with green walls, roofs and the use of low reflectance materials. Green walls have also been recognized as meeting regulatory requirements for the [installation of public art in Oakland, California](#).

Stormwater Management

Green roofs have the ability to retain stormwater through the plants, growing medium and additional layers that capture and hold, or slow the progress of water off a roof. Many jurisdictions recognize green roof assemblies for their stormwater retention benefits through stormwater regulations. In recent years, manufacturers have begun introducing green roof systems that enhance the stormwater retention capacity of green roofs, often through the use of cups in the drainage layer, fabrics or fleeces that expand to hold more water. They are also incorporating systems that allow for the detention of stormwater (typically up to 6 inches in depth) for a period of time, often two to three days, before controlled release. The detention capacity gives civil engineers a greater degree of certainty over stormwater management than retention alone. Managing stormwater on roofs, can save developers costs associated with below grade or under-building stormwater detention structures and the space and mechanisms they require.



Moderne, Saratoga Springs, NY. Photo: Bonacio Construction



Stormwater retention testing. Photo: Green Roof Diagnostics

Support for Density

Public green roof parks, in cities such as Chicago which boasts the Millennium Roof Park, San Francisco which recently completed the Transbay Terminal Roofpark, and New York City which established the linear Highline Park, have all directly contributed to increased density with new developments nearby these important amenities. Office and residential projects adjacent to such amenities have consistently resulted in greater marketability, higher rents, and increased valuations. Increasing density while providing high quality living spaces is key to sustainable community development because it helps to reduce sprawl.

Contribution to Food Justice/Security

The development of rooftop farms, which generate employment and often provide gathering and education opportunities for communities in addition to providing fresh produce, is on the rise worldwide. More than forty rooftop farms are now operating in Canada and the US, some as for-profit enterprises while others are not-for-profit in nature. [See here](#) for a list of rooftop farms across North America. New York City and Toronto both have incentive programs that support rooftop farm development.

Contribution to Rooftop Solar Energy

A number of technologies exist which combine the benefits of rooftop solar with green roofs, as there are multiple synergies between the two technologies. These include higher rates of solar energy production (5 to 15%) due to the cooler rooftop temperatures provided by the green roofs underneath, and the ability of the green roofs to provide ballast to the solar grid without the need for roof penetrations, which can be a source of leaks. Each year, new technologies emerge in this field, the latest being vertical panels.

Summary of the Benefits of Living Architecture

- Energy savings due to reduced demand for heating and cooling from evapotranspiration and insulation
- Energy savings from shading and blocking the wind
- Energy savings from pre-cooling air conditioning unit intake air
- Energy savings from reducing the need to exchange indoor air
- Carbon credits from associated energy savings
- Savings associated with longevity increases to waterproofing and building envelopes
- Improved indoor air quality resulting in improved occupant health and performance
- Improved property values related to better visual amenity accessible amenities and noise attenuation
- Improved patient recovery in hospitals
- Improved academic performance in schools
- Marketing and promotional opportunities
- Integration with site for better overall stormwater management and reuse
- Improved public relations/community relations and potentially faster project approval times
- Improved rentability, saleability of properties and units
- Contributes to reaching USGBC and CAGBC LEED credits
- Contributes to meeting the Living Building Challenge 2.0 and Sustainable Sites
- Access to public incentives and/or enhanced ability to meet regulations such as stormwater management
- Integration with other building systems, such as mechanical systems and solar photovoltaics panels for better energy efficiency and generation
- Potential to generate direct revenue for sale or lease of roof spaces, and from new uses such as urban agriculture production
- Biophilic related benefits resulting in reduced absenteeism

Urban Heat Island Mitigation Resulting In:

- Energy savings in buildings and resulting greenhouse gas emission reductions
- Less smog formation
- Reduction of particulate matter in the air
- More liable environment for citizens and less heat related stress
- Water conservation
- Reduction in associated health care costs from improving air quality and reducing heat
- Contribution to savings on power plants and transmission infrastructure

Improvements in Onsite Stormwater Management Resulting In:

- Reduction in the frequency of combined sewer overflow events
- Increase in life expectancy of pipes and other grey infrastructure
- Reduction in costs of erosion control
- Reduction in frequency of flooding
- Improved water quality



IGA rooftop farm, Quebec, Canada. Photo: La Ligne Verte

Aesthetic/Biophilic Improvements Resulting In:

- Healthier and more productive citizens
- Less crime and associated policing, judicial and incarceration related expenses
- Improved economic activity
- More community cohesion
- Increase in walking, cycling, gardening and running
- Beautifying unattractive building features
- Opportunities for artistic expressions
- Reduced patient care costs in health care facilities

Urban Food Production Resulting In:

- Greater food security
- Better food quality
- Increased employment
- Reduction in transportation of food with associated air pollution, greenhouse gasses, traffic, etc
- Community self-reliance and improved cohesion

Carbon Sequestration:

- Plants and growing media can sequester carbon generating carbon credits

Increase in property values with a corresponding return in property taxes to the city



The mixed intensive-extensive green roof at Denver Botanic Gardens. Photo: Michael Guidi

Employment From Manufacture, Design, Installation, Maintenance and New Uses Resulting In:

- Fewer social problems
- Additional recreational opportunities

Noise Attenuation and Sound Improvement Resulting In:

- Less noise entering buildings which may result in increased property values
- Biologically satisfying noise - like wind rushing through grass

Shading Resulting In:

- Fewer sun related health issues
- Cooler more enjoyable streets, parking lots, subway platforms

Improvements to Building Envelope Longevity Resulting In:

- Reduction in landfill waste
- Replacement cost savings on public buildings

Improved Biodiversity Resulting In:

- Educational/Urban nature experiences
- Carbon sequestration by protecting migratory birds which support boreal forest growth
- Pollination by insects, particularly bees
- Beauty and improved recreation opportunities, such as bird watching

Incorporation of Green Products and Systems Resulting In:

- Improved markets for recycled plastics
- Improve markets for compost and recycled aggregates
- Lower energy in the overall systems
- Improved conservation of water resources

Green Roof Policy Implementation – The Time is Now

Green roof policy is a unique tool, advancing a range of public policy objectives simultaneously. Green roof policies and programs can leverage the considerable private sector investment in the development/redevelopment of buildings. They do so by taking advantage of otherwise underutilized roof space which, depending on the jurisdiction, constitute as much as 30 per cent of the total land area in densely developed cities.

Green roofs and walls provide social, economic and environmental benefits. Within a given city, thousands of green roof projects covering tens of millions of square feet of land area have the ability to reduce the growing threat of the urban heat island effect, and reduce flooding and water quality challenges and costs by retaining and detaining stormwater. The addition of plants improves air quality, resulting in better human health and well being. Some jurisdictions also utilize roof space to provide habitat for pollinators, and rare and endangered species of flora and fauna.

As green roof benefits accrue at various scales, such policies constitute a natural public-private partnership. The real value over time is quantifiable and scalable, and analysis in advance of policy initiatives demonstrating these benefits is one of the single most valuable tools to promoting such policies, whether addressing elected officials, the public, housing advocates, developers, designers, or owners.

At the building scale, green roofs provide private/building owner benefits, which are determined by the type of building. For almost all buildings, green roofs increase the life expectancy of waterproofing membranes and reduce energy costs - benefits that accrue to the building occupants and owners over the long term. For some buildings, added real estate value benefits building owners, as well as affording the opportunity to generate additional revenue through the rental of roof space, and higher prices for amenity decks (whether for sale or rental). For other buildings, such as large warehouses that are not climate-controlled, the benefits of green roofs may be substantially less for the owner.

At the public/community scale, the benefits also include: job creation, substantial energy savings, significant tax base increases resulting from added real estate value, and health benefits resulting from enhanced views, biophilic value and biodiversification. For some of these attributes, the monetary value is quantifiable. For others, the supportive data is more intuitive or observational.

Whether public or private, clearly monetizable benefits result. Regardless of the form of ownership independent life-cycle cost-benefit-analyses conducted by ARUP for the General Services Administration (GSA) have demonstrated that extensive, lightweight green roofs typically offer as little as a five- or six-year simple payback.³ For privately owned projects, this value accrues directly to owners. For rental projects, ultimate savings can benefit the owner and renter. When applied to public buildings, the value returns to the public directly. For projects serving economically challenged communities, the resulting benefits contribute directly to meaningfully advancing social equity goals. The value-added and direct savings resulting from green roofs are genuinely equal opportunity.

³ *Federal High-Performance Green Buildings: Green Roofs. U.S. General Services Administration. (2021, June 4).*

A Single, Tested Tool to Address Multiple Policy Objectives

Green roof policies allow governments to target a range of environmental and health issues, accelerate economic development objectives, and advance environmental and social equity agendas with a single regulatory action. Largely used as a tool to manage stormwater (retention and detention) and build resilience to climate change, green roofs also reduce impervious surfaces, filter stormwater and sequester carbon. Green roofs benefit human health by increasing access to green space and can also contribute to local food production and security through rooftop farming. Green roofs contribute broadly to energy cost savings at the city-scale through the reduction of the urban heat island effect, whether in heating or cooling dominated climates. An ancillary benefit is a resultant increase in real estate valuation, which benefits individual projects as well as tax rolls.

Voluntary implementation of green roofs continues to advance as developers and institutions embrace the value and benefits of such facilities. However, only through the implementation of green roof policies and regulations can sufficient momentum occur that results in the creation or expansion of providers, substantial municipal benefits, a scale sufficient to achieve expeditious first-cost reductions, and a more rapid and broad-scale response to emerging climatic and economic challenges.

Public Policy and Programs

The period of innovation and testing of feasibility of green roofs is in the past. The systems are available, technical approaches are well defined, and the economic efficacy has been determined over an array of economic and bioclimatic geographies, from Alaska to southern Florida and all parts in-between. Public policy programs and awareness campaigns may be required to break through resistance to widespread implementation and facilitate the use of green roofs. In cities already with high rates of green roof installation, public policies have served to stimulate the green roof market by educating developers and community members as well as providing financial incentives and/or regulations.

Increased exposure to green roofs through municipal demonstration projects can also serve to dismantle public misconceptions about the technology. Education targeting building owners, architects, landscape architects, engineers and policy makers will likely have the greatest impact on bringing green roof technology into the mainstream.

For many building owners and developers, the common private benefits may not be perceived as sufficiently quantified or immediate enough to justify the additional upfront capital investment. This is where financial and regulatory incentives become important. Examples include the [City of Toronto's Eco-Roof Incentive Program](#) which offers CDN\$100 per square meter of green roof and Washington DC's US\$15 per square foot incentive in targeted watersheds where combined sewer overflows are frequent.



*Mordecai Children's Garden green roof.
Photo: Michael Guidi*

Some of the policies described in this report are helping to develop the market and turn these public benefits into private benefits through credit systems and development bonuses. There are also policies that help promote education and awareness about green roofs and their benefits through increased access and exposure to green roofs and resources.

The green roof job market for design, installation and maintenance is primarily a local one, and the past 20 years has clearly demonstrated that the industry has grown largely due to the increased demand stimulated by education, financial incentives and green roof requirements.

Few, if any, public policies can accomplish so much with so little, as green roof requirements. They leverage private investment for multiple public benefits, generate private benefits, do so on otherwise squandered space, and are relatively easy and low cost to administer.

Overcoming Perceived Barriers to Green Roofs

With all the benefits that green roofs can provide, why are they not more common in cities across the country? There are perceptual barriers to green roof implementation, one of which is the higher costs than traditional roofing. The initial cost of a light weight, low maintenance extensive green roof is roughly twice the price of a comparable traditional roof. This is more than offset by the longer lifespan of waterproofing membrane systems under a green roof assembly. There is also the added perception that these systems may leak or require costly maintenance.

These concerns have been consistently and entirely disproven. Green roof maintenance requirements are modest and anticipatable, and the stability of such systems and their contribution to roof longevity and durability is well documented. Professional training and the Green Roof Professional (GRP) accreditation program have promoted best practices to ensure that high-quality and well-performing systems predominate. Green Roof Installation and Maintenance Professional (GRIMP) certification provides hands-on training and best practice information to industry professionals.

The following document summarizes green roofs and wall policies across Canada and the United States that encourage widespread adoption. The policies are separated into two categories - mandatory requirements and incentive programs. There is also a section that lists other policies that promote green infrastructure for stormwater management. These case studies can be used in conjunction with Green Roofs for Healthy Cities' other resources to create well-developed and effective policy.



Green Roof Installation and Maintenance Professional (GRIMP) training in progress. Photos: Rushil Malik

Green Roofs for Healthy Cities – Policy and Professional Development Support

Green Roofs for Healthy Cities (GRHC) is an industry association that works on behalf of its members to establish cost-effective green roof and wall policies to recognize their public and private benefits and result in their widespread implementation. This is done by tracking a wide range of green roof and wall policies, providing case studies, completing cost-benefit studies and supporting policy development and advocacy. GRHC has a comprehensive training and certification program – the GRP – Green Roof Professional - which is focused on best practices in the design, installation and maintenance of these systems. The GRP can be required through policies, regulations, and/or standards to help ensure quality design and construction is achieved.

To further support policy development efforts, GRHC has established a number of initiatives and resources:

- The Green Roof Professional (GRP) training and accreditation program can provide you with professionals to help understand best practices in the design, installation and maintenance of green roof systems._
- GRHC's Technical Committee and Policy Committee are available as ongoing resources to provide expertise as helpful.
- GRHC has been directly involved in policy development in Toronto, San Francisco, Denver, New York City, the State of Washington, Cambridge, Vancouver and Washington, DC, providing feedback, analysis, and educational support.

Green Infrastructure Foundation – Program and Performance



A Charrette program. Photo: Green Infrastructure Foundation (GIF)

The Green Infrastructure Foundation (GIF) is the charitable arm of Green Roofs for Healthy Cities. It has an independent board of directors. It supports policy development through community engagement, training and research.

The GIF offers a two day Green Infrastructure Design and Valuation program. This program involves green infrastructure training and monetary valuation techniques to develop monetary values for various biophysical benefits of green infrastructure. This provides the tools to make the economic case for green infrastructure investment in your community. This is followed by a day long design Charrette focused on an area in your community.

GIF generates research reports to promote informed decision making, such as the cost-benefit analysis used to advocate for the Denver Green Roof Ordinance. The study found that:

- An extensive green roof would provide energy and stormwater savings, increased employee productivity and improved real estate values, all of which would more than offset the installation and maintenance cost of the green roof. Additionally, there would be significant community benefits.
- By 2033, an estimated 57.5 million square feet of green roofs would be built, generating approximately 25,000 job-years, reducing the urban heat island and helping to manage stormwater. The Net Present Value of these green roofs would be \$50 million.
- By 2058 the green roofs would have a Net Present Value of \$1.85 billion, because there would only be maintenance costs and the benefits would continue to accrue.

