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Environmental Internship & The Fordham Eco-Roof Proposal

Anthony Giovannone
Fordham University, envstudies16@fordham.edu

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Environmental Internship & The Fordham Eco-Roof Proposal

By: Anthony Giovannone
Spring Semester 2009

Just another impervious surface waiting to be “greener”. Dealy Hall, 2009.
Foreword:

First of all, I would like to thank Professor VanBuren for giving me the opportunity to write this paper. Second, I would like to encourage future students in the Environmental Studies department to use this proposal and expand upon it. Although Fordham University is very “green” there is a need for hands-on applications that are student involved. My experience as an intern, and findings around campus has led me to write this proposal.

Sincerely,

Anthony Giovannone
FCRH ‘09
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Environmental Internship with Camp Dresser & McKee

After spring semester 2008, I decided that it was time for me to obtain some “real world” experience. I wanted to enter the workforce with some understanding of what it meant to be an engineer. As an engineering physics student at Fordham, I am able to choose a career path in engineering, yet tailor that path to what is important to me. In my personal life I consider myself an environmentalist; I take an active role in improving the environment around my community and me. Keeping my passion for environmentalism in mind I came to decide that environmental engineering was the career path I should pursue.

CDM, or Camp Dresser & McKee, was a company that I had never heard of before the end of my junior year. A family friend had once been a part of this major engineering firm, and informed me of their internship program. The CDM Co-Op internship program was then brought to my attention, and I applied for a position with the CDM New York Operation. I was accepted and started as intern at the Maiden Lane office in the NYC financial district.

Who is CDM and what do they do?

CDM is a consulting, engineering, construction, and operations firm based in Cambridge, Massachusetts. Founded in 1947 by Thomas R. Camp, Herman G. Dresser, and Jack E. McKee, all MIT graduates. CDM initially focused on New England
based clients and specialized in water supply and water pollution control as an engineering practice. As CDM expanded as a company it grew into an international corporation with a traditional base of water and wastewater expertise. One expansion was into the field of hazardous waste management, creating the CDM Federal Programs Corporation subsidiary. Within the last two decades CDM has also formed a design-build, construction, and general contracting subsidiary, CDM Constructors Inc. CDM is a privately own corporation with both private and federal clients worldwide.1

The best way to describe the operations of CDM is through example. An U.S. EPA-funded project in the Rouge River watershed in Southeast Michigan is being led by CDM. The Rouge River watershed is a largely urbanized area, similar to the Bronx River watershed, and is home to many communities. CDM led the Rouge River National Wet Weather Demonstration Project team in developing and conducting combine sewer overflow (CSO) assessments and control strategies. These strategies include: stormwater and nonpoint source pollution control programs; watershed assessments, monitoring and management; water quality modeling; wetland resource protection and assessments, geographical information system, and public involvement strategies. CDM is striving to restore and protect the water quality in the Rouge River by controlling CSOs and stormwater, and by implementing watershed management practices to preserve the quality of headwaters.2

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1 www.cdm.com/about_cdm/history.htm
Another example of a CDM project is the High-Capacity Wastewater Treatment Facility, in Okaloosa County Florida. The Arbennie Pritchett water reclamation facility is an award winning and innovative water resources management facility designed by CDM. This plant will treat 10 million gallons of wastewater every day. Sustainable design innovations include a reduced power and operational cost due to a more efficiently designed treatment process.³

**The New York City Office and EPA Region 2**

The New York City office works with federal groups, namely the EPA and the Army Corps of Engineers, on superfund site remediation. The EPA states that, “A Superfund site is an uncontrolled or abandoned place where hazardous waste is located, possibly affecting local ecosystems or people.”⁴ CDM assess these sites for treatability, and designs a system that will remediate the environmental problem.

The New York office works specifically with EPA Region 2, which includes New York and New Jersey. There is no lack of superfund sites in this area. These sites are usually near some form of industrial area, or an area where toxic waste is being held, or was dumped. The pollution from superfund sites is in the ground water and soil, and it can also be ambient in air. This is an important fact that I learned from the scientists at CDM is part of what makes their work so important. As defined by the EPA, vapor intrusion “is the migration of volatile chemicals from the subsurface

³ BE Magazine Volume 6 Issue 1 page 42 and 43
⁴ www.epa.gov/superfund/sites/
into overlying buildings.”

