



A Guide to Rooftop Gardening

FROM THE CITY OF CHICAGO
RICHARD M. DALEY, MAYOR

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Prepared by the
Chicago Department of Environment



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A MESSAGE FROM
MAYOR RICHARD M. DALEY



Rooftop gardening is an attractive and energy-saving alternative to a conventional rooftop.

Rooftop gardens can keep buildings cooler, save energy, extend the useful life of the roof, and add beauty and useable space.

The City of Chicago is using rooftop gardens, along with light-colored coatings and rooftop solar panels, to replace traditional black tar roofs and improve air quality. Rooftop gardening, like greening on boulevards and in parking lots, reduces dark, heat-trapping surfaces, which in turn lowers temperatures and reduces air pollution.

Any roof can be made more energy efficient with the use of light-colored materials, and many roofs are suitable for some kind of gardening. This booklet is offered as a guide to evaluating your options and designing your own rooftop garden.

THE SEEDS OF A SOLUTION

AN INTRODUCTION TO ROOFTOP GARDENS
AND THE URBAN HEAT ISLAND EFFECT

Building owners have many great reasons to install a rooftop garden — adding beauty to their property, pursuing a hobby, or lowering heating and cooling bills. In addition, rooftop gardens can actually help lower air temperatures and improve air quality for everyone.

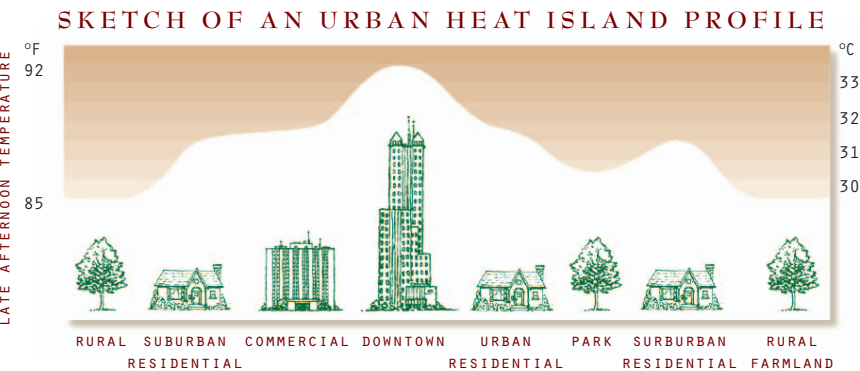
HOT HOME CHICAGO

WHAT IS THE URBAN HEAT ISLAND EFFECT?

The Urban Heat Island Effect is the difference you feel when you go from an asphalt parking lot to a tree-shaded park on a hot summer day. It is also the difference in temperature between a city and the rural area that surrounds it. Dark surfaces absorb and radiate heat, raising temperatures as much as 6 to 10 degrees Fahrenheit. The result is more than uncomfortable. It has consequences for our environment, our checkbooks and our health.

If your rooftop is a dark color, you are paying too much for your air conditioning. But you are not alone. In Chicago, about 60% of all roofs are dark colored. These dark surfaces absorb heat, and so it takes more energy to cool the building's interior. Not only must your air conditioner work harder to keep your building cool, but power plants, one source of air pollution, must work overtime to keep up with the increased demand for energy. The result is higher prices and degraded air quality.

A high concentration of dark surfaces can raise air temperature in that area because the surfaces trap heat. Higher temperatures help create more smog because pollution—from vehicles, homes and factories—is magnified when chemicals in the air react with heat and sunlight. Ground-level ozone is a component of smog and a danger to human health. It irritates the eyes, aggravates asthma, and causes permanent lung damage.



Source: Lawrence Berkeley National Laboratory

GREEN HOME CHICAGO

REDUCING THE URBAN HEAT ISLAND EFFECT

The key to reducing the Urban Heat Island Effect is to reduce the total area of dark, heat-absorbing surfaces such as rooftops and pavement.

Dark roofs can be made cooler by coating them with reflective materials, similar to the way light clothes are more comfortable than dark clothes on a hot day. Many light-colored roofing materials cost about the same as dark-colored roofing materials. Solar panels are another solution. They help shade a roof in addition to generating clean, renewable energy.

