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VOLUME 20 / ISSUE 1 / SPRING 2018

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ISSUE 1
SPRING 2018

INSIDE

On the cover: Development mad Toronto seeks to create core green space for its densely populated downtown by covering the rail lines and implementing a multifunctional 21 acre green roof park at an estimated projected cost of $1.6 billion. See Transformative Power article pages 16-19. Image Courtesy of Public Work for the City of Toronto - TO core.

LIVING ARCHITECTURE MONITOR

VOLUME 20 / ISSUE 1 / SPRING 2018

LIVING ARCHITECTURE MONITOR IS PUBLISHED FOUR TIMES PER YEAR IN PRINT AND DIGITAL BY GREEN ROOFS FOR HEALTHY CITIES (GREENROOFS.ORG)

MISSION

Green Roofs for Healthy Cities' mission is to develop and protect the market by increasing the awareness of the economic, social and environmental benefits of greenroofs, green walls, and other forms of living architecturet hrough education, advocacy, professional development and celebrations of excellence.

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STORMWATER MANAGEMENT
IS IT THE KEY TO GREENER, MORE RESILIENT AND HEALTHIER CITIES?

Imagine a city virtually devoid of plants - just steel, glass, asphalt and concrete. Would you want to live there? Probably not! Now imagine a city where plants are everywhere – on the ground, on the walls, and atop our buildings. Would you want to live there? The odds are that not only you would, but that you'd be willing to pay more to live in such a community.

Regulations requiring stormwater management are fueling renewed efforts to invest in green infrastructure on public and private property. As more jurisdictions look to manage stormwater by using green infrastructure technologies, the demand for urban forests, bioswales, green roofs and walls and other supportive technologies grows.

Stormwater is a serious challenge with annual discharges of more than 10 trillion gallons. Stormwater contributes to flooding, combined sewer overflows, erosion and impairment of water quality. Just look at the streets and think about the poisonous concoction of salt, brake lining residue, silt, rubber, pesticides, and animal feces which is urban stormwater – then add raw sewage to the mix and presto - you've got combined sewer overflow. When it rains, or the snow melts, this highly contaminated liquid discharges into our lakes, rivers, streams and estuaries, or perhaps, a large multi-billion dollar holding tank only to be discharged later. There is no 'away' for stormwater! Our growing awareness that our use of plastic micro beads wash back into our food chain and ultimately into our bodies demonstrates clearly that there is no 'away'.

Reducing stormwater substantially through onsite capture, retention and treatment, can't solve the plastic issue, but does go a long way to addressing many of these problems. Moreover, when we address stormwater management by investing in green infrastructure solutions, we are also able to address other pressing issues in our communities, such as the urban heat island effect which contributes to air quality pollution, the need for employment, access to food, and the unhealthy lack of green space. Taxpayers can get far more bang for their public buck by investing in widespread green infrastructure implementation than huge holding tanks to capture stormwater or new power plants for air conditioners to fight the worsening urban heat island effect.

In many cases, green infrastructure can also deliver value by offsetting or right sizing the use of grey infrastructure. As the case study of a modular green roof in Denver in this issue illustrates, space used for a large cistern in the basement can't be rented as parking space and that lost revenue adds up. The multiple benefits of large green space are brought to light in an article by Emma Tamlin, Assistant Editor, on mega projects in Chicago, San Francisco and a proposed Rail Deck Park in Toronto pictured on the cover. These projects demonstrate tangible environmental benefits, and their social and artistic amenities also fuel nearby development projects. Chicago's Millennium Park has even become the primary tourist attraction with its mix of green space, iconic sculptures, gardens, fountains and architecture.

The capture and reuse of stormwater is also a viable strategy in many projects, even for irrigating green walls, as the article on Whole Foods in Chicago by Amber Ponce illustrates. The beneficial harvesting of water also extends to Quebec's latest rooftop farm, as reported by Joyce McLean, our Associate Editor. This innovative rooftop farm manages stormwater and generates both profits and happy customers. The fine act of designing stormwater retention with the need for supplemental irrigation is explored by Dr. Brad Rowe. He reveals some of the pros and cons of the interrelationship between plants, assemblies and irrigation methods.

Policy is also about stormwater regulation, and our On the Roof With discussion piece features some tough questions about the trends in civil engineering practice and green infrastructure. Elizabeth Fassman Beck of Stevens Institute of Technology and Mike Hardin of Geosyntec share their insights on stormwater civil engineering practice.

The new Living Architecture Performance Tool, explains Rohan Lilauwala, provides policy makers with a vehicle to connect regulations and incentives directly to green roofs and walls. The 110 credit system, based very much on LEED and SITES, provides a much needed performance framework for the industry. We are looking for policy makers and organizations to lead by piloting Version 1.0 of the Living Architecture Performance Tool in the next few years. This will help us fine tune the system and drive demand for better performing green roofs and walls. If you are interested in learning more about how the LAPT certification can help, please connect with us.

As we enter the spring thaw, give some thought to where the stormwater is going and help redirect it toward green infrastructure projects that can deliver multiple benefits in our communities. We really can design and build the kind of cities that we want to live in, for ourselves, our families and our communities.

Sincerely yours,

Steven W. Peck,
GRP, Honorary ASLA
Founder and President

LIVING ARCHITECTURE
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Jennifer Bousselot responded correctly stating the problem and solution from the last Living Architecture Doctor question: "We noted microclimatic issues on the roof in a few areas just like this - mostly under highly reflective glass and metal siding that faced south and west. The reflected light/heat off those surfaces increased evapotranspiration to a point where the plants became very stressed, even with irrigation. The wintertime is challenging as well because our high daytime temperatures in Denver, with the added heat from reflective surfaces, sometimes trigger plants to come out of dormancy. Then at night it freezes again, damaging the plants. The solution is to provide supplemental water, even during dry periods over the winter.

THE LIVING ARCHITECTURE PERFORMANCE TOOL
THE GREEN INFRASTRUCTURE FOUNDATION

The Green Infrastructure Foundation has released the Living Architecture Performance Tool (LAPT), a revolutionary new performance framework and rating system that can be used by designers, owners, policy makers, and manufacturers to promote better green roof and wall performance. The Green Infrastructure Foundation is inviting firms to participate in pilot projects for the first version of the LAPT and policy makers to incorporate the tool into their work. For more, visit greeninfrastructurefoundation.org/lapt

NEW STORMWATER TREATMENT TRAIN ANALYTICAL TOOL RELEASED

On February 15, 2018 the Toronto and Region Conservation Authority (TRCA) released a new tool for stormwater management planning and design practices called the LID Treatment Train Tool. The purpose of the tool is to analyze whether sustainable stormwater management goals can be achieved by low impact design practices. The tool can compare pre and post development hydrology and pollutant scenarios using annual and event based scenarios. The tool was building on the EPA SWMM5 model and is open source. It was developed through the STEP program, a collaboration between Lake Simcoe Region Conservation Authority, Credit Valley Conservation Authority and the TRCA. To download a copy of the tool go to: https:/sustainabletechnologies.ca/low-impact-development-treatment-train-tool/.

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GRP ACCREDITATION GAINING MORE RECOGNITION AMONG POLICY MAKERS – NEW ONLINE EXAM

BY TESSA SOLTENDIECK

In 2009, Green Roofs for Healthy Cities (GRHC) launched the Green Roof Professional (GRP) Accreditation program in an effort to bridge the knowledge gap in industry training and best practice.

Before this time, no traditional discipline or training contained all the competencies necessary for success - from building science, horticulture, irrigation, waterproofing, plant physiology, to maintenance. Prior to the GRP training program, there were no best practices to help avoid established common mistakes. Since 2009, over 5,000 professionals have taken training courses and more than 750 have successfully completed the multi-disciplinary GRP exam and earned the accredited GRP designation.

The General Service Authority (GSA) has mandated a similar policy, requiring that one contractor on any given project hold green roof training as part of landscape solicitation requirements. The GRP training and accreditation meets that requirement.

The Green Infrastructure Foundation (GIF) recently launched the Living Architecture Performance Tool (LAPT), which is a performance criteria and metric for all major types of living architecture. The program's mission centers on helping projects achieve greater performance benefits. The LAPT recognizes the contribution of GRP Accreditation to overall project quality by awarding credits to projects utilizing GRP accredited staff.

"THE GRP ACCREDITATION EXAM WILL BE AVAILABLE ONLINE FOR THIS FIRST TIME THIS SPRING..." - TESSA SOLTENDIECK

GRP Accreditation continues to gain recognition in jurisdictions as each develops supportive policies and programs to promote green roof implementation. Policy makers increasingly acknowledge that GRP Accreditation offers some measure of protection against sub-standard practices, often the result of inexperience in the field. The GRP Accreditation, combined with several years of field experience provides a strong indication that these team members have acquired the knowledge to successfully execute projects.

In November 2017, the citizens of Denver voted in favor of a new law requiring the construction of green roofs and/or solar installations on most new and existing buildings to combat the urban heat island effect and reduce greenhouse gas emissions. As a result, the Denver Community and Planning Department now requires professionals working with green roof systems to have 2-years of total field experience. The Department has recognized the quality of the GRP Training and Accreditation program by allowing it to count towards one year of the total field experience. Denver is in the process of fine tuning the technical components of the new green roof ballot initiative and is looking to ensure that projects are properly executed.

While the GRP Accreditation program is well-embedded within the green infrastructure industry, GRHC is committed to increasing the accessibility and affordability of the training and designation. In the Spring of 2018 the GRP Training program will migrate to the Living Architecture Academy, GRHC's new online education platform. In addition to the existing course set, GRHC will release a series of new online training topics, including Advanced Green Roof Maintenance, Biophilic Design, and Urban Rooftop Agriculture. The GRP Accreditation exam be available online for the first time this Spring, ensuring that accreditation is available to trainees unable to attend in-person examinations thus lowering the cost by more than half to USD$249.

For more information about training please visit www.greenroofs.org. Tessa Soltendieck is the Professional Education Coordinator for Green Roofs for Healthy Cities. tsoltendieck@greenroofs.org

ON THE ROOF WITH... ELIZABETH FASSMAN-BECK, PHD., STEVENS INSTITUTE OF TECHNOLOGY AND MIKE HARDIN, PHD., PE, CFM, WATER RESOURCES ENGINEER FOR GEOSYNTEC CONSULTANTS

INTERVIEW BY STEVEN W. PECK, GRP, HONORARY ASLA

Civil engineers who work in the field of stormwater management are facing considerable challenges, from regulatory agencies who are adopting green infrastructure approaches to extreme weather events that are challenging baseline assumptions.

This winter, I caught up with Elizabeth Fassman Beck, who teaches at Stevens Institute of Technology in Hoboken, NJ and is the Chair of the Environment & Water Resources Institute, Urban Water Resources Research Committee's Green Roof Task Committee and Mike Hardin, of Geosyntec to ask some tough questions about the practice.

1. *In your opinion, how has civil engineering practice around stormwater management changed over the past ten years?*

EFB: Stormwater infrastructure design objectives are usually dictated by regulation. Historically, regulatory compliance has been met with large, centralized facilities designed to reduce flooding, stream erosion (theoretically), and property damage from reasonably larger, infrequent events, and to provide water quality treatment (removal) of particulate-bound pollutants.