Over the past seven years, GIF has developed and implemented the Living Architecture Performance Tool (LAPT), an independent review system to help policy makers establish incentive and regulatory programs. The LAPT creates a minimum standard for green roof and wall performance and allows for four different levels of certification - certified, silver, gold and platinum. Projects can earn up to 110 points and can be a green roof or a combination of green roof and wall. The LAPT third party certification could be used by policy makers by referencing it to incentive programs. There are important prerequisites required for LAPT certification associated with design practice, adherence to local regulations and minimum five year maintenance standards. The LAPT is designed to help policy makers adopt performance standards that make sense in their particular climate, and so that these projects generate the desired performance outcomes.

The Living Architecture Academy provides online training courses, including GRP training, GRIMP training, the Green Infrastructure Introductory Course and a more detailed Green Infrastructure Economic Valuation course. To sign up for online training and learn more visit our LAA website.

Overcoming Green Roof Myths

As with any regulatory proposition, opposition is always a possibility. In locales where green roofs have not yet proliferated or where there has been little opportunity to educate affected constituencies, that opposition may be greater.

The likely arguments against green roofs are generally predictable and typically centered around cost and technical issues. Stakeholders should be identified at the beginning and early outreach should anticipate such concerns, and be prepared to address them as they arise, regardless of the form of public process.



LAPT Platinum Certified green roof at the John Ball Zoo in Michigan

As one example: Denver's citizen-led green roof initiative was a particularly challenging scenario. An aggressive initiative was put to a public vote without the benefit of City support. Most felt that an initiative would not make it onto the ballot, let alone build necessary public support. Those likely to be immediately impacted by such a requirement - developers, builders, and the roofing industry - quickly organized once the initiative qualified to be on the ballot and public interest and support was evident.

The opposition was swift, assertive, well-resourced, and orchestrated a campaign based on false narratives, rather than facts. Efforts to countermand the initiative included blitzing all media outlets, lobbying elected officials, and widely distributing literature filled with unfounded claims.

The claims were all answerable, and the initiative passed with a substantial margin. But the fundamental lesson remains: the best offense is a strong-and-ready (and fact-based) defense.

Cost vs. Benefit

As more and more municipalities have assessed the prospective benefits of green roofs, they've each found the benefits to be unquestionably positive for individual projects as well as the municipality as a whole. This is especially true of green roofs used in stormwater management plans. This has borne out across a range of geographies and climates. These green roofs can often take the place of other costly at-grade features, especially in urban areas where at-grade landscape areas are very limited. In areas where below-grade stormwater options are very expensive, green roofs (and blue-green roofs which combine stormwater retention and detention) can offer a very cost effective and multi-purpose solution.

Green Roofs are Too Expensive for Affordable Housing Projects and Public Buildings

Cities around the world are currently facing an affordable housing challenge. In the absence of analysis and advocacy, policy makers and others will raise the issue of "unnecessary" first costs, claiming such costs would put affordability further out of reach. In fact, more vulnerable projects will benefit most meaningfully: full cost recovery within six years on average and the economic benefits then accruing to those projects and occupants through energy savings and deferred maintenance for remaining decades to come. Affordable projects will be all the more challenged in the future. Green roofs guarantee a more stable and accessible future for such projects and their residents, thus directly addressing environmental equity imperatives.

The same is true for public buildings, where the long-term savings resulting from green roofs benefits the public for the life of the building, which helps armour against the uncertainty of future tax-based economies and public-building maintenance budgets.

Green Roofs Represent a Major Fire Hazard

The biomass on green roofs has never proved sufficient to catch a building on fire. Sedum-based green roof plantings have already been proven to offer some fire resistance on roof tops. ANSI / SPRI VR-1 External Fire Design Standards for Vegetative Roofs gives guidance to making green roofs less susceptible to fire. Think about it: which is more flammable, an exposed roofing material or plants? Sedums retain water, and when exposed to fire, they burst. They have been termed nature's fire sprinklers.

Permitting Green Roofs is Difficult

Clearly defined requirements are readily achievable and can spur and expand the development of higher quality green roofs and lower costs as markets mature. This is especially true in stormwater management permitting where high-performance green roof systems can outshine lower performance green roof systems. This may require the testing of various systems and components, to ensure their performance meets code requirements. There are several ASTM testing protocols specific to green roof components that provide consistent, across-the-board results. See appendix A for all green roof standards.



Award of Excellence winning Coastal Cottage, South Shore, Eastern Long Island. Photo: New York Green Roofs

Maintenance of Green Roofs is Challenging and Cost-Prohibitive

Green roofs are living landscapes on top of buildings and require maintenance, just like landscapes at-grade. Extensive green roofs in particular have minimal maintenance costs once established. These maintenance costs are more-than offset by the embedded value in roof longevity and lesser roof maintenance over time. Green wall maintenance costs, particularly living walls as opposed to green facades, can be significant, and should be factored in during the design of projects, particularly access to all areas of a green wall assembly. Building maintenance into policy helps avoid long term maintenance issues. Requiring a 5-year maintenance contract as part of the permitting process can help address this issue.

Wind Uplift Issues

There's no evidence of wind uplift issues associated with properly installed green roofs. There are standards such as CSA 123.24, which is a standard test method for green roof products to certify their wind uplift capabilities. There are also certain considerations in green roof design to accommodate wind uplift forces. ANSI / SPRI RP-14 Wind Design Standard for Vegetative Roofing Systems is available to assist designers in the proper design of green roofs to address wind. A number of green roof installations have been engineered to withstand forces in high velocity hurricane zones (HVHZ), such as Miami, Florida.

Structural Challenges

When included at the beginning of the design and engineering phase, the weight of a green roof can be easily and affordably accommodated by the structural engineers for the project. Existing structures may have some limitations, but green roofs may be installed with special considerations for lightweight assemblies on buildings originally designed with stout structures (such as buildings designed to accommodate rooftop parking) or can otherwise be addressed through additional structural reinforcement. There are a number of ASTM standards that govern how green roofs and their growing media and components are evaluated including ASTM E2399 which is used to measure saturated weight of the growing media.

Green Roofs Leak

A properly designed and implemented green roof should be more free of leaks than a regular exposed waterproof membrane. The most important part of any green roof project is the waterproofing on the roof deck. Not all membranes are the same. Using a suitable, high quality, durable and long-lasting waterproofing membrane designed to withstand constant moisture conditions for decades can help ensure that the green roof will be in place for a very long time. Green roofs also can make waterproofing assemblies last longer by protecting the membrane from damage by UV light, weather damage (hail, etc.) as well as mechanical damage from maintenance traffic. It is important to include a root barrier, membrane protection and include a leak detection quality assurance process during green roof installation.

Additional Costs = Job Loss

Green roof projects can reinforce and broaden the roofing and green roof industry employment ranks. The multitude of industries associated with the green roof industry span a wide range of industries:

- Designers: Architects, Landscape Architects, GRPs, Engineers, Horticulturalists, Roofing Consultants
- Green Roof plants: Growers and nurseries
- Green Roof Growing Media: Lightweight aggregate producers, sand and smaller aggregate quarries, compost producers, growing media producers
- Green Roof Accessories: Edging manufacturers, drainage manufacturers, irrigation manufacturers, suppliers, installers, paver manufacturers for vegetation free zones
- Green Roof Installers: Specialized installers of green roof components
- Green Roof Maintenance: Specialized green roof maintenance staff

One Policy Size Fits All

Given the variety of buildings, both new and old, that exist, it is important to recognize that policy may need to be fine tuned to meet the specific needs of different market segments. Financial analysis of the costs and benefits of different policies for new and existing buildings, will help policy makers avoid potential conflict with building owners. Existing buildings are rarely 'required' to install a green roof or wall after the fact, but rather, are provided with incentives to do so.



The Urban Rooftop Farm on the Toronto Metropolitan University (TMU). Photo: TMU Urban Farm

Types of Green Roofs

Green roofs have undergone nearly continuous evolution over the past 25 years. Municipalities and government agencies should recognize, embrace and encourage the ever growing list of uses for green roofs and their technologies. There are essentially three types of green roofs: extensive, semi-intensive and intensive.

Extensive Green Roofs

Typically the thinnest assembly (2 - 6 inches of growing medium), these green roofs are some of the most common green roofs constructed today. In certain areas of the USA, these extensive green roof systems are used for significant stormwater Best Management Practices (BMP) facilities. Variants in components can greatly increase the water holding capacities of these extensive assemblies.



The extensive green roof at the Tri-City Water Resources Recovery Facility - Oregon. Photo: American Hydrotech, Inc.

Intensive Green Roofs

As the growing media thickness gets deeper (8 - 48 inches), intensive green roofs successfully support a very wide array of plant species and sizes including full size trees. Very often intensive green roofs are combined with other features such as pedestrian and amenity features to increase the usability of these rooftop environments.



An intensive green roof at the Phipps Center for Sustainable Landscapes 2020. Photo: Phipps Conservatory & Botanical Gardens

Semi-Intensive

Green Roofs Semi-Intensive green roofs involve a combination of extensive and intensive green roof assemblies on the same roof, often due to varying structural loading capacities.

Green roofs can have many different design objectives, as described below.

Lawn Green Roofs

While many green roofs are planted with sedums and other similar perennial plants, there is an important category of green roofs that employ grasses as the primary plant material. These Lawn Green Roofs need to be mowed and maintained like their at-grade cousins and can create very usable amenity spaces to rooftops.

Meadow Green Roofs

Similar to the Lawn Green Roof, the Meadow Green Roof typically employs grasses, native plants and perennials to create a lower maintenance green roof that does not require the frequent mowing of a lawn. These green roof types can employ flowering perennials to encourage and expand habitat areas for pollinators.



Photo: Garage Apartments 2019. Photo: Living Roofs, Inc.

Blue Roofs

Temporarily holding back stormwater is an old concept originating in the roofing world. This technique is coming back as blue roofs detain large amounts of stormwater and slowly release it over a specified amount of time. This water is considered “free water” as it is held by itself in a “container” and not within the growing media. Blue roofs are often combined with overlying green roofs to create a combined retention (green roof) and detention (blue roof). Often pavers are used in blue roof configurations to add an amenity and maintenance feature.

Blue/Green Roofs

These green roof types retain and detain stormwater within an enhanced green roof section by augmenting the growing media with synthetic materials that act like sponges in the green roof. Unlike Blue Roofs, stormwater in a Blue/Green Roof is held in the pore spaces in the growing media and synthetic elements and released via transpiration and evaporation from the plants within the Blue/Green green roof assembly.



Van Dusen Botanical Garden Visitor Centre 2017 by Connect Landscape Architecture Inc. with Architek. Photo: Brett Ryan Studios.

Urban Agriculture Roofs

Growing food on rooftops is an increasingly widespread application where urban farmers grow food crops on specially designed green roofs. A wide variety of crops, from vegetables to vineyards, can be cultivated on rooftops.



The Javits Center, New York City. The waterproofing is done by American Hydrotech, and the urban agriculture assembly is managed by Brooklyn Grange. Photo: Brooklyn Grange.

Agri-Solar Green Roofs

The continued development of solar energy on rooftops is benefited by including green roofs underneath the solar installation. The cooling effects of the green roof can lower the ambient temperatures of the solar arrays which makes them more efficient in energy production. Agri-Solar roofs are an early stage application which involves growing food under solar panels on a rooftop.

Amenity Deck Green Roofs

Developers of hotel, condominium and apartment properties increasingly include rooftop amenity spaces in their projects in order to compete for tenants. These lushly developed amenity spaces often include landscaping of varying types and scales, which provide shade and associated features for the enjoyment of the tenants and visitors to these properties. These amenity spaces have been unequivocally demonstrated to contribute directly to the competitiveness and real market value for both the projects on which they rest, as well as nearby projects that enjoy views to these urban greenspaces.

Biodiverse Green Roofs

Biodiverse green infrastructure are natural infrastructure systems designed to incorporate both biotic and abiotic features which can enhance or establish a broad array of ecosystem services and support local plant and animal communities through access to resources, spaces of refuge, simulation of naturalized environments, and more.

Types of Green Walls

There are many different green wall technologies on the market, with very different approaches to sustaining plants. Two of the basic types are described below. a structured system of climbing plants from a planter bed supported by a wall.

Green Facades

Facades are a structured system of stainless steel cables or grids that support climbing plants growing in planters from a planter bed, supported by a wall or other structure element or directly in the ground.



The Shoppes at Kingsbury Square, 2014

Living Walls

Living walls are systems that use felts, or containers that support plants with or without growing media which attach to a secondary frame attached to the building envelope. They employ a wider variety of plants than green facades.



A living wall in Drexel University, Pennsylvania. Photo: Parker Interior Plantscape.

Common Types of Green Roofs and Wall Policies

Green roof and wall policies are the result of unique regulatory and political environments. As a result, various approaches may be employed individually or in combination as fitting for a given community.

The following provides some simple definitions of the types of policies and programs from across North America that can be used to increase the installation of green infrastructure – focused mainly on green roofs and walls. Some require direct expenditures, while others only administrative costs. There are significantly more green roof policies at present than green wall policies.

Density/Floor Area Ratio Bonus

By including green infrastructure in building design, developers are permitted to increase the density of their building through the allowance of additional floor area than otherwise allowed. Additional height may also be a bonus attribute if that's otherwise a code limiter.

Funding (Grant)

Up-front funding to cover the installation costs of specific types of green roofs or green roofs that retain a certain amount of water. Such funding support typically ranges from \$7.50 to \$15 per square foot and may be capped at a certain amount per project. Below these amounts program uptake is typically minimal. Some jurisdictions provide grants to offset the cost of initial structural loading assessments for existing buildings, thereby removing a barrier to program uptake.

Funding (Rebate)

Projects may be reimbursed for the cost (up to a certain amount) of installing green roofs.

Funding (Subsidy)

Property owners make co-payments for part of the cost of the installation of the green roof.

Mandate (Laws and Regulations)

Green roofs are required under specific circumstances to meet specific standards, typically for stormwater management and/or green space requirements.

Residential Stewardship Programs

Financial incentives and technical support to inspire property owners to volunteer to install and/or maintain green infrastructure and stormwater management techniques.

Stormwater Fee Credit

Property owners receive a credit on their annual stormwater fee. Stormwater fee credits are typically calculated based on the amount of impervious area targeted or based on how effective the green roof is in reducing stormwater runoff and in some cases quality. The credits need to be sufficiently robust to shift market behaviour.

Tax Credit/Abatement

Deductions from taxes (credit) or a reduction of taxes (abatement) for the construction of a green roof. The amount is calculated as a percentage of the cost of construction, or as a dollar amount per square foot of green roof constructed up to a certain limit.

