A NEW YORK STORY
Case Studies in Green Roof Retrofits

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Before and after images of 250 Hudson (top), Symphony House (bottom). (FXFOWLE)
Abstract

This paper articulates the key factors that led to the creation of two Manhattan green roofs on existing buildings – highlighting the motivations, considerations, design, maintenance, as well as the project outcomes. These two case studies, 250 Hudson and Symphony House, will serve as a road map for undertaking green roof retrofits. They will inform practitioners of the analysis, design, and construction processes, equipping them with the tools needed to plot their own course of action.

As one of the major metropolises with a growing population, New York City experiences continuously rising land values and a shrinking number of vacant parcels, limiting the opportunities for open space. While opportunities for new exterior spaces prove scarce on the ground plane, New Yorkers continue to covet the outdoors. Any opportunity to maximize outdoor space within the city is a desirable undertaking. With such an extensive urban fabric of building stock, New York City building owners are constantly seeking ways to maximize the potential of their rooftops. There are over 2 million existing buildings in New York City comprising 55% percent of the land area. Rooftops account for almost 20% of the City’s total area, totaling 20-30 times the area of Central Park.  

The benefits of retrofitting existing buildings with green roofs are vast – from stormwater capture, to urban heat island reduction as well as increasing habitat and species diversity. Given that every existing structure is unique, green roof retrofit efforts require an intelligent strategy based on the distinct programmatic, technical, and financial constraints of each project.

1 City of New York, 2008. Greener, Greater Buildings, plaNYC.
Introduction

250 Hudson is a 16-story office building in Manhattan just west of SoHo. The building benefits from panoramic views of the city in four directions – lower Manhattan to the south, the Hudson River to the west, SoHo to the east and the Empire State Building to the north. As part of the building-wide renovation, FXFOWLE, along with Plant Fantasies, designed an 8,000 SF green roof amenity space available to all building tenants.

Symphony House, also owned & managed by Jack Resnick & Sons, is a 43-story mixed-use office and luxury residential tower in Midtown West. The building’s distinct shape includes a setback at the ninth floor between the podium office component and the residential high rise. FXFOWLE and Plant Fantasies renovated the former 1/4 mile jogging track into 12,000 SF of semi-intensive green roof amenity space available to all residential tenants.

Motivations

In 2007 Jack Resnick & Sons reached out to FXFOWLE to create a green roof as part of the 250 Hudson commercial property redevelopment. As owner of multiple properties in the city, Resnick’s goal in the redevelopment project was to set the building apart from its neighbors in Hudson Square. In 2008 they began a complete renovation to reposition the office building in order to attract new tenants and increase rental revenues. This successful partnership on 250 Hudson led Resnick, Plant Fantasies, and FXFOWLE to develop another green roof together at Symphony House. Each project presented different challenges based on their respective conditions. As such, FXFOWLE developed a systematic methodology to carefully analyze the idiosyncrasies of each building. Outlined below are the components of a typical feasibility study that proved invaluable in the customization and overall success of both green roof retrofits.
Considerations

Converting unused existing roof space into a dynamic design feature for tenant enjoyment can be challenging. Careful examination and analysis of the existing conditions from the onset helps to overcome many of the largest hurdles to the projects. Below is a list of the critical structural and building code issues that require investigation to undertake a rooftop renovation:

- Available Roof Space
- Structural Roof Capacity
- Accessibility and Egress
- Waterproofing Membrane and Warranty
- Edge of Roof Condition
- Access to Sunlight

Available Roof Space

New York is unique in many ways – its building rooftops being no exception. To maximize usable interior (rentable) space, most Manhattan rooftops are densely packed with large chillers and air handlers. Advancements in the design of mechanical systems has greatly reduced the size of rooftop mechanical equipment. It is worthwhile to engage with a mechanical engineer to conduct a study of the existing conditions to determine if the existing mechanical units can be eliminated, reduced in size, or relocated. Chillers or condensers can often be stacked to conserve space.

At 250 Hudson, new rooftop chillers were added as part of the building renovation. Working closely with the mechanical engineer to consolidate and stack rooftop equipment on top of the penthouse office space preserved the 8,000 square feet for a green roof amenity. The 9th floor roof at Symphony House was already free of mechanical equipment; therefore the green roof installation was more straight-forward.

