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Abstract

Queens College students conceived and designed the **St**ormwater **R**eduction **I**ntegrated with a **P**hotovoltaic **E**nergy **S**ystem (StRIPES) initiative, integrating rainwater harvesting and runoff mitigation with an alternative energy source. Up-stream component consists of a 96,100 ft^2 photovoltaic (PV) canopy over a parking deck, producing 1.4 GWh of electricity annually. The canopy captures rainwater to mitigate concrete leaching and efflorescence that are weakening the deck structure and eliminates structural overloading with snow; assures availability of electric power to campus buildings used as emergency shelters during natural disasters; and reduces electricity purchased thereby reducing costs and CO_2 emissions. Runoff from the canopy is directed into vegetated garden terraces, a bioswale and retention pond that includes a permanent pond section and surrounding bioswale that holds runoff from a 10-year rain event and allows it to seep into the ground. The pond, bioswale and terraces are to be developed as a simulated ecotone, a biological catena similar to the surroundings of a woodland pond. Retained water is treated by infiltration and evapotranspiration, thereby helping to reduce the sewage overflow problem for New York City's combined sewer system. StRIPES creates a water-permeable pathway of 900 feet creating a link between the north side of campus and Queens Hall, passing through the new infiltration system, thereby reducing the cross-campus walking distance by half a mile, while providing 5400 ft^2 of permeable surface. The project, designed as a teaching laboratory for environmental science classes, integrates green infrastructure on the QC campus to meet these multiple environmental, educational and economic objectives.

Queens College StRIPES Initiative
Project Narrative

Introduction and Overview

The Queens College **St**ormwater **R**eduction **I**ntegrated with a **P**hotovoltaic **E**nergy **S**ystem (StRIPES) Initiative, illustrated in Fig. 1, is submitted to the EPA Campus RainWorks Challenge as a Demonstration Project. The multiple objectives of the project are to reduce local flooding on campus, reduce runoff water from the campus, and reduce structural damage to a parking facility due to rain and snow while providing a significant source or electric power to the campus. It will also create an outdoor laboratory for teaching, and provide an attractive, multi-use venue for student activities.

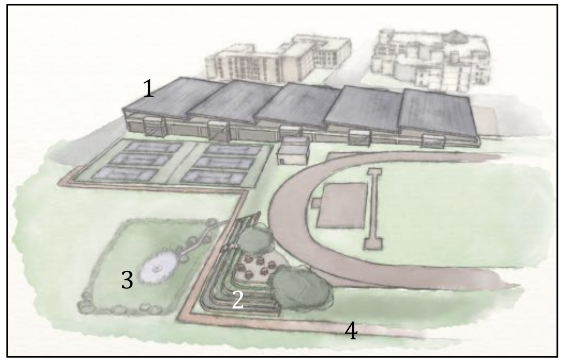

Figure 1. Stormwater Reduction Integrated with a Photovoltaic Energy System (StRIPES) : (1) PV cover over the parking garage from which runoff water is harvested will provide power for pumping irrigation water; (2) vegetated terraces and patio are infiltration areas for runoff water; (3) retention and infiltration area capable of holding runoff from a 10-year rain event; and (4) permeable walkway.

StRIPES integrates a rainwater harvesting and mitigation system on the Queens College campus with a clean energy source, while providing environmental amenities and decreasing electricity costs. It will capture and divert stormwater thus reducing on-campus flooding during heavy rain events. Runoff water will be retained and treated on campus by infiltration and evapotranspiration, thereby helping to reduce the sewage overflow problem for New York City while enhancing groundwater recharge. The retained gray water will be used for irrigating sports fields using pumps powered by the PV system, thus contributing to conservation of both water and energy.

StRIPES also will create a new water-permeable pathway between the north side of campus and Queens Hall, thereby reducing the walking distance by half a mile, while providing 5,400ft^2 of permeable surface contributing to runoff reduction and ground water recharge. The project also is designed as a teaching laboratory for environmental science and biology classes, and it integrates green infrastructure elements to meet multiple goals for water resources while it meets environmental, educational and economic objectives of the college.

