GREEN ROOF TOOLKIT

GREEN ROOF OVERVIEW

There are three types of green roofs: extensive, semi-intensive and intensive. Although the design will differ, the basic layers remain the same.

**Green Roof Types**

**Extensive**
- 3 - 4” of growing medium
- 15 - 30 pounds per square foot (additional roof load)
- Less variety of plants - usually Sedum
- Requires little irrigation - drought resistant
- Low maintenance
- Costs about $10.00 to $30.00 per square foot (above the cost of a conventional roof)
- Few design elements

**Semi-intensive**
- 4 - 8” of growing medium
- 25 - 50 pounds per square foot (additional roof load)
- More plant variety - wildflowers, drought-tolerant herbaceous perennials
- Requires periodic irrigation
- Periodic maintenance
- Costs about $20.00 - $40.00 per square foot (above the cost of a conventional roof)
- Incorporates design elements

**Intensive**
- 8 - 12” of growing medium
- 40 - 150+ pounds per square foot (additional roof load)
- High variety of plants - includes shrubs and trees
- Requires consistent irrigation (summer months)
- Regular maintenance
- Costs about $40.00+ per square foot (above the cost of a conventional roof)
- Highly designed usable green space

**Green Roof Composition**

A green roof is not simply plants placed on a rooftop, but rather a highly-engineered, contiguous system of plantings designed to protect the structural integrity of the building while providing significant environmental, economic and aesthetic benefits.

No one green roof system fits all. While every green roof has the same components and minimum requirements, manufacturers can vary greatly.

**Green Roof cross section**

Plants - sedum & herbs
Jute erosion fabric (optional)
Growing medium
Soil retention curbing
Drainage, root barrier
Geotextile filter fabric
Insulation (optional)
Leak detection (optional)
Waterproof membrane
Roof deck

Visit doee.dc.gov or anacostiaws.org for more information

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GREEN ROOF BENEFITS

Green roofs are a highly sustainable roofing technology, providing numerous economic, environmental and social benefits.

**ECONOMIC**

**Reduce the life cycle cost of the roof.** Green roofs may last 3 times as long as a conventional roof.

**Reduce waste and decrease the need for land-fill expansion.** The extended life of green roofs reduces construction waste and cost.

**Increase property values.** As an added amenity, green roofs attract higher rents and maintain higher tenant retention.

**Save on energy cost.** Green roofs may reduce energy costs 10-20% by keeping the floor directly below 3-4°F cooler and reducing need for expansive HVAC systems.

**Provide sound insulation.** 4” of substrate reduces noise pollution by 40 decibels adding to the desirability of the building.

**Credits for stormwater impact fees.** Green roofs provide possible credits for stormwater impact fees, saving money on regulatory fees.

**ENVIRONMENTAL**

**Reduce the urban heat island effect.** On a hot day, an urban area can be 10°F hotter than the surrounding area, green roofs stay 40-50°F cooler than conventional roofs reducing the ambient air temperature.

**Reduce stormwater runoff.** In summer, green roofs retain 70-100% of stormwater and 40-50% in the winter, reducing the volume and velocity of stormwater and reducing erosion and sedimentation of our water sources.

**Improve air quality.** Green roofs filter airborne particles such as smog, sulfur dioxide and carbon dioxide through vegetation foliage.

**Create wildlife habitat.** Green roofs provide urban green infrastructure for native species repatriation and maintaining species biodiversity.

**SOCIAL**

**Education opportunities.** Green roofs provide areas for instruction in ecology, science and math.

**Provide space for food production.** Green roofs create opportunities for urban agriculture and help increase food security in urban areas.

**Provide aesthetic appeal.** The vegetation and natural beauty of green roofs provide respite from the concrete hard-scape of urban areas.

**Create usable green space.** Green roofs may provide green space throughout urban areas where open space is limited.

**Create jobs and economic security.** The establishment of a green roofing industry creates new jobs in manufacturing, construction, design, installation, maintenance and horticulture.

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ARE YOU GREEN ROOF READY?

Not all buildings are green roof compatible. If your building meets the following criteria, you are green roof ready!

