

Green Roof Design Guideline

This design guideline is intended to be a handy checklist of factors to consider when designing a green roof. Further explanation about each specific topic can be found in the footnotes. Always consult a licensed structural engineer and check local code requirements before proceeding. If you need assistance with any portion of the process, we're here to assist! www.columbia-green.com

PRE-DESIGN

- Establish Priorities for the Green Roof Design (rank all that apply).¹
 - Aesthetics / High Visibility²
 - Amenity Spaces for People³
 - Stormwater Management⁴
 - Extend roof membrane life⁵
 - Improved Building Energy Efficiency⁶
 - LEED or Living Building Challenge⁷
 - Habitat
 - Urban Farming / Food Production⁸
 - Learning and/or Research Site
 - Healthcare and Healing⁹
 - Other

TABLE 1: Green Roof Types	Depth	Saturated Weight (lbs/sf)	Cost	Plant Types
Extensive (Tray or Multi-layer)	3"- 6"	~15 - 32	\$	Limited; Primarily Sedum
Semi-Intensive (Tray or Multi-layer)	5" to 8"	~32 - 51	\$\$	Sedum + Accent Plants
Intensive (Multi-layer)	8" +	~51 +	\$\$\$	Few Restrictions

- Review the main green roof categories and assembly types (above):
- Consult an Engineer to discuss the structural bearing capacity of the roof.
- If Stormwater is a priority, speak to the Civil Engineer about inclusion in the site stormwater management plan.¹⁰
- Review pros and cons of Trays vs. Built-In-Place aka Multi-layer Systems.¹¹
- Determine client expectations regarding appearance at installation.¹²
- Determine client expectations regarding long-term maintenance.¹³
- Determine client expectations regarding green roof warranty options.¹⁴

DESIGN

- Select the most appropriate green roof system and growing media depth using the criteria identified above.
- Develop the plant palette, planting design and planting method.¹⁵
- Consider the interface with other elements such as paving, façade, parapet edge and other built structures.
- Maintenance: How will the roof be accessed for routine maintenance? Is there a readily available source of water?
- Safety: Are tie-offs or window-washing davits required? Is the assembly FM approved?¹⁶
- Irrigation: Drip, Overhead Spray or Hand-watering?¹⁷
- Confirm available water pressure. Pressure less than 30psi may dictate the use of drip or a booster pump.
- Where will the controller, POC and backflow device be located?
- Wind uplift: Review ANSI/SPRI-14 guidelines and adjust setbacks and corners as required.¹⁸

DOCUMENTATION

- Verify the final saturated system weight with the Structural Engineer.
- Details for Inclusion: Typical green roof assembly, edge condition at façade and parapet, edging, vent or exhaust penetrations, irrigation, custom conditions.¹⁹
- If pursuing LEEDv4 or Living Building Challenge, download the Declare label for Materials Transparency.²⁰
- Develop Specifications: Division 7 vs. Division 32.²¹
- What type of roofing membrane is proposed? Review single-source warranty options and list in the specs.
- Growing Media: Should be blended to meet *FLL* standards.²²
- Lead times for plant material can be anywhere from 6-14 weeks. Make sure the contractor has a signed Purchase Order to begin the growing process for a timely installation.
- Compare submittals and any bid substitutions to ensure they meet all weight/stormwater/single-source warranty criteria.

CONSTRUCTION

- Compare submittals and any bid substitutions to ensure they meet the specified growing media, weight limitation and stormwater performance criteria. Ensure that the single-source warranty is intact, if specified.
- Ensure that the contractor and sub-contractors are qualified to work over the waterproofing.
- Schedule pre-construction meeting.
- Construction Observation: Installer should be familiar with roofing
- Schedule an irrigation pressure test, if applicable.
- Final Punch-List

COMMISSIONING & POST-OCCUPANCY

- Review Maintenance Period and Agreement.
- Make sure Owner is aware of maintenance requirements and has a plan in place for ongoing assistance, if necessary.
- Operations and Maintenance Binder: Ensure that the installer has prepared this document in accordance with the project specifications and that it includes a complete planting list for the green roof, irrigation zones and scheduling, and warranty information.