By now, we know that designing stormwater systems to address only these objectives falls very short of protecting our receiving environments and communities. Using technologies like stormwater green infrastructure (GI), and overall approaches like low impact development (LID), we should be minimizing runoff generation, trying to keep runoff and pollutants out of the sewers with small scale controls at or near the sources, and incorporating methods to minimize discharge of a wide range of pollutant forms. Maximizing natural hydrologic processes like infiltration and evapotranspiration and promoting stormwater harvesting and reuse are essential elements. Designing these functions to handle flows from smaller, day-to-day size storm events is critical.

Where we see wide-scale implementation of these ideas is where regulation has changed. Unfortunately, regulation remains the driver, and change is the exception rather than the rule. We have the technology. We need policies to catch up and enable advancement.

MH: In regard to stormwater management, I think there are still plenty of traditional grey infrastructure projects, but I am seeing more green infrastructure projects, specifically, water quality improvement projects to remove nutrients from stormwater driven by total maximum daily loads (TMDLs), and NPDES permit requirements. More recently, the areas of resiliency and sea level rise have been given a lot of attention, especially for coastal communities. This is resulting in more modeling of extreme storm events and municipalities looking to make their stormwater infrastructure more robust and resistant to the effects of weather changes and sea level rise.

2. We keep reading about extreme weather events all over the world? How, if at all, is the profession dealing with the 'new normal' in terms of weather and climate?

EFB: In my opinion, dealing with extreme weather events is still predominantly addressed in a reactionary way. Looking forward, design resilience and redundancy is the key.

MH: Being from Florida, this is very much a reality for the engineering community. I am starting to see more municipalities looking at long-term modeling and planning projects that assess the current state of drainage infrastructure and examine the resiliency based on different climate projections. Additionally, municipalities are looking to model more extreme storm events in their floodplain modeling to understand the potential impacts of a changing climate. This information is used to prioritize infrastructure upgrades in watershed wide planning.

3. *Green infrastructure is increasingly being recognized as a complementary approach to addressing stormwater issues on new and existing buildings and sites. How well are civil engineers adapting to these changes?*
EFB: Civil Engineers (CE) that have opportunities to learn how different GI technologies work tend to be very receptive! Among the challenges we face in broader scale adoption include:

- Implementation of nearly all stormwater management projects is driven by regulation and/or development policy. In many cases, regulations and policy have not kept pace with research or practical observation. In some cases, existing policies actually hinder adoption of GI solutions.
- In the bigger picture of infrastructure, GI is very new. There is a strong need for technical training of the existing design and construction industry. However, without clients or regulatory services demanding GI, there is little incentive to allocate resources to new training.
- Stormwater design integrates knowledge from several different topics within Civil Engineering. From a curriculum perspective, CE courses in stormwater design are most likely offered at the graduate level. Undergraduate curricula in CE are strongly dictated by accreditation, which means that many undergraduates simply don't get the opportunity to enroll, if there is even a course offered.

MH: Based on my experiences, I think civil engineers are adapting and supporting green infrastructure (GI). Typically, local building codes are the biggest impediment to more wide-spread use. I have seen some municipalities go as far as rewriting their building codes to remove impediments to GI as well as incentivize the use of GI by allowing designers to take credit for green space requirements, as an example. I believe the GI will continue to gain in popularity, particularly in urban areas where space is limited, and cost of land prohibits building large stormwater ponds or other large footprint BMPs.

4. *Engineering is very liability sensitive. Are there some types of green infrastructure that are currently better accepted by civil engineers than others, and if so why?*
EFB: To some extent I think preference is given to some GI techniques over others based on perceptions of construction and maintenance costs. I use the word perception specifically. For example, self-mitigating runoff controls like permeable pavement and green roofs do cost more to build compared to a conventional pavement or rooftop – if all you're considering is the cost of the road or the roof. This kind of silo-accounting omits the cost of building an otherwise required downstream stormwater control that occupies more land, needs catch basins and buried pipes to convey runoff to it … and all of that infrastructure also requires long-term maintenance. Dismissal of permeable pavement because of maintenance perceptions suggest poor understanding of appropriate site selection. Likewise, excellent stormwater control in many climates can be

Dr. Elizabeth Fassman-Beck is an Associate Professor of Civil Engineering at Stevens Institute of Technology in New Jersey. Her research on stormwater green infrastructure design seeks to optimize each technology's ability to reduce runoff hydrology and improve water quality.

Geosyntec is a specialized consulting and engineering firm that works with private and public sector clients to address new ventures and complex problems involving our environment, natural resources, and civil infrastructure. Geosyntec delivers solutions with a combined staff exceeding 1,200 engineers, scientists, and related technical and project support personnel from more than 80 offices in the US and world wide.

"I BELIEVE THE GI WILL CONTINUE TO GAIN IN POPULARITY, PARTICULARLY IN URBAN AREAS WHERE SPACE IS LIMITED, AND COST OF LAND PROHIBITS BUILDING LARGE STORMWATER PONDS OR OTHER LARGE FOOTPRINT BMPS."

- MIKE HARDIN

achieved with shallow-depth, reasonably low weight green roofs if materials and plants are appropriately specified.

MH: I think rain gardens and bio-swales are the most accepted GI. They are relatively low risk and low cost. The maintenance of these systems is well understood by the engineering community and easy to relate to municipal or regulatory enforcement personnel. It should also be noted that municipalities struggle with ensuring that the final property owner performs the necessary maintenance to keep GI performing properly, making them more likely to encourage simpler systems that they are more familiar with in case they need to provide some training to get the GI operating properly.

5. *What are the pros and cons, from your perspective, of using green roofs to meet stormwater management requirements?*

EFB: The primary advantage of a green roof is that it is a self-mitigating surface with respect to stormwater. Green roofs prevent runoff generation, or minimize it to a trickle, for the majority of day-to-day storm events. They can be effective even in winter, with dormant plants. If there is no runoff, there is no problem. Among all other stormwater management tools, green roofs offer more ancilliary benefits. Where designed appropriately, we can provide amenity space, habitat, and reduce energy demand at the site-scale.

MH: There are several pros but the big one is turning a stormwater generator into a stormwater sink. Implementation of green roofs allows for more developable or revenue generating land or minimizing the amount of land needed to meet stormwater management requirements. This is especially true if a cistern or other water storage is used in conjunction with green roofs to capture and reuse green roof runoff, which frequently results in a significant water quality benefit due to the significant volume reductions. The biggest cons are the initial cost of green roofs, building code impediments, and lack of an in-depth understanding of the technology in the general engineering community.

6. *There are some green roof configurations that are more like blue/green roofs, designed to retain more water than typical systems? What do you think are the most promising new approaches to building-based stormwater management?*

EFB: On-site runoff management provides the most technically effective opportunities for minimizing stormwater impacts to the environment and infrastructure.

MH: I think that blue/green roof projects that incorporate stormwater and grey water capture and reuse are the most fascinating and promising approaches to whole building water management. As fresh water supplies continue to be stressed, designs will more and more need to manage water in a more holistic fashion to preserve supplies. I see blue/green roofs, stormwater harvesting, and grey water reuse as being integral to this process.

7. *Which models are best able to address the contribution green roofs make to stormwater management and why?*

EFB: Stormwater regulations carry quantitative objectives. Civil engineers must be able to calculate runoff quantities and quality under a variety of scenarios. Of utmost importance is to accurately quantify the effect of a green roof, and to be able to integrate that

calculation into the context of the whole site (i.e. not just the building footprint), or possibly a whole catchment or sewershed.

Flow processes through an engineered green roof (and many other green infrastructure systems) are very complicated. Unfortunately, current design guidance offered by many regulatory agencies either neglects calculation instruction altogether, or offers very simplified approaches which are akin to a bucket filling up and emptying or overflowing. This approach neglects the dynamic operation of a green roof, and tends to underestimate performance.

The US Environmental Protection Agency's Stormwater Management Model (SWMM), is the only model of which I am aware that specifically incorporates calculation routines that might accurately represent green infrastructure technologies. I say "might" because its accuracy hasn't been widely tested (yet) against observed data. SWMM can be applied at any scale – from a single building to an entire watershed. SWMM also offers the benefit of being an open-source, publicly available model. We're working on generating field performance data that can evaluate SWMM's accuracy for a variety of green infrastructure technologies.

MH: Green roofs in Florida typically require irrigation during the dry season. Additionally, to provide a water quality benefit, it may be necessary to capture and reuse green roof runoff. For this reason, when designing green roofs in Florida, it is recommended to provide some water storage to capture this runoff. To effectively size the cistern a long term, 10 years or greater of precipitation data, continuous simulation model is recommended. There are many software programs available to perform this modeling such as EPA SWMM, ICPR, or even using Microsoft Excel.

8. *Are you aware of any developments coming down the pipe that will either strengthen or weaken the use of green infrastructure, and if so what are they?*

EFB: At the moment, major investments in green infrastructure are occurring across the USA in order to comply with regulations, and avoid potential massive environmental fines, by reducing the frequency and volume of combined sewer overflows (CSOs). In cities like New York and Philadelphia, investments are anticipated at over US$1B. This isn't a problem unique to large cities though. The US EPA indicates that most communities with CSO problems have fewer than 10,000 people. Widespread stormwater GI implementation has been shown to be a critical contributor to technically achieving the required level of runoff mitigation.

MH: I would say resiliency and sea-level rise might be an ally to the green roof industry. This is because green roofs can reduce runoff at a given site without additional footprint. In a future where stormwater attenuation and storage will be harder to find, green roofs might offer a solution in space limited urban areas.

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THE EFFECT OF IRRIGATION ON STORMWATER MANAGEMENT

BY DR. BRADLEY ROWE, MICHIGAN STATE UNIVERSITY, EAST LANSING

The ability of a green roof to retain stormwater depends on many factors including plant species, substrate depth and composition, and the pre-existing moisture present before a given rain event. All of these factors can be influenced by irrigation practices which in turn may have a positive or negative influence on a green roofs ability to retain stormwater.

Plant species can influence stormwater retention. Plant photosynthetic metabolism has a major effect on transpiration (see my 2016 discussion comparing C3, C4, and CAM plants, Living Architecture Monitor 18(1):24-29). In addition, those plants with more biomass have a greater ability to intercept rainwater with their foliage and allow it to evaporate before reaching the substrate surface. Nagase and Dunnett (2012, Landscape and Urban Planning 104:356-363) showed that plant types such as forbs and grasses that possessed greater shoot and root biomass were more effective in reducing water runoff than those with less biomass such as sedum.

Tied to plant species is substrate depth and composition. Deeper substrates are able to hold more water and therefore are able to support plants with greater biomass. Changes in composition can also influence water holding capacity and capillary movement. As aerated pore space decreases, water holding capacity increases and vice versa.

