

Measuring and Quantifying Our Living Green Infrastructure Assets

International Green City Conference

Wednesday, March 16, 2016

What do we mean by 'green infrastructure'?



We mean LIVING green infrastructure.

Green Infrastructure Focus Areas

Urban
Agriculture

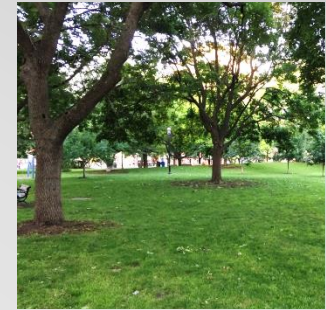
Green
Roofs/Walls

Urban Forest

Stormwater
Systems

Public Spaces

Natural
Heritage



Related Areas

Climate Change

Health

Energy

Urban Forest | Green Roofs | Park and Open Spaces Stormwater Systems | Natural Heritage | Urban Agriculture



Before & After: Artist's rendering of a Philadelphia neighbourhood revitalization using green infrastructure intervention. Philadelphia, PA.

GIO activity areas

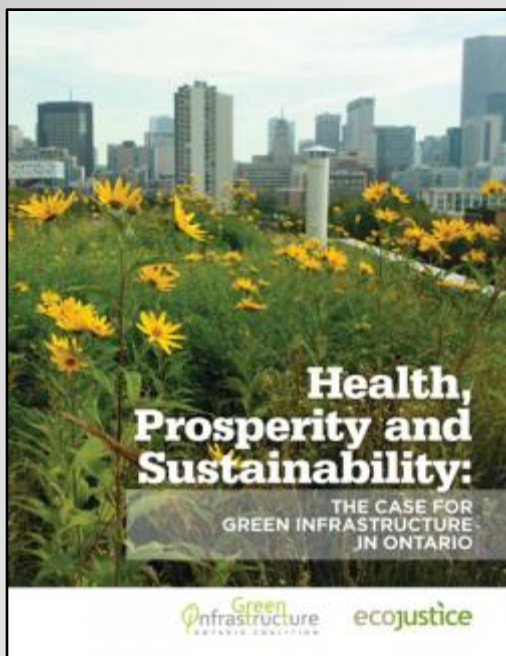


**1) Communication
& Knowledge
Sharing**

2) Advocacy

Communication & Knowledge Sharing

Health, Prosperity and Sustainability: The Case for Green Infrastructure in Ontario



Makes the environmental, social and economic case for green infrastructure protection and investment by the Province of Ontario (available on GIO website)

Communication & Knowledge Sharing

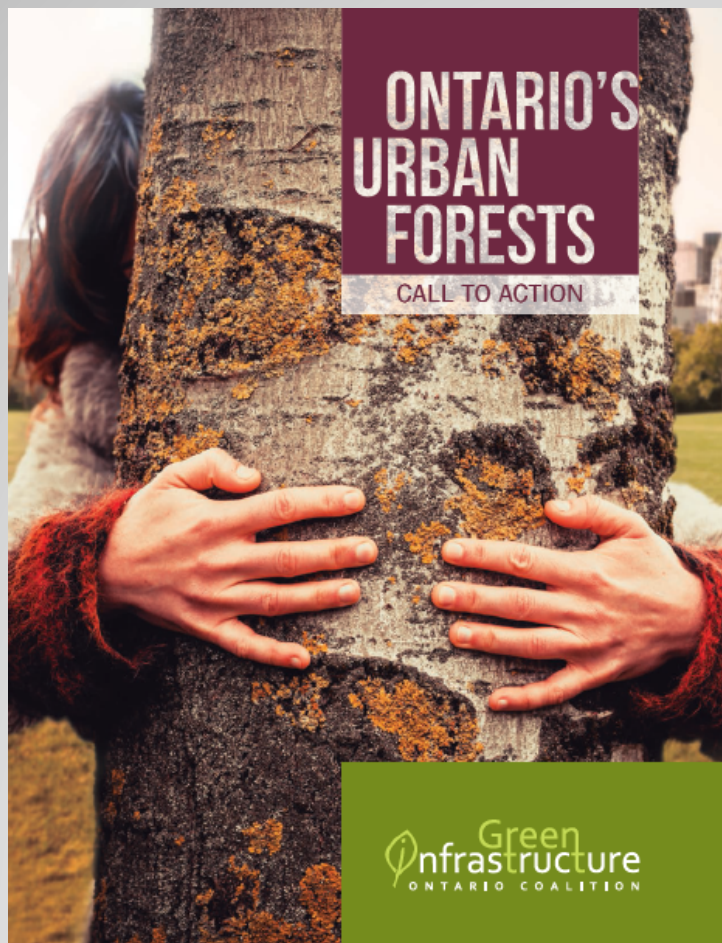
State of the Urban Forest Report

- First ever assessment of regional urban forest canopy
- Presents a strong case of urban forests as infrastructure and the need for asset management