Existing conditions at the roof level 250 Hudson (l), Symphony House (r) (FXFOWLE)
Structural Roof Capacity

Before plants, roof pavers, and occupants can be added to a roof, it is critical to determine if the required structural capacity of the existing roof construction is adequate to support additional live and dead loads for an assembly occupancy. Typically, a roof structure is designed to meet building code minimum loads (40 lbs/sf snow load) in New York as opposed to the 100lbs/sf required for assembly spaces. Calculating an existing roof’s capacity is not always straightforward. The simplest method is to review the building’s certificate of occupancy, which states the floor loads and use for each level. The next option is to contact the building’s original structural engineer or architect – depending upon the building’s age, this often proves difficult. The most complex and last resort for structural identification is making a probe of the roof’s structure. This involves cutting into the roof assembly from above to determine and measure the structure of the roof. By measuring the thickness of the beams, concrete slab, and roofing material, a structural engineer can calculate the available capacity. To complete the calculations, the interior column spacing and floor to floor heights will need to be determined.

After probing the roof at 250 Hudson, the structural capacity was deemed insufficient to support a green roof. In order to make the green roof vision a reality, a new structural concrete slab was installed above the existing concrete roof to provide the required support. Adding the new structural slab was costly and time consuming. By contrast, at Symphony House the structural engineer was able to confirm that the required loads were available by reviewing as-built drawings.
Accessibility & Egress

“Because tenants were to have access to this green roof, it was necessary to satisfy building-code egress and ADA requirements. Thus, the amount of accessible/usable space was dictated by the available means and methods of exiting. Once this was resolved, we had the freedom to use larger plantings and add other features that greatly enhance the quality of the experience.”

– Bruce Fowle, FAIA, Founding Principal FXFOWLE

Accessible assembly roof spaces require three elements: a minimum of two egress stairs, an elevator that provides direct access to the exterior space, and a connection between the interior and exterior space that conforms to ADA requirements. It is rare to find all three requirements already in place. When visiting a potential roof space it is critical to carefully review how the roof is accessed. If steps are required to access a higher exterior roof level it will be more challenging to provide access than if the roof is lower than the interior space.

As illustrated in the image below, the roof at 250 Hudson was higher than the interior floor level. To provide an accessible route, two steps and an extra accessible ramp were added as part of the green roof design. This was only possible because the new structural concrete slab was engineered to accommodate a depression aligning with the interior floor and accommodating the ramp. As part of the building renovation new elevators were added to access the roof level.

The existing conditions at Symphony House were the opposite of those found at 250 Hudson. The ninth floor already had full access to the residential elevators and the existing roof was lower than the interior floor finish. Concrete pavers were installed on adjustable pedestals in order to align the interior and exterior floor levels, creating a seamless transition between interior and exterior.
Waterproofing Membrane & Warranty

The most important aspect of installing a green roof on top of a membrane – new or existing – is not to damage the membrane or void the warranty. For this reason, an excellent time to add a green roof is when an existing roof membrane is being replaced. If the existing waterproofing membrane is to remain it is important to determine what type of membrane it is – modified bitumen, liquid, TPO, EPDM, etc. This can be done by probing the roof which might lead to the discovery of multiple membranes applied on top of each other. Once the membrane type is determined, it is advisable select a green roof assembly and root barrier that best protects the existing membrane.

It is always important to select waterproofing membranes and green roof systems that are compatible and won’t damage one another. Plant roots can deteriorate many bituminous membranes, while TPO and PVC are not susceptible to deterioration from plant roots. If a bituminous membrane is selected, manufacturers require a root barrier be placed between the membrane and the plants.

At both 250 Hudson and Symphony House, modified bituminous membranes were installed with root barriers above them. Due to the increased height of the roof at 250 Hudson, new counter flashing was installed along the parapet wall. At Symphony House, the existing through-wall flashing was reused and only the counter flashing required replacement.

When selecting a waterproofing membrane it is important to determine what, if any, components of the green roof are supplied by the membrane manufacturer and exactly what is covered by the manufacturer’s warranty. There are typically two types of green roof warranties - single source and multiple source. A single source warranty typically means that the roofing manufacturer provides the entire green roof assembly including the membrane, drainage mats, filter fabric, growing media, and plants. The advantage of this model is that if a leak occurs, a single company is responsible for removing the green roof and fixing the leak. When the leak is fixed the roofer replaces the green roof. The disadvantage of this arrangement is the limited plant palette offered by roofing companies and the standard growing media depth. A multiple source warranty means the roofing assembly is warrantied separately from the green roof assembly. The advantage of this system is freedom to select different plants and vary the depth of the growing medium. The disadvantages of this system are when a leak occurs the landscaper must remove the green roof overburden so the roof can access the membrane to fix the leak. Once the leak is fixed, the landscaper is responsible for replacing the green roof.

