

TORONTO TRANSIT COMMISSION REPORT NO.

MEETING DATE: June 13, 2007

SUBJECT: GREEN ROOF FEASIBILITY REPORT
ROOFING REHABILITATION PROGRAM

RECOMMENDATION

It is recommended that the Commission:

1. Endorse adoption of the City of Toronto report "Making Green Roofs Happen" to buildings owned by the Toronto Transit Commission.
2. Approve the staff recommendation to implement a green roof pilot project at the existing Victoria Park Subway Station, new Victoria Park Canopy, and the existing Wilson Carhouse (cool roof).
3. Authorize staff to seek approval of additional funds of \$3,200,000.00 (\$2,700,000.00 for Project 3.1 Finishes, Roofing Rehabilitation Program and \$500,000.00 for Project 3.9 Buildings and Structures Projects, Victoria Park Bus Terminal Replacement) in order to implement the green roof pilot project at the above locations as part of the 2008-2012 Capital Program, subject to City approval of the project and additional funding.
4. Forward this report to the Deputy City Manager and Chief Financial Officer, the City Manager and the City Budget Committee for consideration and confirmation of increased debt target financing and funding through the Green Municipal Funding Program.

FUNDING

Funding for the roofing program is included in Project 3.1 Finishes, Roofing Rehabilitation Program (as set out on pages 529 to 538 of the State of Good Repair/Safety Category) of the TTC 2007-2011 Capital Program, which was approved by City Council on March 7, 2007.

Funding for the Victoria Park Canopy is included in Project 3.9 Buildings and Structures Projects, Victoria Park Bus Terminal Replacement (as set out on pages 905R to 907R of the State of Good Repair/Safety Category) of the TTC 2007-2011 Capital Program, which was approved by City Council on March 7, 2007.

The current approved funds do not include green roof alternatives, and as such additional funds of \$3,200,000.00 would be required to install green roofs / cool roofs for the pilot projects proposed for existing Victoria Park Station (\$2,300,000.00), new Victoria Park canopy (\$500,000.00) and

existing Wilson Carhouse (\$400,000.00). An additional \$5,800,000.00 would be required for the remaining locations identified in the five year window, totalling \$9,000,000.00 for the proposed green roof / cool roof initiative.

In addition, the new developments; Kipling / Islington Redevelopment, the Station Modernization at Pape and the McNicoll Bus Garage projects would require additional funds of approximately \$10,300,000.00 in order to implement the green roof initiatives. This increase in the initial capital investment is for both the green roofing system and the design and construction of the roof framing to support a semi-intensive green roof.

BACKGROUND

The Commission has approximately 342,000 sq. metres of roofing. The range of roofing materials and construction types consists of all commercially available types, including 4-ply built-up roofing (BUR), single ply Ethylene Propylene Diene Monomer (EPDM), modified bitumen, asphalt shingle, Poly Vinyl Chloride (PVC), urethane foam, and metal roofs. A multi-year Roofing Rehabilitation Program was initiated in 1996 to return the roofs on Commission buildings to a state of good repair, as opposed to spot repairs to deal with emergency situations. Based on previously completed condition surveys, a rolling five year schedule is developed each budget cycle.

On January 31, 2006 Toronto City Council adopted the *Making Green Roofs Happen* report, and recommended that where feasible and practical, green roofs be installed on existing City-owned buildings, including Agencies, Boards, and Commissions, when roofs are due to be replaced.

As a result of this initiative the TTC completed a Green Roof Feasibility Study. This study was completed on the majority of large roofs which have been included in the current five year window, prior to any design work being done. The purpose of the study was to evaluate the feasibility of incorporating green roofs during future roof replacements using life cycle cost analysis and to develop a framework by which additional TTC buildings can be evaluated.

DISCUSSION

The Green Roof Study assessed the suitability of the following sites:

- Greenwood Shop and Offices (17,000m²)
- Victoria Park Station (8,600m²)
- Malvern Garage (23,000m²)
- Lawrence West Station (3,700m²)

- Davenport Garage (5,520m²)
- Davisville Station (2,100m²)
- McNicoll Garage (25,500m²)

The City of Toronto defines a green roof as one in which a vegetated area becomes part of the roof and includes the following layers: vegetation, growing medium, filter layer, drainage layer, root resistant layer, insulation, and waterproofing membrane. Green roof benefits include storm water mitigation, increased membrane service life, reduced cooling costs, improved air quality, reduced urban heat island effect, increased urban green space, and many more. The cost of a green roof is significantly greater than that of a conventional roof but this can be offset by its extended service life.

Methodology

The following phased approach was employed to complete the Green Roof Feasibility Study on existing TTC roofs.

1. Structural Assessment

A preliminary structural assessment of each building was conducted to determine their reserve structural capacities and the building's ability to accommodate a green roof installation. It should be noted that further detailed structural analysis will be conducted prior to the implementation of a green roof.

2. Detailed Investigation

This included an assessment of each site and its context pertaining, but not limited to: neighbouring buildings and properties, orientation, site greenspace, views to and from the roof and potential benefits from a green roof installation.

3. Life Cycle Cost Analysis

A life cycle cost analysis was then performed for each building to compare the green roof options to the base case of the conventional 4-ply built-up TTC roofing standard.

Green Roof Categories

The following is a brief description of the categories generally used to describe green roof installations – Extensive, Semi-Intensive and Intensive:

Extensive Assemblies

Extensive green roofs generally consist of a growing medium with a depth of 75mm to 150mm (3" to 6"), with plants growing either in a mat or in a loose laid growing medium. Because of their lower weight, extensive green roofs are often suitable for large areas and retrofit applications where structural improvements are cost prohibitive. This option also has lower initial capital costs than the other types of green roofs and, once vegetation is established, lower maintenance costs as well.