FOOTNOTES & ADDITIONAL RESOURCES

¹ Keep these priorities in mind for the duration of the project to aid in the decision making process. If you are unsure, *Green Roofs for Healthy Cities* is a good source of general information about the benefits of green roofs <http://www.greenroofs.org/>. For project profiles try www.greenroofs.com, or pinterest for imagery.

² Consider using blocks of planting, pavers and or sections of contrasting material such as river rock to give definition to patterning.

³ Most Rooftops with Amenity Spaces for people contain at least some areas of intensive planting.

⁴ Stormwater management is one of the largest quantifiable benefits that green roofs offer. Continued expansion of urban development throughout the world results in increased amounts of impervious surfaces. These impervious surfaces decrease both infiltration and evaporative water loss from soils and plant surfaces due to the removal of native vegetation and natural ecosystems. In addition, pollutants deposited on these surfaces are transported into our surface waters; further degrading water quality and surrounding natural habitats. Green roofs slow down peak flows to help prevent combined sewer overflows. Multilayer Systems typically retain between 30-40% of annual run-off; whereas tray systems retain 60-70%. <http://environmentalresearchweb.org/cws/article/news/54311>

⁵ Green roof systems have been shown to extend roof life from two to three times that of a traditional system which have an average life of fifteen to twenty years. Some green roofs in Germany have lasted as long as forty years. Planted roofs can actually protect a roof membrane from intense ultra violet degradation and expansion and contraction from temperature extremes, thereby enhancing their long term performance.

⁶ See the PSU Green Roof Energy Calculator: http://greenbuilding.pdx.edu/GR_CALC_v2/CalculatorInfo_v2.php

⁷ Overall, Green Roof systems installed on 50% or more of the roof surface virtually guarantees 2 LEED points and can contribute an additional 7+ points toward LEED-certification, almost 20% of the total needed for a project to be LEED-certified. Green Roofs also contribute petals to the Living Building Challenge. The Columbia Green Tray system is the only green roof tray with the DECLARE materials transparency label, an important criteria for LBC and LEED v4.

⁸ Special precautions may be necessary to prevent damage sharp tools from damaging the roof membrane!

⁹ Health care facilities incorporating green roofs is a major trend, as numerous studies have shown that they can reduce patient stress and lead to shorter recovery times. <http://www.facilitycare.com/greening-healthcare/green-roofs>

¹⁰ The first step is often to confirm whether green roofs are an accepted BMP according to the applicable stormwater manual. If not, Columbia Green Technologies can assistance with project-specific stormwater modeling. The amount of stormwater that a green roof can retain is dependent on a number of factors including: depth of growing media, antecedent moisture conditions, and green roof assembly type. Tying the green roof to the stormwater management plan can help prevent Value Engineering at later stages of the project.

¹¹Each situation is unique, but some common reasons to choose a built-in-place system include: Extensive (low profile) green roofs are the lightest option for retrofits or new construction with limited structural capacity. They start at about 19 lbs/ft² saturated weight. Multilayer systems are most compatible with curvilinear or organically shaped roof layouts and they also offer maximum soil depth flexibility. We recommend anywhere from 3-inches to 24-inches+ of media depth.

Some common reasons to consider trays is that they retain more stormwater and have the advantage of being very easy to install or remove. A common concern regarding trays is visible tray lines, however Columbia Green Technologies trays can be overfilled with media for invisible gridlines. They can also be pregrown off-site for an instantaneously mature roof. Columbia Green Technologies offers both multilayer and trays so we are impartial about helping you choose the best solution for a given project.

¹² If an immediate ‘photo-ready’ green roof is important, consider using pre-grown tiles, mats or pre-vegetated trays. If the client is willing to wait a full growing season for the green roof to become established, cuttings or plugs may also be good options.