250 Hudson and Symphony House were both multiple source warranties where the roofer warranted the membrane and the landscape installer warranted the plants. Installation of built-up green roof systems at both projects provided maximum flexibility of plant selection.
Parapet Condition

Most existing inaccessible or mechanical roofs do not have parapets. Accessible roof amenity spaces require a 42” tall guardrail at the perimeter of all gathering spaces. Adding a green roof typically increases the finished elevation of the roof by 8”-24” which alone renders most existing parapets inadequate by the code.

Adding a new guardrail can be challenging depending on the condition of the existing parapet. Parapets are unique building elements that are exposed to the weather on three sides – the exterior, top and inside façade – which often causes a parapet wall to deteriorate more rapidly than the rest of the building exterior.

At 250 Hudson the finished floor was increased by 18” to accommodate the new structural concrete slab, building insulation, drainage mat, paver pedestals, and roof pavers. The existing parapet was 38” tall before. After the green roof was installed it was reduced to 20” tall. New guardrails were designed throughout, but first we had to determine how they would be attached to the parapet.

Structural probing and analysis is typically required to determine the strength and composition of the existing parapet. At 250 Hudson, the structural engineer determined the parapet was capable of supporting a new guardrail if anchored to the inside face. To limit the number of penetrations through the waterproofing membrane, it is preferable to anchor railings to the parapet above the counter flashing rather than the structural slab below.

Parapet railings can also experience high wind loads due to this location at the top of a building. At 250 Hudson, instead of a solid glass wind screen to block the wind, the design team created frames with a stainless steel mesh infill that allowed the wind to pass through, adding only minimal loads to the connection at the parapet.

Once again, the existing conditions at Symphony House proved more advantageous. The existing brick parapet was 42” tall and in excellent condition. Having a code-compliant railing already in place significantly shortened the length of the project’s construction schedule.
Access to Sunlight

A critical part of the analysis process is to study the roof’s access to direct sunlight. To do this the design team used a 3D modeling software called Ecotect. Ecotect is an analytical tool that measures a building’s geometry, neighboring structures and geographic location relative to the sun’s path throughout the year. By understanding the amount of direct daylight a roof receives plant can be appropriately selected to match the conditions: full sun, partial sun or shade tolerant.

250 Hudson is the tallest building within 3 blocks in all directions, so the analysis clearly indicated that the roof experienced full sun exposure throughout the day and year. However, Symphony House was quite different. Located in mid-town Manhattan, Symphony House is surrounded by equally tall buildings. Therefore, the 9th floor roof experienced conditions ranging from full exposure to no direct sunlight at all. Specifically, the alcove on the north side of the building experienced no direct sunlight, so the project quickly became focused on the southern roof along 56th street. Here this analysis informed more than just plant selection – it determined the scope of the planted areas on the roof.

Daylighting analysis at Symphony House (FXFOWLE)
Design

Once the opportunities and constraints were established, FXFOWLE worked collaboratively with Plant Fantasies to respond to Jack Resnick & Sons goals of creating a great amenity for building tenants. As a building owner and manager of both buildings, JR&S carefully balance design decisions with maintenance requirements throughout both design and construction.

In designing each space, FXFOWLE focused on the program requirements to develop an organization diagram for each roof. At 250 Hudson, the focus was to create a large gathering space to celebrate the building’s panoramic views. By contrast, at Symphony House the design focused on creating an inward focused serene landscape with a variety of individual spaces. Below are descriptions of the critical moments encountered on the design process of each project.
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Programming

To respond to each building’s unique function the layout and design of each roof was very different. 250 Hudson’s focus was to create a large gathering space for office tenants. Whether it was one user hosting a cocktail party or 10 different companies each having 10 employees use the roof each day for lunch. The largest tenant has 300 hundred employees in the building who all come up to the roof for company events. On a daily basis the furniture is used to divide the space into smaller seated areas, which tenants reorganize to fit their needs. We provided a mix of four person tables with individual chairs so they could be moved independently. Also specified were an Adirondack style chair made from 100% recycled milk jugs, with wide armrests that can support a laptop.