The up-stream component of the StRIPES initiative consists of a photovoltaic canopy over a two-story parking garage deck that will produce 1.4 GWh of electricity per year (Fig.1). It will collect rainwater from the 97,100 ft^2 of this canopy and direct it into a vegetated garden, a bioswale and retention pond. The purpose of the photovoltaic (PV) canopy is three-fold: 1) to capture rainwater in order to mitigate concrete leaching and efflorescence that are weakening the parking garage structure, and eliminate structural overloading with snow; 2) to assure availability of electric power to campus buildings used as emergency shelters during natural disasters; and 3) to reduce the amount of electricity purchased from the grid and thereby reducing both long-term costs and CO_2 emissions. Integrating the rainwater capture project with the PV canopy installation will improve the likelihood that both will be accomplished. Both the PV canopy and the water collection and infiltration systems will be built to Leadership in Energy & Environmental Design (LEED) standards.

The StRIPES Initiative is the product of the interdisciplinary, writing-intensive capstone course for students in Environmental Science and Environmental studies, but the StRIPES Team has majors in six different degree programs at Queens: Environmental Studies, Environmental Science, Environmental Engineering, Music Performance and Art Management, and Biology. Professor George Hendrey is the faculty instructor of the project and sponsor of the proposal. The proposal is an abstract of a 353-page report prepared by the class during the Fall semester of 2014 that covers all aspects of StRIPES in great detail. The report will be put up on the StRIPES web page.

Consultation with Queens College Facilities Administration

StRIPES supports the sustainability mission of QC expressed in our Strategic Plan. The QC *10-year Sustainability Plan*, among other things, led to our inclusion by the *Princeton Review Guide to 322 Green Colleges*. The LEED Innovative Design (ID) Credit 3 *The School as a Teaching Tool* recognizes sustainable design integration into a school's educational mission and curriculum.

To assure that the project integrates into the needs and plans of the college the StRIPES team worked closely with Ms. Staci Cohen of the QC Department of Buildings and Grounds, and with her supervisor, Mr. William Keller, Vice President for Finance and Administration, who oversees all campus facilities and budgets. Mr. Keller's letter of support, attached to the proposal, notes that "the likelihood of this project being built is high."

Context of the StRIPES Initiative

Queens College (QC) is a Minority Academic Institutions (AANAPISI) as defined in the rules of the EPA Campus RainWorks Challenge with over 25% of enrolled students identifying as Asian American and Native American Pacific Islanders. QC is one of eleven senior colleges of the City University of New York (CUNY). Approximately 20,000 students are enrolled at QC and 42% of these are in the Division of Mathematics and Natural Sciences. QC is perhaps the most diverse institution of higher education in the nation with students from 120 different countries, speaking 66 different native languages, reflecting the ethnic, racial and cultural richness of the borough of Queens, the most diverse county in the nation.

The QC campus, covering 80 acres, receives 6.67 acre-feet of water for each inch of rainfall. Due to impermeable surfaces on the campus much of this volume runs into the municipal sewer system. Areas adjacent to the parking garage are prone floods due to sewer surging, because the sewer pipes frequently cannot handle the hydraulic load from runoff. The runoff drained to the sewer system is channeled to the city's main combined sewer system off campus and is processed at Tallman Island Wastewater Treatment Plant. During heavy rain events runoff exceeds capacity of the treatment plant and is discharged without treatment into Flushing Creek as a combined sewer

Figure 2. Project site showing parking deck with approximate placement of 5 PV canopies, and the area of the terraces and retention pond.

overflow (CSO).

Existing Conditions

The parking garage consists of a ground floor parking area with a parking deck above. The Parking deck area of 96,100 ft^2 is built of pre-cast concrete sections supported on steel-reinforced columns and is located on the west side of campus adjacent to sports fields (Fig. 2). The structure of the deck cannot support heavy equipment to remove snowfall so the deck is closed during most snow events eliminating over 400 parking spaces. With light snowfall, salt is used on the deck to melt snow and to inhibit freezing. Rainwater and salty water seep through seems between the pre-cast sections causing erosion of the concrete, and dripping of salty water onto the cars below. During heavy rain events, runoff from the garage deck contributes to water backing up in the combined sewer system on campus causing local flooding near the garage.

