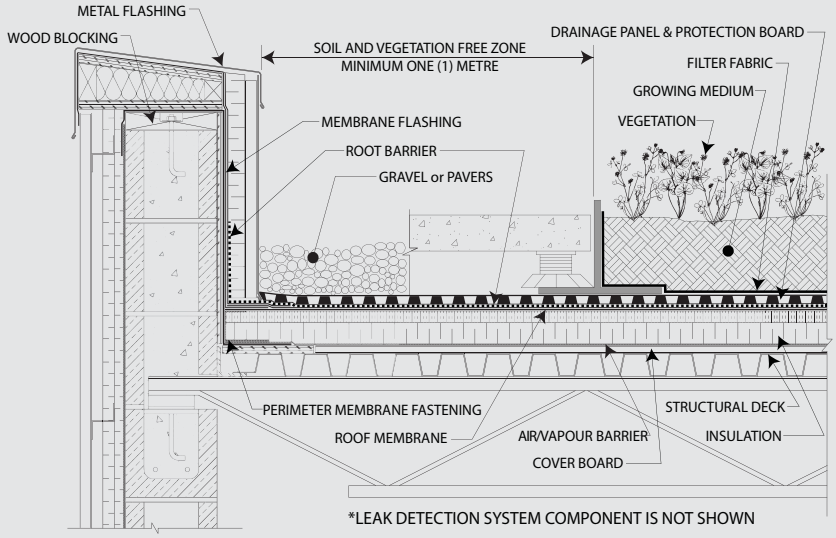
GREEN ROOF DESIGN

Considerations for New and Existing Structures

Alberta Infrastructure

DESIGN & TECHNOLOGY SERIES **03**

Vegetative (i.e. "soft") landscaping has long been used as an effective strategy for enhancing the built environment at grade. Similarly, a green roof can be introduced into the design of new and, sometimes, existing buildings to improve the aesthetics, durability and longevity of the roofscape. The design, construction and ongoing maintenance of a green roof have to be carefully considered in order to ensure the long-term functional and economic viability of the completed assembly.



Roof height above grade, exposure to wind and sun and shading by surrounding buildings will all impact the design of a green roof (including vegetation types and placement). Plant selection should take into consideration the significantly harsher growing conditions of a roof: plant species that thrive at grade may not survive even a few stories above it. A sloped roof structure is preferred over relying on tapered insulation. Additional roof loads must also be considered and are of particular concern with existing buildings.

Where possible, it is preferable to have a single contractor manage a green roof project, from (re)roofing to planting. This avoids scheduling conflicts and damage claims between multiple trades, and establishes a single point of responsibility post-construction.

Access to the green roof site is crucial, not only for installation and ongoing maintenance, but also for transporting materials, soil, and plants. Design consideration should be given to storage, water supply and drainage, and clearances around parapets, equipment, and roof penetrations. No roof, vegetated or otherwise, is maintenance free; a plant's ability to survive on a green roof is directly proportional to the maintenance time and budget allocated to the project.

Maintenance and visual inspections of the waterproofing membrane can be complicated by the fact that the membrane may be completely covered by the green roof system. Inspection and testing is recommended before the membrane is covered. A leak detection system may be provided underneath the waterproofing membrane to pinpoint the exact location of a leak. In an SBS system, a second base-sheet layer will increase longevity and provide added protection to the waterproofing component of the roof assembly. Flood testing may also be appropriate to confirm the impermeability of the roof prior to installation of vegetation.

Green Roof System Types

Extensive (50mm to 200mm):

- Typically within standard roof weight-bearing parameters (additional 70 to 170kg per m^2);
- Low-growing communities of plants and mosses can be selected for stress-tolerance qualities;
- Thin growing medium; may be installed using pre-planted modules;
- Most require little or no permanent irrigation after establishment;
- Often not publicly accessible, however they may be designed for appealing views from within a building.

Intensive (200mm to 600mm):

- An intensive green roof serves both a functional and aesthetic purpose.
- Structural considerations need to be made to accommodate extra weight (additional 290 to 970 kg per m^2).
- Greater diversity of plant communities can be selected based on substrate depth, climate, building height, exposure and irrigation facilities.
- Often requires permanent irrigation.
- Typically are publicly accessible (e.g. hospital healing gardens).