At Symphony House the roof was designed quite differently. Here the largest group we envisioned would be a family gathering or dinner party for 10-15 people. To create more intimate personal sized spaces, we organized the roof with a circulation spine set against the building, which acts as a corridor separated from seated areas by vertical planted trellises. The trellises were planted with clematis and Boston Ivy and in a few years will be completely covered, creating a visual separation between the circulation zone and seating area. Furniture here is a mix of rectangular dining tables with full length benches that seat up to eight, and large armless lounge chairs for reclining.
Plant Selection

In both projects, prior to planting the design team sculpted the beds to give them each their own topography and undulation. To create changes in elevations, we used geofoam and expanded polystyrene were used underneath the drainage mat plants to create topography. The geofoam is very lightweight, creating elevation change without the excessive burden of the growing media.

At 250 Hudson, the planting beds were conceived as a changing element. Therefore, seasonal color was a major consideration in plant palette selection. To achieve a colorful variety of plants, three palettes were developed, each representing a specific range of colors. One group was comprised of plants blooming or with vegetation in shades of blue and lavender, one with pink and rose tones, and one in yellow and golden tones. The areas of intensive plantings were then composed in large sweeps of each of the three palettes so that there would be an interlacing of color that would provide a good balance of all palettes throughout the seasons.

In addition to color and bloom time, drought tolerance and sun/shade requirements were important considerations. For example, the trellis planters wrap around the bulkhead with one side facing south in full sun and the other facing west with afternoon sun and partial shading. However, it was desirable to have the appearance of the two sides as consistent as possible. The selection of the Boston ivy and clematis planting on the trellis was in large part chosen to meet this requirement with plants that would perform equally well in both conditions. Though growth rates have differed between the two faces, in time, both have proven to be successfully flourishing.

The biggest change that the design team would likely make in future projects would be a reduction in plants which self seed. At 250 Hudson this was limited to a handful of varieties, but some were still retained as an insurance policy knowing that they would produce additional plants which could fill in if others failed. While the alliums and artemisia are good performers, most of the other selections are not successful enough to merit the additional weeding which they require. Non-seeding plants with similar colors and textures may have been more successful in the long run.

At Symphony House, plants were selected based on the microclimate of the roof and its full exposure to sunlight. Planted in pairs, multi-stem river birches provide rich texture and a mix of stems and green leaves from top to bottom. Shallow-rooted perennials and sedums were chosen that could tolerate the windy rooftop. The flower color palette of primarily yellows and purples was timed to provide blooms throughout the growing season. Each of the native species selected for this rooftop garden was planted in massed swaths, layered within the slightly bermed planting beds. As each plant grew to maturity, the gardens have become soft multi-textured meadows that reflect the natural native landscape.

Built up roofing for planting at 250 Hudson (l) finished results (r) (FXFOWLE)
Maintenance

Jack Resnick & Sons building maintenance staff and Plant Fantasies staff jointly maintain both green roofs. Responsibilities can vary, however, the building staff addresses building elements such as cleaning roof drains, power washing roof pavers, removing trash from receptacles and general clean up around the planted areas. Plant Fantasies is contracted to provide weekly maintenance of the planted areas throughout the Spring, Summer and Fall. They weed the planted areas, maintain the drip irrigation system, monitor plant health, replace individual plants as necessary and administer fertilizers and herbicides as required. PFI is also responsible to winterize the drip irrigation system each fall, extremely important in climates that experience below freezing temperatures.

Irrigation

All of the planted areas at both 250 Hudson and Symphony House Street have been installed with an efficient drip irrigation system. The irrigation system is split into zones so that watering can be fine-tuned to the needs of the plants in each area, using as little water as possible. While the trees and raised trellis plantings are expected to always need additional water during the summer season, it is hoped that watering of the perennial and succulent areas of the green roof can be reduced to minimal supplemental levels once plants have established themselves.

Fertilization

Fertilizer is used as little as possible and using only organic sources where needed. Trees are fertilized twice annually, spring and fall, using Holly-Tone fertilizer. Perennials and grasses are not fertilized. The progress of these plants is being monitored to determine a regimen for fertilization, or soil nutrient replacement. While most all varieties used are not very demanding in this regard, the green roof soil is a high mineral, low organic blend, so some nutrient depletion may occur over time.

Weeds and Pests

As needs have arisen, weeds and pests are dealt with as naturally as possible. No herbicides are used at either location. Weeding is done by hand and with small hand-held cultivators during weekly growing season visits and as needed on monthly winter visits. For insect pests, biological and integrated pest management strategies are used when needed. Ladybugs have been introduced to the beds at 250 Hudson Street when aphids have been noticed on rose and milkweed varieties. Semaspore bait, made from a naturally occurring fungal grasshopper pathogen, is used to control grasshopper populations during the summer.
Results and Achievements

“The bottom line is 250 Hudson is full and all of the major tenants are requesting additional space. If we could raise the roof and put five more floors on the building, I think we’d rent them very quickly.”