The area in which the patio, terraces, bioswale and retention pond are to be built is west of the parking area (Fig. 2). The southern portion of the area, with a triangular shape adjacent to the sports track, is elevated by 12 feet above the northern area, which is currently used as a soccer practice field. Both areas are covered with grass, with a few trees on the upper level. The upper triangular section will be developed as a patio with permeable paving blocks. The mature trees here would be retained as part of the project design and three terraces would be constructed along the slope between the terraces and the field.

Green Infrastructure Approach

PV Canopy-- StRIPES proposes to cover the entire upper deck of the Queens College parking garage with a set of Canadian Solar CS6X-305 panels assembled into five linked canopies. The rated power for the five canopies is 1,399 kW DC. These cover an area of 96,100 ft^2 over the deck and are able to withstand 110 mph winds and 20 psf (pounds per square foot) snow load. Snow guards, a water management system and lighting will be installed. The PV canopies are connected to a battery storage system to allow energy generated to be stored for use when the PV power output is low or zero (i.e., nighttime). In addition, power from the batteries may be utilized during peak demand hours when electricity is more expensive, thereby providing energy credit to the campus from ConEd. A storage battery system of 1-2 MW would allow a sufficient amount of energy generated by the PV system to be stored for later use but increasing storage capacity further is an option. The approximate cost of these canopies with snow guards, drainage system and battery backup is $4,895,000. The design meets the LEED Sustainable Sites (SS) Credit 6.1 *Stormwater Design—Quantity Control* through implementation of a stormwater management plan. In addition, the PV canopy will meet LEED SS Credit 7.1 *Heat Island Effect—Nonroof*, which requires that a canopy addition project cover at least 50% of parking spaces for credit recognition.

Runoff Catchment-- The PV canopy of 96,100 ft^2 with a runoff capture system redirects 8,008 ft^3 of runoff water for every inch of rain. Climate data for the area shows a10-year storm recurrence interval rain event of 5.1 inches in 24 hours. This would produce canopy runoff volume of 40,842 ft^3 in a day, or 212 gallons per hour. The PV units will have K-style 0.032mil aluminum guttering along the lower, long edge and these will lead to rectangular aluminum downspouts. These feed into a 6-inch pipe at the level of the upper car deck. The drainage system is scaled to the 10-year rain event and will handle at least 212 gallons per minute. For more extreme events, the design includes an overflow diversion to preexisting underground cisterns located near the garage, with a capacity of 29,348ft^3.

The rain and snowmelt runoff from the canopies is collected and piped to a set of vegetated terraces and a retention pond. From the garage area, drainage is via 6-inch perforated PVC pipe running 265ft underground north of the track (Fig.1) to the terraces to be constructed for this project. A tee pipe will split the flow so that some goes to the terraces and some goes directly to the bioswale and retention pond. Valves on each side of the split flow will allow adjustment to achieve an optimal flow so that the terraces are sufficiently irrigated. The pond includes a permanent pond section and a large, surrounding bioswale that can hold the runoff from a 10-year rain event and allow it to seep into the ground. The pond, bioswale and terraces are to be developed as an ecotone, a biological catena similar to woodland-pond ecotone.

Retention pond-- The infiltration area will be separated into two major parts; a large, vegetated area as the active retention pond/bioswale (hereinafter called the bioswale), within which is a small permanent basin or pond (Fig. 3). The bottom of the pond will be sealed with bentonite to prevent water loss by infiltration (Keese, 2014) and will hold water even during moderately dry periods. The surrounding bioswale area will be the temporary or active part of the retention pond, receiving water rapidly during storms and gradually draining by infiltration into the ground and by evapotranspiration from the vegetation planted within it. The dimensions of the entire retention pond area will be 90 ft by 150 ft, for a surface area of 13,500 ft^2. The top of the pond is intended to be 75ft by 45ft (surface area of 3,375 ft^2), and up to 5 feet deep to accommodate permanent populations of fish and other life in this habitat. The permanent pond volume will be about 10,600ft^3. The bioswale will slope gradually to 5 feet deep at the upper limit of the pond. Total volume of water that the bioswale can retain (not including the volume within the pond) is 42,200 ft^3 of water. A fountain will be installed in the pond to keep the water aerated and to prevent still waters (Powell, 2014). Power captured from solar panels can be used to keep the aerating fountain running.