New Construction
By incorporating a green roof into the original design of new construction and additions you will save time and money. Ensuring that the roof is built to hold at least 30 pounds per square foot for the added weight of the green roof, incorporating safe and legal roof access into the design and ensuring there are sufficient funds will facilitate the installation.

Retrofits to small buildings and single family residential homes
Are you planning to replace your roof or waterproofing membrane within the next year?

Does your building have LEGAL roof access, a roof veranda or deck?

If you do not have a roof deck, was your building built after 1960?

If your building was built before 1960 and doesn’t have a roof deck, have you had structural reinforcing or new roof joists installed in the last 10 years?

Is your rooftop sunny with relatively few or no trees growing above?

Can you afford to spend $10-30 per square foot, in addition to replacing your roof with a specialized waterproofing membrane, approximately $7-12 per square foot?

Green roof retrofits to commercial and multi-family residential buildings
Are you planning to replace your roof or waterproofing membrane within the next year?

Is your rooftop relatively flat with no more than 30 degrees of pitch?

Do you currently have an IRMA or ballasted roof system?

If not, does your roof have public roof access, a roof veranda or deck?

If not, can the building support 25 pounds per square foot, beyond snow and wind loading?

Is your rooftop sunny with relatively few or no trees growing above?

Can you afford to spend approximately $8-15 per square foot, in addition to replacing your roof with a specialized waterproofing membrane approximately $7-15 per square foot?

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If the answers to the questions above are “NO,” green roofing may not be right for your building or might not be feasible at this time.

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It takes a strong roof to support a green roof. Understanding the structural components of your roof is essential to know if you can install a green roof or if additional steps need to be taken.

**Structural Engineering Assessment**
You should get a structural analysis of your roof before you install any green roof. To qualify for our rebate, you must have your roof assessed by a structural engineer licensed in the District of Columbia as part of your application. When having a structural engineer assess your roof, make sure he or she looks at, and helps you understand, these things:

- Structural integrity and maximum load your roof can support
- Any weak members or spots
- Rotting, cracked, damp, or damaged structural members
- Weak or damaged joints
- If your roof can be reinforced with traditional methods or reinforced fiber polymer sheets
- Structural or building elements that will obstruct the green roof or allow deeper media

**The Weight of a Green Roof**
With the various drainage materials, planting medium, and plant types available, a green roof weighs more than a typical roof. Your roof will need to withstand all of those added weights, even in changing weather. All green roofs will have different dead loads depending on the materials used (a dead load is simply the weight of an object if it never moves); a typical extensive green roof will add between 7-50 lb per square foot per inch depending on the materials and the type of soil you are using (confirm with structural engineer). The more intensive you want the green roof to be, the more support you will need per square foot.

Considering 100 square feet of 4 inch growing medium without any additional weight from weather conditions, you are adding approximately one ton (2,000 lb) of weight to your roof. This can damage your roof and add potential safety issues if appropriate action is not taken in advance.

**Roof Shape**
Sometimes a roof’s design makes it unable to support a green roof. A roof which is sloped between 5-15° generally does not need, but would likely benefit from, additional supports. A roof sloped between 15-45° needs additional supports to protect the roof from erosion and gravity. Any part of a roof which is sloped more than 45° should be designed like a green wall.
Green roofs are defined as the vegetation and additional layers above the waterproof membrane. However, choosing the right waterproof membrane is important to the proper function of the green roof.

**Waterproof Membranes and Green Roofs**

Installing a green roof over a waterproof membrane will significantly extend the life of the membrane and the life cycle cost of the roof.

There are several factors to consider when choosing a waterproof membrane to be used in conjunction with a green roof beyond waterproofing such as durability, environmental friendliness, tensile strength and root resistance.

To be used in conjunction with a green roof, the waterproof membrane should be made of an inert material that cannot be penetrated by roots or an additional root barrier must be installed with the green roof. Waterproof membranes that are commonly used in conjunction with green roofs are:

- PVC (45-90 single-ply)
- TPO (Thermoplastic Polyolefin single-ply)
- EPDM (Ethylene Propylene Diene Monomer single-ply)
- Built-up hot applied high-polymer asphalt
- 2 layers of high polymer SBS modified bitumen with root barrier

**Is your membrane ready for green roofing?**

In addition to ensuring the compatibility of the waterproof membrane, the age of the membrane at the time of green roof installation is important. A green roof should not be installed on a membrane more than a couple of years old and in good condition.