In addition, pre-existing substrate moisture present before a given rain event is a major factor. To achieve maximum stormwater retention we want the roof to be dried out before each rain event. However, a minimum moisture level must be maintained if one wishes to keep alive the herbaceous perennials and grasses that possess this greater biomass. Because of their higher transpiration rates many of these plants may die during periods of drought. In addition, in some cases a shallower depth supporting sedum may actually be able to hold more rainwater since this shallow depth may be completely dry, whereas a deeper depth may still contain pre-existing moisture.

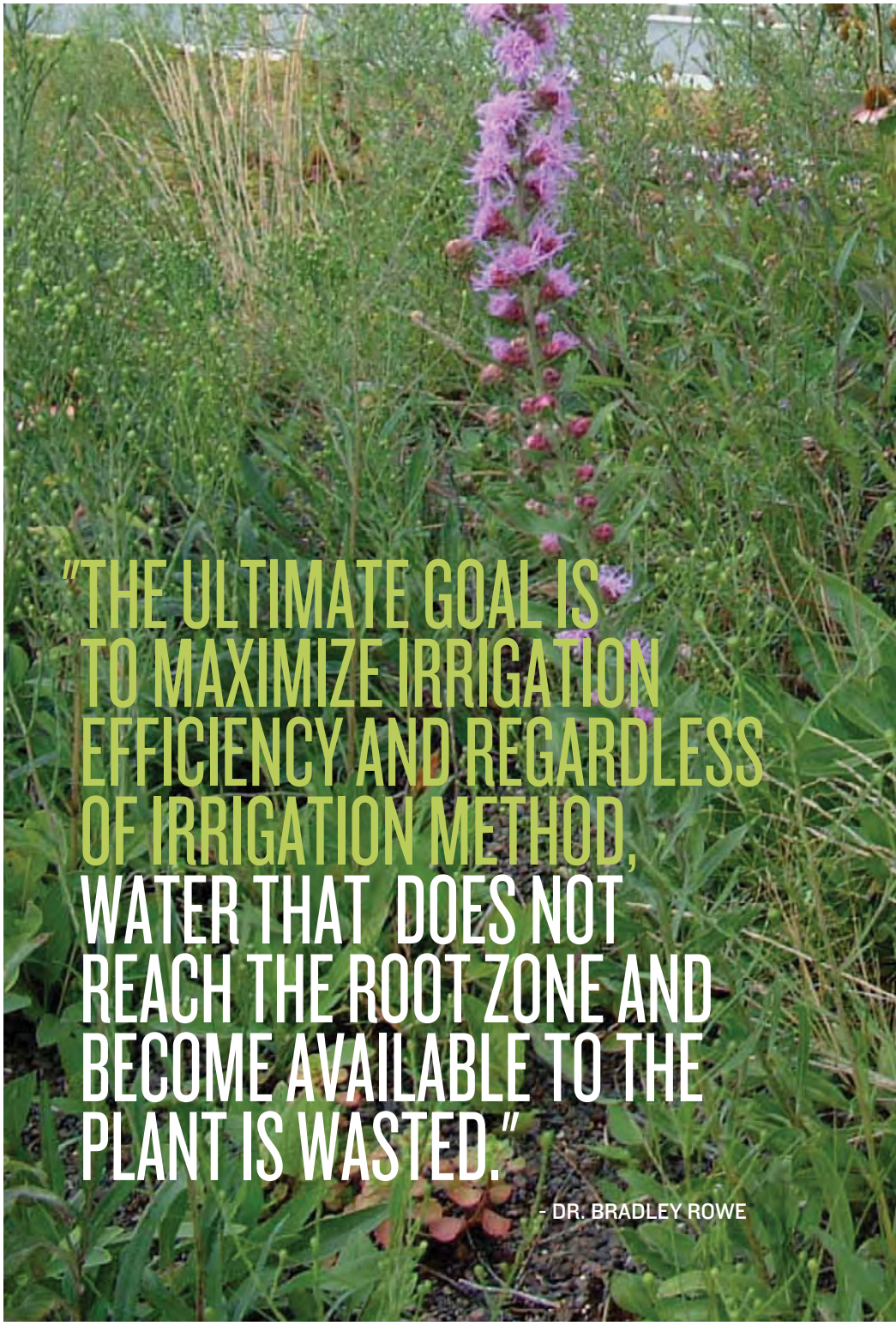
A good example is the roof on the Molecular Plant Sciences Building at Michigan State University. This roof was planted in a substrate depth of 20 cm (8 in) with 17 species of native herbaceous perennials and grasses during 2011. The roof was watered as needed the first two years to ensure establishment, but thereafter it had to rely on natural rainfall. After eight years, ten of the original 17 species have disappeared. The roof is now dominated by *Allium cernuum* with a limited number of *Asclepias tuberosa*, *Coreopsis lanceolata*, *Geum triflorum*, *Koeleria macrantha*, *Penstemon hirsutus and Sporobolus heterolepis* still present. There is also sedum infiltrating from the surrounding

shallower roof. Plant diversity decreased every year, but plummeted in 2016. The major die off was likely due to drought conditions during the spring and summer of 2016. During a 57 day period, May 16 to July 11, total rainfall amounted to 3.28 cm (1.29 in). About a third of that fell on one day, July 1. Comparatively, normal rainfall for May, June, and July is 8.5, 8.8, and 7.2 cm (3.35, 3.46, and 2.83 in), respectively.

The Molecular Plant Sciences study points out the fact that supplemental irrigation may be critical to maintaining species diversity on a green roof. Irrigation may be necessary or the substrate must be deep enough to support the plants selected. Apparently, 20 cm (8 in) is not deep enough for long-term survival of herbaceous perennials and grasses in East Lansing, Michigan. Overall, a balance must be found between providing enough water to maintain plant health and aesthetics while allowing the substrate to dry out enough to provide maximum stormwater storage capacity. To increase water use efficiency, moisture sensors could be installed in the substrate that would trigger an irrigation event when water availability reaches a minimum threshold.

If the decision is made to provide irrigation, the next question is by what method. When comparing the efficiency of overhead, drip, and sub-irrigation on green roofs, we found that overhead was most favorable for water distribution and retention as well as plant health (Rowe et al., 2014, Ecological Engineering 64:306-313). Because green roof substrates tend to be coarse to allow adequate drainage, limited capillary movement resulted in the majority of the water draining directly to the bottom and out of the system for both the drip and sub-irrigation treatments. In contrast, overhead irrigation distributed water over 100 per cent of the surface, wetted the entire area in a much shorter period of time, and resulted in less wasted water. This conclusion could be altered depending on factors such as windy conditions, frequency and duration of irrigation events, spacing of emitters, and whether the roof was just planted or had time to become established. Even so, drip irrigation may be more practical for irrigating individual plants such as trees, shrubs, or vegetables that may be found on an intensive roof. The ultimate goal is to maximize irrigation efficiency and regardless of irrigation method, water that does not reach the root zone and become available to the plant is wasted.

In addition, the use of moisture retention fabric (MRF) and cups in drainage layers are other methods to



GREEN ROOF ON THE MOLECULAR PLANT SCIENCES BUILDING AT MSU

Photo courtesy B. Rowe

retain additional water. In the above irrigation study comparing irrigation methods, the use of MRF improved irrigation efficiency for all three irrigation methods, especially for drip and sub-irrigation. In contrast, in a previous study we found no consistent differences in plant growth or visual appearance among systems with retention cups and those without retention cups (Monterusso et al., 2005, HortScience 40(2):391-396). However, the physical existence of such cups means that some volume of water is retained in them.

As green roof practitioners, the choices we make in plant selection, substrate depth, and irrigation practices will go a long way in determining how well a green roof performs.

Brad Rowe has been conducting green roof research at MSU since 2000. Research topics include plant selection, growing substrates, carbon sequestration, stormwater runoff, energy conservation, and roof vegetable production. He was the founding chair of the GRHC Research Committee and received the GRHC Research Award of Excellence in 2008. Brad also teaches a course on green roofs and walls at MSU.

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GROCERY STORE PRODUCES FRESH FOOD AND HARVESTS WATER IN VILLE ST. LAURENT, QUEBEC

BY JOYCE MCLEAN, ASSOCIATE EDITOR, LAM

It's just 44 steps up to the roof from Richard Duchemin's office in his family-run IGA on Henri-Bourassa Boulevard West in Saint Laurent, Quebec. Those 44 steps lead him to the retail food store's food producing green roof – a first on a food store roof in Quebec and still a rare application for food production in North America.

In 2014, the city of Saint-Laurent (part of Greater Montreal) passed a requirement for all new construction to have at minimum 50 per cent vegetation coverage on the roof, a key component of the city's climate change adaptation strategy, and to help lower greenhouse gases and provide much needed greenery.

At the time, while others might have seen this policy as a problem, Richard Duchemin and his two brothers Daniel and Jean saw an opportunity. The IGA store, started by their father Normand in 1984, was already well known for its innovative approach to marketing food to its customers. In 1988, they were the first food store in Quebec to display fresh produce at the front of the store; the first supermarket to roast coffee beans in 1996; and in 1996, the first supermarket to include a fresh fish display with over 100 feet of counter and ice.

After several store renovations and a 30 per cent expansion in the mid-1990s, the Duchemins knew their business could sustain a larger building. They set out to build a green building, which would reflect their personal commitment to sustainability. In 2016, the Duchemins finished construction on their 25,000 square foot supermarket and the building attained LEED Silver certification.

The Duchemins used the expertise of La ligne verte: Toit vert – a Montreal-based firm – who worked with Richard closely for over a year to design, construct and implement the green roof which was incorporated into the design when the building was open in 2016. As it was a new building, the green roof consultants ensured that there was sufficient loading capacity to support the kind of green roof plants that Richard envisioned offering his customers in the store. La ligne verte:Toit vert also ensured the roof was fully accessible with a safety railing.

The range of produce grown in 2017 included a variety of greens, such as spinach, Swiss chard, lettuces and kale; carrots, radishes, white turnips, broccoli, cauliflower, red and yellow beets, eggplant, beans, bell peppers, hot peppers, tomatoes, cucumbers and garlic. In addition to strawberries, the green roof is also supporting the production of herbs such as dill, coriander and basil. Several beehives are also situated on the roof.

Two different kinds of spring mix lettuce have been the most consistent and successful crops grown on the roof,

ROOFTOP FARM ADVERTISES IGA BRAND AND DELIVERS PRODUCE TO HAPPY CONSUMERS IN SAINT-LAURENT, QUEBEC.

"THE CUSTOMERS AT THE IGA LOVE NOT ONLY THE IDEA OF PLANTS ON THE ROOF, BUT THE AVAILABILITY OF IN-STORE SUPER FRESH VEGETABLES AND HERBS."