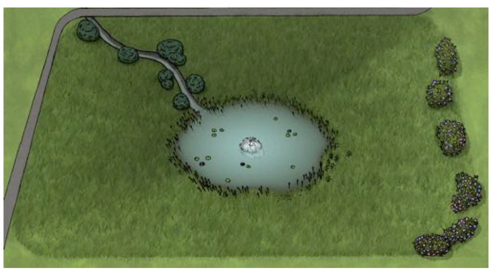

Figure 3 Small permanent pond within the Bioswale.

In the bioswale area a highly permeable soil/sand mix will be used. Compaction will be avoided during the construction phase to maximize seepage through the pond. Plant life with fairly deep roots that can withstand wet/dry changes will be established, maintaining soil stability and preventing erosion (Powell, 2014). Depending on the length of time the bioswale area is flooded, the vegetation will simply merge into the surrounding grass-covered field.

The average pH of rain in our region is 4.0-4.5, ten times more acidic than unpolluted rainwater (DEC, 2014). A surge of low pH water into the retention pond may lead to a decrease in its biodiversity. To avoid this, limestone will be used as a buffer. The limestone could be spread over the pond directly, but the hard structure of the terraces described below, and all drainage channels, are made of limestone block to provide some ability to neutralize rain acidity.

Infiltration-- The soil makeup of the campus is a medium grain, well sorted sandy loam (Ludman, 2014) with saturated hydraulic conductivity of 5.94μm/s (USDA(a)). The soil classification is Foresthills-Montauk, characterized as well drained with some fill (USDA(b), NCSS). The hydrologic classification of the site soil is type B indicating a medium-high permeability rate of 1 inch/hr (USDA(c) 1986.) The approximate infiltration area of the retention pond is the entire area of the bioswale/pond minus area of the permanent pond (which has an impermeable bottom), or about 10,125 ft^2. If the bioswale is completely full and the permeability rate is 1 inch/hr then the maximum groundwater recharge from this pond alone would be 1.7 million gallons per year (227,322 ft^3/yr). This is more than 5 times the volume of water captured from a 10-year storm. In addition, during light rain events, a significant fraction of the runoff water is expected to infiltrate from the perforated pipe, from the drain channels along the terraces and from the walkway.

While we cannot be certain that the bioswale will be drawn down so it can hold the runoff when that 10-year rainstorm occurs, the idea of an infiltration system at this site appears to be entirely feasible. A drain at the high-water line of the bioswale will conduct overflow to the underground tanks near the tennis courts, which can be used as a backup retention system (Cohen (a), 2014). With an active volume of 42,187 ft^3 in the bioswale and the added 29,348 ft^3 of storage from these tanks we should be able to capture 100% of the ten year storm volume of 40,842 ft^3 of runoff from the PV canopy, even if the bioswale is partly full. Gray water can be pumped from the retention pond and tanks, using power from the PV system, for irrigation of the sports fields, contributing to conservation of the municipal water supply. This qualifies for LEED SS Credit 6.2 *Stormwater Design—Quality Control* as it captures 90% of runoff from the catchment.

Landscape Modification

Terraces-- The hill separating the upper and lower areas (Fig.1) has a rise of 12ft and a run of 24 to 30 feet. It will be graded to form 3 terraces, each 8ft wide, 3 feet high (Fig.4). Terrace retaining walls are made of of limestone bricks. The slope dividing the lower and upper fields wraps around the right angle of the triangular shaped plot above (Fig.5), so the terraces will be of different lengths, respectively: 220ft, 205ft, 190 t and 175ft. The uppermost terrace wall is higher by 30 inches than the others to serve as a bench next to the patio. In the center of the terraces there will be a staircase to allow access by students to the path between the north and west sides of the campus, and for maintenance of the area.