For a membrane that is a couple of years old, check thoroughly for leaks prior to green roof installation

**Flood testing** prior to installation may be used to discover any breaches in the membrane. This method is used on flat roofs and requires water to be pooled on the roof for 24 hours to see if there are any punctures in the membrane which could lead to leaks in the future.

**EFVM** (Electronic Field Vector Monitoring) technology may be utilized after a green roof is installed to detect any breaches in the membrane which may lead to leakage. This technology works on both flat and sloped roofs and reduces the possibility of overloading the roof.

A **Leak Detection Layer** may also be installed with the green roof to further ensure leaks are detected and located immediately.

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All green roof projects require a building permit. Permits are obtained through the Department of Consumer and Regulatory Affairs (DCRA).

**Pre-Application and Application**

**Find out the property’s zoning district**
Are you in a zoning overlay district? (zoning overlay districts have additional requirements and restrictions that must be met to receive a permit.) Visit the [DC Office of Zoning](#) website for a complete list of overlay zones.

**Obtain a plat**
A plat is a scaled drawing of a lot, showing lot lines and record dimensions.
- You will need the Square, Suffix and Lot (SSL) number for each property.
- Cost of a regular plat is $30.00. Turnaround time is a minimum of 10 working days.
- To order you must go IN PERSON to the Office of the Surveyor:
  1100 4th Street SW, Room 3174
  Washington, DC 20024
  (p) 202.442.4400

**Fill out permit application and Environmental Intake Form (EIF)**
Make sure that all required information is provided and applicable boxes are checked.

**Build Permit Application**
Environmental Intake Form

**Ensure all requirements are met**
Follow requirements in link below for type of permit applying for:

**Building Permit Application Requirements by Permit Type (DCRA document)**

**Permit issuance**

**Timeline (DCRA’s goal to review)**
- 1 - 999 SQ FT | within 24 hours
- 1000 - 2999 SQ FT | within 14 days
- 3000 + SQ FT | within 30 days

**Permit Fees:**
There are different fees for new construction or additions, alterations or repairs to existing construction. There are also reduced permit fees for green building, such as green roofs.

Please view link below to determine the cost of the building permit for your green roof project.

**Building Permit Fees**

**Obtaining the permit**
You will be contacted when the permit is ready for pick-up.

First get an invoice from Issuance Counter and pay for the permit in the Cashier’s office.

Show your Cashier’s receipt to obtain the permit.

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EXTENSIVE GREEN ROOF PLANTS

Extensive green roofs have growth medium depths of 2–4 inches, limiting the design and plant variety suitable for the system.

Choosing extensive green roof plants

Although there are numerous choices for extensive green roof plants due to different design considerations such as stormwater management, energy conservation, habitat formation, heat island mitigation, aesthetics and creation of usable green space, there are basic qualities in certain plants that make them ideal for extensive green roofs.

Ideal extensive green roof plant characteristics:

- **Low growth height**
  Plants withstand high winds and lowers fire hazard.

- **Rapid growth and spreading**
  Ensures complete coverage, increased stormwater retention, elimination of viable space for weed establishment and helps anchor growth medium.

- **High drought tolerance**
  Reduces need for costly irrigation systems and plant replacement.

- **Fibrous root system**
  Protects roof membrane.

- **Low maintenance**
  Reduces the time and financial costs of the roof year after year.

- **Non-invasive**
  No airborne seed generation prevents green roof plants from invading other landscapes.

- **Self propagating**
  Reduces the number of plants needed to cover a green roof, reducing the cost of the roof.

Preferred extensive green roof plant list

The following plants thrive on green roofs. At least 5 or 6 different varieties of plants should be incorporated into each roof design to create diversity of color and flowering times. Please click on links below to find out additional information about each plant, such as flower color and blooming period.