The use of vegetation on a roof is an excellent option. Plants reflect heat, provide shade, and help cool the surrounding air through evapotranspiration. A rooftop garden cuts the energy use within the building, especially for cooling. The insulation a garden provides helps conserve both heating and cooling energy.

Rooftop gardens absorb rainfall and reduce urban runoff that otherwise would collect pollutants and empty into sewers. A rooftop garden filters and moderates the temperature of any water that is released to the sewer.

In addition, plants actually filter the air. Plants improve air quality by using excess carbon dioxide to produce oxygen. On a neighborhood or regional level, temperatures are lowered and air pollution is reduced when the overall area of dark surfaces is reduced and the area of reflective and shaded surfaces is increased.

The layers of a rooftop garden protect the constructed roof from damage and can extend both the warranty and the useful life of the roof.

A rooftop garden can add usable leisure space to a property that is attractive not just to people, but to wildlife such as birds and butterflies.

ROOFTOP GARDEN TYPES

UNDERSTANDING THE OPTIONS

A simple rooftop garden can be created with planting containers or potted plants. This kind of garden is the most common for homeowners to construct because they are relatively low in cost and easy to maintain. A container garden provides the benefits of reflectivity, shade, and evapotranspiration. Compared to a green roof system, it is not as effective at insulating or reducing stormwater runoff.

A more elaborate rooftop garden is one where the garden actually becomes the roof. In that case, specially designed layers separate the garden from the “hard” roof, provide drainage, supply nutrients, and even add contours. This type of rooftop garden is referred to in the industry as a “green roof system.”

There are two types of green roof systems — “extensive” and “intensive.” An extensive green roof weighs less than an intensive green roof. It generally has shallower growing material and heartier plants that require little maintenance.

Intensive green roofs are the most like gardens on the ground—with deeper growing material, more intricate or delicate plantings, and more maintenance needs such as irrigation and pruning.

The type of rooftop garden you design depends partly on your interest in gardening and maintenance, and on the environmental benefits you may wish to achieve. Most importantly, you must evaluate the structural capacity of the building in order to assess your options. The next section walks you through the steps of designing a rooftop garden suitable for your building.