Whether in the water or the air these substances can create serious health problems for human beings and other biota.

**My Internship**

Large underground aquifers in New York and New Jersey are often used as a source of water for private homes. These aquifers spread for large distances hidden underground. When these large pockets of water are polluted, they can taint water for miles. One aspect of my work at CDM was tracing out these areas on maps to be put in treatability studies. I would also create maps pointing out our specific testing wells in the area, and how much pollution they were reporting. This way CDM and the EPA could track the pollution and design a remedial system specific to the site. Another aspect of my work at CDM was to help create and modify health and safety plans for work sites. It is important that CDM protects its employees while they are on-site, as dangerous chemicals, VOCs, or volatile organic compounds, and other hazardous wastes are common to all of these superfund sites. My time at CDM also included checking reports for completeness and modifying current and future project plans.

Working at CDM I was able to see what environmental engineers, geologists and a myriad of other scientists and engineers did to help improve and maintain environmental integrity. Our ability to pollute the environment is tremendous, but before working with CDM, I never knew that our ability to remediate these problems was also immense. I am sure now that environmental engineering is a field I would like to study. Though I do enjoy the work associated with superfund site

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5 [www.epa.gov/superfund/health/conmedia/index.htm](http://www.epa.gov/superfund/health/conmedia/index.htm)
remediation, I hope to broaden my career and work with wastewater management teams and sustainable designers. This work is not only a means of a career, but also a means to help improve environmental standards.

The operations and sustainable practices of CDM’s project are pertinent in understanding how to remediate existing problems in Fordham University’s area of the Bronx. In the next section I will propose a project that will help educate Fordham students on technologies and applications associated with sustainable practices. From my experience at CDM, I know that storm water runoff compromises the health of our aquifers, rivers, and other waterways. It is a significant problem in the Bronx and other areas of the country. The Fordham Eco-Roof, proposed in the next section will give students hands-on experience with sustainable practices that help to remediate the problems associated with storm water runoff and non-point source pollution, as well as other environmental issues.
Fordham Eco-Roof Proposal

I. Introduction

Fordham University is known for being the largest green acre campus in New York City. Located near the New York Botanical gardens, Fordham is nestled in a more natural environment than most of the city. Clearly, this aspect of Fordham has attracted students, as we see students enjoy spending time on Edwards Parade and running through the Botanical Garden. As the world enters an era of environmental uncertainty, Fordham is certainly lucky to be surrounded by nature. Although Fordham is a natural green oasis within the city of New York, we need to move forward, and allow students to act sustainably.

II. Purpose and Mission

Fordham received its 2008 College Sustainability Report Card\(^6\), scrapping by with a C- while Columbia received an A-, and NYU a B-. Adding to this low score is a C grade on student involvement, which is the essentially why I am writing this proposal. There is an increasing awareness, in college students, of human caused effects on the environment, and its potential degradation due to human action. Many

\(^6\) http://www.greenreportcard.org/report-card-2009/schools/fordham-university
Fordham students would consider themselves environmental citizens, and most are willing to be active. There is a need for an educational application of solutions to the everyday problems that involve human action and the environment. Fordham's environmental studies, engineering, architecture, and ecology students would all benefit from an environmental study project. In this essay I will discuss a proposal for an environment-based project that could potential involve over 5 different departments and many students. It could serve at an educational tool allowing Fordham to look towards the future in the way of environmental studies and scientific applications to environmental problems. In addition, I will include a basic feasibility study, including an estimated cost report for this project, which I am calling the Fordham Eco-Roof project. Also, there has been a discussion among Fordham environmentally literate students, who would like to see some form of an organic garden on campus. I will discuss how this could be integrated into the Fordham Eco-Roof project as well as other potential sites on campus that could be potential organic gardens. This project will strengthen Fordham's sustainability report card by adding student involvement to the list of already developing environmental practices.