Green Area Factor

The regulatory authority assigns different targets for green space across the city. When a major development or retrofit occurs, the owner must meet the targeted green space requirement, using different types of green infrastructure, each of which has a different benefit value assigned to it. This approach provides flexibility and steadily increases the overall green space in the city. For example; if a building with a 5,000 square foot footprint is in an area with a green factor target of 8, then they must design the green infrastructure on and around the building to achieve $(0.8 \times 5,000\text{sf})$ 4,000 square feet of coverage. If a green wall is constructed that is 1,000 square feet and its benefit value is 0.7, this results in 700 square feet (1000×0.7) . With the addition of an intensive green roof that is 4,000 square feet with a benefit value of 0.9 this would yield an additional 3,600 square feet $(4,000 \text{ sf} \times 0.9)$. Together the green roof and wall total 4,300 square feet, which exceeds the green factor target for that area. In addition to green roofs and green walls, trees, planters and porous pavement are also included as options to meet the green area factor targets.

Procurement

New and or existing government facilities, or the facilities of government funded agencies, boards and commissions are required to install green roofs during new construction and/or when re-roofing occurs, if structural support is sufficient.

Other

Additional, less common policies and programs to inspire the construction and installation of green roofs and walls, include:

- Expediting project permits if green roofs are a part of the project plan.
- Low interest loans.
- Using green roofs and walls to achieve points for sustainable development plans.
- Employing a stormwater credit trading system that allows developers to purchase some of their regulatory retention of stormwater requirements on the open market, or sell excess capacity, beyond the regulatory minimum. This ability helps to finance capital and maintenance costs associated with multiple forms of stormwater management.



Photo: Habitat Horticulture Exterior Living Wall at 2177 3rd St. in San Francisco, CA.

Construction Standards

Developing construction standards alongside incentives and regulations is critical to the success of your policy initiative. Some jurisdictions have developed detailed construction standards which incorporate a combination of prescriptive and performance based elements. These standards are essential for ensuring that green roofs are properly designed, installed and maintained, as long standing public assets. Below is an example of a construction standard implemented in 2012 by Deven's Enterprise Commission for its green roof regulations. See appendix B for an example of a comprehensive construction standard from Devens.

Stages of Green Roof Policy Deployment

Developing construction standards alongside incentives and regulations is critical to the success of your policy initiative. Some jurisdictions have developed detailed construction standards which incorporate a combination of prescriptive and performance based elements. These standards are essential for ensuring that green roofs are properly designed, installed and maintained, as long standing public assets. Below is an example of a construction standard implemented in 2012 by Deven's Enterprise Commission for its green roof regulations. Here is an example of a [comprehensive construction standard](#) from Devens, Mass.

Though there is no one-size-fits all template for green roof policy evolution, there are some typical stages that have been identified over a number of initiatives that may be useful when considering such efforts. They are as follows:

Discovery/Initiation

Establishing/identifying the policy potential, possibly to include a strategic window of opportunity, and initiating accordingly. This opportunity can take various forms: a project champion (such as the right mayor, elected official, or department head), a climate change initiative, or other related planning efforts (whether at a neighborhood, district, or citywide scale). San Francisco's green roof path began with a motivated official, a willing elected sponsor, and an emerging climate change agenda. In Denver, the lack of interest or willingness on the part of public officials catalyzed a citizen-led effort that prevailed - despite the lack of official support - with the voting populace demanding effective action.

Environmental Enlightenment

Focusing on the environmental potential, and establishing how it correlates with existing or prospective policies or strategic opportunities.

Geography-Specific Evolution (bioclimatic/political/economic)

Establishing the existing conditions, and building an environment and economic case based on those conditions.

Initial Regulation - Development and Implementation

Crafting appropriate policy/regulations given the local regulatory/political context.

Professional Ripening

If regulatory mandates are established and markets are invigorated, trades and professionals will emerge to meet new market opportunities and demands.

Economic Maturation

As markets evolve and the supportive environment tracks with that evolution, economies of scale contribute to greater economic efficiency and value.

Innovation and Regulatory Advancement

As industries and public acceptance and appreciation augment, an environment evolves that allows for new industries and innovation to emerge alongside additional supportive regulation.

Principles for Establishing Effective Policies

Every locale is a “special flower”, but not.

This resource document provides a comprehensive list of policies and regulations currently in place, and resources and contacts to dive deeper when looking for best-comparables as new initiatives are considered or getting underway. With the publication in 2019 of the [preceding document](#), this earlier information was well-exploited. It's highly recommended that each next effort steal and borrow freely, adopting and customizing these existing wheels rather than inventing new ones. Pre-existent models to advance the case that green roof requirements are not exotic and uncertain, but are – in fact – fully vetted and effective at the building, community, regional, and – ultimately – planetary scales.

Policy is fine, but must establish a clear path to actual implementation.

Policy advocacy and placement can contribute to awareness of green roofs as a climate-change strategy, and promote education about green roofs. For entities just entering the climate change arena, identifying green roofs as an essential and practical response may be a useful and necessary initial step. However, policies without implementation goals and tools push the critical work farther into the future. Any policy should establish defined and aggressive goals and timelines.

Likelihood of success is dramatically improved if defensible financial analysis is at the forefront of the effort.

Understanding the added value and cost of any regulation is critical to both immediate and long-term support and effectiveness. Making the business case for new green roof policy is essential, in a way that incorporates local conditions and real costs based on local expertise, trades and real estate economics.

Any effort to establish a policy or regulation should include anticipatory financial analysis to address concerns about the first-cost of green roof installation and maintenance. Economic concern is inevitable: it's the one aspect that all policy makers and the constituencies most affected will raise early. Demonstrated benefits for different types of buildings and at various building scales, and at the community-wide scale have proven to win over a wide variety of constituencies for the policies in cities like New York, Denver, San Francisco and Toronto.

The financial analysis should be applied to an array of building typologies given the wide range of economic factors at play. For example, multi-unit housing and big box retailers face very different cost and benefit scenarios and have different opportunities for cost savings/revenue generation associated with green roofs. Assumptions within such analyses need to be based on local bioclimatic conditions, zoning and the specific development environment. The more ready and complete the analysis, the greater the likelihood of advancement. Once an analysis is established for a particular geography, it is a modest effort to apply it to various building typologies as appropriate for the locality. This information will address concerns of stakeholders, and can also contribute to the crafting of a more effective policy.

The analytical tools exist and are accessible. Executing a cost-benefit analysis that is transparent and defensible is essential to best understand and describe the implications and benefits of prospective policy initiatives. San Francisco's analysis was procured and designed with the specific intent of being non-proprietary, transferable, and readily calibrated and applied to other climates and market conditions. Since its origination, Green Roofs for Healthy Cities has assisted in applying this essential tool elsewhere.

For more information on conducting cost-benefit analysis see San Francisco Cost-Benefit Study. Also see the Living Architecture Monitor's Volume 20, Issue 4. Winter 2018 "Green Roof Mandates at The City Scale: Good Practice is Good Economics, Good Economics is Good Policy", by Jeff Joslin, Director of Current Planning Emeritus, San Francisco.



Identify stakeholders, both supporters and others, early in the process to best-define an effective regulatory approach and accompanying advocacy strategy.

It is recommended to seek input from other municipalities who have generated policies and regulations in order to employ that intelligence to achieve early support from stakeholders.

Denver, Colorado

Denver is a good recent example where such early input was not achievable, with mixed results as a consequence:

In 2017, Denver passed the Green Roof Ordinance, following a citizen-led effort in reaction to local government's climate change inaction. The stringent ordinance mandated green roofs on both new and existing buildings. Following passage, a technical committee was convened to adjust the mandated requirements. That process determined that green roofs were not feasible for most existing buildings. This opened the initiative to a fundamental reworking, which was amended to mandate a less stringent and impactful set of compliance options.

The Denver effort provides two principle lessons. First: in the absence of policy leadership and best public participation practices, fundamental stakeholder issues may not be adequately vetted and incorporated, and ultimate results may be compromised. Second, if efforts are not appropriately led by policymakers; citizens can, and will, act.

Cambridge, Massachusetts

Cambridge is another example of - when elected officials and leaders do not adequately address the imminence of the climate change threat, citizens will step in. In that case, Mothers Out Front orchestrated a sophisticated and intentional multi step effort to manifest a clear and assertive green roof requirement. Their approach is fully documented and an excellent template for citizen action.⁶



Photo: Mothers Out Front

San Francisco, California

Alternatively, San Francisco developed and applied its financial analyses early. Armed with that information, it then proactively identified and educated elected officials, neighborhoods, housing advocates, and designers. Once the city's mandatory green roof and solar regulations were defined and went through public processes, there was no opposition whatsoever.

⁶ Melissa Ludtke, *Living Architecture Monitor Summer 2021*. A Climate Solution: How Mothers Out Front Won A Green Roof Requirement in Cambridge, Mass. <https://livingarchitecturemonitor.com/articles/mothers-out-front-green-roof-requirement-in-cambridge-massachusetts-su21>

Mandatory approaches are ideal, but some flexibility is essential to address competing roof technologies.

Mandatory policies provide the most immediate path to green roof deployment. However, flexibility is necessary in terms of public support and performance.

In the case of San Francisco, the option to employ solar, living roofs, or a combination was key to its ready path to approval and implementation. Financial analysis included balancing the cost benefit for these respective approaches so as to offer a level playing field for projects considering one option or the other. As the cost-effectiveness of these two approaches would likely change over time, consideration might be given to revisiting the balancing of the options once or twice a decade for municipalities offering a menu of choices.

As described above, Denver was able to achieve consensus once stakeholders arrived at a menu of compliance options. However, Denver's highly politicized process did not go through a process of assessing the relative environmental and cost benefits for each option, and tailoring them accordingly. As a result, many developers will pursue the lowest first cost solutions.

Similar to Denver, in New York City, recent policies in support of green roofs include an either or provision for solar panels, which enjoy a high level of subsidies. As a result, many developers are opting for solar panel only roofs, even though the two technologies are complementary in many ways, including increasing solar panel efficiency by anywhere from 1 to 15 per cent. .

Establishing a level playing field between various competing roofing technologies is one approach, while another is deciding to tilt the market to a technology which best suits local needs. For example, if the area in question is lacking in accessible green space, then policy can be developed that provides enhanced support for this application. This approach is exemplified by Green Area Factor policies, which provide a weighing of different green infrastructure applications, based on the extent to which they provide public benefits.

If there are no clear policy priorities, then at a minimum, consideration needs to be given to creating a level playing field: each path or technology should be assessed in terms of cost-recovery and environmental benefit, and calibrated accordingly.

Properly scaled incentives can facilitate policy acceptance, and encourage emergent supportive providers to enter the marketplace.

Incentives have played a big role over the last decade in many cities, particularly when the benefits of green roofs were unproven and/or unknown. Incentives make sense now, only if it is the only politically viable path.



PollinateTO grant recipients, Toronto. Photo: Matt Forsythe

Incentives can encourage markets, but regulations establish markets, and provide predictable demand so that private sector suppliers can ramp up their activities. Mandates are also simpler and more cost-effective to implement and less likely to fall victim to future budgetary cycles.

Several jurisdictions, recognizing the need for flexibility, offer developers the opportunity to buy out of the requirement for a green roof, typically at higher rates than compliance. In the case of Toronto, the money is deployed into the Eco-Roof Fund which provides financial incentives to implement green roofs on existing buildings. It is important to price the buy out properly, and design-in recalibration of the buy-out rate over time, so that it is properly scaled and not the least expensive option. It is also important to employ funds to achieve a similar effect.

Complementing compliance options for mandatory policies with incentive policies may make choosing a green roof option more appealing. However, incentive policies with low tax abatements, minimal rebates, or strict restrictive covenants will not be adequate to encourage markets to emerge. The benefits of incentive programs must outweigh or at least meet the cost of installing a green roof for private property owners in order to have a meaningful effect. If there are buy-out options for those having green roofs mandated, the cost of the buy-out must be at least the same or higher than compliance with the mandate.

In an era where greenwashing is commonplace, language matters.

Be clear about what is meant by ‘green roof’ as it relates to other roof technologies, such as solar panels or reflective roofing. San Francisco employed the term “living roof” because that ordinance was advanced following a period of drought, and it was thought “green roof” could be optically problematic in a moment where homeowners were being asked to minimize water use. Portland has long-used the term “ecorooft”, as green was already in abundance and the terminology helped reinforce the environmental enhancement qualities of green roofs.

Performance is the purpose.

Performance-based measures, such as minimum retention rates for stormwater, coupled with prescribing systems and components, is fundamental to establishing best practices. Performance requirements allow for market flexibility, as well as maintaining space for innovation.

Municipalities do not need to invent such a framework (unless they really want to): The Living Architecture Performance Tool is available to calibrate the performance of green roofs and walls. It provides a scientifically based framework of performance measures and minimum prerequisites for the design, installation, and maintenance of these technologies.



LAPT Silver: Harvard Business School's McArthur McCollum Building. Photo: [Recover Green Roofs](#)

Best practitioners provide a certain path to best practices.

Green Roof Professional (GRP) certification is designed to provide those who earn the accreditation with knowledge of best practices in design, installation, and maintenance. Should concern be raised about the availability of professional capacity or expertise, such certification can be referenced, and even incentivized by providing expedited review for certified professionals.

As in so many things, the green roof policy perfection can be the enemy of the good.

Local appetite for new regulation is variable, particularly when considering “new” technologies in an evolving market. There’s wisdom in manifesting politically expedient “starter” requirements if necessary, allowing the market and the trades to mature, in anticipation of additional requirements down the road as changing political landscapes and other policy efforts present new opportunities to expand or otherwise augment approaches already in-place.

Implementation Should Incorporate Performance Assessment and Compliance Flexibility

It is necessary to be specific about what is meant by a ‘green roof’ with a clear delineation of performance requirements, and appropriate but minimal detail about specific assemblies. For example, four inches of growing medium can retain a quarter inch of stormwater, or three inches of stormwater, depending upon its composition. If stormwater retention is a primary policy driver, it is more appropriate and accurate to define a requirement established based on inches of rainfall retained, rather than prescriptive language about individual systems. This is particularly key, as technologies and practices will evolve over time. A resilient regulation will be able to deliver results, while allowing for the evolution and innovation of technical approaches.

The Living Architecture Performance Tool describes all of the potential green roof and wall benefits and provides performance measures, minimum requirements, and examples of how they can be achieved. Many building owners/developers will seek the least costly compliance path; clearly and convincingly defining the relative costs and benefits of the technologies can help projects select approaches most suitable for their performance and program.

For more information on conducting cost-benefit analysis view the San Francisco Cost-Benefit Study. Also see The Living Architecture Monitor’s Volume 20, Issue 4. Winter 2018 “Green Roof Mandates at The City Scale: Good Practice is Good Economics, Good Economics is Good Policy”, by Jeff Joslin, Director of Current Planning Emeritus, San Francisco.



East Building Addition, Adlai E. Stevenson High School, Lincolnshire, IL.
Photo: Wight and Company, Omni Ecosystems, and Nedlaw Living Walls

Lessons Learned

Policy is a great tool to address the lack of awareness of green roofs and promote education about green roofs. But policies without implementation tools are not effective at increasing the installation of green roofs or walls in cities. The time to implement meaningful tools is now. Any effort to establish a policy or regulation should include anticipatory financial analysis to address inevitable concerns about the first- cost of green roof installation and maintenance.