- RICHARD DUCHEMIN

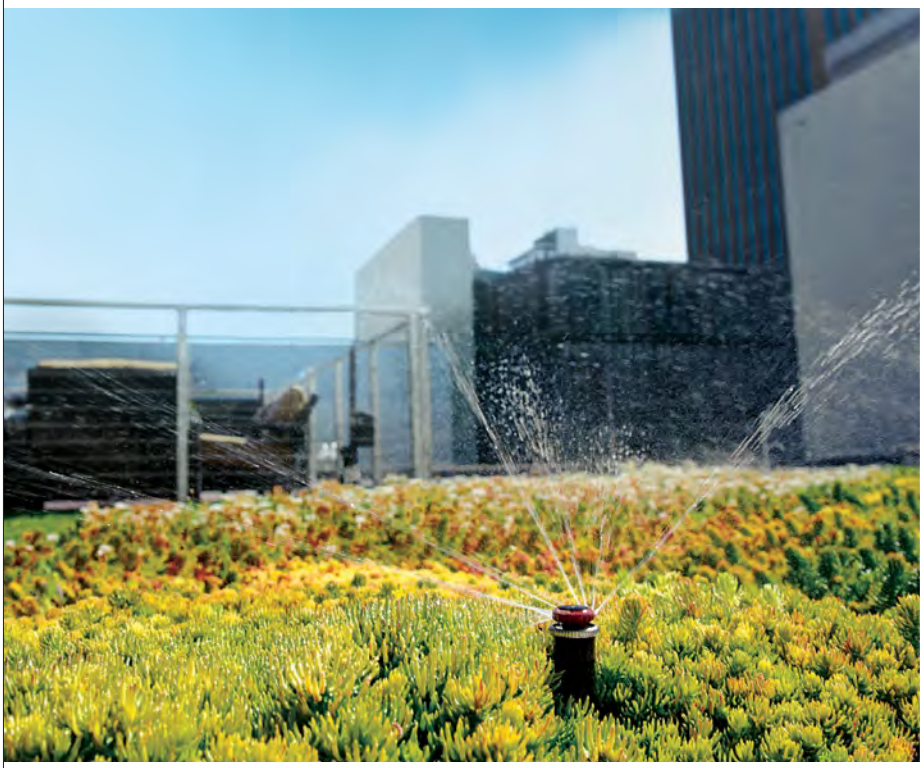
according to Richard. All produce grown is certified organic. In the future, the owners are considering adding tulips and mushrooms to the list of crops.

The plants are being grown in six inches (15 cm) of growing medium. As this is shallow growing medium, growing long rooted vegetables is not really an option. The store's much needed summertime air conditioning and dehumidification system is the source of the bulk of the water being used to irrigate the plants. The condensate water is being collected instead of directed down the drain and smartly distributed to the thirsty rooftop plants.

"The customers at the IGA love not only the idea of plants on the roof, but the availability of in-store super fresh vegetables and herbs." said Duchemin. "In the era of consumers wanting to buy local, buying vegetables grown on the roof, couldn't be more local." As a testament to that, the sale of the supermarket's organic produce increased 50 per cent from 2016 to 2017. The owners are hoping this is a continuing trend. Other supermarkets have reached out to the Duchemins to enquire about their process and their success and while confidential, there are indications that other supermarkets will copy their idea. Sobeys, a large supermarket retailer that owns the IGA brand, is watching the progress of this green roof with great interest as consumer interest in good quality, local food continues to grow across North America.

Joyce McLean is a Toronto-based environmental consultant and writer.

Photo courtesy R. Duchemins



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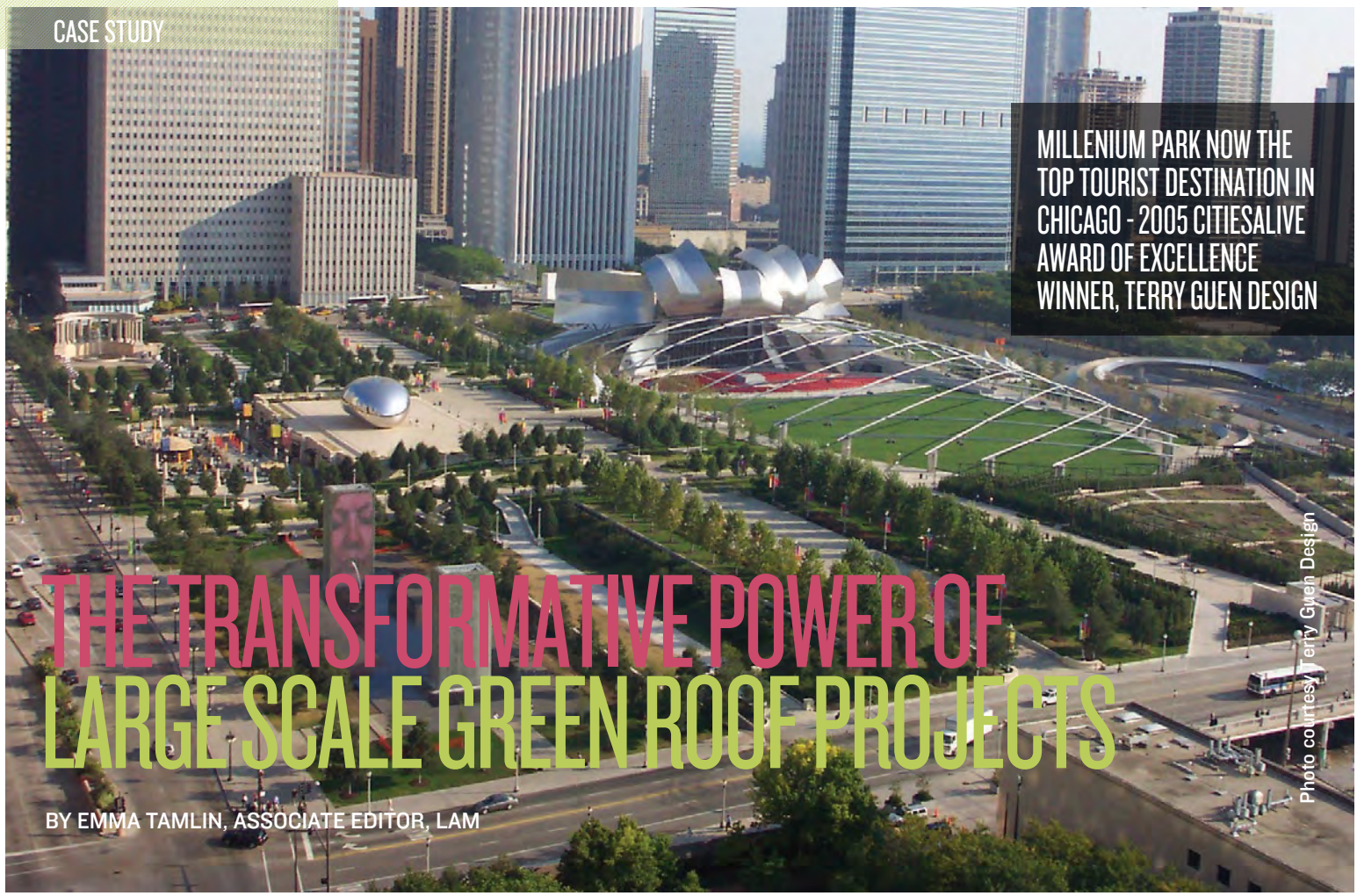


MILLENIUM PARK NOW THE TOP TOURIST DESTINATION IN CHICAGO - 2005 CITIESALIVE AWARD OF EXCELLENCE WINNER, TERRY GUEN DESIGN

Photo courtesy Terry Guen Design

THE TRANSFORMATIVE POWER OF LARGE SCALE GREEN ROOF PROJECTS

BY EMMA TAMLIN, ASSOCIATE EDITOR, LAM

Cities have never been static environments and throughout history have always faced multiple challenges. In the 21st Century, cities are forced to looked more innovatively at land use due to rapid population growth, rising land premiums and the need to build for resilience.

Now more than ever, political leaders, city planners, and design professionals recognize the need to have multi-functional spaces integrated into the urban fabric. These spaces are often taking the form of large scale green roof projects. These three projects exemplify the global trend towards blending the natural and built environments through green roofs, in what has become a key element in 21st Century city building.

Despite initial opposition and hesitation regarding the challenging technical design, Chicago's Award of Excellence-winning Millennium Park opened in July 2004 after six years of construction. The eyesore of the rail deck from the offices above is said to have inspired visionary Mayor Richard M. Daley to want to cover the rail tracks with a park. Major features of the roof park include the Jay Pritzker Pavillion which can accommodate 11,000 music lovers; Cloud Gate, a 100-ton sculpture by Anish Kapoor; the interactive Crown Fountain by Jaume Plensa; and the four-season Lurie Garden, designed by Kathryn Gustafson, Piet Oudolf and Roberter Israel. These features all sit atop a parking garage and a commuter rail station which services the city's downtown core. The project construction cost approximately USD470 million and was financed through a combination of $270 million in public funding with the remainder secured through private donations.

A study conducted by Dennis Jerke from Texas A&M University in 2011, found that of the 39.2 million domestic and overseas visitors in 2010, 12 percent visited Millennium Park and this accounted for $1.4 billion of direct spending and $78 million in tax revenue during that year alone. In 2017, Millennium Park was ranked as the top tourist destination in Chicago, and among the top ten destinations in the U.S. The park hosts numerous festivals and events throughout the year, including the Grant Park Music festival. Since the park opened, there has been an increase in development around it, resulting in an increase of more than 4,800 apartment and condo units, all within walking distance of the park. This real estate boom was stimulated in part by the construction of the park.

The environmental case for Millennium Park is also signifi-

cant. Jerke's report finds that the park retains almost 70 per cent of the stormwater that falls on the site and the remainder is cleaned, filtered, and diverted into the Chicago River. The park's 500 plus trees help remove 426.9 pounds of air pollutants each year. Millennium Park and the environmental stewardship culture it has created has no doubt had a role to play in Chicago's ongoing success in moving towards sustainability. Chicago has long been a supporter of green roof development, through regulations and incentives and Millennium Park is an award-winning example of how green spaces contribute to a both a city's economy and sustainability targets.

The City of San Francisco has progressive environmental and climate change goals and its recent initiatives reflect this. With the implementation of the Better Roofs Ordinance in January 2017, San Francisco now requires green roofs, solar panels or a combination of both on new construction projects. Transbay Transit Center, due to be completed in early 2018, is a modern regional transit hub that will connect eight Bay Area Counties and the State of California through 11 transit systems. The new transit center will accommodate up to 45 million riders annually, including bus, commuter rail, and high-speed rail passengers, many walking or riding their bicycles to and from the Center.