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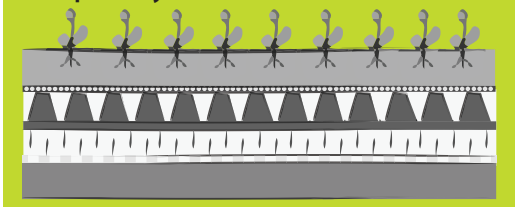
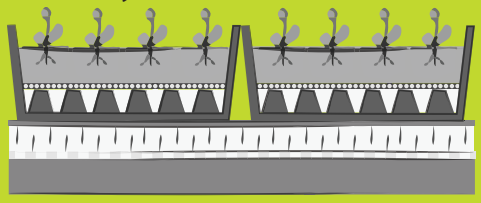
Installation Types

Complete Systems:



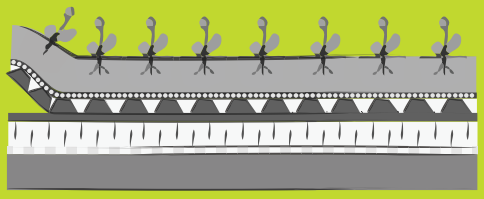
Each component is installed as an integral part of the roof system.

Modular System:



Self-contained vegetation trays cultivated off site are installed above the existing roofing system.

Pre-grown Vegetated Blanket System:



Growing medium and plants are rolled onto prepared roof (drainage mat, root barrier, etc., preinstalled).

Benefits of a Green Roof

Stormwater Management: Surface runoff can be minimized by slowing the release of stormwater. Rainwater infiltrates and is absorbed by the growing medium and plants. Excess rain travels through the growing medium and exits the filter layer into the drainage layer where it then flows along the roof membrane to the roof drains. The stored water is either taken up by the plants or released through evapotranspiration.

Moderation of Urban Heat Island Effect (UHIE): Urban heat island effect is the heating of urban areas due to increased hard surface areas (e.g. black pavement, roofing). When plants are added to a roof they use the solar radiation that would normally heat a conventional roof to draw water up from the soil and release it as water vapour through their leaves (evapotranspiration). This liquid to gas phase change can significantly reduce UHIE - a study in New York City found that the average temperature of a green roof was 33C less than that of a standard black roof[1].

Improved Air Quality: The plants on a green roof can filter out fine airborne particles that get trapped in the surface areas of the greenery and washed into the growing medium by rainwater. Larger and taller grasses, shrubs and trees typically found on intensive green roofs have been found to trap far more particles than shorter plants, such as sedums[2]. The plants are also able to filter and sequester gaseous pollutants through photosynthesis (to later become humus once the leaves are shed and decompose).

Increased Biodiversity: Careful green roof design can create a desirable habitat for a variety of plants, insects, birds, etc. and can improve the ecological diversity of the site.

Additional Amenity Space: A green roof can create appealing amenity space for building occupant or public use (e.g. community garden, healing garden, recreational space). Accessible green roofs need to be designed in conjunction with safety requirements set out by Occupational Health & Safety authorities.

Energy Efficiency: The amount of energy needed to cool the interior of a building during the summer can be reduced due to the combined effects of shading, insulation, evapotranspiration, and thermal mass in reducing heat gain. Note that reducing heat loss requires improved insulation and minimizing heat loss through radiation[3].

Roofing Membrane Durability: Both the growing medium and the plants protect the waterproofing membranes from extreme temperature fluctuations, the negative impacts of ultraviolet radiation and damage due to pedestrian traffic and maintenance activities.

Fire Resistance: A green roof has a much lower burning heat load and can help slow the spread of fire to and from a building through the roof, especially when the growing medium is saturated with water.

Noise Reduction: Systems can be designed to insulate for sound, with the growing medium blocking lower frequencies, and the plants blocking higher frequencies.

Information Sourced From:

1. https://www.nrdc.org/sites/default/files/GreenRoofsReport.pdf
2. http://www.greenroofs.com/content/Green-Roofs-and-Air-Pollution-in-the-UK.htm#.V79NjFUrLRY
3. http://archive.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc46412/nrcc46412.pdf
4. https://www.epa.gov/heat-islands/using-green-roofs-reduce-heat-islands#1

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