It is recommended to seek feedback from other municipalities who have generated policies and regulations, as well as attempt to achieve early support from stakeholders. In 2017, Denver passed the Green Roof Ordinance after a citizen-led effort advocated for green roof policy. The ordinance mandated green roofs on both new and existing buildings. The requirements for green roofs on all existing buildings were particularly concerning to some constituencies, and led to well-organized and funded opposition to the initiative. Following passage, a technical committee was convened to adjust the requirements mandated by the sweeping initiative. Over the course of that process, it was determined that green roofs are not a feasible option for 95 percent of existing buildings because they would be unable to support the extra loading requirements. This opened the initiative language to a fundamental reworking, and it was ultimately amended to now mandate that buildings have a cool roof and one of a series of compliance options, of which installing green roofs or walls are included. The complicated array of options in Denver comes with an immediate cost: staffing to administer the ordinance is multiples greater than other cities with clear codified mandates. This added cost also makes the program vulnerable to future budget processes in leaner times.



Multi-story green facades around an inner courtyard, Jakob Rope Systems, Vietnam. Photo: Oki Hiroyuki for G8A Architects, HCMC, Vietnam

Complementing compliance options for mandatory policies with incentive policies may make choosing a green roof option more appealing. However, incentive policies with low tax abatements, minimal rebates, or strict restrictive covenants do not make installing green roofs accessible or appealing. The benefits of incentive programs should outweigh or meet the cost of installing a green roof for private property owners. Conducting a cost-benefit analysis that is transparent and defensible to best understand and describe the implications and benefits of prospective policy initiatives is key. Once an analysis is established for a particular geography, it is a modest effort to apply it to various building typologies as appropriate for the locality. This information will help you not only to address concerns of stakeholders but can also contribute to a more effective policy. Avoid either or options for regulatory compliance, particularly since green roofs, blue roofs, solar roofs and reflective (white) roofs have very different cost and benefit profiles and are therefore not equivalent to each other.

Consult with various stakeholders and you will likely find that there is a very large public constituency in favor of policies that support green roofs and walls. Building owners and developers are already on board with green roof and wall policies that can be hugely helpful in countering concerns.

Be clear about what is meant by ‘green roof’ as it relates to other roof technologies, such as solar panels or reflective roofing. Language matters: San Francisco employed “living roof” terminology because that ordinance advanced following a period of drought concern, and it was thought “green roof” could be optically problematic in a moment where homeowners were being asked to minimize water use.

Use performance-based measures, such as minimum retention rates for stormwater, rather than prescribing systems or their components. This allows the market flexibility as to how best to meet the performance requirements. The Living Architecture Performance Tool is designed to improve the performance of green roofs and walls by providing a scientifically based framework of performance measures and minimum prerequisites for the design, installation and maintenance of these technologies. It can provide a framework for meeting your policy objectives and performance goals.

Support professional training by acknowledging the Green Roof Professional designation which is designed to provide those who earn the accreditation with knowledge of best practices in design, installation and maintenance.

In this age of significant public resource constraints, and growing challenges, green roofs and walls provide proven approaches to meeting multiple policy objectives at minimal cost, and can contribute over time, to helping make our communities more resilient.



Carroll Rooftop Farm, Chicago, IL. Photo Courtesy [Omni Ecosystems](#)

Conclusion

Despite the numerous recent advances in implementing green roof regulations, green roofs and walls continue to be underutilized in many cities across North America. Cities each year are establishing increasingly stringent beneficial requirements in order to address a number of policy goals. It is appropriate, and necessary to continue to advocate for policy where there is none to incorporate green roofs and walls in all major new developments. Appropriately conceived policy will ensure that green roofs and walls are installed and maintained according to best practices. Such expansive deployment is already advancing the real estate value and city-scale environmental benefits. Green Roofs for Healthy Cities continues to monitor and provide feedback on legislation to evaluate individual policies and facilitate continuous improvement.

Green Roofs for Healthy Cities is committed to continuing to develop tools that municipalities can use as a guide to create their own policy. In addition to green roof performance standards, it will continue to address the applicability of appropriate programs in different geographies and bioclimates, elaborate on different regulatory measures, and be available to support future such efforts.

Ultimately, success in increasing green roof policy and the widespread implementation of green roofs is a direct result of green roof champions in government and industry collaborating to promote and sponsor legislation. In partnership with third parties, such as Green Roofs for Healthy Cities, and passionate citizens advocating for change, green roofs will continue to be assertively advocated for and implemented as an essential and effective means to combat local and global environmental challenges.



River City 3 Condominiums, Toronto. Photo: Eric Durnford

Resources

Green Roofs for Healthy Cities

GRHC is an industry non-profit organization that promotes the development of green roof infrastructure across North America. With a mission to enhance urban environments and promote sustainable building practices, GRHC provides education, advocacy, and certification programs to advance the green roof industry.

Some resources include:

- [Grey to Green Events](#)
- [Virtual Symposiums](#)
- [Green Roof Installation and Maintenance Professional \(GRIMP\) training and certification](#)



The lobby of Hatch 41, Chicago, IL. Photo: Omni Ecosystems

Living Architecture Academy

This online learning platform is dedicated to bringing you the best, most up to date professional training information on design, installation and maintenance practices. Register today to begin earning CEUs from AIA, APLD, LA CES, GRP, with new courses being added regularly.

Some courses include:

- [Green Roof Professional \(GRP\)](#)
- [Introduction to Green Infrastructure](#)
- [Biophilic Design](#)
- [Advanced Green Roof Maintenance](#)
- [Policy Development Virtual Symposium 2022](#)
- [Green Infrastructure Policy Virtual Symposium](#)
- [CitiesAlive 2018 Policy Track](#)

Living Architecture Monitor

The [Living Architecture Monitor](#) (LAM) is a quarterly magazine that focuses on the green roofs, walls, and living architecture industry. Featuring case studies, research, and best practices, the LAM provides a platform for professionals to share their expertise and experiences in designing, constructing, and maintaining living architecture systems. The LAM also has a search function, and archived articles can be searched [here](#).

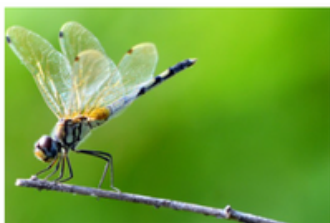


Summer 2023, From the Founder, Steven Peck

Five Reasons to Incorporate Biodiversity into Your Green Infrastructure Designs and How To Begin Doing It

Discover the importance of biodiversity and how to reconnect with it in your living architecture projects. Learn practical steps to incorporate biodiversity and enhance the value of your designs for a sustainable future.

[Read More →](#)



Summer 2023, Plant Profile, Bruce Dvorak

Designing Green Roofs for Dragonflies

Discover how to design biodiverse green roofs that attract and support dragonflies. Learn about the importance of water, stones, and flowering plants in creating dragonfly habitats on green roofs. Explore case studies and expert insights.

[Read More →](#)



Summer 2023, Podcast

Replicating Ecologies with Dusty Gedge

This episode, Sustainable Futures sits down with noted ecologist Dusty Gedge, president of the European Federation of Green Roof and Wall Associations, to discuss fostering biodiversity through urban naturalization, developments in bio-solar technologies, and his background as a lifelong birder. Join us for a conversation on his life as a passionate bird watcher, his career advocating for biodiverse green infrastructure, and the imperative of addressing the climate crisis for future generations.

[Read More →](#)



Summer 2023, Case Study, Phipps Conservatory and Blaine Stand

The Center for Sustainable Landscapes – An Ecological Showpiece in Pittsburgh

Discover the Center for Sustainable Landscapes, a remarkable ecological masterpiece in Pittsburgh's Schenley Park. Learn about its green certifications, net-zero energy, and water goals. Explore the collaborative creation, ecosystem enhancement, and context incorporation that make it a sustainable marvel.

[Read More →](#)

The Living Architecture Monitor Summer 2023 Issue.

Sustainable Futures: Designing Green Communities and Buildings Podcast

[Sustainable Futures](#) is an all new biweekly podcast from Green Roofs for Healthy Cities featuring interviews and discussions about the innovative approaches to green infrastructure, resilience planning, and sustainable design with host and GRHC Founder/President Steven Peck. This podcast brings together thought leaders from around the world, bringing the knowledge and insight to you, wherever and whenever you are.

Overview of Policies and Programs

Location	Mandate or Regulation	Incentives						Policy Name
		Tax Credit	Funding (Grant, Rebate, or Subsidy)	Stormwater Fee Credit	Density or Floor Area Ration Bonus	Residential Stewardship Program	Other	
Austin, Texas					X			2014 - Downtown Density Bonus Program
Bellingham, Washington				X				2017 - Vegetated Roof Incentive
Cambridge, Massachusetts							Fees in lieu of greenspace on appropriate buildings	2021 - Green Roof Ordinance
Chicago, Illinois	X		Subsidy (of permit and consultant code fees)		X		Accelerated permit process	2014 - Green Permit Program 2015 - Floor area Bonus 2015 - Green Roofs Incentives 2017 - Sustainable Development Policy
Covington, Washington					X			2022 - Green Building Incentives
Denver, Colorado	X						Minimum roof pitch requirement waived	2017 - Green Building Ordinance 2023 - Green Roof Incentive
Devens, Massachusetts	X							2012 - Policy for Construction of Vegetated Roofs 2012 - Industrial Performance Standards and General Regulations: Greenhouse Gas Mitigation (974CMR 4.11 2.(c)) 2013 - Viewshed Overlay District Vegetated Rooftops and Vegetated Walls Requirement (974CMR 3.04(8) (i)5)
Ellensburg, Washington					X			2013 - Density Bonus Incentives
Fife, Washington	X						Green Factor?	2009 - Green Factor
Hoboken, New Jersey					X		Fees if stormwater performance measures are not met	2018 - Green Infrastructure Bonus Standards for Impervious Coverage
Kirkland, Washington				X??			Accelerated permit process	2013 - Priority Permit Review
Marion County, Indiana				X				2016 - Stormwater Credit
Milwaukee, Wisconsin			Grant					2019 - Green Infrastructure Partnership
Minneapolis, Minnesota				X				2017 - Stormwater Utility Fee Credit
Nashville???								MISSING LINKS apparently

Location	Mandate or Regulation	Incentives						Policy Name
		Tax Credit	Funding (Grant, Rebate, or Subsidy)	Stormwater Fee Credit	Density or Floor Area Ratio Bonus	Residential Stewardship Program	Other	
New York (State)		X						2008, revised 2013, 2019 - Green Roof Property Tax Abatement Program
New York City, New York	X	X	Grant			??see green roof information		2011 - Green Infrastructure Grant Program 2019 - Green Roofs for New Construction 2019 - Green Roof Information 2019 - Green Roofs on Smaller Buildings 2022 - The Clean Water, Clean Air, and Green Jobs Environmental Bond Act of 2022
Northeast Ohio Regional Sewer District				X				Revised 2016 - Impervious Area Reduction Credit
Onondaga County, New York			Grant					2018 - Green Improvement Fund
Palo Alto, California			Rebate					2017 - Stormwater Measures Rebate Program *GREEN ROOF REBATES ON HOLD
Philadelphia, Pennsylvania		X	Grant	!!! need year	X			2007, revised 2016 - Green Roof Tax Credit 2018 - Stormwater Grants 2021 - Philadelphia Home Rule Charter ss.14-702(16)
Portland, Maine				X				2015, latest update 2021 - Stormwater Credit Manual
Portland, Oregon	X					X		2018 - EcoRoof Requirement
Prince George County, Maryland								2013 - Rain Check Rebate Program
Redmond, Washington					X			2011 - Green Building and Green Infrastructure Incentive Program
Saint Laurent, Quebec	X							2016 - Règlement sur le zonage no RCA08-08-001
San Francisco, California	X						Green Factor?	2017 - Better Roofs Ordinance 2019 - Central SOMA Plan Living Roof and Solar Requirement
Seattle, Washington	X		Grant and Rebate	?	X	X	GF?	2007 - Green Factor 2022 (as amended) - Land Use Code
Shoreline, Washington							Waiving of application and pre-application fees, reduced Transportation impact fees, Departures from Development Code allowed, accelerated permit process	2022 - Deep Green Incentive Program
Toronto, Ontario	X		Grant					2009, amended 2011 - Green Roof Bylaw 2016 - Eco-roof Incentive Program
Washington, DC	X		Rebate	X				2007, revised 2016 - Riversmart Green Roof Rebate Program 2013 - Stormwater Retention Credit Training Program 2017 - Green Area Ratio

Mandatory Green Roof Requirements

Chicago, Illinois

Policy Name: Sustainable Development Policy

Year: 2017

Policy Details: The Sustainable Development Policy requires that development projects earn a number of points by implementing select sustainable strategies. It applies to new developments, TIF funded developments receiving over \$1 million, or multi-family housing projects over 5 units that receive specific financial assistance. All new developments are required to reach 100 points. The two compliance pathways are earning points from the strategies menu without building certifications or earning points from a building certification and earning the reset of the points from the strategies menu. The menu includes strategies in the following categories: health, energy, stormwater, landscapes, green roofs, water, transportation, solid waste, work force and wildlife. The green roofs will earn a project 10 points if 50-100% of the building's net roof area is covered with vegetation, or 20 points if it covers 100% of the net roof area. The net roof area is the gross roof area with the exception of the area for mechanicals, maintenance pathways, window washing systems, swimming pools and skylights. More than 5 million square feet of green roofs have been implemented in Chicago to date as a result of its policy initiatives in support of green roofs.

Link: https://www.chicago.gov/city/en/depts/dcd/supp_info/sustainable_development/chicago-sustainable-development-policy-handbook0.html

Denver, Colorado

Policy Name: Green Building Ordinance

Year: 2017

Policy Details: New buildings, new additions to buildings and existing buildings with a certificate of occupancy that are 25,000 ft² must have a cool roof and comply with one other Green Buildings requirements. The compliance options are: green roofs/green space, installing or purchasing solar or other renewable energy, energy cost savings/using less energy than code, green building certifications, payment to the Green Building Fund, and enrolling in the Energy Program. The compliance option for green space can be achieved by installing a green roof. With this option, the green roof of new buildings must be calculated by starting with the total roof area and deducting the following: private terraces equal to or smaller than the gross floor area of the abutting unit at the roof level, outdoor amenity spaces, rooftop mechanical and electrical equipment, skylights, glass covered atriums, window glazing, and areas covered by renewable energy devices. Vegetation shall be designed to cover 80% of the vegetated roof within 3 years, or be used for urban agriculture.

Link: <https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Community-Planning-and-Development/Green-Buildings-Ordinance>

Devens, Massachusetts

Policy Name: Policy for Construction of Vegetated Roofs

City: Devens Enterprise Zone, MA

Year: 2011, amended 2012

Policy Details: When building a green roof, a member of the construction team must be a Green Roof Professional (GRP). The policy requires that the vegetation on the roof not be an invasive species, and that it must be native plants with seeds appropriate to Devens' USDA hardiness zone (5b). Green roofs shall have a minimum of 4 inches of growing media that cover 40% of the roof area, with at least 80% coverage within three years of the date they are planted.