According to the Department of Public Works, the Transbay Terminal Center will be LEED Gold certified. It incorporates the use of natural lighting, a geothermal system, and greywater recycling. Additional features include:

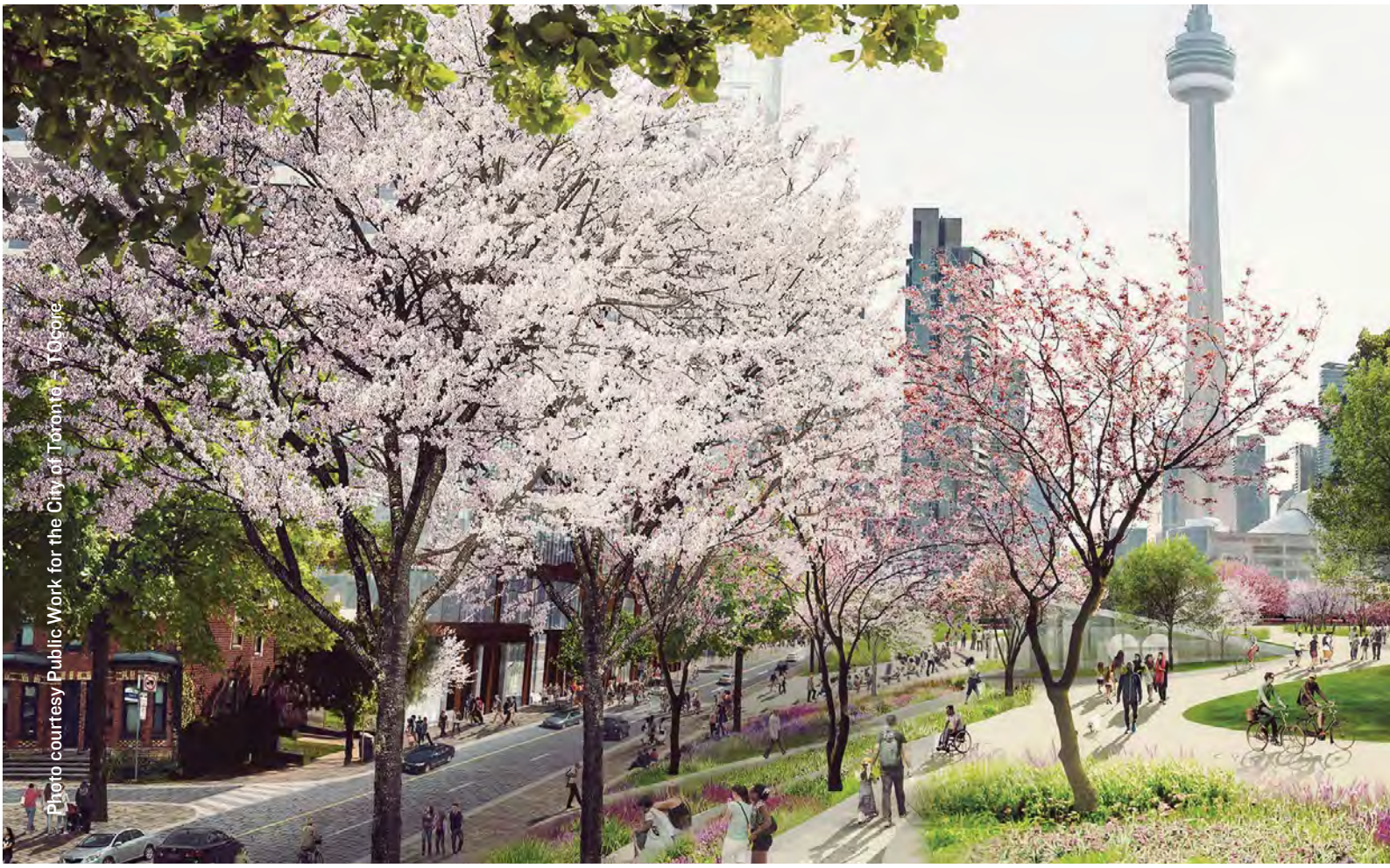
- a five and a half acre rooftop park that will absorb carbon dioxide from bus exhaust, retain and filter stormwater, and provide a habitat for local wildlife;
- extensive use of natural lighting which will reduce energy costs;
- reuse of greywater and stormwater to minimize potable water consumption and to substitute other non-potable water; and
- use of a geothermal system to significantly reduce the cooling costs as the system will harness the relatively low temperature in the ground to chill water. Pipes will be coiled under the building footprint, circulating water deep below grade.

The 5.4-acre green roof was designed in part by Paul Kephart of Rana Creek Design, a keynote speaker at the upcoming Grey to Green conference in Toronto (greytogreenconference.org). According to Rana Creek Design, the park is designed to promote water reuse and conservation while also providing much needed green space in a rapidly urbanizing downtown. The greywater system will provide water for the center's toilets and will save an estimated $50,000 per year. Major real estate development projects are also planned for around the Transbay Transit Center.

The Transbay Transit Center rooftop park will serve as a model for future projects in San Francisco and California's ongoing efforts to become more sustainable. The project will also provide a

SAN FRANCISCO'S MULTI-FUNCTIONAL TRANSBAY TRANSIT CENTER TO INCLUDE 5.4 ACRE GREEN ROOF PARK

Images courtesy Rana Creek Design



unique opportunity for public education and engagement and foster a stronger connection between residents and the local ecosystem.

Toronto, Ontario was the first major city in North America to require green roofs on most new construction. Since 2009, when the Green Roof Bylaw passed, the city has seen more than 500 green roofs installed. In the Fall of 2016, the city saw another progressive green infrastructure idea brought to the table. City Councillors proposed to cover the rail corridor in downtown Toronto with parkland, providing the city with much needed green space and the opportunity to connect neighborhoods currently separated by the rail tracks. The park, aptly named the Rail Deck Park is a contentious issue for some, in a city facing continual budget constraints and a lineup of other big budget infrastructure projects.

A recent report by Ryerson University's City Building Institute, a multi-disciplinary research center, entitled *The Opportunity of the Rail Deck Park*, provides multiple justifications for a major investment in the Rail Deck Park in the downtown core. The Report focuses attention on the area's projected population growth and the lack of green space.

The report states that residents of downtown Toronto have much less parkland on both an area and per person basis than the citywide average. The citywide average for parkland is 300 square feet per person but in the downtown core this drops to only 45 square feet per person. Parkland accounts for just under seven per cent of all land in the valuable downtown core. The city has experienced rapid growth with a 20 per cent increase in people living downtown between 2011 and 2016, while the rest of the city only grew by three per cent over the same period. As the downtown population continues to increase, the strain on parkland will only become more prominent, especially since most people live in condominiums with no access to a backyard.

The Ryerson Report maintains that the Rail Deck Park can be financed partly through fees accumulated through Toronto's cash-in-lieu program for which the city has already generated a significant amount. Given the high value of downtown property, most developers opt to pay the cash-in-lieu of land designated as green space. The cash-in-lieu of parkland provision has accumulated over CDN $128 million in reserves for the downtown area over the last ten years.

The CDN $1.6 billion estimated price tag of the Rail Deck Park appears reasonable, when compared to other major infrastructure investments that Toronto is currently considering – including rehabilitating the entire elevated highway called the Gardiner Expressway for $3.6 billion and $3.5 billion for a one stop underground subway in the north-eastern part of the city.

In a November 2017 Toronto Staff report, *Rail Deck Park – Results of Feasibility Analysis & Next Steps for Implementation*, the next phases of the rail deck are provided in detail. Upon Toronto City council approval, the design of the park could begin as soon as 2019, with one idea being to host an International Design Competition.

The Rail Deck Park provides Toronto with an opportunity to take advantage of the last large expanse of land to build a unique cultural landscape. The park will likely provide a number of environmental benefits such as stormwater management, improved air quality and

ONE POTENTIAL VIEW OF THE PROPOSED FUTURE RAIL DECK PARK AT TORONTO'S INTERSECTION OF DRAPER STREET AND FRONT STREET

MAJOR PROJECT COMPARISON

	RAIL DECK PARK	MILLENNIUM PARK	TRANSBAY TERMINAL
COMPLETED	TBD	2004	June 2018
PARK AREA	21-acre park	24.5-acre	5.4-acre
COST	$1.665 Billion (Cdn)	$490 million (US)	$2.26 billion (US)
ARCHITECT	TBD, Carlton Studio at DIALOG	Skidmore, Owings & Merrill LLP, Frank O.Gehry and Associates	Pelli Clarke Pelli Architects
DESIGNER	International Design Competition may be scheduled Mid 2019	Gustafson Guthrie Nichol Ltd.	Pelli Clarke Pelli Architects (PCPA), Rana Creek Design
LANDSCAPE ARCHITECT		Terry Guen Design Associates, Inc.	Peter Walker and Partners

improved human health along with promoting an urban culture connected to nature. Previous examples of large scale green infrastructure projects suggest that if it's properly designed, the 21 acre project could generate multiple health, social and economic benefits and continue to payback the city and its citizens.

Urban populations are increasing at rapid rates and our cities are more vulnerable to extreme weather than ever before. As civic leaders grapple with how to provide a high quality of life and prepare for the inevitable impacts of climate change, one clear trend is to re-purpose and re-surface land and buildings with green roof technology. These large scale, transformative green infrastructure projects allow us to respond to the pressing need to integrate nature into our cities. The challenges posed by climate change, and stormwater run off along with the importance of building for human health can be realized through green infrastructure implementation. As witnessed, these large scale green infrastructure projects can also contribute to a city's cultural capital, provide economic benefits through tourism and act as a beacon of sustainability and innovation.

The Rail Deck Park will be presented at the Opening Plenary of the *Grey to Green Conference* greytogreenconference.org. The Ryerson Report can be found at citybuildinginstitute.ca

Emma Tamlin is the Marketing and Associate Editor and Communications Coordinator at Green Roofs for Healthy Cities

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EPA'S DENVER MODULAR GREEN ROOF MANAGES STORMWATER AND MAKES SPACE FOR PARKING RENTALS

BY STEVEN W. PECK, GRP, HONORARY ASLA

After a green roof design and installation training in Denver in 2017, my students and I had a special treat – we visited the 10 year old modular green roof system that lies on the top of the Environmental Protection Agency's (EPA) Region 8 headquarters.

It's the first time I've seen one of the early modular systems, in this case a Green Grid system, after many years of wear and tear. It was holding up very nicely. The 19,840 square foot green roof is accessible to building occupants, features four inches of proprietary growing medium, and six species of drought tolerant sedum. It's been the subject of plant research by Jennifer Bousselot of Colorado State University who focused on how solar panels on the roof impacted plant survival. There is a weather station that collects rainfall, temperature and other data, as well as a supplemental irrigation system that provides water during periods of drought. The plant coverage rises and falls depending on the season, and it was November when we arrived.

Back in 1969, Denver State Legislators created a quasi-governmental organization called the Urban Drainage and Flood Control District following some significant flooding events. This new body established water management goals regarding drainage and flood control over a 1,608 square mile area, which includes Denver and more than 2.8 million people. The stormwater retention goal is to retain the 85-percentile storm event, which in Denver averages out to a 0.6 of an inch precipitation event or less. Cities determine how the stormwater goals are to be met. In urban areas, buildings with more than one half an acre footprint, such as the EPA headquarters, are required to manage the 85th percentile storm event onsite. Typically, civil engineers have met this requirement by building large retention vaults for projects in urban areas, which take up considerable space in the basements of the buildings. The retention of stormwater onsite does not contradict Denver's Water Law requirements for infiltration, as long as stormwater management technologies are allowed to drain within 72 hours of a rain event.