The Fordham Sustainability Policy states that, “Fordham University will advance understanding of environmental change through its curriculum and academic programs.” Although Fordham has a number of courses that study the environment, there is no student involved, physical application to sustainable practices on campus. In order to give back to the environment while enhancing

campus life through sustainably practices, Fordham needs to adopt new projects, such as my proposed Eco-Roof. Though students are encourage to recycle and attend lectures on the environment, a “hands-on” academic program is equally effective. Another aspect of Fordham’s sustainability plan is the green space initiative.\(^8\) Much like my introduction, this initiative states all of the already existing green spaces that surround Fordham. My proposed Eco-Roof project will enhance this initiative by making a clear example of an urban green space. There is a lack of nature in New York City, however sustainable practices can change that. I will be exemplifying green roofs and their benefits to urban areas, illustrating how Fordham can be a small-scale example of this sustainable practice. Overall, this Eco-Roof project will bolster student involvement in campus sustainability projects, create community awareness of sustainable practices, and help preserve the existing natural elements of the Fordham environment.

III. Background of Green Roofs

In order to understand why the Fordham Eco-Roof project illustrates a sustainable urban practice, we must first explore the ever more popular science of green roofing. Though the Fordham Eco-Roof project will not be a fully functioning green roof, the idea is to make an example of a green roof on campus to serve as an educational tool and potential site for an organic garden.

A. Benefits of Green Roofing

A green roof is a roof of a building that is partially or completely covered by soil, plants, and a waterproofing layer. The U.S. Department of Energy releases a

\(^8\)http://www.fordham.edu/campus_resources/campus_facilities/facilities_management/green_campus_initiative/green_space_initiative_30451.asp
Federal Technology Report in 2004, outlining the benefits and capabilities of a green roof. “Green roofs are an important conservation technology because they increase the energy performance of buildings, improve indoor as well as outdoor air quality and enhance the health of urban watersheds.”^9 There are two different kinds of green roofs, for our purposes at Fordham an extensive, as opposed to intensive, green roof is more feasibly. An extensive green roof has a low soil profile, meaning the soil depth is shallow, where the intensive green roof, having over 12 inches of soil depth. Consequently, extensive green roofs require much less structural support. Plants for extensive roofs should have relatively low-growing roots and need to be built keeping wind, sunlight, and water in relation to the site in mind.

Green roof technology is extremely beneficial to urban environments. The U.S. Department of Energy states that, “This technology is especially effective in urban areas, because roofs make up such a large percentage of a city’s impervious surfaces.”^10 This is important because impervious surfaces are conducive to two major environmental problems in urban communities: 1. Urban heat island effect and 2. Urban stormwater runoff. First, the urban heat island effect is the result of conventional roof surfaces absorbing solar radiation and re-emitting that radiation, in the form of heat energy, into the air inside and outside of the building. In urban areas this heat is so intense that it creates ground-level ozone, which traps pollution and creates smog. In addition, when the indoor air of building is heated via conduction from the roof, air conditioners, which use copious amounts of electricity, are used to expel the warm air out into the urban environment. This only adds to the

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^9 [http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf](http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf) (pg. 3)

^10 [http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf](http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf) (pg. i)
air quality problem. A green roof solves the urban heat island effect problem by creating a barrier between solar radiation and the building’s roof, hence reducing the roof’s temperature. Since soil and plants absorb the energy emitted by the sun, as opposed to radiating back to the air, like conventional roofs, the urban heat island effects is significantly minimized around buildings with green roofs.

The second reason that green roofs, as opposed to impervious surfaces, are beneficial to urban areas is their ability to control stormwater runoff. “Stormwater management is probably the most tangible direct benefit,” of green roofs. Impervious surfaces do not absorb rainwater, which is one reason for an urban sewer system. The second reason for urban sewer systems is for the transport of sanitary waste. Many of these systems combine rainwater and wastewater, and they will overflow into rivers, streams, aquifers, and even streets when they are overburdened with water flow. Known as CSOs, these combine sewer overflows often contain raw sewage. “There are several of these raw sewage-containing CSOs that are designed to run directly into the Bronx River.” Also, non-point-source pollution, or the sediment and oil from streets and roofs, is carried by runoffs into the same waterways, adding to the pollution. A green roof significantly reduces the amount of rainwater runoff from building because the plants and soil absorb, store, and use this water. A green roof with just 1 inch of soil will retain 58% of rainwater

11 http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf (pg ii)
annually. Therefore, a green roof will significantly reduce the problems associated with combine sewer overflow systems.