¹³ An established green roof requires surprisingly little care, but there is no such thing as a ‘zero-maintenance’ green roof. Generally speaking, the more complex the plantings and the more visible the roof, the more resources should be allocated to maintenance. There is an initial establishment period, and after that weeding and basic inspections should occur at a minimum of once per season. Project specifications are typically written so that the installer is responsible for maintenance for a period of the first 3 months, and may also request a proposal for maintenance for the first two years. A successful project will take the owner’s maintenance expectations into account when designing the plant palette and layout.

¹⁴ Green roof warranties come in three varieties. A single-source warranty means that all components from the roof through the green roof come from a single provider and are warrantied for the life of the roof membrane, which offers exceptional reassurance for a building owner should a problem ever arise requiring removal of the overburden. In contrast, a ‘full-system’ warranty covers only the green roof components themselves. Providers of both of the previously mentioned types also offer optional extended plant warranties. Choosing the proper warranty requires a multi-disciplinary approach between the party responsible for specifying the waterproofing system and the party responsible for specifying the green roof. Columbia Green Technologies private labels our technology in order to offer single-source warranties for all our green roofs. Please see our website for a complete list of partners.

¹⁵ Hardy drought-tolerant plants are best for extensive and semi-intensive green roofs because they are adapted to the extremes of temperature and solar exposure common to rooftops. Sedum species, bulbs such as allium, creeping strawberry and some ornamental grasses are common choices. We recommend a blend of at least 5 (primarily evergreen) species to avoid bare growing media during dormant periods. Avoid large blocks of monoculture plantings, as rooftop microclimates vary widely and you want to avoid overreliance on a single species. Planting methods for sedums include cuttings, plugs, and pregrown tiles or mats. Intensive roof gardens can support a much wider range of plant choices comparable to at-grade landscapes.

¹⁶ FM (Factory Mutual Insurance) is a third party, objective testing program to certify that building products and services meet rigorous loss prevention standards. These standards are particularly important within the roofing industry. We are pleased to offer FM approval for our Tray system under Approval Standard 4470.

¹⁷ Industry experts highly recommend including an automatic irrigation system, at least during the establishment period. Green roof growing media is very lightweight and porous, meaning it does not hold onto water very well. A single weekend of excessive hot or dry weather can scorch a young green roof, and they are more vulnerable the shallower the



depth. The Columbia Green Tray system is offered with an integrated drip irrigation system, which is economical and simple to install. For multi-layer systems consider specifying an overhead spray system.

¹⁸ Wind up lift can be mitigated in a number of ways, but before formal design begins the architect or engineer should calculate the building requirements based on ANSI/SPRI RP-14.

[http://www.greenroofs.org/resources/ANSI SPRI RP 14 2010 Wind Design Standard for Vegetative Roofing Systems.pdf](http://www.greenroofs.org/resources/ANSI_SPRI_RP_14_2010_Wind_Design_Standard_for_Vegetative_Roofing_Systems.pdf)

¹⁹ Typical details are available for download at www.columbia-green.com

²⁰ The Declare Label is a voluntary disclosure of building material ingredients which offers Living Building Challenge Project teams a materials guide for product specification. We are pleased to announce that our tray system has been certified 'Red List Free' which means it doesn't contain "worst in class" materials, chemicals, and elements known to pose serious risks to human health and the greater ecosystem. <http://www.declareproducts.com/>

²¹ Landscape specifications are typically found in division 32, whereas roofing and vegetative roofing can also be listed in Division 7.

²² FLL is an acronym which stands for the German term Forschungsgesellschaft Landschaftsbau Landschaftsentwicklung, or Guidelines for the Planning, Construction and Maintenance of Green Roofing. Germany, a pioneer in the roof-garden industry, has set rigid standards to ensure excellent multi-decade performance. Tests establish dry and saturated densities, particle-size distribution by mass, saturated-air porosity and hydraulic conductivity. The objective is to provide a sterile, soil-less medium that is lightweight, yet able to hold large quantities of rainwater while allowing the plants' roots access to sufficient oxygen, even when saturated. The FLL standards also help to prevent compaction of the growth medium.

FURTHER ASSISTANCE

If you would like further assistance, please contact the main office or one of our sales associates.

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