Plants for green roof areas with full sun exposure:

- Allium schoenoprasum (chives)
- Sedum album
- Sedum album f. ‘Murale’
- Sedum kamtsch. var. flor. ‘Weihenstephaner Gold’
- Sedum reflexum ‘Blue Spruce’
- Talinum calycinum

Plants for green roof areas with full shaded areas:

- Delosperma nubigenum ‘Basutoland’
- Sedum kamtschaticum
- Sedum sexangulare
- Sedum spurium ‘Fuldaglut’
- Sedum spurium ‘John Creech’
- Sedum hybridum ‘Immergrünenchen’
- Sedum spurium ‘White Form’


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GREEN ROOFS AND BIODIVERSITY

Green roofs can create urban wildlife habitat and help maintain species biodiversity to make our cities healthier and more sustainable.

What is Biodiversity?
Biodiversity (or biological diversity) typically refers to the variety of animals, plants, fungi and bacteria that inhabit a given area. It is usually quantified by the number of different species.

Why is Biodiversity Important?
Biodiversity provides countless ecological services necessary for everyday life – some are measurable, others are not. It is the basis of our agriculture, fisheries and other vital industries essential to our economy and survival as a species.

Biodiversity and Green Roofs
Green roofs create wildlife habitat by providing urban green infrastructure for native species, which helps maintain species biodiversity. Most green roofs are better for wildlife than conventional roofs, and some are better than others. The value of a green roof for biodiversity depends on various aspects such as; growing medium depth, plant species used, the habitat connectivity with the surrounding landscape, and the plant communities that are installed. To provide better wildlife habitat, green roofs should meet specific local biodiversity conservation objectives and mimic the characteristics of local habitats.

Green Roof Benefits for Biodiversity
- Green roofs provide essential habitat for wildlife in urban settings.
- They can help recover and protect biodiversity to make our city healthier and more beautiful.
- Green roofs can act as stepping stones for mobile species such as birds and invertebrates in the urban landscape, creating linkages to other habitat fragments, e.g. wooded parks and other green spaces.
- They can provide food and breeding habitat for ground-nesting birds.
- Studies in Europe have shown that green roofs support an abundance of different invertebrates, included some endangered and rare species.
- Biodiverse green roofs can be valuable for the conservation of threatened habitats, plants and wildlife species - especially mobile species.

Plant Species and Wildlife Habitat
Creating green roofs with plants that are biologically diverse can be beneficial for native urban wildlife. There are also several native plant species that are being used in the mid-Atlantic and many others that are being tested for their long-term suitability on green roofs. Please let us know if you’re interested in assisting with these efforts here in the Chesapeake Bay watershed.

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Information largely from www.urbanhabitats.org
GREEN ROOF TOOLKIT

GREEN ROOF MAINTENANCE

Extensive green roofs, when properly installed, should require relatively limited maintenance. They are NOT maintenance free.

What a green roof needs

Weeding
Weeds and native grasses are carried to the roof by wind, birds and insects. These invasive plants can be problematic as they compete with the green roof flora for moisture, nutrients and sunlight. In order to keep the green roof healthy, all invasive plants (weeds) must be removed regularly. *When weeding, be sure to pull out the roots.*

Water
- For sedum-planted roofs, rain is often adequate.
- Water once a week for a newly planted roof.
- Water once a month for an established green roof in times of extreme drought.
- Supplemental watering can often be done through a sprinkler attached to a garden hose.
- For green roofs planted with more traditional landscaping, more frequent watering may be needed.

Nutrients
Once a year, lightly apply a specially blended organic fertilizer to help keep a green roof looking at its peak. Sometimes, due to wind shear and other factors, soil media is blown away. Supplemental soil media may be needed, preferably with jute netting as wind protection.

Safety during green roof maintenance

*Wear* sun protection, protective eyewear, closed toe shoes, hard hat, gloves, a harness and tieback system if there is no railing or if working outside of a railing system.

*Drink* plenty of water (especially on hot days).

*Ensure* ladders are well secured and held by someone when in use.

“NEVERs” of green roof maintenance:

Never walk backward on a roof.
Never work on the roof alone.
Never use chemical weed killers.
Never use a sharp or pointy weeding tool - the point may damage the green roof system.
Never cover a green roof with a protection tarp for more than 3-4 hours - they can smother or “bake” green roof plants.
Never use a flame-based weed torch system - the flame can damage the system layers.
Never place stakes deeper than the soil depth directly down through green roof
Never over-water - excess irrigation can result in mold growth.

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