Yet another great benefit of green roofs is the space. Having a green space in the city is sometimes hard to come by. Green roofs often provide food and a resting area for wildlife and humans. Butterflies and migratory birds are sure to benefit from green roofs. “Green roofs might not be able to replace ecosystems, but multiple areas may plan an important role in reconnecting fragmented habitats.” In addition, green roofs effectively reduce heat transfer through a building’s roof, therefore, it would hinder heat loss during winder months.

B. Implementing Green Roofing into Fordham Eco-Roof.

Though it may be environmentally friends and economically feasibly for Fordham to install a full-scale extensive green roof, the Fordham Eco-Roof project would feature a small-scale green roof area serving educational purposes. The area covered by the green roof would roughly be 10x10 or 100sqft. There is a layering method that would have to be in place underneath the soil in order to provide adequate waterproofing and drainage. The design would include various levels: substrate, drainage and water storage, insulation, waterproofing, as well as protection and separation layers. An example of this layering is shown in the figure below.

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The Fordham Eco-Roof green roof apparatus could be contained with a wood or concrete siding in order to contain the necessary layers in a 100sqft area. Drainage areas would have to be set up near the edges of the plot. Flow rate meters will calculate the amount of water flowing from the green roof apparatus. Monitoring of

this water, by environmental studies students and other interested students would provide an education research opportunity. As stated earlier, the main benefit of green roofs is their ability to reduce rainwater runoff. A study could use the green roof apparatus as a model of full-scale green roofs.

The growing medium must be conducive to the rooftop elements: wind sun and water. The soil, between 2 inches and 4 inches will be based upon whether the apparatus will be used for growing an organic garden, or simply as a means of studying green roof sustainability. A list of plants suitable for green roofs can be seen in Appendix A. Another important aspect to the design of the green roof apparatus is the actual load of the green roof. Most building on campus will be able to withhold the load of this simple model. A table of loads for various green roofs of soil can be seen in Appendix B. More details on possible locations, costs, and materials are included in the feasibility study in the latter half of this report.

IV. Other Aspects of the Fordham Eco-Roof Project

The Fordham Eco-Roof Project will not only feature a green roof, but also other sustainable practices. A small photovoltaic solar panel, vertical axis wind turbine, and extra public space for students will be included.

A. Solar Panel and Wind Turbine

Dr. Martin Sanzari, director of Engineering Physics at Fordham, has expressed a need for undergraduate research facilities for engineering physics students. This past semester I took Laser Theory and Design with professor Sanzari, and we were able to build our own helium neon lasers. The engineering students at Fordham are certainly eager to do some hands on projects. The Fordham Eco-Roof
project will feature a small photovoltaic cell as well as a small vertical axis wind turbine. Dr. Sanzari and the engineering students would be more than willing to construct and experiment with these technologies. Electrical engineering students would be able to get some hands on experience working with and analyzing electrical circuits. Similarly students from other departments could use the photovoltaic panel and the small wind turbine as a means to study. Small meters measuring electrical power would be set-up and monitored throughout the year.

**B. Public Space and Education Use**

The Fordham Eco-Roof project could also be used as a public space for students to display projects or to simply relax. Professor Colin Cathcart has many pre-architecture students that are interested in sustainable design. I took his design and nature course, where most of the students were passionate about helping improve environmental standards at Fordham. The Fordham Eco-Roof would provide an area for models and projects to be displayed and tested. Similarly Environmental policy students, under John VanBuren’s Environmental Studies Department, as well as SEPA (Fordham’s environment club) could use the Eco-Roof as an educational tool. Potential projects could include a project assessment reports, or a community involvement activity. Local students could benefit from the Eco-Roof as well if Fordham students take an initiative to showcase the sustainable aspects of the project.

Lastly, in conjunction with an Eco-Roof, it would be nice to see some vegetable gardens around campus. I have included site proposals for organic gardens on campus in the Feasibility Study. An example of a university managed
organic garden is that of SUNY Binghamton in up-state New York. The garden is located on Binghamton University-owned property.

