

A Guide to Green Roofs on Existing School Buildings

What is a “Green Roof”? What does it do?

Green Roofs can mean different things. It can include vegetative plantings, solar thermal installations, solar PV racks, rain catchment systems, cool roof barriers, and other items intended to improve the “green” infrastructure of the building. In this guide, the term Green Roof is used to describe a system of layers (primarily consisting of protective roofing membranes, growing medium, and vegetation) that is installed on a rooftop of a building.

The primary function of the Green Roof is the same as any other roof – it protects the building by keeping water from entering. It also provides another way of funneling and retaining stormwater. The simplest type of Green Roof is an “extensive” green roof, which includes a shallow layer of soil or other planting substrate, and plants such as sedum or other hardy, low-growing ground cover that will not require irrigation. More complex and costly Green Roofs, usually called “intensive” roofs, can include more elaborate plantings or vegetable gardens and will require more maintenance.

Environmental Benefits of Green Roofs

- **Stormwater (Rain Water) Management**

Rain water that is absorbed and held by the Green Roof’s planting substrate (soil or other planting medium) will typically not enter the city’s sewer system at all. It will irrigate the plants, and will evaporate into the atmosphere, providing a cooling effect. When there is more rain than can be held by the Green Roof, the roof’s existing drainage system conveys this excess to the sewer system. By permanently or temporarily holding back stormwater from the sewer system, the Green Roof helps to reduce the volume of stormwater runoff that can cause Combined Sewer Overflows. Green Roofs may also filter any excess stormwater, but this depends on the makeup of the planting substrate.

- **Roof Life Extension**

Roofing material exposed to the heat and ultra-violet rays of the sun is under constant thermal stress, and will, over time, deteriorate, crack and leak. A Green Roof includes a layer of soil, which protects the roofing membrane from the direct effects of the sun, and lessens the temperature fluctuations between day and night. The Green Roof system therefore tends to increase the useful life of the roofing membrane.

- **Reduction of the “Heat Island Effect”**

The vegetative Green Roof minimizes the trapping and retaining of the sun’s heat that is the hallmark of dark-colored impervious roofing material. This “heat island effect” can be reduced by the evaporative cooling that occurs with a Green Roof. As a result the Green Roof reduces the summer cooling load for the building, and the energy cost for operating the cooling equipment. Reduced energy demand results in a decrease in air pollutant and greenhouse gas emissions associated with energy production, thus contributing to improved air quality.

- **Improved Air Quality**

Air quality is affected by heat waves; as the temperature rises, the pollutants that contribute to ozone depletion are increased due to the increased demand for cooling power. A Green Roof, due to its natural cooling effect, reduces warming trends and ozone depletion. The net result is improved air quality and better quality of life for all, in particular people who suffer from respiratory diseases.

Educational Opportunities

A Green Roof will offer the school community a working example of a sustainable, vegetative roof with environmental benefits. The simplest utilitarian Green Roof, with very limited access, can provide environmental benefits. A more complicated Green Roof, with access for students and staff, might be used as an educational setting in and of itself.

- **A Simple Green Roof “ancillary” to the educational program**

If the intention for the Green Roof project is not to provide a “classroom setting”, but rather a working example of a sustainable, vegetative roof, no additional accessibility enhancement is required. In this case a teacher might bring students to the roof to demonstrate the roof’s environmental benefits (evaporative cooling as compared to the “heat island” of a non-vegetated dark, impervious roof). If the school itself is accessible to non-ambulatory students, but the roof is not, the school must also supply a smaller scale example of the Green environment (in contrast to a dark, non-vegetated one) in a classroom or outside at grade, to ensure the same ancillary educational opportunity for all students.

- **A Green Roof as a Working Classroom**

If the school envisions the Green Roof as a classroom, to be programmed regularly as other classrooms are, then it will be considered a "new use", and

therefore the Certificate of Occupancy for the building will need to be amended. The amendments include the new use and occupancy for the roof and handicapped accessibility (Local Law 58 compliance) would need to be provided as well as other safety features that the NYC Building Code requires for an "occupied classroom". In this case, an Architect must be engaged to define the scope of work necessary to provide an "accessible route" that would allow a non-ambulatory person to travel from the sidewalk outside the school up to the roof.