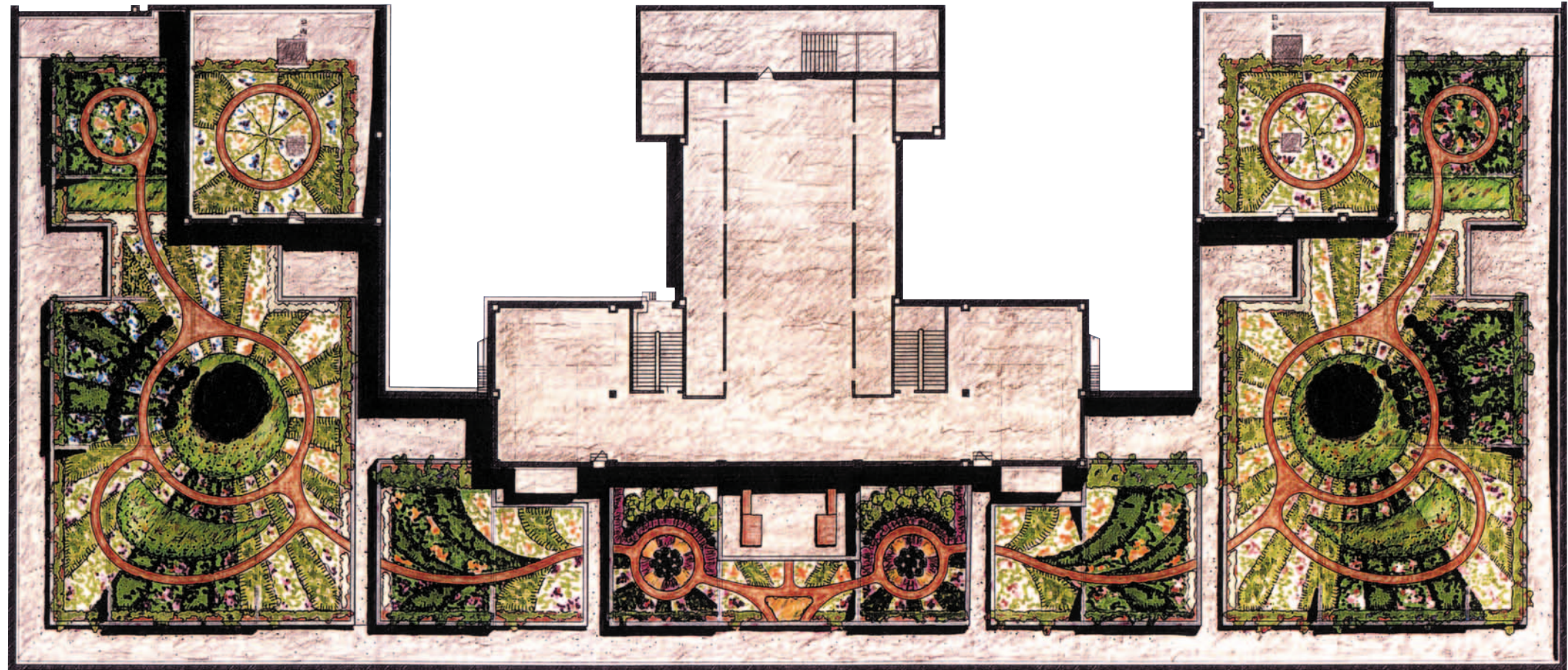
PAINT THE TOWN GREEN

A ROOFTOP GARDEN
DESIGN GUIDE

Going green is not as complicated as it seems. The following section will take you step-by-step along the path to a beautiful — and beneficial — rooftop garden.

TAKING THE INITIATIVE

TOPPING OFF CITY HALL: A CASE STUDY



Mayor Richard M. Daley's vision of a green-topped City Hall is now a reality. After extensive planning, construction on the 20,000 square-foot garden began in April 2000. The Mayor planted the first plant at a dedication ceremony on September 20, 2000. This garden is funded through a settlement agreement between the City and ComEd.

The project is the first of its kind in the City of Chicago and will be a showcase of the possibilities that can grow out of plans for a green roof. The design includes both extensive and intensive systems, as well as climbing plants.

The green roof contains 20,000 plants in all, consisting of more than 100 varieties, including shrubs, vines, and two trees. Thousands will be able to enjoy the green roof from the many taller buildings that surround City Hall, even though the rooftop will not be open to the general public.

Scientists will monitor City Hall's rooftop garden for its air quality benefits. This includes energy use within the building and temperature readings on top of the roof. For comparison, the adjacent Cook County building, which is the same height and area as City Hall but which has a black tar roof, will be monitored.

The City also will monitor temperature, rainfall, wind speed, and wind direction. This data will help evaluate the garden itself and help the City advise other rooftop gardeners about what works best.

P L A N N I N G A R O O F T O P G A R D E N

Following are the steps for planning a garden on a rooftop:

- 1) Consider:
 - *Condition of the Roof*
 - *Structural Capacity of the Roof*
 - *Access to the Roof*
- 2) Determine:
 - *Weight of Garden*
 - *Cost*
- 3) Design:
 - *Special Design of a Green Roof System*
 - *Irrigation*
 - *Drainage*
 - *Selection of Plants and Growing Media*
 - *Maintenance*
- 4) Obtain Permits

C O N D I T I O N O F T H E R O O F

The most cost-effective time to construct a rooftop garden is when the roof needs to be replaced or newly constructed. This way you can make features, such as a water-proof membrane, a root-resistant layer, or certain containers, part of the new roof.

Working with an existing, intact roof is not impossible, but it will mean taking into account the roof’s faults, such as existing leaks, damage, and inability to resist roots and standing water.

S T R U C T U R A L C A P A C I T Y O F T H E R O O F

Prior to designing and constructing your rooftop garden, you must first determine if your roof can support the additional weight of soil and plants. A licensed structural engineer or architect must be hired to conduct a structural analysis. The purpose is to determine the amount of weight the roof can support at different locations on the roof.

The structural capacity largely will dictate the type of rooftop garden that you can build. Roofs with limited structural capacity may require lighter-weight techniques such as containers or an extensive green roof system unless structural, and possibly costly, reinforcement measures are instituted. New buildings can be designed with adequate structural capacity for any type of garden.