The garden is located on Binghamton University-owned property. According to Richard Andrus, a professor in the environmental studies department, it was created because of students. "As a student living in Hillside, the garden is just a 15-minute walk up Bunn Hill Road, so it’s a very convenient location for me," Davis [A Binghamton student] said. "I would guess that its proximity to campus makes it convenient for everyone else as well."16

A few small organic gardens on campus would be beneficial for students, and as in Binghamton, be used and maintained by a student run organization.

V. Feasibility Study

The Feasibility Study is a combination of my findings around campus and from various sources on how easily the Fordham Eco-Roof will be implemented.

A. Location

Due to the nature of this project it is clear that a suitable roof is needed. There are various buildings that would be able to host the Fordham Eco-Roof.

1. Dealy Hall

The roof of Dealy hall is ideal for the Fordham Eco Roof Project. There is plenty of space, sun and wind. Also, Dealy is located in the center of campus and has guardrails on most of the roof. This would be both safe and convenient. The roof has many different areas; each could have its own theme and space. For example one corner could be the green roof apparatus the other a photovoltaic cell

2. Freeman Hall and Martyrs (pictures respectively)

Freeman hall is home to the ecology department and the engineering physics department at Fordham. Having the Eco-Roof in Freeman hall would be a good idea because the engineering and ecology students would be able to easily maintain and study the ongoing. Freeman provides a different space because it’s long and rectangular. Perhaps this would be better for maintenance but less aesthetic. Martyrs on the other hand would be more difficult for students to access because it is a dorm. However, a roof top garden and other projects would look spectacular in the background of Martyrs lawn.
3. New Residences as Fordham

As Fordham strives for LEEDS silver rating on the new dorms, and Eco-Roof would certainly be beneficial. Again it may be more realistic to have the Eco-Roof on an academic building as opposed to a dorm, but if the roofs are made suitable for the project, these new residence halls would be ideal candidates.

4. Organic Farm sites

There are a number of locations around campus that could be used as small-scale organic farms. The area around the tennis courts near Fordham prep is sometimes used as a small garden According to Bob Hawthorn, tennis coach at Fordham, the area was maintained by a member of the Fordham Facility Staff. Bob was not sure if the garden would be planted an looked after again, claiming it was “a
shame, but the man may not have the time to take care of it.”

B. Cost Report

1. Green Roof Apparatus

There will be a number of measures which need to be taken in order to install the green roof apparatus. I have found two reputable green roofing companies in the area that could help with the implementation. Typically a green roof costs around between 15 and 25 dollars per square foot. For a 100 square foot plot the cost would be around $1500, for the extensive design. Getting a quote from a company would be the initial step, and asking about student involvement in the

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17 Interview with Bob Hawthorn, Tennis Coach, Fordham University
18 http://www.greenroofs.com/Greenroofs101/faqs.htm
installation could lower the price. Please see Appendix C for contact information on
green roof installation companies.

2. Photovoltaics and Vertical Axis wind Turbine.

The Photovoltaics are readily available on the market. I suggest a build your
own solar panel kit, that could be shipped to the University and assembled by
students. These kits usually run around $200. The Wind Turbine could cost a bit
more, but smaller models will run around $200 as well. More research will have to
be put into finding the best solar panel and wind turbine for the site. A list of
producers is included in Appendix C.

3. Organic Gardens

There are few costs associated with growing the organic gardens. Besides the
seeds, water, and the tools there is little more to pay for. As long as students are able
participate, it will be cheap and easy to implement these gardens.

VI. Design

The design of the Fordham Eco-Roof should be left up to Fordham students.
Pre-architecture, visual arts, and engineering students could come together and
design the roof. Ecology students could choose the plants, and environmental
studies students could help with construction and design as well. The Eco-Roof
should be implemented and designed by students as much as possible. In the 2002
Environmental Audit19, Professor Colin Cathart gave his recommendations for
sustainability in new buildings at Fordham. His architectural firm, Kiss + Cathcart

19 VanBuren, John, Environmental Audit Case Study of Greening Fordham University
And Preserving Its Historic “Green Campus(es)”, 2002
Design\textsuperscript{20}, focuses on sustainable design. The Fordham Eco-Roof will be even more successful if Professor Cathcart’s abilities and students are part of the design process.