Planning Requirements and Considerations

Planning a green roof for your building is not an easy process and can be expensive. Consider these requirements and considerations when thinking about whether or not you should pursue a green roof project. The green roof can only be installed on DOE-owned buildings (not leased).

- **Up-Front Costs - building retrofits and initial installation**

Depending on how ambitious the plans are, and on the conditions of the existing school building, the Green Roof project may be quite expensive, even cost-prohibitive. It is important therefore to have realistic idea of whether or not the school will have funds to support the effort, from start to finish. This will include a Green Roof Feasibility Study, which must consider all of the issues that must be addressed including, but not limited to: structural capacity of the roof, the condition of the existing roofing, status of the roof's warranty, available environmental studies (hazardous materials), access, ADA requirements, egress, approved roof occupancy, landmark status, and safety requirements for having an occupied instructional space on the roof. A green roof project can also trigger compliance with new building code requirements that may otherwise have been "grandfathered", increasing the cost of the project.

Up-front costs, beyond the planting substrate and plants themselves, may need to include: replacement of the existing roof if it is not in good condition; added egress stairs to meet Code requirements; a new lift or elevator for accessibility; and a perimeter fence around the working Green Roof area for safety.

The school must work with an Architect or Engineer up front, to identify the scope of work required for the project, and cost estimates for the design/engineering and for the construction and installations. Note that in addition to the construction and installations, the cost of all of the studies, evaluations and investigations must be funded by the school.

The school, PTA, or other funding source must be identified **before** any planning or design for the Green Roof project begins. Grants may be available for different phases of the green roof project from sources such as the NYC Department of Environmental Protection, City Council, or a Borough President's Major Capital Improvement Fund

- **Existing Roof Condition**

The existing roof will need to be in good condition and not be too old. Generally a relatively new roof (up to perhaps 8 or 10 years old) would be a suitable candidate depending on warranty provisions for green roof projects. Otherwise it will need to be replaced before the project begins. Once the Green Roof assembly is in place, making repairs to a failing roof below is difficult and disruptive. Therefore, an evaluation of the existing roof must be made by a DOE or SCA qualified tradesperson or professional architect or engineer, and it will need to be reviewed for approval by DOE and SCA. The evaluation must include an assessment of the condition of the roof membrane, flashing, masonry parapets, and roof penetrations, and the existing roof drains and drainage system.

If the existing roof requires replacement, the cost of the replacement combined with the green roof installation can range from \$30 to \$50 per sq. ft. (based on 2012 costs.) These costs depend on the roofing system and whether or not asbestos abatement will be required. If the roof replacement involves work on the masonry parapet, skylights, HVAC equipment, the roof drains, or any other repairs, the cost will increase further. It is therefore important to have a cost estimate developed along with the existing roof evaluation.

If the existing built-up roof is in good condition, and is a good candidate for a green roof, a new protective waterproof membrane and root barrier should still be put on top of it before the planting is begun. (This is because a built-up roof should not be constantly wet or damp.) This membrane will cost \$5 to \$10 per sq. ft.

- **Structural Loading Capacity**

Because the Green Roof will add weight to be carried by the roof structure, a licensed Professional Structural Engineer (P.E.) must establish the roof's existing structural capacity to determine whether or not adding the weight of the Green Roof components, and potentially a group of people, is allowable. The engineer

and/or architect must be SCA-approved. Additional load, such as furniture, planters, pathways, etc. must be factored into the capacity.

There are many roofs where a quick determination can be made that the existing building, as designed, is not suitable for a Green Roof. Where such a determination is less clear cut, the proposing entity must be able to fund the feasibility investigation of whether or not the structure can be reinforced for the additional load. DOE and SCA can often provide plans for the existing roof, and, in some cases, may have other related information as well.

- **Equipment Maintenance and Fire Department Access Paths**

The planning for a new Green Roof must include walkways (typically pavers) for access to existing roof-top equipment and parapets. In addition, clear paths must be provided in accordance with Fire Code to allow for Fire Department access from the front to the back of the roof and around the perimeter. When laying out the vegetation plan, the designer will need to consider how the roof is used by the maintenance staff. The paver path must be configured to permit access to all of the equipment, and must be wide enough to allow for the use of service equipment such as ladders. The plan will be reviewed for these access issues.