A C C E S S T O T H E R O O F

An important consideration is access to your roof. In addition to access for the people who will be constructing and enjoying your garden, you will need to transport materials for construction and maintenance, and may need to consider the need for electricity. Typical access includes stairs or fire escapes. Generally, Chicago’s Building Code requires two separate exit paths.

WEIGHT OF GARDEN

Weight considerations are at the heart of planning a rooftop garden of any type. You must determine the weight of the garden you wish to plant and make sure it does not exceed the structural capacity of your roof. With the structural capacity determined by the licensed architect or structural engineer, an architect or landscape architect can design the garden.

To determine the weight, you must take into account: what system(s) you will use to store water, the growing media and plants you wish to use, the kind of containers you may want, equipment for heating, ventilating and air conditioning, and snow loads. Weight capacity might limit the number of people who may access the roof.

The following are estimates you may find useful:

- *Water stored in tanks weighs about 8 lbs/gallon.*
- *Extensive green roof systems weigh about 20-34 lbs/ft².*
- *Intensive green roof systems weigh about 80-150 lbs/ft².*
- *The City of Chicago Municipal Code requires at least 30 lbs/ft² for the design snow load.*

COST

In addition to the cost of the structural analysis and design assistance, your construction budget should include any needed structural or safety improvements, irrigation systems, garden materials, maintenance costs, transportation, and fees associated with any ongoing professional assistance and permits.

Container gardens can easily be adapted to fit your budget, depending on the type (wood, fiberglass, ceramic, terra cotta, concrete) and quantity you use. Green roof systems, as a general rule of thumb, cost about 50% more than a conventional roof. An extensive green roof system is generally less costly than an intensive garden. Either kind of green roof system can increase the useful life of your roof by about 50% over a conventional roof because the green roof system layers protect the “hard” roof from exposure to harsh weather.

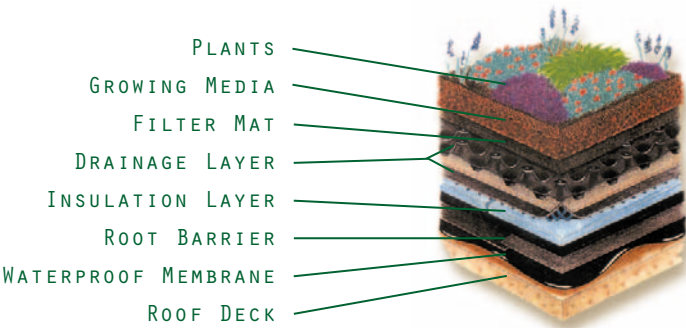
DESIGN OF A “ROOF GARDEN”

Typically, the cross section of a green roof begins (starting from the bottom) with an insulation layer, a waterproof membrane to protect the building from leaks, and a root barrier to prevent roots from penetrating the waterproof membrane. For the waterproof membrane, look for products that can withstand the effects of acids released by some plant roots.

A drainage layer, usually made of lightweight gravel, clay, or plastic is next. The drainage layer keeps the growing media aerated in addition to taking care of excess water. Since a green roof system covers the entire roof, drainage points must be accessible from above for maintenance purposes. In some designs, and with certain products, the drainage layer can do double duty, serving to store water for use by the plants at a later time. On top of the drainage layer, a geotextile or filter mat allows water to soak through but prevents erosion of fine soil particles.

Finally, the top layers consist of growing media, plants, and a wind blanket. The growing media is lightweight material that helps with drainage while providing nutrients to the plants. A wind blanket is used to keep the growing media in place until the roots of the plants take hold.

A COMPLETE GREEN ROOF CONSISTS OF MANY LAYERS.THESE LAYERS MIMIC THE CONDITIONS FOUND IN NATURE, CREATING AN ENVIRONMENT SUITABLE FOR PLANT GROWTH. IN THIS WAY, ROOFTOPS CAN BE CONVERTED FROM DEAD SPACE INTO VIABLE GREEN SPACE THAT WILL BENEFIT EVERYONE.



Source: American Hydrotech, Inc.

IRRIGATION

The City encourages landscaping with native plants as an environmentally beneficial garden design. In addition to providing habitat, native plants usually survive well on rainwater. Still, there may be times during the year when rainfall will be insufficient to supply the water requirements of even drought-tolerant plants.