Link: http://devensec.com/development/DEC_vegetated%20Roof_policy_revised_January2012.pdf

Policy Name: Industrial Performance Standards and General Regulations: Greenhouse Gas Mitigation (974CMR 4.11 2.(c))

Year: 2012

Policy Details: Projects that require an air quality permit are required to have a vegetated roof that covers at least 30% of the roof. The roof must be designed in compliance with the Policy for Construction of Vegetated Roofs.

Link: <http://www.devensec.com/rules-regs/decregs411.html>

Policy Name: Viewshed Overlay District Vegetated Rooftops and Vegetated Walls Requirement (974CMR 3.04(8) (i)5)

Year: 2013

Policy Details: The design standards for buildings in the Viewshed Overlay District (projects visible from the Museum of the New England Landscape) are required to the extent possible to install vegetated roofs and vegetated walls.

Link: <http://www.devensec.com/rules-regs/decregs304.html>

Fife, Washington

Policy Name: Green Factor

Year: 2009

Policy Details: In order to receive a project permit, new developments, redevelopments and construction sites must have a landscaping plan that achieves the green factor. Plans meet the green factor by implementing green factor elements, each of which have a score. The total green factor score that must be met is calculated by dividing "the green area factor by the lot area". Each green factor element has a correlated multiplier, which is used to calculate the green factor. The green factor elements include green roofs.

Link: <https://www.cityoffife.org/258/Fife-Green-Factor>

New York City, New York

Policy Name: Local Law 94

Year: 2019

Policy Details: New buildings and existing buildings undergoing major renovations in specific occupancy groups defined in the New York City Building Code are required to have a 100% of the available roof space as a sustainable roofing zone. A sustainable roofing zone is covered in a green roofing system and/or solar panels and/or wind turbines. Currently, only 1 in one thousand buildings have a green roof in New York City.

Link: <https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3557657&GUID=B4C3A822-2FBB-45FD-8A74-C59DD95246C1&Options=ID%7CText%7C&Search=1032>

Policy Name: Local Law 92

Year: 2019

Policy Details: The requirements for green roofs for new construction are adjusted for smaller buildings. Additionally, the Department of Housing Preservation and Development must study the impact that the installation of green roofs has on building affordability.

Link: <https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3332071&GUID=A2326DB7-EBE2-4CF3-AC1D-50834B9BDDC9>

Policy Name: The Clean Water, Clean Air, and Green Jobs Environmental Bond Act of 2022

Year: 2022

Policy Details: 4.2 billion dollars are being allocated towards mitigation projections such as flood risk reduction, clean energy, and land conservation. The bond mandates that disadvantaged communities receive 40 percent of overall benefits of state spending on clean energy. The bond act will support over 84 000 jobs and 8.7 billion dollars in project spending and the projects that receive funding must comply with minimum wage requirements.

Link: <https://www.nysac.org/files/NYSAC%20Whitepaper%20-%20Clean%20Air,%20Clean%20Water,%20and%20Green%20Jobs%20Bond%20Act.pdf>

Portland, Oregon

Policy Name: EcoRoof Requirement

Year: 2018

Policy Details: New buildings with a net building area of 20,000 square feet or more must have an ecoroof that covers 100% of the building area (with exceptions). New buildings with a net building area of 20,000 square feet or more must have an ecoroof that covers 100% of the building roof area, except that up to 40% of the area may be covered with elements such as skylights, solar panels, mechanical equipment, etc. The ecoroof must also meet the Portland Stormwater Management Manual's Ecoroof Facility Design Criteria. The ecoroof requirement applies in the Central City 2035 Plan District. Previously, Portland provided grants for green roof installations to help manage stormwater (33.510.243 Ecoroofs).

Link: <https://lpdd.org/resources/portlands-ecoroof-requirements/>

Saint Laurent, Quebec

Policy Name: Règlement sur le zonage no RCA08-08-001

Year: 2016

Policy Details: All flat and low-pitched roofs, and flat and low-pitched roof sections must be covered in vegetation or covered in materials with a solar reflective index (SRI). A permit will be required for the installation and replacement of any roof cladding for a flat or slow-pitched roof (under 2:12) or for a section of a flat or slow-pitched roof. Only the following types of materials are authorized to cover a flat roof or a low-pitched roof:

- Green roof (vegetated).
- Light roof covered with white gravel.
- Light roof covered with a material with a Solar Reflectance Index (SRI) of at least 78, as attested by the manufacturer or a professional.

Link: http://ville.montreal.qc.ca/pls/portal/docs/PAGE/ARROND_SLA_EN/MEDIA/DOCUMENTS/2018%20TOITPLAT%20ANG.PDF

San Francisco, California

Policy Name: Better Roofs Ordinance

Year: 2017

Policy Details: New buildings are required to have 15% of the roof space as solar panels or 30% of the roof space as a Living (green) Roof. The ordinance applies to buildings that are: non-residential buildings with a gross floor area of 2000 square feet or residential buildings of any size, and the buildings have 10 or fewer occupied floors. The growing media should be at least 4 inches deep. The vegetation must have a high species diversity, include native species, and be low water use and use low maintenance plants.

Link: http://default.sfplanning.org/publications_reports/ZAB_11_Better%20Roofs_051517.pdf

Policy Name: Central SOMA Plan Living Roof and Solar Requirement

Year: 2019

Policy Details: New buildings are required to have 15% of the roof space as solar panels and 50% of the roof space as a Living (green) Roof. The ordinance applies to buildings that are: on a lot 5000 square feet or larger with a building height 160' in height or less.

Seattle, Washington

Policy name: Green Factor

Year: 2007

Policy Details: Minimum Green Factor scores must be met for areas requiring landscaping. There are different scores required depending on the zoning of the development. Under the Seattle Green Factor, varying landscape elements are assigned a multiplier value (or a score). The Green Factor is calculated by multiplying the square feet of a landscape element by its score. The landscape elements include green roofs and walls along with other types of green infrastructure. Green roofs must have at least 2 inches of growing medium, and have a higher score if they have over 4 inches of growing medium.

Link: https://library.municode.com/wa/seattle/codes/municipal_code?nodeId=TIT23LAUSCO_SUBTITLE_IVAD_CH23.86ME_23.86.019GRFAME

Toronto, Ontario

Policy name: Green Roof Bylaw

Year: 2009, amended 2011

Policy Details: New commercial, institutional and residential developments with a minimum gross floor area of 2000 meters squared are required to have green roofs. detailed construction standards. The plant selection and design must cover at least 80% of the green roof within 3 years of planting. The growing medium must be at least 4 inches to help ensure winter plant survival.

The coverage requirements for the green roof bylaw are graduated. Buildings with larger gross floor area are required to cover more from 20% at the low end to 60% at the high end. Available Roof Space. The bylaw allows for solar rooftops by defining Available Roof Space as excluding areas for renewable energy. A if gross floor area is > 4,999m², 30% of available roof area if gross floor area is 5,000-9,999 m², 40% of available roof area if gross floor area is 10,000-14,999m², 50% of the available roof space if gross floor area is 15,000-19,999m² and 60% of the available roof space if gross floor area is 20,000m²+

Developers can provide cash-in-lieu for reduced green roof area, or to avoid implementing a green roof at a cost of \$200/meter squared. To date, less than 10% of new buildings have requested any payment of cash-in lieu. This money goes to fund the Ecoroof Grant Program, which provides grants to existing building owners of up to \$100/meter squared for green roof installations. To date, more than 6.5 million square feet of green roofs have been implemented in Toronto through this policy over the past thirteen years.

To encourage more biodiverse, Toronto developed guidelines for biodiverse green roofs that describe best practices to create habitat and promote biodiversity. In 2022, through the City's green building requirements for new development, the Toronto Green Standard Version 4, higher performance green infrastructure became a requirement for all new development. This has driven the uptake of more intensive and biodiverse green roof systems.

Link: <https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/green-roofs/green-roof-overview/>

Washington, DC

Policy Name: Green Area Ratio

Year: 2017

Policy Details: All new buildings that require a Certificate of Occupancy must meet the appropriate Green Area Ratio (GAR) based on the zoning district. The Green Area Ratio is the ratio of the weighted value of landscape elements to land area. The score of landscape elements is calculated by multiplying the area of each element by its multiplier value and adding the scores together. Landscape elements include: soil and amendments, bioretention, new and existing planting, trees, vegetated walls and roofs, and more. Vegetated roofs must have a minimum of 5-7 species and no more than 20% of the total vegetated roof can be individual native species. Plants should achieve minimum 80% coverage after 2 years. There must be a minimum of 2 succulent plugs/square foot or 10 lbs of cuttings/100 square feet. Designs must include supplemental water. Green walls must include 1 cubic foot of soil/10 square feet of green façade.

Link: <https://doee.dc.gov/node/619622>

Incentive Programs

Austin, Texas

Policy Name: Downtown Density Bonus Program

Year: 2014

Policy Details: Developments may achieve bonus area for buildings by providing green roofs. The green roofs must be built to the Vegetated Roof Performance Standards. For 30-49% coverage of green roof (which is calculated as a portion of total roof area excluding mechanical equipment), 2 bonus square feet are granted; and for 50% or greater coverage of green roof, 3 square feet are granted. 2 additional bonus square feet can be achieved if the roofs are publicly accessible and 2 additional bonus square feet can be achieved if the roof meets the Downtown Public Plaza Standards. The green roofs must be 90% native species or adapted species with no invasive species.

Link: <http://www.austintexas.gov/edims/document.cfm?id=206958>

Bellingham, Washington

Policy Name: Vegetated Roof Incentive

Year: 2017

Policy Details: Use of a vegetated roof will help to meet criteria that could qualify a project for a 50% reduction in the stormwater development charges.

Additionally, a vegetated roof can also be incorporated into a project to help avoid the triggering of the 0.1 cfs increase in flow for the 100-year storm threshold to require stormwater detention or to reduce the required size of stormwater mitigation facilities by using allowed stormwater modeling credits. Credits can be found in the Stormwater Management Manual for Western Washington published in 2005 or the Low Impact Development Technical Guidance Manual for Puget Sound.

Link: <https://cob.org/wp-content/uploads/amm303-vegetated-roof.pdf>

Chicago, Illinois

Policy Name: Green Permit Program

Year: 2014

Policy Details: Projects that include green technologies, including green roofs, can receive an expedited permit process (fewer than 30 days) and possibly a reduction of the permit fees. Projects which meet the most stringent sustainability guidelines may qualify for a waiver of consultant code fees (\$25,000).

Link: <https://www.chicago.gov/city/en/depts/bldgs/provdrs/permits/svcs/green-permits.html>

Policy Name: Floor Area Bonus

Year: 2015

Policy Details: The floor area ratio is the total square footage of the building divided by the lot area. Developers can build on extra (bonus) floor area in downtown mixed-use districts if they have green roofs that cover more than 50% of the net area of the roof.

Link: <https://secondcityzoning.org/resources/Chicago-Zoning-Ordinance.pdf>

Cambridge, Massachusetts

Policy Name: Green Roof Ordinance

Year: 2021

Policy Details: The Green Roofs initiative will require developers within the city to integrate vegetative or biosolar roofs into their design plans going forward when constructing new buildings. This ordinance also includes incentives which the previous initiative in 2009 did not have for developers to create vegetative roofs. Developers who do not meet the city's new green roof requirements will be obliged to make a payment to the Cambridge Affordable Housing trust to fund green roofs on supportive housing projects.

Link:

<https://www.cambridgema.gov/CDD/zoninganddevelopment/sustainabledevelopment/article22greenroofsrequirement#:~:text=Under%20the%20Green%20Roofs%20Requirement,in%20the%20Gross%20Floor%20Area.>

Covington, Washington

Policy Name: Green Building Incentives

Year: 2022

Policy Details: Cottage owners can receive a bonus of one and one-half times base density if the cottage and community building are built to LEED Gold, or Built Green 4 Star or 5 Star standards.

Affordability and green building incentives may be combined up to a maximum of two times base density.

Note that 4 and 5 Star Built Green levels require verification by a third party.

Link: <https://covington.municipal.codes/CMC/18.37.040>

Denver, Colorado

Policy Name: Green Roof Incentive

Year: 2023

Policy Details: If a green roof occupies more than 50% of the total area of any building's primary roof surface, the minimum requirement for pitched roof provision will be waived provided the building design complies with the other major standard intentions

Link:

<https://steamboatsprings.net/DocumentCenter/View/3854/Sec404BaseAreaDesignStandards9242019?bidId=>

Ellensburg, Washington

Policy Name: Density Bonus Incentives

Year: 2013

Policy Details: The purposes of the Density Bonus Initiatives are to promote a variety of housing types built with green building practices, promote compact development patterns, promote the integration of trails, promote the preservation of historic resources, promote the integration of affordable housing into new developments, encourage the preservation of valuable resource lands outside of the city.

There are several bonus elements Developments may use a combination provided they comply with the maximum density provisions set forth for the zone. An exception to the maximum density provisions is only provided for projects complying with Net Zero Energy standards. See below the table of Density Bonuses for the R-S and R-L zones

Bonus Element	Density Bonus % Increase	Special Conditions
Energy efficient construction/Built Green, LEED or other similar environmental certification	25 - 150%	See subsection (A) of this section for details
Greater mix of housing types	10 - 15%	See subsection (B) of this section for details. This option may be applied to all development sites with at least 5 acres.
Off-street trails	5 - 20%	See subsection (C) of this section for details.
Transfer of development rights (TDR)	Up to 50%	See subsection (D) of this section for details.
Historic preservation	15 - 50%	See subsection (E) of this section for details.
Affordable housing	15 - 50%	See subsection (F) of this section for details.

Kirkland, Washington

Policy Name: Priority Permit Review

Year: 2013

Policy Details: This is a way to get faster permit processing in Kirkland for new single-family home or duplex projects that certify through programs such as Built Green or LEED. Not only will your permit get priority, but the homes or homes you construct will have the added value of being certified through a widely recognized green building program and will be better for the people who live in them and better for the environment. Use of a vegetated roof will help to meet criteria that could qualify a project for a 50% reduction in the stormwater development charges.

In order to qualify for Priority Permit Review under Kirkland's Green Building Program, you must submit with a completed building permit application the following items:

1. A completed and signed Green Building Program Priority Review for New Single-Family Residences contract
2. A preliminary checklist that shows how the design is to achieve either:
 - a. Four star or better rating through Built Green or
 - b. Silver or better rating through LEED for Homes
3. A copy of a Third-Party Verifier contract who will verify your Built Green or LEED project.