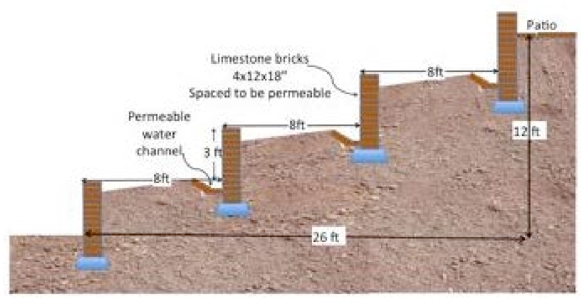

Figure 4. StRIPES terrace profile

Runoff water from the PV canopy is piped underground to the south-west end of the upper terrace where it enters an open channel lined with limestone bricks spaced to allow seepage, but not wide enough for significant erosion to occur. Water courses across the terrace to a pipe in the east end of the channel that carries the water to a similar ditch on the east end of the middle terrace. Water then flows in the middle terrace channel to the SW end and by pipe into the channel of the lower terrace, thence to the east end of the lower terrace. From there it is piped into the stream/bioswale.


Figure 5 Pond, Bioswale and terraces simulate a forest-edge ecotone.

Blueberry bushes will be planted along the sides of the stream forming a sort of hedge, and limestone rocks fill in the center ditch. In this way the terraces are irrigated and some of the runoff water infiltrates into the ground. Each terrace will be planted with a different type of vegetation to simulate an ecotone design contiguous with the bioswale and pond. On the bottom step closest to the pond, there will be upland vegetation, which will include Violets, Black Eyed Susans, grasses and shrubs. On the second step from the bottom, there will be an additional Upland vegetation layer, which will include Elderberry and Viburnum (leatherleaf) shrubs. On the third terrace there will be vegetation similar to the edge of local woodlands, which will include Rhododendrons and River Birch trees. Total planted area of the terraces will be 4,696 ft^2 excluding the 144 ft^2 of the staircase. The slope will be graded to fit these new dimensions

Terrace maintenance--After the terraces are constructed and planted, the soil will require mulching wherever necessary. Workers will be instructed to avoid compaction of the soil, and that may require hand harrowing. Straw mulch will be used to help avoid erosion of the loose soil from the terraces and to help retain water for most plants. The topsoil layer necessary for all of these steps will have to be 6 inches in depth or more. The topsoil layer will also have to be tilled and raked in order to decompact and aerate the soil so that the new vegetation may have the proper conditions for growth. The maintenance plan will include installing goose fencing around the new plants to prevent animals from eating them, setting up an auxiliary irrigation system to water the newly-planted vegetation, mowing the grass and weeding, and periodically removing plants that have been affected by windthrow, disease, and other destructive forces. These terraces fulfill LEED SS Credit 5.1 *Site Development—Protect or Restore Habitat*. and LEED SS Credit 5.2 *Site Development—Maximize Open Space*, which recognizes projects that promote biodiversity.

Patio-- The patio above the terraces will feature permeable bricks, to promote percolation of rainwater into the ground below and alumni will be able to purchase and dedicate bricks. The patio will also feature tables with attached umbrellas supporting PV panels. These will provide energy to charging stations to allow students and faculty to enjoy the outdoor seating area while working on electronic. EnerFusion Inc. has a Solar Power-Dok table and umbrella system that Queens College has installed elsewhere on campus. These have three 45 W and one 100 W solar panels, for a total of 235 W. The tables have four surge protected outlets and 4 USB ports, as well as a button to turn on an LED light system that has a timing system to conserve energy (EnerFusion Inc., 2014).

Infiltration Area Vegetation Plan

The infiltration area encompasses 18,252 ft^2 of vegetated surface, including the retention pond, bioswale and the part of the stream that is in this area. This will be planted with a variety of species; e.g., cattails, marsh marigolds, hydrangeas, and swamp milkweed, as appropriate to the wetness of the soil (see also Table 2). Animals that inhabit the area now, include organisms in the soil such worms, various protozoans, and nematodes and animals that live above the ground such as bees, squirrels, birds (including blue jays, robins, and pigeons), Canadian geese that often migrate to the area, Italian wall lizards, crickets, and the occasional raccoons.