\textbf{VII. Community Involvement}

There are a number of organizations in New York city that deal with stormwater management and sustainable design. The first organizations I would like to mention is the Bronx River Alliance. This is their stance on stormwater management:

\begin{quote}
We are working to manage storm water infiltration, thereby reducing runoff, combined sewer overflows and pollution affecting the river. The Alliance works collaboratively with Westchester County, the US Army Corps of Engineers and the NYC Department of Environmental Protection on Bronx River watershed planning. In addition, the Alliance continuously monitors the activity of regulatory and infrastructure agencies, and provides comments on rule changes, studies, and other plans that will impact the health of the river.\textsuperscript{21}
\end{quote}

The Bronx River Alliance would help support the Fordham Eco-Roof project, mainly because of the green roof aspect and its benefits. They seek to restore the Bronx River to a more natural state, by reducing the effects of CSOs and non-point source pollution. Green roofing may be something that significantly reduces pollution flow into the Bronx river. The alliance should be aware of Fordham’s Eco-Roof initiative.

Another community group that is important to mention is S.W.I.M. or Storm Water Infrastructure Matter. Their mission:

\begin{quote}
Storm Water Infrastructure Matters is a coalition dedicated to ensuring swimmable waters around New York City through natural, sustainable storm water management practices in our neighborhoods. This approach is environmentally and fiscally responsible because it utilizes storm water, currently viewed as waste, as a resource.\textsuperscript{22}
\end{quote}

\textsuperscript{20} www.kisscathcart.com
\textsuperscript{21} http://www.bronxriver.org/?pg=content&p=aboutus&m1=1&m2=1&m3=17
\textsuperscript{22} http://swimmablenyc.info/?page_id=2
One of SWIM’s initiatives is to implement green roofs as a part of their involvement in GreeNYC, a part of PlaNYC\textsuperscript{23}. SWIM has decided to use GreeNYC, as a platform to build green roof, as green roofs are an infrastructural remedy to stormwater pollution. The Bronx River Alliance, SWIM and GreeNYC are all organizations that would likely participate and endorse the Fordham Eco-Roof project. I will include contact information for all of these organizations in Appendix D.

\textbf{VIII. Fundraising}

The Fordham Eco-Roof is sure to attract some attention. Students could fundraise for the project if funds become an issue. Alumni donations could be allocated to this project, and students could hold fund raising events to raise money for the Project. I have included a publicity flyer for the Fordham Eco-Roof project, appendix E, to show just how marketable this project actually is. Also, community organizations, like the SWIM, may be able to help out in raising funds for a project, especially if they are allowed to be involved. Lastly, the local government, and PlaNYC, may be interested in helping with funding for this project, as it complies with the 2030 greening plan for New York City.

\textbf{IX. Conclusion}

The Fordham Eco-Roof project could help Fordham University, New York City, The Bronx River Alliance, and SWIM achieve set goals for sustainable practices. The Fordham Eco-Roof would exemplify the benefits of green roof in preventing storm water run-off from polluting the Bronx River.

\textsuperscript{23} \url{http://www.nyc.gov/html/planyc2030/html/greenyc/greenyc.shtml}
It will also be an effective demonstration of carbon reduction through use of solar panels and wind turbines. Most of all, it will give Fordham Students hands-on experience with sustainability, something that could be extremely useful in the current economy. This project would benefit many departments within the university, and would surely catch the interests of alumni and other special interest groups. This educational platform would be a great addition to the Fordham community.
## APPENDIX A