- **Regular Green Roof Maintenance Access**

A clear path for circulation must be provided for maintenance staff to the roof so that the Green Roof system can be maintained to its full, productive benefit.

- **Egress from the Green Roof**

Proper code-mandated egress – typically 2 stairs that open onto the Green Roof area - would need to be provided if the project anticipates visitors to the roof. Note that the area available for visitors on the roof should be limited so as not to invoke “Public Assembly” requirements of the NYC Building Code. An Architect or Engineer must review the existing conditions, and develop the Green Roof plan to ensure compliance with all relevant NYC Building Codes.

- **ADA Requirements**

Each project, which anticipates bringing students and staff to the roof for instructional activities, must comply with NYC Local Law 58, which enforces the Americans with Disabilities Act (ADA) requirements. This will ensure that the roof will be accessible to everyone in the school community. As part of plan examination objections by the Department of Buildings (covered in Local Law 58/87), the school could apply to the Mayor’s Office for People with Disabilities (MOPD) for a handicap accessibility waiver. Prior to the issuance of this waiver,

the MOPD should be consulted and will issue a recommendation to the Department of Buildings on interpretation of code requirements.

- **Student Safety on the Green Roof**

If students and staff are anticipated to come to the roof for observation, measurement and recording activities, a tall, fence-type protective barrier will need to be provided at the perimeter of the roof area as a safety measure. This installation will need to be planned by the Architect or Engineer to ensure that it doesn't negatively impact the waterproof envelope of the building, and that it doesn't trigger other agency requirements such as State Historic Preservation, NYC Landmarks or NYC Public Design Commission.

- **On-Going Costs - maintenance**

The additional maintenance and operational cost for Green Roofs, which are "ancillary" to the instructional program, is expected to be approximately \$1,000/year for every 10,000 sq. ft. of roof. Where the roof is used as a full teaching environment, the cost of maintaining the equipment needed to access the roof, and regular cleaning of the instructional space will add to the cost above. It is anticipated that the annualized cost will be \$2,500/year/1,000 sq. ft. of teaching space, plus \$1,500 annually to maintain the equipment needed for accessibility. These costs need to be addressed and included in any request for a Green Roof. If the cost is too great, consider planning a green space at the yard level of the school building.

Any planting proposed for the Green Roof must be approved by the Department of Education and the School Construction Authority. This is required regardless of whether the space is intended for use as a classroom with special plantings or as a utilitarian vegetative roof. In general, only sedum or other hardy low-maintenance ground cover is recommended for the utilitarian Green Roof.

No plantings are fully self-sustaining. All Green Roof systems recognize the need for providing fertilizer or nutrient admixtures. It is critical that the fertilizers or plant additives be compatible with the roofing system as well as the plants. The Green Roof proposal must include a maintenance plan that includes the use of fertilizers (type, amount and frequency), weeding (responsible person and frequency) and replacement plan for when some of the plantings die off. Plant warranties may require a plan using authorized personnel to maintain the warranties.

The Division of School Facilities (DSF) managers should be involved up front as well – the principal will need their support for the project from beginning to end. For costly projects involving capital construction work (roof replacement, and other major work in the building), the School Construction Authority should be involved at the early planning stage, and throughout Design and Construction.

Next Steps

If you have considered these requirements and considerations and would still like to move forward with a feasibility study for a green roof project, we have provided a checklist for the feasibility study for you to follow. The checklist is guidance for whom to involve in the process and at a minimum what should be included in the feasibility study. The first step would be to have a conversation with building's custodian.

Green Roof Feasibility Study Checklist

❖ Who to involve at feasibility study point

- Custodial Staff
- Deputy Director of Facilities for your school
- Architect and/or engineer
- School Construction Authority

❖ Scope of Project

- Definition of Project
- How much of roof to be occupied by the green roof (square footage)
- Types of vegetation

❖ Planning Requirements and Considerations

- Existing roof condition
- Structural load capacity
- Access to roof
- Fire egress
- ADA requirements
- Safety requirements
- Equipment maintenance paths

❖ Cost estimates

- Design
- Engineering
- Construction/Installation

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The NYC DOE
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