Table 2 Bioswale Vegetation

Common Name	Scientific Name
Broadleaf cattail	*Typha latifolia*
Common arrowhead	*Sagittaria*
Quill-Leaf	*Sagittaria teres*
Rice Cutgrass	*Leersia oryzoides*
Hop sedge	*Carex lupulina*
Bulrush	*Scirpus atrovirens*

Spatterdock is an essential food source and housing ground for many amphibian like the Northern Cricket

Frog and Eastern (Red-Spotted) Newt (NYSDEC (a), 2007). On the other hand, Waterweed has a high capacity for pollutant removal of heavy metal absorption, particularly Cu, Mn and Cr (NNHP, 2014). Additionally, waterweed is an exceptional water oxygenator, which will continually sustain microbial activity and significantly reduce the build-up of dead matter at the bottom of the pond. Encompassing the Endangered Species Act (ESA), the pond will serve as a reserve and breeding ground starting with at least 10 different native species of terrestrial and aquatic organisms that are considered threatened or endangered according to the Department of Environmental Conservation (DEC, 2014). Endangered organisms like fibrous bladderwort (*Utricularia striata*) and chittenango ovate amber snail (*Novisuccinea chittenangoensis*) are ecologically important. Fibrous bladderwort for instance acts as housing and reproductive grounds for euglena and diatoms. An initial assessment will be conducted within the inaugural year of the pond completion to evaluate the characteristics and quantity of species that survived.

Table 3 Retention Pond Biota.

Common Name	Scientific Name
Chara, Muskgrass	*Chara spp*
Nupha lutea	*Nupha lutea*
White Water lily	*Nymphaea*
Canadian Waterweed	*Eleodea Canadensis*
Fibrous Bladderwort	*Utricularia striata*
Northern Cricket Frog	*Acris crepitans*
Easter (Red-Spotted) Newt	*Notophthalmus viridescens*
Eastern Tiger Salamander	*Ambystoma tigrinum*
Chittenango Ovate Amber Snail	*Novisuccinea chittenangoensis*
Mosquito fish	*Gambusia affinis*
Common carp	*Cyprinus carpio*

Integration of PV Energy

With the addition of a photovoltaic canopies, Queens College would generate 1,4200 MWh/year of clean energy (Leyden, 2014), decreasing the Queens College "carbon footprint" by 827 tons of CO_2 per year. In terms of the entire campus, the photovoltaic canopy would account for 2.03% of campus electricity demand, but 100% of Fitzgerald Gym's energy consumption in a year (Cohen, 2014). Based on the overall campus electric bill, this would save the college $156,300 each year (Cohen, 2014). At the system cost of $4,895,000, the Return on Investment would be 32 years (Cohen, 2014). The LEED Energy and Atmosphere (EA) Credit 2 *On-Site Renewable Energy* recognizes projects that minimize non-renewable energy consumption through renewable energy production.

On our campus, Fitzgerald Gymnasium is used as an evacuation center for natural disasters. During Hurricane Sandy, Fitzgerald Gym housed some 600 evacuees. Additionally, the residence hall on the Queens College campus houses about 500 students and faculty. As a result of the hurricane, about 90% of Long Island lost power for anywhere from 30 hours to 18 days (Senner and Fthenakis, 2014). Power was lost to the gym during this period, and fuel for diesel generators was in short supply. In the event of another natural disaster, Queens College would be even more prepared with a photovoltaic source of energy for Fitzgerald Gymnasium.

The PV canopy will supply power to twenty General Electric Charging Stations within the parking structures. This installation will promote the use of electric cars on campus, and also benefit those who already drive electric cars. This could also motivate Queens College to utilize more electric vehicles for day-to-day travel around the campus. This would qualify for the LEED SS Credit 4.3 *Alternative Transportation—Low-emitting and Fuel-Efficient Vehicles*, provided that charging stations account for 5% of total parking capacity on that upper deck. We have approximately 380 parking spots on that top deck, so this meets the 5% standard.