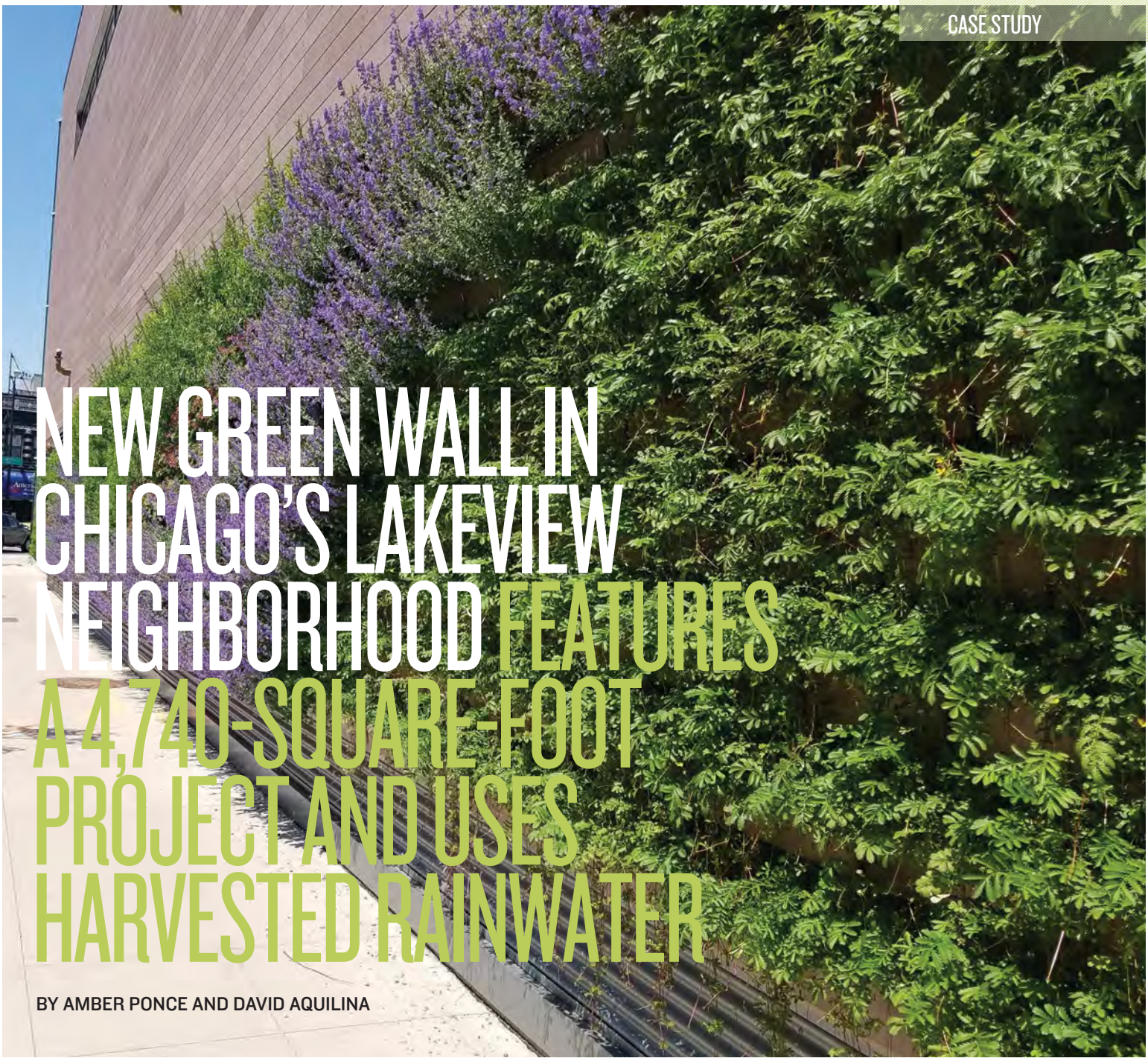
Research conducted on the EPA building's green roof demonstrated clearly that the modular system had no trouble in managing this much water. Our tour guide, Greg Davis, of USEPA Region 8 told us, "The green roof works really well and consistently to meet the water quality capture requirements. It is also

STORAGE VAULT FOR STORMWATER AT EPA HEADQUATERS IN DENVER TAKES UP VALUABLE SPACE THAT WOULD GENERATE $30,000 PARKING REVENUES ANNUALLY

Photo courtesy S. Peck

first generation modular technology and the new systems will just expand the benefits." These include changes to growing media formulations to improve water retention, changes to the design of modules so that they hold more and slow water movement, and geotextiles that have the capacity to expand and retain significant amounts of water. Research on the EPA green roof was submitted to the Urban Drainage and Flood Control District which then accepted green roofs as an approved Best Management Practice (BMP). Now developers can utilize green roofs to meet stormwater requirements without the additional technical analysis required of non-standard BMPs. Modular green roofs and green roofs in general have incorporated additional strategies for retaining and slowing down the flow of stormwater, thereby improving performance.

At the EPA headquarters in Denver, the volume of water retained is estimated to be the equivalent of four parking spots worth of space. The retention vault currently takes up 12 parking spots worth of space. Utilizing new green roof technology with its increased stormwater capture potential, it may be possible for savvy building engineers in Denver to design green roof systems that virtually eliminate the need for large concrete retention vaults, thus freeing up valuable parking spaces. In the case of the EPA headquarters, this would represent an estimated $30,240 in additional parking income potential for the building annually, plus the savings of not having to build the retention vault and associated plumbing. The same benefit, in terms of right sizing cisterns, or stormwater management ponds, can confer immediate and annual economic savings for developers and building owners who utilize green roof technology to manage stormwater. "In time, the use of green roofs will become standard practice for buildings across North America", said Gregory Davis at the end of our visit. Given the many public and private benefits they bring, green roofs are thankfully, already at that point in many jurisdictions.



NEW GREEN WALL IN CHICAGO'S LAKEVIEW NEIGHBORHOOD FEATURES A 4,740-SQUARE-FOOT PROJECT AND USES HARVESTED RAINWATER

BY AMBER PONCE AND DAVID AQUILINA

Big development projects in dense urban areas bring big challenges, especially in historic areas of a major city. Local residents and business owners often have concerns about how the scope and style of a project might affect the character of their neighborhood.

There are rules and regulations to follow. Novak Construction faced these challenges in the re-development of the historic Ashland-Belmont-Lincoln intersection in the Lakeview neighborhood of Chicago, where they constructed a building for a new 75,000-square-foot Whole Foods Market store. A LiveWall green wall proved to be important for helping Whole Foods' new Midwest flagship location fit into the neighborhood.

"The living wall represents what Whole Foods is all about: organic, natural, and intimately tied to the neighborhoods we serve. It complements both the new landscaping added outside the store as well as the area's existing landscape," said Nick Aholec, construction project manager, Midwest Support Office, Whole Foods Market.

The 10-foot high green wall totals 4,740 square feet, and is divided into three sections. The north section is 251 feet long, the south section is 179 feet long, and the west section is 44 feet in length. The LiveWall system's modular planters, which are high-impact, UV-resistant, architectural quality moldings, were manufactured in a custom brown color to harmonize with the building's exterior. Based on an analysis of the anticipated patterns of sun and shade on the different sides of the building, a customized plant selection was developed for each section from a palette of seven different perennials. In total, the green wall contains more than 5,000 plants.

The City of Chicago traditionally has been skeptical about outdoor green walls and reluctant to approve them. Many green wall systems confine plants to small pockets or pouches with limited amounts of growing medium. In Chicago's hot summers, they dry out quickly, increasing the need for irrigation, which local city officials consider a waste of water.

In contrast, LiveWall grows and sustains plants in modular planter boxes engineered to provide significant growing medium. With more growing medium, LiveWall retains more water, reducing irrigation requirements.

LiveWall installations start with attaching its vertical furring tracks on the building wall. They provide a framework for fastening the other components that form the system. They also establish air space between the wall and the system for ventilation. Horizontal aluminum rails, with conduits that bring water to each planter box, are affixed to the tracks. The molded modular planter boxes then slide into place along a slot in the rails. Finally, separate liner inserts, reusable plant containers with growing medium and pre-grown nursery plants, drop into the planter boxes. For outdoor installations, the system uses precisely metered spray nozzles for irrigation to water plants much like natural rain.

The Whole Foods green wall is combined with an underground system that captures and stores stormwater from the rooftop. Water flows from the roof drains down into three Vortex filters, and the clean water is then gravity fed into a cistern and used to irrigate the green wall. This innovative solution enabled the project to meet the city's stormwater management requirements and add the green wall.

"The neighborhood got a beautiful vertical landscape," said Michael Berkshire, green projects administrator for the City of Chicago. "And it uses rainwater, not city water, for irrigation."

This green wall provides an exceptional amenity for the building and the neighborhood while conserving potable water. Facing three directions, it will yield valuable information about plant adaptability and survivability in the Chicago climate for years to come.

Amber Ponce, GRP is on the editorial board of the Living Architecture Monitor and Business Development Manager for LiveRoof and LiveWall. David Aquilina, Strategic Storyteller, is a communications consultant and freelance writer.
For more information see the youtube video at: https://www.youtube.com/watch?v=8OfYrFxIuM&feature=youtu.be

"THE NEIGHBORHOOD GOT A BEAUTIFUL VERTICAL LANDSCAPE, AND IT USES RAINWATER, NOT CITY WATER, FOR IRRIGATION."

- MICHAEL BERKSHIRE

PROJECT SUMMARY OUTLINE

- NAME OF OWNER: Novak Construction Company
- NAME OF PROJECT: Lakeview Whole Foods Market
- INSTALLATION DATE: March 2017
- NUMBER OF PLANT VARIETIES: 7
- NUMBER OF PLANTS: 5,130
- PLANT PALETTE: Perennials
- SIZE IN SQ FT: 4,740
- DIMENSIONS: Three sections North, South and West... North: 251' x 10', South: 179' x 10', West: 44' x 10'
- SLOPE IN DEGREES: Zero
- WALL ORIENTATION: North, South, and West
- LIGHTING: Outdoor Natural Light
- PARTICIPANTS OF RECORD:
  - OWNER, DEVELOPER, GENERAL CONTRACTOR: Novak Construction Company
  - TENNANT: Whole Foods Market
  - ARCHITECT: Gensler
  - GREEN WALL MANUFACTURER: LiveWall
  - PLANT SUPPLIER: LiveWall
  - INSTALLER: Classic Landscape, LTD
  - MAINTENANCE: Intrinsic Landscaping