Additionally, a vegetated roof can also be incorporated into a project to help avoid the triggering of the 0.1 cfs increase in flow for the 100-year storm threshold to require stormwater detention or to reduce the required size of stormwater mitigation facilities by using allowed stormwater modeling credits. Credits can be found in the Stormwater Management Manual for Western Washington published in 2005 or the Low Impact Development Technical Guidance Manual for Puget Sound.

Link: <https://www.kirklandwa.gov/Government/Departments/Development-Services-Center/Green-Building>

Marion County, Indianapolis

Policy Name: Stormwater Credit

Year: 2016

Policy Details: Individual residential properties can receive a credit up to 25% for implementing best management practices. Multi-residence, industrial and private properties can receive credits up to 50% for practices that reduce stormwater quantity and improve its quality. Approved best management practices are rain gardens, on-site stormwater storage and vegetated filter strips. The rain garden must cover at least 50% of the roof, or an equivalent amount of impervious area must drain into the rain garden. Additionally, non-residential properties can receive a credit for using Green Infiltrative Infrastructure, and educational facilities can receive an education credit for educating students on stewardship of water resources.

Link: <https://citybase-cms-prod.s3.amazonaws.com/515488394718481f85d7c98d231aa959.pdf>

Milwaukee, Wisconsin

Policy Name: Green Infrastructure Partnership

Year: 2019

Policy Details: The program offers incentive funding on a per-gallon captured, reimbursement basis for a host of green infrastructure strategies designed to capture and clean water where it falls. The eligible strategies include green roofs.

Link: https://www.mmsd.com/application/files/5615/4696/0544/18-009_Funding_Natural_SolutionsWEB.PDF

Minneapolis, Minnesota

Policy Name: Stormwater Utility Fee Credit

Year: 2017

Policy Details: Property owners can receive credits against their stormwater utility fee for installing a green roof. There are two categories of credits for constructed stormwater management practices: Category 1: Stormwater quality credits: The amount of the quality credit (up to 50 percent of the stormwater utility fee) is based on the percentage of the total impervious area on the parcel treated by BMPs. Category 2: Stormwater quantity-reduction credits: Property owners who can demonstrate that all stormwater is retained on site without discharge during the 10-year design storm (50% credit) or the 100-year design storm (100% credit), may be eligible for a stormwater quantity reduction credit.

Link: <http://www.minneapolis.gov/www/groups/public/@publicworks/documents/webcontent/wcmsp-205493.pdf>

Montgomery County, Maryland

Policy Name: Rainscapes Rewards Rebate Program

Year: 2018

Policy Details: Residential properties can receive a rebate of \$9/square foot up to a total of \$7,500 for installing a minimum 100 square foot green roof. Green roofs on institutional/commercial properties must be a minimum 200 square feet and are eligible for up to \$20,000 in rebates. The green roofs must have at least 4 inches of growing media.

Link: <https://www.montgomerycountymd.gov/water/rainscapes/rebates.html>

New York State

Policy Name: Green Roof Property Tax Abatement Program

Year: 2008, revised 2013 and 2019

Policy Details: Property owners can receive a one-year tax abatement of \$5.23/square foot for the installation of a green roof, and in certain high need areas, as much as \$15 per square foot. At least 50% of the roof must be covered with a vegetation layer. The vegetation layer must be 80% sedum or an equally hardy species. The application must be submitted by a registered architect or licensed engineer. In 2019, New York City Council passed a resolution to call on the state legislature to pass and the governor to sign legislation that would increase the real property tax abatement for the installation of green roofs to \$15/square foot. Details of this abatement are still being worked out at the time of publication.

Link: https://www1.nyc.gov/assets/buildings/pdf/green_roof_tax_abatement_info.pdf
<https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3331993&GUID=78C453B3-D03B-49C7-AE5E-255E41404254&Options=&Search=>

New York City, New York

Policy Name: Green Infrastructure Grant Program

Year: 2011

Policy Details: Private property owners can apply for a grant to fund the design and construction of a green roof. The funding is determined based on the area of the green roof and the depth of the soil. Roofs must be between 3500-20,000 square feet. At 1.5-1.99 inches of soil depth, projects receive \$10/square foot; at 2-2.99 inches of soil depth projects receive \$15/square foot; at 3-3.99 inches of soil depth, projects receive \$25/square foot; and at 4+ inches of soil depth, projects receive \$30/square foot. There is a restrictive covenant with the grant stating that projects cannot be destroyed, removed or altered without the city's consent and must be maintained for 20 years.

Link: https://www1.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_grant_program.shtml

Policy Name: Green Roof Information

Year: 2019

Policy Details: The office of Alternative Energy is required to post and maintain updated information about green roofs and resources for installing green roofing systems.

Link: <https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3557664&GUID=9AE78AF4-EEE1-40BE-A1FB-14A3B00EA9C8&Options=&Search=>

Northeast Ohio Regional Sewer District

Policy Name: Impervious Area Reduction Credit

Year: Revised 2016

Policy Details: If a green roof is properly designed and installed, the area of the previous area will be reduced from the property's impervious area calculation. Property owners must recertify yearly to confirm that the green roof hasn't been removed and that it is being maintained. The current impervious area charges for residential properties are: \$3.09 for less than 2,000 square feet; \$5.15 for 2,000-3,999 square feet; \$9.27 for 4,000 square feet or more; and \$2.07 for any size homestead. The current impervious area charges for non-residential properties are \$5.15 per ERU or 3,000 square feet.

Link: https://www.neorsd.org/Library.php?SOURCE=library/CreditManual_ALL_12182012.pdf&a=download_file&LIBRARY_RECORD_ID=4699

Onondaga County, New York

Policy Name: Green Improvement Fund

Year: 2018

Policy Details: Facility property owners are eligible for grants for the installation of green infrastructure for stormwater management, such as green roofs. Green roofs on high-priority sites can receive up to 30 cents/gallon captured, medium-priority sites can receive up to 20 cents/gallon, and captured low-priority sites can receive up to 10 cents/gallon.

Link: http://savetherain.us/wp-content/uploads/2018/06/2018_GIFApplication_051618.pdf

Palo Alto, California

Policy Name: Stormwater Measures Rebate Program

Year: 2017

Policy Details: Property owners can receive a rebate of \$1.50/square foot of a green roof installed. Rebates are also available for the installation of rain barrels, permeable pavement, and cisterns. As of the publishing of this document, green roof rebates are on hold until further notice.

Link: <https://www.cityofpaloalto.org/gov/depts/pwd/stormwater/rebates/default.asp>

Philadelphia, Pennsylvania

Policy Name: Green Roof Tax Credit

Year: 2007, revised 2016

Policy Details: Businesses can apply for a Green Roof Tax Credit for 50% of the cost to construct a green roof, up to \$100,000.

Link: <http://www.greenroofsphilly.com/incentives.html>

Policy Name: Density Bonus

Year: 2015

Policy Details: In specific zoning districts, applicants may receive an exemption to residential density rules by installing a green roof that covers at least 60% of the rooftop. To be eligible for the bonus, there must be at least 5,000 square feet of earth disturbance. The Water Department's Design Standards require that the vegetation thoroughly cover the growing medium when it is fully established. Invasive plants are not permitted, and the plants must be healthy and able to withstand tough conditions.

Link: [http://library.amlegal.com/nxt/gateway.dll/Pennsylvania/philadelphia_pa/title14zoningandplanning?f=templates\\$fn=default.htm\\$3.0\\$vid=amlegal:philadelphia_pa](http://library.amlegal.com/nxt/gateway.dll/Pennsylvania/philadelphia_pa/title14zoningandplanning?f=templates$fn=default.htm$3.0$vid=amlegal:philadelphia_pa)

Policy Name: Stormwater Grants

Year: 2018

Policy Details: The goal of the grant program, in addition to stormwater management, is to “add new landscaping, fix drainage problems, ...improve the appearance of...property, and lower stormwater bills.” Non-residential properties are eligible to receive a grant to fund the costs of the design and construction of stormwater management projects.

The Philadelphia Water Department lists green roofs as a stormwater management method. The Philadelphia Stormwater Management Guidance Manual includes green roof plan standards for the development and construction of green roofs.

Link:

<https://www.phila.gov/water/wu/Stormwater%20Grant%20Resources/StormwaterGrantsManual.pdf>

Policy Name: Stormwater Credits Program and Incentives

Year:

Policy Details: Non-residential, condo and multi-family residential property owners can reduce their monthly stormwater charge with a credit of up to 80% by installing green roofs to increase pervious surfaces. The area of the green roof should be the largest feasible area. To receive a credit, the green roof must be an extensive green roof, with half of the plants being sedums and at least four different species of sedums.

Link: <https://www.phila.gov/water/PDF/SWRetroManual.pdf>

Policy Name: Stormwater Credit

Year: 2015

Policy Details: The credit structure is focused on structural controls that reduce the impact of the development on the stormwater drainage system. Residential properties can earn a credit of 0.5 SBU (stormwater billing unit) for every whole increment of 600 square feet of impervious area treated, up to a maximum of 0.5 SBU for properties with less than 1800 square feet of impervious area, and 1.0 SBU for properties with 1800 or more square feet of impervious area. A total Basic Credit of up to 60% of the stormwater service charge is available to non-residential properties.

Link: <https://www.portlandmaine.gov/1102/Credit-Manual-and-Applications>

Prince George County, Maryland

Policy Name: Rain Check Rebate Program

Year: 2013

Policy Details: The program reimburses property owners who install stormwater management practices. Residential property owners can be reimbursed up to \$4,000, and larger property owners can be reimbursed up to \$20,000. Stormwater management practices include green roofs with \$10/square foot of green roof reimbursed for at least ¼ of the roof being a green roof for residential properties; and at least \$10/square foot for at least 6 inches of planting material on ¼ of the roof for non-residential properties. Non-residential properties can also receive \$20/square foot for over 6 inches of planting material.

Link: <https://cbtrust.org/grants/prince-georges-county-rain-check-rebate/>

Redmond, Washington

Policy Name: Green Building and Green Infrastructure Incentive Program

Year: 2011

Policy Details: The incentive program details sustainable development techniques which may be used when building green buildings and infrastructure. Points are rewarded for using such techniques, and can be used toward certain incentives. See the link below for the full table and explanation of which techniques are awarded points.

Technique	Points Awarded		Incentive	Points Required
1. Site Assessment	2 (when optional)		1. Sustainable development award	0
Assessments plus identification of amenities	1 additional		2. Priority building permit processing	0
3. Green Building Certification			4. Online and print recognition	2
3 star/LEED certified	1		5. Unit type flexibility	
4 star/LEED silver	2		Duplex	3
5 star/LEED gold	3		Triplex	4
3. Drought-tolerant landscaping	1		Fourplex	5
4. Native vegetation retention			6. Lot size reduction	
20%	1		15%	2
30%	2		25%	3
50%	3		30%	4
5. Native soil preservation	1		7. Density bonus	
6. Native soil restoration	2		5%	3
8. Impervious surface area reduction			10%	5
10%	1		9. Clustered node	4
20%	2		10. Alternative road standard	2
8. Permeable materials				

50%	1			
100%	2			
Green (vegetated) roofs				
25% of roof area	1			
50% of roof area	2			
11. Roof rainwater collection	1			
12. Minimal excavation foundation	3			
13. Bioretention or infiltration				
50% detained or infiltrated	1			
75% detained or infiltrated	2			
100% detained or infiltrated	3			

Note Stormwater Infrastructure requirements are based on impervious area. Use of techniques at left is likely to reduce infrastructure costs - an additional incentive

Link: <https://www.codepublishing.com/WA/Redmond/CDG/RCDG20C/RCDG20C3057.html>

Seattle, Washington

Policy Name: Land Use Code

Year: Amended July 2022

Policy Details: There are height exceptions for elevator penthouses if the elevator provides access to a high-rise rooftop that has a green roof.

Link: [https://library.municode.com/wa/seattle/codes/municipal_code?](https://library.municode.com/wa/seattle/codes/municipal_code?nodeId=TIT23LAUSCO_SUBTITLE_IIILAUSRE_CH23.75MAPLCO_PT3DEST_23.75.100STHE)

[nodeId=TIT23LAUSCO_SUBTITLE_IIILAUSRE_CH23.75MAPLCO_PT3DEST_23.75.100STHE](https://library.municode.com/wa/seattle/codes/municipal_code?nodeId=TIT23LAUSCO_SUBTITLE_IIILAUSRE_CH23.75MAPLCO_PT3DEST_23.75.100STHE)

Shoreline, Washington

Policy Name: Deep Green Incentive Program

Year: 2022

Policy Details: In order to request exemptions, waivers, or other incentives through the Deep Green Incentive Program, the applicant or owner shall submit a summary demonstrating how their project will meet each of the requirements of the relevant certification program, such as including an overall design concept, proposed energy balance, proposed water balance, and descriptions of innovative systems.

An eligible project shall qualify for the DGIP upon determination by the Director that it has submitted a complete application pursuant to SMC 20.30.297, Administrative Design Review (Type A), and has complied with the application requirements of this subsection.

The project must be registered with the appropriate third-party certification entity such as the International Living Future Institute, Built Green, US Green Building Council, Passive House Institute US, or Salmon Safe.

Projects requesting departures under the DGIP shall meet the current version of the appropriate certification program, which will qualify them for one of the following tiered packages of incentives:

Tier 1 – Living Building Challenge or Living Community Challenge Certification: achieve all of the Imperatives of the ILFI programs;

Tier 2 – Emerald Star or Petal Certification: satisfy requirements of Built Green program or three or more ILFI Petals, including at least one of the following: water, energy, or materials;

Tier 3 – LEED Platinum, 5-Star, PHIUS + Source Zero plus Salmon Safe, or ZE plus Salmon Safe: satisfy requirements of the respective USGBC, Built Green, PHIUS, ILFI, and/or Salmon Safe programs. The addition of Salmon Safe certification to PHIUS+ Source Zero or ZE projects is not required for detached single-family projects; or

Tier 4 – PHIUS+ or 4-Star: achieve all requirements of the PHIUS or Built Green programs.

Link: <https://www.codepublishing.com/WA/Shoreline/#!/Shoreline20/Shoreline2050.html#20.50.630>

Toronto, Ontario

Policy Name: Eco-Roof Incentive Program

Year: 2009

Policy Details: Existing buildings, new buildings with a gross floor area of less than 2000 metres squared, and new construction projects by schools and nonprofits are eligible to receive a grant of \$100/square metre of green roof installed and up to \$1000 for a structural assessment to determine if a green roof is feasible. The roof must be built according to Toronto's detailed Green Roof Construction Standards.

Link: <https://www.toronto.ca/services-payments/water-environment/environmental-grants-incentives-2/green-your-roof/>

Washington, DC

Policy Name: Stormwater Retention Credit Training Program

Year: 2013

Policy Details: Property owners can install green infrastructure to reduce stormwater runoff and generate Stormwater Retention Credits. One gallon of stormwater retained in one year is equal to one credit. Credits can be sold to projects that are required to implement stormwater management practices; and credits can be sold to the Department of Environment and Energy if they drain into the District Water Bodies. The purchase price per credit is based on the infrastructure's location in the Municipal Separate Sewer System, with non-tidal credits at \$1.95 and tidal credits at \$1.70. To be eligible for credits, the infrastructure must pass maintenance inspections.