Collected rainwater can be used for non-potable uses such as irrigation to the surrounding practice fields, with electric power from the PV canopy driving the pumps to move water from the cisterns and from the pond. The revegetation of the area will act to control erosion. The retention pond itself provides ecological benefits and also incorporates an aesthetic component to the surrounding area. The pond will provide a habitat for native organisms and increase biodiversity. Emergent vegetation is great at slowing runoff and allows suspended solids, sediments, and debris to get blocked in the vegetation before it even reaches the pond.

StRIPES will create an alternate path of just 900 feet in length but providing a link from the north and east sides of the main campus to Queens Hall, located over half a mile away (Fig. 1). The path will reduce the walking time by half from the gym, dorm, dining hall and music complex, to Queens Hall. The $5400ft^2$ of materials used in the path will be permeable and allow water to percolate through to the underlying soil while adhering to ADA requirements.

Education

StRIPES is designed as an outdoor education site for QC and the surrounding educational community. Not only would StRIPES serve as an outdoor classroom but its partnership with various citizen-science endeavors would allow for data about the site to be studied remotely off-site as well. A website is currently in preparation for this purpose.[1] Since our design incorporates varied elements there is educational value for many academic departments of QC. Furthermore, four schools border our campus: Townsend Harris High School, John Bowne High School, P.S. 219 and P.S./I.S. 499. StRIPES would give these neighboring educational communities an incentive to visit the QC campus as well as a place to learn about the environment.

Lab Exercise at the Pond

A method for monitoring the pH of the retention pond is to plant pH sensitive flowers near the retention pond, such as hydrangea and violet. Hydrangea changes color in the early flowering period based on the pH of the soil. The color of the hydrangea blooms in basic condition will becomes pinker and in acidic condition the color will become bluer (Williams, 2014).

Another option would be for the schools to participate in the citizen-science program offered by The GLOBE Program. GLOBE is a K-12 program to improve science education by involving students and their teachers in research examining long-term global change. GLOBE provides training for K-12 teachers in how to provide authentic, inquiry-based science education for their students in five areas: atmosphere, water, soil, land cover, and phenology. New York Metro GLOBE Program, managed by QC School of Earth and Environmental Sciences (SEES) and provides training of middle-school and high school teachers in curricula using the GLOBE framework of environmental observations. The Director of the New York Metro GLOBE Program will develop teaching modules using StRIPES facilities.

Combining passive education in the form of interpretive signs along with outdoor education conducted by teachers will make StRIPES a model of successful open-air learning. Signage elucidates the history of a site without much effort on the part of the visitor. So the visitor is thus educated passively, without the need for an instructor or further research. While each component of StRIPES has a very different function they all work together to accomplish an important task: to manage rainwater sustainably. This, and the EPA Campus RainWorks Challenge that inspired our design, would be discussed in the StRIPES *Welcome* display. A map of the Queens College

[1] http://elissajo93.wix.com/qcstripesinitiative.

campus with each StRIPES component would also be included. Other interpretive signs would be placed around the sites, from the PV canopy to bioswale. There would be a path linking all the interpretive signs, so that a visitor could essentially walk a self-guided tour.

Funding Plan

QC StRIPES initiative will cost ~$5.5 million to build with additional maintenance costs. This includes costs of the PV canopy, the water harvesting and pumping system, the retention pond (revegetation, signage, terraces, lighting, etc.), and costs for environmental risk assessment and maintenance. To finance such a massive venture various resources will be pursued. Several grants may work for SRIPES at city-, state-, and federal-levels. Examples in NY include the NYC Department of Environmental Protection Agency's (NYC-DEP, 2014) Green Infrastructure Grant Program, which QC won in 2012; NY State's Environmental Facilities Corporation (EFC, 2014) offers the Green Innovation Grant Program which has generously supported several QC projects over the last 5 years, providing over $92 million in grants and leveraging over $162 million in funding from other sources. StRIPES Initiative has strong potential for success due to its multi-faceted approach to making the campus environmentally conscious and sustainable.

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