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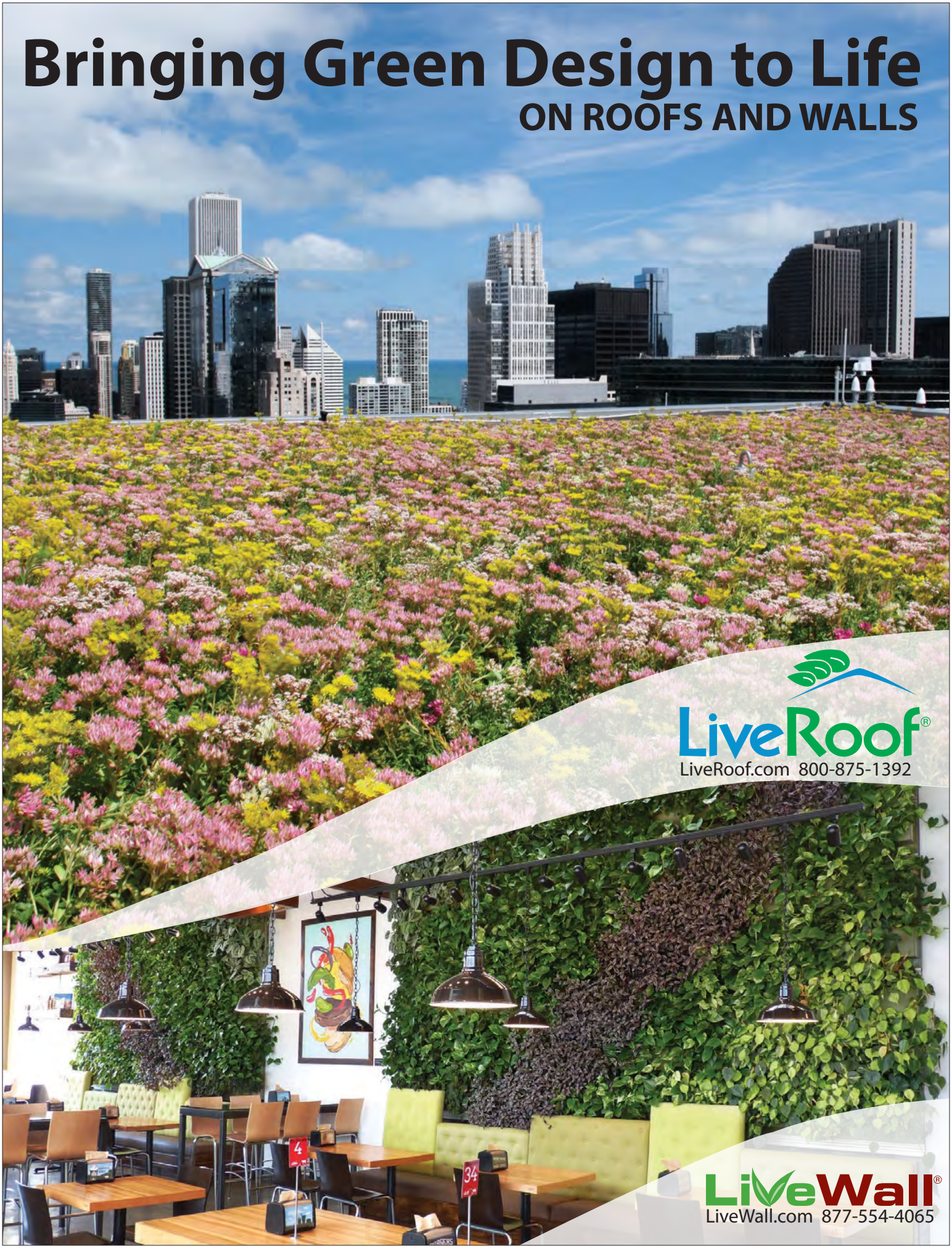

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GREEN INFRASTRUCTURE FOUNDATION LAUNCHES THE LIVING ARCHITECTURE PERFORMANCE TOOL TO IMPROVE POLICY MAKING AND PERFORMANCE

BY ROHAN LILAUWALA, GRP

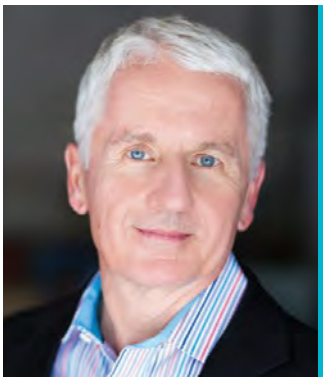
Over the past five years, Green Roofs for Healthy Cities - and more recently the Green Infrastructure Foundation - have been working to establish a set of comprehensive performance criteria and metrics that apply to green roofs and walls: the Living Architecture Performance Tool (LAPT). The LAPT is to green roofs and walls what LEED is to green buildings: it takes a very complex system of technologies, environments, and performance levels, and makes it understandable.

The LAPT is a 110-credit system that covers the wide range of potential performance benefits, and which ties into and builds upon existing rating systems such as LEED and SITES. The goal of this project is to improve the performance of living architecture systems by ensuring that they meet minimum standards, and act as a guide for future policy making, project design, installation, and maintenance.

The LAPT has the potential to revolutionize the green roof

LAPT IS DESIGNED TO PROVIDE THE FOLLOWING BENEFITS

- Design, installation, maintenance professionals and building owners/developers can use it to maximize potential benefits, identify synergies, ensure long-lasting living architecture projects by strengthening maintenance practices, improve branding and marketing, and integrate living architecture projects into buildings to prevent value engineering
- Policy makers can adopt the LAPT (in whole or part) to inform regulatory or incentive programs, outsource compliance when expertise or capacity does not exist in-house, and ensure living architecture policies are effective by maximizing public benefits
- Product manufacturers can develop new products, innovate, or market existing high-performing products to help maximize benefits and achieve LAPT credits



DAVID YOCCA REPLACES SARA LOVELAND AS GIF CHAIR

After two years as GIF Chair, Sara Loveland has stepped down from the Board of Directors. Replacing her is David Yocca, FASLA, Senior Partner at Conservation Design Forum (CDF). David has served as Project Principal on many of CDF's pioneering demonstration projects. David's focus on performance-based landscapes has guided him to serve on boards and committees of similarly aligned organizations, including SITES and GIF, where he has been an instrumental part of the LAPT's development. We welcome David as our new board chair.

and wall industry by advancing performance, helping public and private investments in living architecture achieve their intended design goals. In spring 2018, GIF is inviting designers of living architecture projects to submit a project for the LAPT pilot phase. This is a great opportunity for innovators to help refine this important tool while setting their organizations apart as leaders in the field. GIF is also reaching out to policy makers to engage them in using the LAPT to achieve their policy objectives. For more information about the terms and conditions of the Pilot Project, please contact rlilauwala@greenroofs.org.

GREEN INFRASTRUCTURE CHARRETTES COMPLETED IN THREE ONTARIO COMMUNITIES; MORE PLANNED

Over the course of 2017, GIF and the Ontario Parks Association (OPA) engaged key stakeholders in Mississauga, Toronto, and Richmond Hill to build capacity around using green infrastructure in their communities. Stakeholders in the public, private, non-profit, and educational sectors were brought together to reimagine the future potential of actual sites using green infrastructure. Their redesigns were subjected to a customized financial analysis using GIF's Green Infrastructure Cost-Benefit Matrix. The redesigns showed the potential for communities to reduce stormwater runoff and increase resilience to climate change's impacts, all while managing growth and intensification in a sustainable manner.

The full report, which includes visuals, cost-benefit analysis, and recommendations for future actions, is available at greeninfrastructurefoundation.org/resources. GIF and OPA are planning to continue to engage communities and build capacity for greater green infrastructure use. In 2018 and 2019, training courses and workshops will be delivered to staff in six communities. GIF is also developing a half day course on green infrastructure valuation which will be available online by the end of 2018.

Rohan Lilauwala is Program Manager at the Green Infrastructure Foundation and Senior Researcher at Green Roofs for Healthy Cities. For more information visit www.greeninfrastructurefoundation.org or email rlilauwala@greenroofs.org

GREEN INFRASTRUCTURE CHARRETTE PARTICIPANTS REDESIGNING THE COMMUNITY WITH GREEN INFRASTRUCTURE

Images courtesy Rana Creek Design

WASHINGTON DC DEVELOPS MULTIPLE INITIATIVES IN SUPPORT OF LIVING ARCHITECTURE

BY EMMA TAMLIN, ASSOCIATE EDITOR, LIVING ARCHITECTURE MONITOR

According to the Department of Energy and Environment (DOEE), as of 2017, there are currently more than 3 million square feet of green roofs in the District. The rise in green roofs in DC can be attributed to the city's rigorous stormwater regulations and grant programs designed to provide incentives for the installation of green roofs.

DC receives more than 40 inches of rainfall each year and with more than 43 per cent of the Districts land cover being impervious, a single 1.2-inch storm falling on the area can produce as much as 525 million gallons of stormwater runoff.

Over the years, the DOEE has been very successful in its green infrastructure policy creation and implementation. Stricter stormwater regulations were introduced, along with the Green Area Ratio, RiverSmart programs, and the Stormwater Retention Credit Trading Program.

In 2013, the DOEE released the 2013 Rule on Stormwater Management, Soil Erosion, and Sediment Control (2013 SWM Rule). The DOEE recognized soil erosion due to stormwater runoff as a key factor in decreased water quality in the District's streams and rivers. In addition, the Office of Planning navigated the passing of the Green Area Ratio (GAR) through the Zoning Commission. According to the DOEE website, the GAR is an environmental sustainability zoning regulation that sets standards for landscape and site design to help reduce stormwater runoff, improve air quality, and keep the city cooler.

The DOEE also promotes stormwater management through its various RiverSmart Programs. RiverSmart Programs provide financial incentives to help property owners install green infrastructures such as rain barrels, green roof, rain gardens, permeable pavers, shade trees, and more. The rebate program, since its inception in 2006, offers a rebate of $10 – $15 per square foot for voluntary installations of green roofs and has greatly contributed to the installation of green roofs District-wide.

The array of policies and programs available in DC increases compliance as developers and property owners are able to choose the option that best meets the specifications of their project. DC is a leader in green infrastructure policy and has implemented a diverse set of solutions to mitigate stormwater runoff while simultaneously promoting the installation of green roofs, improving human health and establishing a market for stormwater retention.

One of the most interesting programs and potentially the most transformative is the new stormwater credit trading which is profiled on the next page.

WASHINGTON, DC'S STORMWATER RETENTION CREDIT (SRC) TRADING PROGRAM

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GENERAL OVERVIEW

- The Stormwater Retention Credit Trading Program promotes the installation of green infrastructure projects and the reduction of impervious surfaces by allowing property owners who either manage stormwater voluntarily, or above the minimum regulatory requirement to sell their credits on an open market to individuals/ companies who do not meet the regulatory stormwater requirement. This system helps to lower the overall costs of managing stormwater.

STATE REGULATIONS

- Development and redevelopment projects must meet a 1.2-inch storm runoff retention requirement.

WHO SELLS SRC'S?

- Property owners who manage stormwater voluntarily, or above the regulatory requirement
- Stormwater Retention Credit (SRC)-generating business

WHO BUYS SRC'S?

- SRCs are sold on the open market to large development projects
- Large development projects are required to use green infrastructure to retain stormwater runoff but have the option to meet up to 50 per cent of their requirement off-site using SRC's.
- The DOEE also buys eligible SRCs through the SRC Price Lock Program.

HOW DOES IT WORK?

- To generate SRC's property owners must meet a set of eligibility requirements and complete the SRC certification process.

1. Submit a Stormwater Management Plan (SWMP)
2. Obtain DOEE Approval of SWMP
3. Install eligible GI or land cover
4. Pass DOEE Final Construction Inspection and submit as built SWMP
5. Apply to DOEE to certify SRC's with maintenance contract
6. Obtain DOEE certification for up to 3 years of SRC's
7. Maintain Retention Capacity and pass subsequent inspections

- Each SRC represents one gallon of GI retention maintained for one year. DOEE will certify up to years' worth of SRCs at one time.