### Green Roof Plants

Table 5. Plants Suitable for Green Roofs in Various USDA Zones

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
<th>Height (Inches)</th>
<th>Flower Color</th>
<th>USDA Zone</th>
<th>Bloom Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennaria dioica*</td>
<td>Pink Pussy Toes</td>
<td>3&quot;</td>
<td>Pink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armeria juniperifolia*</td>
<td>Spanish Thrift</td>
<td>2&quot;</td>
<td>Pink</td>
<td>2</td>
<td>June</td>
</tr>
<tr>
<td>Armeria maritima 'Pride of Dusseldorf'*</td>
<td>Common Thrift</td>
<td>5&quot;</td>
<td>Pink</td>
<td>2</td>
<td>April-June</td>
</tr>
<tr>
<td>Aubrieta 'Argenteo-vanegata'</td>
<td>Rock Cress</td>
<td>4&quot;</td>
<td>Purple</td>
<td>4</td>
<td>April-June</td>
</tr>
<tr>
<td>Campanula 'Birch Hybrid'</td>
<td>Bellflower</td>
<td>4&quot;</td>
<td>Blue</td>
<td>4</td>
<td>June-Sept</td>
</tr>
<tr>
<td>Sedum acre 'Aureum'</td>
<td>Golden Stonecrop</td>
<td>3&quot;</td>
<td>Yellow</td>
<td>3</td>
<td>June-August</td>
</tr>
<tr>
<td>Sedum aizoon</td>
<td></td>
<td>4&quot;</td>
<td>Yellow</td>
<td>5</td>
<td>July-August</td>
</tr>
<tr>
<td>Sedum album 'Murale'</td>
<td></td>
<td>1&quot;</td>
<td>White</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sedum cyaneum 'Rose Carpet'</td>
<td></td>
<td>2&quot;</td>
<td>Pink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedum dasyphyllum</td>
<td></td>
<td>3&quot;</td>
<td>White</td>
<td>5</td>
<td>June</td>
</tr>
<tr>
<td>Sedum dasyphyllum 'Blue Cadet'</td>
<td></td>
<td>1.5&quot;</td>
<td>White</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sedum dasyphyllum 'Blue Carpet'</td>
<td></td>
<td>1&quot;</td>
<td>White/Pink</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sedum divergens</td>
<td>Old Man Bones</td>
<td>4-6&quot;</td>
<td>Yellow</td>
<td>5</td>
<td>July-August</td>
</tr>
<tr>
<td>Sedum ewersii</td>
<td>Pink Stonecrop</td>
<td>6&quot;</td>
<td>Rose-Pink</td>
<td>3</td>
<td>Late Summer</td>
</tr>
<tr>
<td>Sedum 'Jelly Bean'</td>
<td>Jellybean Sedum</td>
<td>4&quot;</td>
<td>Yellow</td>
<td>3</td>
<td>June-July</td>
</tr>
<tr>
<td>Sedum kamtschaticum</td>
<td>Russian Stonecrop</td>
<td>6&quot;</td>
<td>Yellow</td>
<td>3</td>
<td>June-July</td>
</tr>
<tr>
<td>Sedum linare 'Variegatum'</td>
<td></td>
<td>5&quot;</td>
<td>Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedum lineare 'Golden Teardrop'</td>
<td></td>
<td>3&quot;</td>
<td>Yellow</td>
<td>3</td>
<td>May-June</td>
</tr>
<tr>
<td>Sedum matrona</td>
<td></td>
<td>24&quot;</td>
<td>Pink</td>
<td>6</td>
<td>Sept</td>
</tr>
<tr>
<td>Sedum 'Mentha Requein'</td>
<td>False artillery fern</td>
<td>2&quot;</td>
<td>Yellow</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sedum pinnifolium 'Blue Spruce'</td>
<td></td>
<td>5&quot;</td>
<td>Yellow</td>
<td>4</td>
<td>June-July</td>
</tr>
<tr>
<td>Sedum reflexum</td>
<td></td>
<td>4&quot;</td>
<td>Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedum sexangulare</td>
<td></td>
<td>4&quot;</td>
<td>Yellow</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sedum spurrum 'Fuldaglut'</td>
<td>Dragon's Blood Sedum</td>
<td>6&quot;</td>
<td>Red</td>
<td>3</td>
<td>Fall</td>
</tr>
<tr>
<td>Sedum spurrum 'Roseum'</td>
<td></td>
<td>6&quot;</td>
<td>Pink</td>
<td>3</td>
<td>Fall</td>
</tr>
<tr>
<td>Sedum spurrum 'Tri-Color'</td>
<td></td>
<td>6&quot;</td>
<td>Pink</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Sedum spurrum 'White Form'</td>
<td></td>
<td>6&quot;</td>
<td>White</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Sedum ternatum 'Larimere Park'</td>
<td></td>
<td>2&quot;</td>
<td>White</td>
<td>3</td>
<td>May-June</td>
</tr>
<tr>
<td>Sedum tetractinum</td>
<td></td>
<td>4&quot;</td>
<td>Yellow</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sedum floriferum 'Weihenstephaner Gold'</td>
<td></td>
<td></td>
<td>Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedum 'Arthur Branch'</td>
<td></td>
<td>18&quot;</td>
<td>Red</td>
<td>4</td>
<td>August-Sept</td>
</tr>
<tr>
<td>Sempervivum arachnoides 'Sparkle'</td>
<td>Spider-web Hen &amp; Chicks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thymus praecox 'Coccineus'</td>
<td>Red Creeping Thyme</td>
<td>1&quot;</td>
<td>Red/Purple</td>
<td>2</td>
<td>July-August</td>
</tr>
<tr>
<td>Thymus praecox 'Effin'</td>
<td>Miniature Thyme</td>
<td>1/2&quot;</td>
<td>Pink</td>
<td>2</td>
<td>July-August</td>
</tr>
<tr>
<td>Thymus praecox 'Pseudolanuginosus'</td>
<td>Woolly Thyme</td>
<td>1&quot;</td>
<td>Pink</td>
<td>2</td>
<td>July-August</td>
</tr>
</tbody>
</table>