Semi-Intensive Assemblies

Semi-intensive systems generally consist of a growing medium with a depth ranging between 100mm to 200mm (4" to 8") with plants growing either in loose laid growing medium or in trays.

Semi-intensive green roofs can take advantage of areas with greater loading capacity and can be planted with greater bio-diversity than extensive roofs. Initial capital cost and maintenance costs are in between the extensive and intensive options.

Intensive Assemblies

Intensive green roofs generally consist of a growing medium with a depth greater than 200mm (8"). The weight for an intensive green roof can vary widely depending on the depth of the growing medium used. Intensive green roofs have better stormwater management properties, greater biodiversity potential, and a greater opportunity for human uses, but at the price of greater initial capital cost, higher maintenance costs and greater structural load.

Cool Roof (Light Coloured Roofing)

Although not a green roof, an alternative roof that would reduce cooling costs and the urban heat island effect is a cool roof. Cool roofs work by reflecting a greater percentage of solar radiation than do normal dark coloured roofs, thereby decreasing a building's heat gain. This feature typically involves installing a white roof membrane or white/reflective ballast and coating to the roof's surface.

Results of the Study

Upon completion of the preliminary structural analysis, detailed investigation and life cycle cost analysis, it became evident that generally reinforcing an existing building's roof framing to carry the additional loading associated with a green roof is not economically feasible and in many cases would be extremely disruptive to TTC operations. For these scenarios the cool roof alternative would be recommended.

Greenwood Shop and Offices, Victoria Park Subway Station, Lawrence West Station and Davisville Station southbound platform were found to be suitable for green roof applications subject to detailed structural analysis. These buildings appear to have reserve structural capacity that will permit the installation of green roofs with minimum growing medium requirements. An extensive green roof assembly is recommended at these green roof candidate buildings. The life cycle cost analysis, which included a net present value analysis, was performed for the green roof candidate buildings over a 35 year study period. The results of the life cycle cost analysis demonstrated that the green roof installations would break even compared to the current TTC standard roofing system. However, an increase in initial capital investment of approximately 50% would be required to upgrade from the standard TTC built up roof to an extensive green roof, provided no structural reinforcement is required.

Davenport Garage, Davisville Subway Station northbound platform and Malvern Garage were not identified as green roof candidates due to structural limitations and it is recommended that a cool roof (white/reflective ballast and coating to the roof's surface) be installed at these buildings. An additional initial capital investment of approximately 10% would be required to implement the cool roof. However, the life cycle analysis demonstrated that the cool roofs would generally result in a savings of approximately 5% as compared to the standard TTC built up roof.

For new developments such as the McNicoll Bus Garage the installation of a semi-intensive green roof assembly would require structural reinforcement in order to carry the additional load. Based on the life cycle analysis conducted and the limited preliminary structural analysis, the results show that the net present value after 35 years indicates that the green roof assembly would be approximately 50% higher than that of the standard TTC built up roof. However, due to the limited analysis performed (one location) every new facility would need to be analyzed on a case by case basis.

Due to the need to fully assess the costs and impacts of a green roof / cool roof, a pilot project is recommended. Victoria Park Subway Station and Wilson Carhouse have been selected as the pilot project sites. Victoria Park Subway Station and the new canopy were selected for an extensive green roof because they are highly visible, clear of equipment and Victoria Park Station will be undergoing construction as part of the station modernization project. The Wilson Carhouse is selected for a cool roof (white/reflective ballast and coating to the roof's surface) application since that option is currently being proposed for the Wilson Carhouse Expansion project.

The duration of the pilot project is recommended to be for five years in order to allow the green roof to be fully developed and properly maintained. In addition to helping the TTC develop a green roof standard, some of the objectives of the pilot project would be to:

- assess appropriate application of green roof standards to TTC facilities;
- fully assess maintenance resources and costs associated with green roofing and develop the necessary skills to successfully manage the roofs;
- provide a sufficient period to evaluate the suitability of different vegetation/growing mediums and surfaces;
- allow lessons learned to be implemented on future green roof projects; and
- factor the results of the pilot project into future roofing standards and future capital program requests.

In order to implement the green roof pilot project for these two buildings, approximately \$3,200,000.00 would be required.

JUSTIFICATION

The City of Toronto recommended that where feasible and practical, green roofs be installed on existing City-owned buildings, including Agencies, Boards, and Commissions, when roofs are due to be replaced.

June 13, 2007
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COMMISSION REPORT RE: GREEN ROOF FEASIBILITY STUDY
ROOFING REHABILITATION PROGRAM
CONTRACT NO. G85-223

#	ROUTING	CONCUR	NON-CONCUR	DATE	ATTACHMENT(S)
3	GM - ENG & CONST				Commission Report
8	GM - EXECUTIVE				
7	GM - OPERATIONS				
6	DEPUTY GM - SUBWAY				
5	GS - PLANT MAINTENANCE				ACTION REQUIRED BY CHIEF GENERAL MANAGER
	GENERAL COUNSEL				<input type="checkbox"/> SIGN AGREEMENT <input type="checkbox"/> RECEIVE FOR INFORMATION <input type="checkbox"/> APPROVE <input checked="" type="checkbox"/> APPROVE FOR SUBMISSION TO COMMISSION <input type="checkbox"/> APPROVE FOR SUBMISSION TO CHAIR
4	CHIEF FINANCIAL OFFICER				
	MGR - HUMAN RES				
2	MGR - ENGINEERING				
1	CHIEF PROJ MGR - CONST				
				SIGNATURE	DATE