WHO DETERMINES MARKET VALUE?

- Stormwater Retention Credit (SRC) prices are privately negotiated and DOEE does not set a market price. DOEE has created a price floor for new, voluntary GI in the MS4 through the SRC Price Lock Program.
- The SRC Price Lock Program allows eligible SRC generators to sell SRC's to the DOEE at a fixed price without losing the option to sell to another buyer.
- SRC purchase prices will be determined based on where the project is located in the Municipal Separate Storm Sewer System (MS4).

RESOURCES

- DOEE offers free training seminars on Stormwater Retention Credits (SRCs). For training dates and information visit https://goo.gl/jxotLZ.
- For more information on the Stormwater Retention Credit Trading Program email src.trading@dc.gov or call (202) 715-7644.

The SRC program has the potential to revolutionize how we manage stormwater by lowering overall costs and improving performance.
Hamid Karimi, DOEE will be speaking about this program at the Grey to Green Conference in Toronto on May 16, 2018.

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KEY LESSONS LEARNED FROM OVER 60 YEARS OF ROOFING, 45 YEARS OF PLAZA WATERPROOFING AND 20 YEARS OF WATERPROOFING GREEN ROOFS

BY TIM BARRETT

Keeping the moisture out of a building is far from the most sexy or thrilling aspect of designing a green roof (for most people) but it still remains absolutely critical to the success of any green roof project.

Failure to keep the water out and where it belongs can cause significant, ruinous costs both during and after installation of a green roof besides discouraging development of other green roof projects.

A properly designed, installed and maintained green roof will last longer than brick and mortar. If an installation is anything less than it could be, it can jeopardize a major green roof benefit of extending the life expectancy of the waterproofing system. Sustainability in roofing is, in large part, making things last longer and sending less waste to the dumps.

My experience with actual installations, manufacturing, consulting, chairing and co-authoring two RCI eight hour green roof courses, speaking at numerous Green Roofs for Healthy Cities conventions, my appreciation of biophilia and of excellence in general have taught me many lessons which may be instructive for anyone involved with green roof design or installation. As green roof markets continue to grow, the art and science of green roofs will continue to evolve. My evolution to date has taught me the following:

- Select a reputable manufacturer with a proven waterproofing system capable of lasting for a long time and with a track record of use with green roofs. Putting inexpensive or unproven waterproofing under a green roof assembly is risky and an unwise choice.
- Waterproofing is distinguishable from weatherproofing as defined in NRCA and RCI glossaries, among others. Know the difference and only use real waterproofing under green roofs.
- Putting insulation under a waterproofing membrane is less than optimum design and compromises the longevity of a green roof. Insulation is best placed above the membrane.
- The waterproofing system should provide total adhesion to the structural deck or at the least, very limited containment in order to eliminate untraceable moisture migration across roof decks.
- Membranes tenaciously adhered to the structural deck stop below-membrane water migration and make it far easier to locate and repair any leakage or damage should it occur.
- Structural Concrete decks are preferable to steel and wood decks.
- Irrigation considerations appear more important than the industry originally thought.
- A low-slope drainage gradient is often not provided but remains highly desirable.
- Ensure the waterproofing membrane can repel plant roots or that a FLL approved root barrier is used to protect the waterproofing membrane.
- Reasonable design considerations for water accessibility and pedestrian safety are necessary.
- Select and prequalify experienced contractors to install the waterproofing and vegetation.
- Roofing is hard work conducted in harsh environments. Having an experienced and dedicated installation team is a major key to success.
- Remain mindful of changing code requirements and the various load factors.
- Chose a Team Leader who understands the macro picture, a Green Roof Professional (GRP) being a good place to start.

- It takes a lot of different players to bring all the elements of a green roof to fruition so utilize the "Early Team" approach with all involved parties followed by a pre-construction meeting with all stakeholders.
- Involving the manufacturer in design and on-site quality control monitoring is advised.
- Construction sequencing is an all-important consideration that may not always please general contractors and construction managers. Fight for what is right! Properly scheduled installation will limit construction traffic over completed waterproofing and vegetation.
- Most leaks that occur with waterproofing are the result of some form of error or abuse that occurs during or soon after the installation process.
- Quality control with qualified, independent auditors should be a vital component of any green roof installation. It is money well spent.
- Electronic leak detection before and after installing the overburden is highly recommended. Keep the wiring in place for future use.
- Maintenance requirements for waterproofing, growing media amendments and vegetation need to be clearly specified and enforced.
- Examine and compare warranties but DO NOT count on them to keep the water out. They are no substitutes for quality products, design or workmanship.
- Green roof repairs, which are mostly avoidable, can easily cost ten times more than a conventional roofing system. The economies dictate – do it right the first time!

In conclusion a well-designed, well-constructed and well maintained green roof will result in the most economical, environmentally desirable, long-life green roof installation, lasting longer than the brick and mortar.

Tim Barrett, RCI, RRC, CSI, CDT, GRP is the President of Barrett Company, Millington, NJ a provider of green roof systems as well as high performance waterproofing and roofing systems.

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1285 Ritner Highway, Carlisle, PA 17013, carlislesyntec.com

CITY OF TORONTO ECO-ROOF INCENTIVE PROGRAM
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toronto.ca/livegreen/ecoroofs

DOWNES TREE SERVICE
65 Royal Ave., Hawthorne, NJ 07506, downestreeservice.com

ETERA
14113 River Bend, Mount Vernon, WA 98273, etera.com

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JAKOB
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jakob-usa.com

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UPCOMING CONFERENCES

GREY TO GREEN 2018
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CITIESALIVE 2018
Brooklyn, NY: September 24-28

WORLD GREEN INFRASTRUCTURE CONGRESS
Bangalore, India: June 5-6. worldgreenroof.org

UPCOMING LOCAL MARKET SYMPOSIA

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VANCOUVER SYMPOSIA
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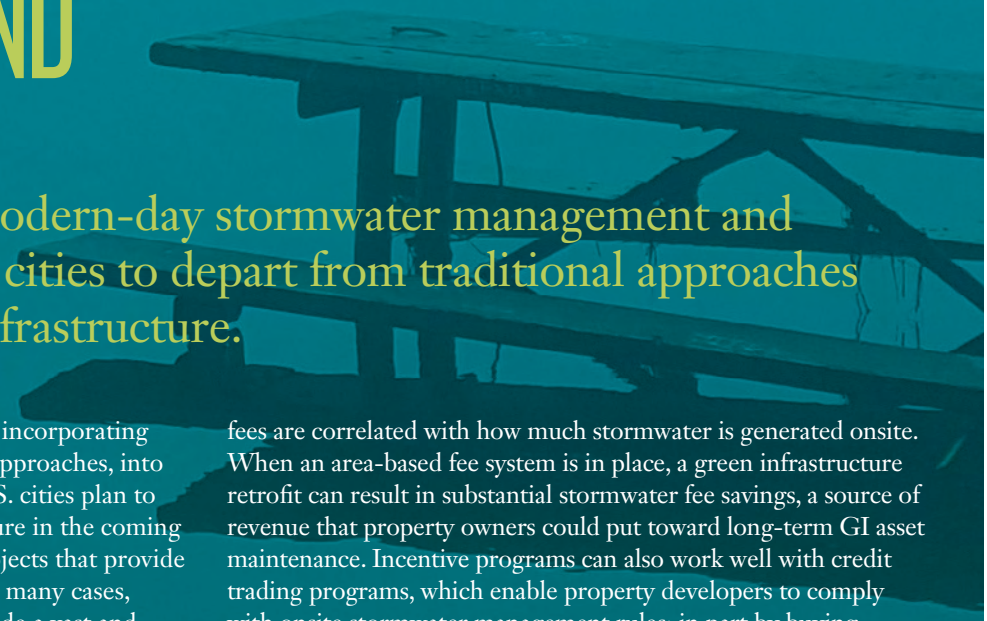
HOUSTON SYMPOSIA
October 22, 2018

Contact Blaine Stand for symposia booth and speaking opportunities. bstand@greenroofs.org

MAKING STORMWATER MARKETS: HOW CITIES CAN SPUR VOLUNTARY GREEN STORMWATER MANAGEMENT ON PRIVATE LAND

BY ALISA VALDERRAMA



The twin challenges of modern-day stormwater management and climate resilience require cities to depart from traditional approaches to a new view on water infrastructure.

To address these challenges, many cities are incorporating decentralized "green infrastructure (GI)" approaches, into their water infrastructure planning. As U.S. cities plan to spend tens of billions on green infrastructure in the coming years, it will be crucial for them to invest in projects that provide the maximum social benefit per dollar spent. In many cases, managing stormwater on private land can provide a vast and largely untapped opportunity for these lower-cost multi-benefit projects. However, capturing those opportunities will require cities to implement new policies and programs to motivate private property owners to act.

Of the cities that have large-scale GI commitments, most are currently relying heavily on building green infrastructure on publicly-owned land and in the public right-of-way. However, public space is limited: over 50 per cent or more of impervious area in any given city may be privately owned. Cities are finding that very low-cost green stormwater management opportunities exist on private land. For example, in 2013 the City of Philadelphia was paying approximately $250,000 per acre to capture stormwater from one impervious acre in the public right-of-way. By creating incentive programs that offer $100,000 toward the cost of a "greened acre" on private property, the City has managed to spur private property owners to green their own parcels, and thereby greatly reduce the City's overall costs.

Private property GI incentive programs are important beyond providing water quality benefits. They can also be targeted to motivate greening in the areas of a city that would stand to benefit most from GI's advantages such as temperature regulation, improved air quality, green jobs, or beautification.

Incentive programs work best when coupled with area-based stormwater billing systems, where property owners' stormwater fees are correlated with how much stormwater is generated onsite. When an area-based fee system is in place, a green infrastructure retrofit can result in substantial stormwater fee savings, a source of revenue that property owners could put toward long-term GI asset maintenance. Incentive programs can also work well with credit trading programs, which enable property developers to comply with onsite stormwater management rules; in part by buying stormwater capture credits from owners who voluntarily retrofit. In Washington D.C.'s stormwater credit trading program, for example, the city has committed to buy nearly $12 million in stormwater retention credits - setting a "price floor" - which effectively creates an incentive program similar to the one in Philadelphia.

For cities that successfully use incentive programs, payoffs can be substantial. Not only can decentralized GI on private land cost less and deliver more benefits; but creating a market for private property retrofits also widens the range of available private financing mechanisms. These can be structured so that the city pays based not only on project completion but on measured project performance (e.g., gallons of stormwater reduced).

The more that cities embrace stormwater management on private property, the more we will have a cleaner, greener future where cities are able to better manage risks, keep water rates low, and provide the widest possible range of environmental, economic, and social benefits from each public infrastructure dollar spent.

Alisa Valderrama is Founder of Neptune Street Environmental Markets Advisors. Previously, she was Director of Water Infrastructure Finance at the Natural Resources Defense Council and co-author of "Catalyzing Green Infrastructure on Private Property: Recommendations for a Green, Equitable, and Sustainable New York City (2017)."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