Link: <https://doee.dc.gov/src>

Policy Name: Riversmart Rewards Program

Year: 2013

Policy Details: Residents, businesses and property owners can install green infrastructure, including green roofs, to receive a stormwater fee credit. They can receive a discount of up to 55%, and the discount is based on the volume of stormwater that is reduced.

Link: <https://doee.dc.gov/riversmartrewards>

Policy Name: Clean Rivers Impervious Area Charge Incentive Program

Policy Details: In conjunction with the Riversmart Rewards Program, property owners can receive up to a 4% discount off their Clean Rivers Impervious Area Charge by installing best management practices, including green roofs.

Link: <https://www.dewater.com/iac-incentive>

Other

Policy Name: Property Assessed Clean Energy (PACE) Financing

Year: 2018

Policy Details: This is a financing program provided by Counterpointe Sustainable Real Estate that provides financing for energy efficiency, renewable projects and disaster resiliency improvements to buildings. These projects include loans for green roof capital and maintenance costs. The loans can be repaid over 5-25 years. Property taxes are increased on the building at an agreed upon rate to finance the programs. The program is available in 20 states and DC.

Link: <https://counterpointesre.com/projects/>

Green Infrastructure Stormwater Management Policies

Adams County, Colorado

Policy Name: Stormwater Utility Credit

Year: 2014

Policy Details: Adams County's Stormwater Utility Credit encourages technical design and maintenance of stormwater best management practices. These credits are granted to properties on two bases: 1) control of water quantity and 2) control of water quality. Additional credit may be granted to properties for stormwater infrastructure maintenance conducted on behalf of the County to ensure the proper function of regional treatment on that property. Following are the maximum available credit percentages:

- Water Quality Credit: 25%
- Water Quantity Credit: 35%
- Self-Maintenance Credit: 5% (of impervious area treated)

Basic criteria for eligibility is:

- Credit will only be granted to non-single family properties
- The amount of credit given for a BMP will be based on the amount of impervious area for which the practice provides water quantity or quality treatment
- Ongoing credit will be available only to properties that maintain their structural controls in fully functional condition
- Credit is not available for any property outside the utility service area. Maximum credit does not differ from one property to the next based on proximity to water bodies
- Maximum credit is not contingent upon lot size
- In general, each of the three credit types can be granted at once. The maximum credit for water quality and quantity credits is 60% credit.

Link: <http://www.adcogov.org/sites/default/files/5708.pdf>

Baltimore, Maryland

Policy Name: Stormwater Fee Credit

Year: 2013

Policy Details: This fee provides citizens with a credit for maintaining, operating, and improving the City of Baltimore's stormwater management system. Stormwater fees for single family homes are calculated based on the amount of impervious area on the property with the highest monthly fee being \$10 USD. Citizens can receive credits/ a discounted rate on this monthly fee via public participation such as participating in tree planting or stream clean ups. For every 4 hours of such participation, one can receive a credit of \$10 USD for a maximum of \$30/year. Citizens can also claim credit by utilizing Simple Residential Best Management Practices such as installing rain gardens to claim up to \$16/year, planting trees to claim up to \$5/year per tree, and rainwater harvesting systems to claim up to \$25 per rain barrel.

Link:

<https://publicworks.baltimorecity.gov/sites/default/files/SFP%20Stormwater%20Guidance%20Document.pdf>

Fort Wayne, Indiana

Policy Name: Catching Rain Green Infrastructure Initiative

Year: 2018

Policy Details: This program helps citizens build and maintain a rain garden at home. A direct cash payment is given to help with some of the costs of plants and seeds. This incentive is only available for residential buildings in Fort Wayne.

Link: <http://www.catchingrainfw.org/incentive-program>

Kitchener, Ontario

Policy Name: Stormwater Credit Policy

Year: 2012

Policy Details: Kitchener's Stormwater Credit Policy rewards residents and businesses for reducing the runoff flowing into local drainage systems.

Link: https://www.kitchenerutilities.ca/en/services/stormwater_credit_policy.aspx

Seattle, Washington

Policy Name: Stormwater Facility Credit

Year: —

Policy Details: Provides a credit to privately-owned systems that reduce stormwater flow and/or provide water quality treatment. Typically, single family homes do not have qualifying stormwater systems. Any parcel property owner with a functioning, well maintained stormwater system in compliance with City Stormwater Code standards qualifies for this program. These properties can still install green stormwater infrastructures to receive this credit.

Link:

<http://www.seattle.gov/util/ForBusinesses/DrainageSewerBusinesses/StormwaterFacilityCredit/index.htm>

Policy Name: Rainwise Program

Year: 2009

Policy Details: Seattle's Rainwise Program helps property managers manage stormwater by installing cisterns and/or rain gardens on private property. To receive the rebate, you must live in an eligible combined sewer overflow (CSO) basin. The Rainwise Program webpage features an interactive map so you can see if your property is eligible for the program.

Link: <https://www.700milliongallons.org/rainwise/>

Vancouver, British Columbia

Policy Name: Green Rainwater infrastructure

Year: 2019

Policy Details: The City of Vancouver has embraced Green Rainwater infrastructure which incorporates nature to help solve water related issues caused by rainfall. The infrastructure will increase water quality, enhance biodiversity and create new ecological habitats all with the goal to clean 90% of average rainfall and manage 40% of runoff by 2050.

Link: <https://vancouver.ca/home-property-development/green-infrastructure.aspx>

Washington, DC

Policy Name: RiverSmart Landscaping Rebates

Year: 2018

Policy Details: RiverSmart Rebates are for residents who do not want to wait for a stormwater assessment through RiverSmart Homes, want to hire a contractor, or do it themselves. You can front the cost for four different options, install the feature, and then submit for partial reimbursement. For trees, you can receive rebates up to \$100 for individuals who plant trees on private residential or commercial property, you can receive rebates of \$2/gallon for rain barrels with a maximum rebate of \$1000, you can receive rebates of \$3/square foot of area treated by a rain garden with a maximum rebate of \$2200, and you can receive rebates of \$10 per square foot of impervious surface removed and replaced with permeable pavers and \$5/square foot of impervious surface removed and replaced with vegetation, with a maximum rebate of \$4000.

Link: <https://doee.dc.gov/riversmartrebates>

Appendix A - Green Roof Standards

Standards, Ratings, and Tools

There are a variety of mandatory and voluntary guidelines and standards that govern the green roof industry. These concern the establishment of testing protocols that are used to determine the performance of products—such as measuring the rate of water runoff through a drainage layer or the root repellency capabilities of a waterproofing membrane. Guidelines and standards can be either performance-based, such as “the green roof assembly must retain the first two inches of rainfall”; or prescriptive, such as “a particular product or its equivalent must be used.” Performance-based standards differ from prescriptive ones because they lay out measurable criteria that have to be fulfilled without determining how they are met. With voluntary standards, like the US Green Building Council’s LEED® program or the Sustainable Sites Initiative™ (SITES™), there may be certain minimum requirements that must be met, while others are optional or performance-based.

Standards are typically developed by independent, non-profit standard setting bodies such as the International Code Council (ICC), ASTM International, Canadian Standards Association (CSA) and the American National Standards Institute (ANSI) and later adopted by state or local governments.

In addition to standards developed by governments and traditional standard setting bodies, a number of standards and guidelines have been published on the design and construction of green roof systems and components, including those by FLL, a German standard-setting body and FM Global, which writes guidelines for its insurance partners.

What follows is an overview of standard and guideline setting bodies and the work that is applicable to green roof product testing, design and installation.

Green Roof Standards and Guidelines

These standard issuing bodies will be cited throughout the document and have been used to determine some Best Management Practices (BMPs) contained herein.

Forschungsgesellschaft Landschaftsentwicklung Landschafts bau e.V, (FLL) (The German Landscape Research, Development and Construction Society)

In Germany, green roofs must meet certain guidelines regarding the performance characteristics of their material properties and their method of construction. The German landscaping industry’s non-profit research and standard setting body, Forschungsgesellschaft Landschaftsentwicklung Landschafts bau e.V (FLL), first began developing a set of green roof standards known as the Guidelines for the Planning, Execution and Upkeep of Green Roof Sites in 1975, with the initial publication appearing in 1982. Since then, the guidelines have undergone numerous revisions, with English translations released in 1995, 2002, and 2008.

The FLL Guidelines are prescriptive and specify elements like seam overlaps and vegetation-free zones. Some North American companies use FLL as a mark of their products' and systems' excellence. However, when drawing on the recommendations therein it is important to remember that these guidelines were produced for the German market and as such cannot always be directly applied in the diverse North American climate and weather context. Local building codes, ordinances, and other geographically specific legislation, as well as climate extremes, should take precedence over imported standards.

At time of writing, the most current version of the FLL Guidelines in English was revised in 2008 and contains the following, applicable to green roofs:

- FLL Guideline for the Installation and Maintenance of Green Roofs (2008) Richtlinie für die Planung, Ausführung und Pflege von Dachbegrünungen
- Advice for the Maintenance of Green Roofs (2002) Hinweise zur Pflege und Wartung von begrünten Dächern
- [Click here](#) to read about the standard.

ASTM International (ASTM)

ASTM has published eight Green Roof Performance Standards at time of writing. For a brief outline of the standards listed below and a more complete list of ASTM standards applicable to various components and processes involved in roof systems, see Appendix V.

- E2777-20 Standard Guide for Vegetative (Green) Roof Systems
 - [Click here](#) to view the standard.
- E2400/E2400M-19 Standard Guide for Selection, Installation, and Maintenance of Plants for Vegetative (Green) Roof Systems
 - [Click here](#) to view the standard.
- E2396-05 Saturated Water Permeability of Granular Drainage Media
 - [Click here](#) to view the standard.
- E2397-05 Determination of Dead Loads and Live Loads Associated with Green Roof Systems
 - [Click here](#) to view the standard.
- E2398-05 Water Capture and Media Retention Standards of Geocomposite Drain Layers for Green Roof Systems
 - [Click here](#) to view standard.
- E2399-05 Maximum Media Density for Dead Load Analysis of Green Roof Systems
 - [Click here](#) to view standard.
- E2400-06 Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roofs
 - [Click here](#) to view the standard.
- E2788-11 Standard Specification for Use of Expanded Shale, Clay and Slate (ESCS) as a Mineral Component in the Growing Media and the Drainage Layer for Green Roof Systems
 - [Click here](#) to view the standard.

ANSI Standards: Single Ply Roofing Industry (SPRI) and GRHC

Green Roofs for Healthy Cities works to develop a number of standards in support of the further development of the industry. Working in close partnership, GRHC and the Single Ply Roofing Industry (SPRI) developed design guidelines for Fire, Wind Uplift, and Root Repellency, which have been approved by the American National Standards Institute (ANSI). ANSI approves the voluntary standards written and maintained by a large number of standards developers, primarily in the US.

ANSI standards related to green or vegetated roofs include the following:

- **ANSI/SPRI VF-1 (2017) External Fire Design Standard for Vegetative Roofs**
 - This design standard provides a method for designing external fire resistance for vegetative roofing systems. It is intended to provide a minimum design and installation reference for those individuals who design, specify, and install vegetative roofing systems. It shall be used in conjunction with the installation specifications and requirements of the manufacturer of the specific products used in the vegetative roofing systems (SPRI). This standard was developed by SPRI in 2007, approved as an American National Standard in 2010, and reaffirmed in 2017.
 - [Click here](#) to view the standard.
- **ANSI/SPRI RP-14 (2022) Wind Design Standard for Vegetative Roof Systems**
 - This standard provides a method of designing wind uplift resistance for vegetative roofing systems. It is intended to provide a minimum design and installation reference to be used in conjunction with, or enhanced by, the installation specifications and requirements of the manufacturer of the specific products used. The standard provides guidance in areas including, but not limited to, maximum wind speed for various parapet heights, as well as parts and components of vegetative roofing systems as they relate to designing for wind (GRHC). This standard should be used in conjunction with installation specifications and requirements of the manufacturer of the specific products.
 - [Click here](#) to read more about the standard.
- **ANSI/GRHC/SPRI VR-1(2011) Procedure for Investigating Resistance to Root Penetration on Vegetative Roofs**
 - This testing standard has been developed to evaluate the ability of a roofing material to resist normal root or rhizome penetration through a root protection barrier, or waterproofing layer. The test is based on the FLL Procedure for Investigating Resistance to Root Penetration at Green Roof Sites, and has been approved by the American National Standards Institute (ANSI).
 - [Click here](#) to view the standard.
- **CSA A123.31 (2014) CSA Standard Wind Uplift Resistance of Membrane-Roofing System**
 - This is a normalized test method which assess the dynamic wind uplift resistance of the membranes of roofing systems. This test uses the Load Resistance Factor Design (LRFD) to test buildings with the requirements of the CSA A123.31 standard. The standard has two options to determine resistance factors. The first is using sustained pressure from three specimens that have the same construction details. The second is through using 0.65 as the maximum value when the specimen is sustained under pressure less than or equal to 11.5 kPa (240 psf). The Wind Uplift Resistance Calculator is maintained by the National Research Council of Canada.
 - [Click here](#) to view the standard.

- **Living Architecture Performance Tool (LAPT)**

- Living Architecture is defined as the integration of living systems on or within a building envelope. This includes green roofs, living walls, and green facades. LAPT is a rating system and resource that is designed to certify that green roofs and walls are designed to achieve measurable and replicable performance benefits. This ensures that green roofs can be funded, designed, installed, and maintained with a high degree of confidence. The LAPT is a 110-point system with 30 credits in 8 areas of living architecture. These 8 areas include: process, water, habitat & biodiversity, innovation, management & operations, health & well-being, post-construction, and energy.
- [Click here](#) to view the standard.

FM Global

Though it is not a formal standard setting body, FM Global, a commercial and industrial property insurance and risk management organization, exerts a large amount of influence over the construction industry. It published Property Loss Prevention Data Sheet 1-35: Green Roofs in early 2006. This prescriptive document is largely based on FLL Guidelines and draws on other FM Data Sheets to establish standards for an FM Approved Green Roof Assembly.

FM 4477 Approval Standard for Vegetative Roof Systems, released in 2010, outlines FM approval requirements for all vegetative roof systems that are installed over an FM Approved roof assembly (FM 4470). Vegetative roof systems are evaluated for performance related to fire from above and below the structural deck, foot traffic, and water leakage.

In addition to standards that address green roofs specifically, like those described above, a number of voluntary rating systems for green buildings and sites also acknowledge the environmental benefits of these technologies.