- Burt Resnick, Chairman and CEO, Jack Resnick & Sons

Office tenants at 250 Hudson use the roof throughout the day. One Human Resources Director uses it to conduct interviews on summer mornings. A prominent architect in the building held his book signing on the roof. At lunchtime it is difficult to find an empty chair. The most unexpected result is the overwhelming number of requests to host private events on the roof. Throughout the spring, summer and well into the fall, building tenants reserve the roof space for their own private events. A policy was developed allowing only building tenants to reserve the space. Two to three nights per week and occasionally weekends the roof is reserved by one of the tenants, for a small fee. This fee provides the tenant access to the freight elevator, a porter and a security guard to oversee the event and lock up.

In just three years, 250 Hudson has been awarded LEED Silver Existing Buildings and the 2010 Green Roof Award of Excellence from Green Roofs for Healthy Cities. The building also received a New York State Green Roof Tax Credit.

At Symphony House the response as been similarly positive. Completed in 2011 in just its first year the roof has been used extensively by residents for meals and relaxation. The most unforeseen change occurred in the smoking habits of building tenants overlooking the green roof. Previously many tenants were accustomed to flicking their cigarette butts off their balconies onto the defunct jogging track now having seen the transformation the quantity of cigarettes requiring removal from the planting beds is significantly reduced.

Building tenants aren’t the only occupants on the roofs; they are also living ecosystems. Insects ranging from grasshoppers to bees inhabit the spaces, birds frequent the roof because of the insects and the range of flowering plants. Tenants have even seen hawks visit the roofs.

The successes of the green roof retrofits at 250 Hudson and Symphony House did not come about accidentally. They can be attributed to a diligent analytical process that investigated the existing conditions of the context, building and roof, identifying opportunities and constraints. Allocating the additional time and effort to undertake a thorough feasibility study at the onset helped define the proper parameters that guided the project through its inception and beyond. As well, a careful consideration of program, code requirements, and plant type was carried out when developing the design. Finally, as with any living system, a highly collaborative team was key, particularly the commitment from the building management to proper ongoing maintenance practices.
About the Authors

Scott Melching, AIA, LEED BD+C GRP FXFOWLE
Scott is a project architect with FXFOWLE. As a key member of the firm’s Team Green, a committee of design professionals dedicated to research, investigation, and development of new sustainable systems, materials, and technologies, Scott leads the office’s efforts to design and install green roofs on existing New York City buildings. He is a registered architect, LEED Accredited Professional and an accredited Green Roof Professional by Green Roofs for Healthy Cities.

Jonathan Resnick, President Jack Resnick & Sons
In 1996, Jonathan D Resnick joined Jack Resnick & Sons, one of New York City’s preeminent, family-owned real estate development and management companies. He was named President in 2007. Mr. Resnick oversees the firm’s vast portfolio of approximately six million square feet of commercial office and retail space, and approximately 900 rental apartments. He is directly involved with asset management, capital projects, leasing, new development, and the day-to-day operations of the firm.

Teresa Carleo, Founder and President, Plant Fantasies, Inc.
Ms. Carleo founded PFI nearly 25 years ago and has over 30 years of experience in horticulture. Her passion for gardens and people has led to the creation of a design/build company specializing in urban gardens and urban green roofs. She also provides landscape contracting services for major projects throughout the Manhattan area. Teresa embraces all types of projects, from private spaces to large scale construction sites. She personally oversees all aspects of daily operations, from planning, design, estimating and personnel management, to sales and company financial requirements.

Project Credits

250 HUDSON
Design Architect: FXFOWLE
Architect of Record: A-Squared
Structural Engineer: GMS
Landscape: Plant Fantasies
Contractor: Plaza Construction
Pavers: Hanover Architectural Products
Stainless Steel Mesh: GKD Metal Fabrics
Furniture: Loll & Henry Hall

SYMPHONY HOUSE
Architect: FXFOWLE
Structural Engineer: Rodney Gibble Consulting Engineers
Electrical Engineer: MSM Electrical
Landscape: Plant Fantasies
Contractor: Rally Restoration
Planters and Trellis: GreenScreen
Pavers: Stepstone Inc.
Furniture: EMU & Modern Outdoor