You should plan for the need to supplement rainfall with irrigation. Examples of irrigation systems include, but are not limited to, rainwater storage tanks, drip irrigation systems, moisture sensors to regulate irrigation needs, or hose-bibs for manual watering. You will need to hire a licensed plumber or irrigation contractor to design and install an irrigation system or new water connections on your roof.

DRAINAGE

The water drainage system is an essential component of any rooftop garden.

A key environmental benefit of rooftop gardens is that they absorb rainwater and reduce runoff to sewer systems. Still, any excess water not absorbed by the growing media, used by the plants, or stored by the water storage system must be effectively drained from the rooftop. Failure to do this will create “bathtub” conditions that may cause root rot and disease as well as add significant weight beyond the roof design load.

Most gardens should be able to use the existing rooftop drainage system with only minor modifications. Typical drainage systems include gutters, downspouts, drains, and screens or barriers to prevent erosion of the growing media and clogging of the drainage system.

SELECTION OF PLANTS AND GROWING MEDIA

Since natural soils are heavy, particularly when wet, rooftop gardeners typically use lightweight growing media consisting of high-quality compost and recycled materials. The purposes of these materials are to be water permeable, to retain water and air, to resist rot, heat, flying sparks, frost and shrinkage, to provide nutrients appropriate to the chosen plants, and to provide a rooting medium. Plants appropriate for extensive green roofs favor poor soils. Generally, the growing media should be as deep and have as great a volume as possible within the constraints of the structural capacity, in order to provide plants with stability in wind and keep the system from becoming too dry.

Rooftops can be hostile environments for plants due to the effects of wind, heat, rain, and shadows. Extra insulation may be needed inside and/or outside of planting containers to protect plants from freeze/thaw cycles in winter. A rule of thumb is that wind speed doubles for every ten stories of building height. Windy conditions increase the loss of moisture from growing media and leaves, so drought-tolerant plants often survive best. Many plants, especially native varieties, are suitable and attractive options for rooftop gardeners.

The Chicago Department of Environment’s web site, WWW.CITYOFCHICAGO.ORG/ENVIRONMENT, contains a list of plants to consider and information about their use on Chicago’s City Hall Roof.

MAINTENANCE

Rooftop gardens must be maintained just like any garden, for instance by watering or weeding. The amount of maintenance will depend on the types of plants used and the garden design. Larger plants, shrubs, and trees must be pruned to ensure safety during windy conditions. Drains and gutters must be inspected and cleared more frequently than without a garden, because of the plant material.

PERMITS AND ZONING REQUIREMENTS

Before you begin constructing any kind of rooftop garden in the City of Chicago, you will need to have the Chicago Department of Buildings review your plans, and you will need to obtain the proper permits.

Terminology is important. A “rooftop garden” is presumed to mean it will be accessible to people. Thus there will be requirements such as ensuring proper barriers at the edge of the roof, raising exhaust stacks on the roof, providing two exits, or calculating a higher garden weight to account for people. A “green roof” means the garden will not be accessible to people except for occasional maintenance.

To obtain a permit, you will need drawings that document the design. If your home is a free-standing single-family house, you may draw the plans yourself. If your building has more than one dwelling unit, or if the building is commercial or industrial, the plans must be prepared by an architect licensed in the state of Illinois.

For most applicable permits, you will need to provide four sets of drawings produced, certified, and stamped by a licensed structural engineer and/or architect. These include:

- *Drawings of existing roof conditions, including dimensions of all structures on the roof.*
- *Structural framing drawings.*
- *Weight capacity of the existing roof. This includes calculations of snow load, snow drift load if your roof abuts a taller part of the building, and the weight of plant material both wet and dry.*
- *Drawings of the proposed garden. This includes all plant, soil and subsoil layers, irrigation and drainage, a landscape diagram of where plants will be and their growing heights, and any changes being made to the roof such as raising exhaust stacks or adding guardrails.*

There is a fee for a building permit, which includes a review by the Zoning Department. The Building Department may return a correction sheet to you which details any changes you need to make to your submittal before it can be approved for a permit. After construction begins, a building inspector also may visit your site to assure that the construction conforms to the approved plans.

The City of Chicago Department of Buildings web site, WWW.CITYOFCHICAGO.ORG/BUILDINGS, has additional information on obtaining permits.