Leadership in Energy and Environmental Design (LEED®)

Green roofs can have a powerful positive impact on the environmental performance of buildings. This impact is recognized within the LEED green building rating systems. Perhaps the most popular of the rating systems used in North America, LEED is a third-party certification program developed by the US Green Building Council (USGBC). The USGBC has separate LEED rating systems for different building types and a LEED for Neighborhood Development rating system. A further distinction is made for school and healthcare facilities, which must certify under their respective facility-specific rating systems. In Canada, the Canadian Green Building Council (CaGBC) has adapted the USGBC LEED system and tailored it specifically for Canadian climates, construction practices and regulations.

As a component of larger integrated design strategies, green roofs and walls can contribute to earning LEED credits, usually in conjunction with other sustainable building elements. In other words, LEED is a measure of total building sustainability, and does not propose to measure the sustainability of individual building components, such as roofs.

For commercial buildings and neighborhoods to earn LEED certification, a project must satisfy all LEED prerequisites and earn a minimum number of points on the LEED rating system scale as prescribed for various project categories (USGBC, 2013). Green roofs can help achieve these points. By consequence, the end goal of LEED certification is driving many building owners to incorporate green roofs into their designs.

The Sustainable Sites Initiative™ (SITES™)

Development of the Sustainable Sites initiative began in 2005 in Austin, Texas. It is the result of an initial partnership between the American Society of Landscape Architects and the Lady Bird Johnson Wildflower Center at the University of Texas at Austin, later joined by the United States Botanic Garden in conjunction with a diverse group of stakeholder organizations. The central message of the Sustainable Sites Initiative is that any landscape—whether the site of a large subdivision, a shopping mall, a park, an abandoned rail yard, or even one home—holds the potential both to improve and to regenerate the natural benefits and services provided by ecosystems in their undeveloped state (Sustainable Sites Initiative, 2009). The result of this partnership is the creation of the first national (American) voluntary guideline for sustainable landscapes or “sites,” which includes green roofs and walls.

The *2013 Rating System and Reference Guide*, released in the fall of 2013, is the culmination of a two-year pilot program and extensive collaboration. It replaces the pilot document *Guidelines and Performance Benchmarks 2009*. The credit system aims to fill in the gap left by US Green Building Council (USGBC) and other organizations, which are primarily focused on the building's envelope and may not adequately address all land in a designated site or space. By providing a holistic guideline and rating system for sustainable sites, the social and economic benefits to both the immediate site and the surrounding region may be more adequately credited. Prerequisites and credits are organized into nine sections that follow the logical flow of site development (much the way this first course in the GRP curriculum is organized) beginning with *Site Selection* and ending with *Monitoring and Innovation* (Sustainable Sites Initiative, 2009). Green roofs may contribute to SITES credits in the areas of onsite stormwater management; minimizing building cooling requirements; providing views of vegetation and quiet outdoor spaces for mental restoration; reducing the UHI effect; and preserving or restoring appropriate plant biomass on site.

International Green Construction Code (IgCC)

In 2012, the IgCC was released by the International Code Council (ICC) in cooperation with ASTM and the American Institute of Architects (AIA). The code acts as an overlay to the existing set of International Codes, including provisions of the International Energy Conservation Code and ICC- 700, the National Green Building Standard, and incorporates ASHRAE Standard 189.1 (see below) as an alternate path to compliance (ICC, 2012). It is the first model code to include sustainability measures for the entire construction project and site, addressing all stages of green building development from design through to construction, certificate of occupancy and beyond (ICC, 2012). The IgCC is not a rating system but a code, designed for mandatory adoption. Though intended as a mandatory measure, the IgCC allows jurisdictions the option of adopting the code on a voluntary basis.

As a regulatory framework, the IgCC establishes minimum green requirements for new and existing buildings. The code complements voluntary rating systems, which may extend beyond the baseline of the IgCC. Jurisdictions may also choose to customize the IgCC to set higher minimum levels of performance.

The IgCC provides definitions for green roofs under three labels: vegetative roofs; extensive roof, and intensive vegetative roofs.

Examples of sections related to green roofs include:

- Section 404 - covers mitigation of the heat island effect
- Section 406 - details site development requirements
- Section 404.3 - requires that 75% of eligible roof area be vegetated or effectively white

ASHRAE Standard 189.1

ASHRAE was formed as the American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE Standard 189.1 Standard for the Design of High-Performance Green Buildings was developed in partnership with IES and USGBC and serves as an alternative compliance option in the IgCC. The standard addresses site sustainability, water use efficiency, indoor environmental quality, and the building's impact on the atmosphere, materials, and resources. Sections that relate to green roof implementation are:

- Section 5.3.2 covers mitigation of the heat island effect
- Section 5.3.2.2 related specifically to the shading of walls through the use of “shade-providing plants” among other elements
- Section 5.3.2.3 addresses roofs, requiring 75% of eligible roofs to be effectively white unless trumped by another use—green roofs included (Sigmon, 2011)

ICC 700 National Green Building Standard

National Association of Home Builders (NAHB) and the International Code Council (ICC) partnered in 2007 to establish a nationally recognizable standard definition of green building. The result of this partnership is the ICC 700, the first residential green building rating system to undergo a full consensus process and receive approval from the American National Standards Institute (ANSI). The IgCC requires compliance with the ICC 700 if a jurisdiction chooses to regulate buildings four stories or less in height. Chapters related to green roofs include:

- Chapter 5 Lot Design, Preparation, and Development: 3 pts. for stormwater management
- Chapter 6 Resource Efficiency: 3 pts. for green roof system.

Living Building Challenge

The Living Building Challenge (LBC), developed by the International Living Building Institute, is an international program with active projects in the US, Canada, Ireland and Australia at time of writing. The LBC aims to define the most advanced measure of sustainability in the built environment possible by incorporating into its standards the most progressive thinking from the worlds of architecture, engineering, planning, landscape design and policy (ILFI, 2012).

It is simultaneously a certification program, advocacy tool, and philosophy, taking an ambitious and holistic approach to green infrastructure and human accountability to nature. The LBC provides a framework for design, construction and the “symbiotic relationship between people and all aspects of the built environment” (ILFI, 2012).

The Living Building Challenge sites two primary rules:

- All Imperatives assigned to a Typology (project type) are mandatory.
- Certification is based on actual performance, rather than modeled on anticipated outcomes; therefore, projects must be operational for a minimum of twelve consecutive months prior to evaluation.

The LBC framework is comprised of seven performance areas (Site, Water, Energy, Health, Materials, Equity and Beauty), which are subdivided into a total of twenty Imperatives, each of which focuses on one of the performance areas or “spheres of influence” (ILFI, 2012). Examples of Imperatives include zero net energy, net zero water, biophilia (see Section 4.0), and democracy and social justice. The Imperatives can then be applied to nearly any project type, referred to as a Typology within the LBC framework, be it a new construction or renovation, infrastructure, landscape or community development. The LBC also uses the New Urbanism Transect model created by Duany Plater-Zyberk & Company to account for a development’s rural to urban categorization, of interest to planners and developers.

Green roofs fall under the Building Typology whether for a new or existing project. Many, if not all, of the imperatives for the Building Typology can provide guidance in the myriad decisions made in the design, installation, and maintenance of green roofs and green walls.

Appendix B - Devens Enterprise Commission Policy



**Devens Enterprise Commission
POLICY for CONSTRUCTION of VEGETATED ROOFS
Amended
January 31, 2012**

(1) Purpose: To create a DEC Vegetated (Green) Roof Construction Standard that sets out minimum requirements for the construction and maintenance of green roofs.

(2) Requirements:

- (a) A designer of a vegetated roof shall apply the measures described in this policy.
- (b) Adherence to the Mandatory Provisions is considered an acceptable solution for the design and construction of a vegetated roof.
- (c) A vegetated roof designed to the DEC Vegetated Roof Construction Standard may be constructed on both combustible and non-combustible buildings.
- (d) A member of the vegetated roof design and construction team shall be an accredited Green Roof Professional (GRP) with knowledge of vegetated roof design, installation and maintenance procedures and best practices.

(3) Mandatory Provisions. The following standards shall be met in the design and construction of a vegetated (green) roof:

- (a) Assembly. A vegetated roof assembly shall, at a minimum, consist of:
 - 1. a root repellent system (Root repellent mat shall not include herbicide or copper sulfate inhibitors. Data sheet shall be submitted 30 days prior to construction for approval. Root repellent is NOT required if the waterproofing membrane has been tested and passed either the FLL Root Resistant Procedure or ANSI/GRHC/SPRI VR-1 2011 Procedure for Investigating Root Resistant Penetration on Vegetative Roofs.) ;
 - 2. a drainage system;
 - 3. a filtering layer;
 - 4. a growing medium;
 - 5. plants;
 - 6. waterproof membrane.
- (b) Gravity loads:
 - 1. The applicant shall calculate vegetated (green) roof gravity loads following the protocol provided by the ASTM standard: "ASTM E2397.05 – Standard Practice for Determination of Dead Loads and Live Loads Associated with Green Roofs Systems."
 - 2. The density of the growing media shall be determined:
 - a. In accordance with "ASTM E2397.05 – Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems"; or alternatively
 - b. The designer may use an un-factored, saturated density of the growing media of 3.9 inches (1344 lbs./ft. or 2,000 kg/m).
- (c) Slope Stability. All roofs with slopes in excess of 10 degrees (17%) that support vegetated (green) roof assemblies shall incorporate anti-shear measures.
- (d) Parapet height and/or overflow scupper locations.
 - 1. Parapets and scuppers shall be specified in the design, as required, to limit retained rain water loads to within structural limits in the event of obstructed internal drains.
 - 2. The referenced point for the overflow scupper height must be clearly indicated to avoid the possibility of confusing the overflow scupper height as being measured above the finished

green surface or other layer above the waterproofing resulting in higher water load than accounted for by the design as indicated in the sketch below.

- (e) Wind uplift. The applicant shall provide a report, stamped by an engineer, providing that the roof meets ANSI/SPRI RP-14 Wind Design Standards for Vegetative Roofing Systems approved 6/3/2010. The intent of the report is to illustrate that wind uplift pressures are being designed for (including a description of how the pressures were determined), and describing how the design addresses these pressures.
- (f) Fire safety. Where roof penetrations, intersecting walls, parapets, upturns or mechanical equipment are clad with combustible materials the design shall include a vegetation-free border zone abutting such features and the vegetation-free border shall be equal to the vegetation height at maturity but in no case be less than 1.5 ft. (0.5m). The applicant shall provide a report stating how the roof design meets ANSI/SPRI VF-1 External Design Standard for Vegetative Roofs approved 1-29-2010.
- (g) Occupancy and safety. The applicant shall state, in a vegetated roof declaration form and the vegetated roof application, the use of the roof and whether or not it will be accessible to the public.
- (h) Waterproofing.
 - 1. The waterproofing membrane must have been tested and passed either the FLL Root Resistant Procedure or show how the root barrier qualifies for ANSI/GRHC/SPRI VR-1 2011 Procedure for Investigating Root Resistant Penetration on Vegetative Roofs. The waterproofing membrane must have a documented track record in green roof construction with supporting projects in the New England area.
 - 2. 20 Year System Warranty: The green roof assembly including the waterproofing membrane components including insulation, barrier boards, metal edge system, etc. and vegetative overburden including but not limited to water retention mats, and trays shall be warranted for a minimum of at least 20 years. Warranty sample shall be submitted and written approval provided by the owner's representative at least 30 days prior to construction. Vegetation shall have a two (2) year warranty.
 - 3. Immediately prior to installation of the vegetated roof, the applicant shall cause to be conducted one of the following leakage testing protocols:
 - a. Flood test;
 - b. Electric field vector mapping;
 - c. Impedance test;
 - d. Infrared (IR) thermal imaging;
 - e. Low voltage testing;
 - f. High voltage testing;
 - g. Moisture sensors;
 - 4. a report documenting a successful test, signed by an architect or engineer, shall be provided to the Building Inspector.
- (i) Drainage.
 - 1. The design hydraulic load shall be evaluated assuming that the vegetated roof system is fully saturated prior to the maximum fifteen-minute rainfall.
 - 2. Positive slope to drain shall be provided at the level of the waterproofing membrane.
 - 3. The system shall permit effective drainage beneath the growth media.
 - 4. Vegetation-free zones shall be provided around all perimeters, penetrations and drains.
- (j) Water retention.
 - 1. Water retention mats or equivalent materials shall be employed as required to promote vegetation growth.
 - 2. The drainage layer shall be appropriate for storm water retention and must be selected following "ASTM E2398-05 Standard Test Method for Water Capture and Media Retention of Geo-composite Drain Layers for Green Roof Systems."

- (k) Vegetation Performance. In order to support plant survivability:
1. When structurally possible, the growing media shall be at a minimum 4 inches (10 cm); or
 2. The applicant shall provide a report confirming that the engineered system as designed provides plant survivability comparable to that of an un-irrigated system with growing media at a minimum 4 inches (10 cm).
- (l) Plant selection.
1. Vegetation on a vegetated roof shall not include any invasive species defined in Invasive Plant Atlas of New England, as may be amended from time to time.
 2. The plant selection and design shall be such that within three years of the planting date the selected plants shall cover not less than 80% of the vegetated roof.
 3. The plant material selected shall consist of USDA hardiness zone appropriate native plant and seed material.
 4. Compliance with the plant coverage required in the preceding sentence can be satisfied by a design that will provide one or more of the following:
 - a. That seeds for groundcover plantings shall be sown at a rate not less than 30/ft² (325/m²);
 - b. That cuttings shall be distributed not less than 12kg/100m² (2.5lbs./ft²); and
 - c. Either that pre-grown plugs shall be installed not less than 11/m² (1/ft²) or a report from the designer that describes how the design fulfills this coverage requirement shall be provided with the application.
- (m) Irrigation. Adequate measures shall be provided to permit irrigation necessary to initiate and sustain the vegetation during the service life of the vegetated roof. A secondary water source at roof level is recommended in the event the irrigation system malfunctions and cannot be immediately repaired.
- (n) Maintenance plan.
1. The applicant shall develop a maintenance plan for the vegetated roof which shall define programs of routine maintenance and inspection sufficient to ensure that the vegetated roof components perform their required functions for the duration of their design service lives.
 2. The maintenance plan shall address the requirements of the specified growth media and vegetation for vegetation survival.
 3. The maintenance plan shall address re-planting, in the event that re-planting should become necessary, and assure that complete coverage at canopy level is achieved within three growing seasons and maintained for the service life of the vegetated roof.
 4. The maintenance plan shall address and provide for maintenance worker training. Given the potential turnover in maintenance personnel, the maintenance plan shall incorporate provisions for training all personnel (who will be performing maintenance) about appropriate clothing and footwear, safety practices, plant types (what weeds to pull and what not to pull, what debris needs to be removed, and what can potentially void any warranties, etc).
 5. The maintenance plan shall reference the safety practices to be employed during maintenance, including the location of safety harness tie-downs or anchors in order to assure appropriate worker safety.
 6. The maintenance plan shall be submitted with the application for a building permit for the vegetated roof. It shall cover the first five years and address plant establishment and post establishment periods.