Note: Invasive sedum species—such as Sedum sarmentosum, a native of China—should be avoided on green roof applications. Salsola, or ice plant, is also difficult to control on some roofs.

* These require about 4 more of soil.

From: [http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf](http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf) page18
APPENDIX B
Loads for Green Roof Soil Media (for maximum water retention)

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Load per 1-inch Depth (lb/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topsoil with mineral and organic content</td>
<td>8-10</td>
</tr>
<tr>
<td>Mineral substrate with high organic content</td>
<td>5-7</td>
</tr>
<tr>
<td>Mineral substrate with low organic content</td>
<td>5-7</td>
</tr>
<tr>
<td>Expanded clay or slate</td>
<td>3.5-4</td>
</tr>
<tr>
<td>Recycled aggregates (broken bricks)</td>
<td>5-7</td>
</tr>
<tr>
<td>Expanded clay or slate</td>
<td>3.5-4</td>
</tr>
</tbody>
</table>

From: [http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf](http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf) page 15
APPENDIX C

Contact Info

Green Roof Consulting Companies:

Alive Structures
33 Flatbush Ave. 5th Floor
Brooklyn, NY 11217
Phone 917-743-7735
Fax 718-865-0823
E-Mail info@alivestructures.com
http://www.alivestructures.com/

Greener By Design
87 Wolfs Lane
Pelham, NY 10803
Info@GreenerDesigns.com
Phone: (914) 637-9870
Fax: (914) 470-2112
http://www.GreenerDesigns.com

Photovoltaic Solar Panels:

http://www.wholesalesolar.com

http://www.solarhome.org/


http://www.earth4energy.com/solarpanels.php

Wind Turbine:

http://www.ecobusinesslinks.com/vertical_axis_wind_turbines.htm

http://www.urbangreenenergy.com/

Gardening:

Home Depot
2560 Bruckner Blvd
Bronx, NY 10465
(718) 828-1071
http://www.homedepot.com
*Also provide solar panel service
Appendix D
Community Service Contact Info

BRONX RIVER ALLIANCE
ONE BRONX RIVER PARKWAY
BRONX - NY 10462
718.430.4665
718.430.4658
WWW.BRONXRIVER.ORG

S.W.I.M.
swimmablenyc@gmail.com
718.430.4690
swimmablenyc.info

GreeNYC
http://www.nyc.gov/portal/site/nycgov/menuitem.047d873163b300bc6c4451f401c789a0/index.jsp?doc_name=/html/mail/html/appoint.html
Fordham University has taken Major Bloomberg’s plan of greening the city of New York to the next level. Professor John VanBuren, Director of Fordham University’s Environmental Studies Department has helped students launch a sustainable roof project including photovoltaic solar panels, a wind turbine, and a green roof apparatus. This Project brings knowledge of sustainable practices to the Fordham student population as well as the Bronx community. This project shows the benefits of green roofs in reducing stormwater run-off. It also features carbon reducing solar panels and wind turbine. Engineering, pre-architecture, ecology, and environmental policy students at Fordham designed and implemented the roof.

Fordham Eco-Roof

APPENDIX E
Sample Promotional Flyer
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