Communication & Knowledge Sharing

Urban Forest Call to Action




Baum Professional Tree Care
Cabbagetown ReLEAF
Citizens Environment Alliance of Southwestern Ontario
City of Oakville
City of Thunder Bay
City of Toronto
Credit Valley Conservation
Deep Root
Evergreen
Forests Ontario
Green Roofs for Healthy Cities
Guelph Forest Friends
Landscape Ontario Horticulture Trades Association
LEAF (*Local Enhancement and Appreciation of Forests*)
More Trees 29
Ontario Association of Landscape Architects
Ontario Parks Association
Ontario Urban Forest Council
ReForest London
Toronto and Region Conservation
Toronto Parks and Trees Foundation
Tree Canada
University of Toronto, Faculty of Forestry
Urban Forest Innovations
York Region

Communication & Knowledge Sharing

Green Infrastructure in Municipal and Regional Official Plans

- 18 of 103 OPs in Ontario include green infrastructure
- All 18 are from 2014 or newer
- Likely a direct result of the updated 2014 Provincial Policy Statement

Official Plans Review



Green Infrastructure and Official Plans in Ontario

Single Tier Municipalities:

- City of Ottawa
- City of Toronto

Regions:

- Niagara Region

Cities/Towns within Regions:

- City of Oshawa (Durham)
- Town of Ajax (Durham)
- City of Brampton (Peel)
- City of Mississauga (Peel)
- Town of Oakville (Halton)
- City of Kitchener (Waterloo)
- City of Markham (York)

Counties:

- Essex County
- Leeds & Grenville County
- Northumberland County

Cities within Counties:

- City of London (Middlesex)
- City of Sarnia (Lambton)

Districts (Major Cities):

- City of Kenora
- City of Temiskaming Shores
- City of Thunder Bay

Who mentions GI?

- 18 of 103 mention green infrastructure (see panel to the left)
- 13 of 18 only mention it between 1-2 times
- 3 of 18 mention it between 3 and 5 times
- 2 of 18 mention it between 6 and 10 times

Single Tier Municipalities:

- The City of Ottawa mentions green infrastructure once, and the City of Toronto mentions it twice.

Regions and cities/towns within regions:

- Of the 6 regional plans, only 1 mentions GI – Niagara Region. It is the only official plan to mention it in Niagara Region, none of the 10 towns/cities in the Niagara region mention GI in any official plans.
- In York region, Markham is the only municipality, including the region itself, to mention GI in its official plan – it mentions it 4 times.
- In Waterloo region, the City of Kitchener is the only municipality to mention GI in its official plan, it mentions it 6 times in 4 separate locations throughout the plan.
- In Peel region, 2 out of 3 municipalities mention green infrastructure in their official plans. The city of Brampton mentions it 6 different times, and city of Mississauga mentions it 3 times.
- In Durham region, the City of Oshawa and the Town of Ajax each mention GI once.
- Halton Region has the least representation of the term, with only one municipality mentioning GI in their plan just once (Town of Oakville).

Counties:

- Out of 17 counties, 3 mention GI in their official plans.
- None of the major cities within those counties mention GI in their official city plans

Cities within Counties:

- Of 22 cities and towns from the counties, only two mentioned GI in their official plan. The city of London (Middlesex County) mentions GI 6 separate times in their plan and the city of Sarnia (County of Lambton) mentions GI twice in their official plan.
- The counties that these cities belong to do not mention GI in their county plans

Districts:

- 3 out of the 11 mentioned GI in their city's plans.
- The city of Kenora, the city of Thunder Bay, and the City of Temiskaming Shores each mention GI once in their official plans.

2 of the 18 plans that mention GI are draft plans, and haven't been approved yet. The oldest plan that mentions GI is from 2013 (City of Brampton). The earliest adopter seems to be City of Ottawa, they added GI with an OMB update in 2011, regarding development applications; as well as the Town of Oakville who consider their urban forests as GI in their 2011 plan. 15 of the 18 plans that mention GI are either from 2014 or 2015

Who Does Not Mention GI?

- Towns and cities within the more rural counties, districts, and regions do not seem to be prioritizing or mentioning GI in their official plans
- 13 of 18 plans mentioning GI have populations over 100,000. 2 of 18 plans mentioning GI have populations below 50,000

How is Green Infrastructure Discussed in Official Plans?

Most Official Plans discuss GI in the context of stormwater management and Climate Change impacts, and with regard to green space and parks. None of the 18 official plans discussed GI in the context of urban agriculture.

The following describes how many of the 18 official plans that mention GI also mention the components that make up the definition of GI:

Green Infrastructure Components:

1. Stormwater Management Systems and Climate Change Impact: 10 of 18
2. Green Space, Open Space, Parklands and Recreation: 8 of 18
3. Urban Forest: 6 of 18
4. Natural Heritage Features: 3 of 18
5. Green Roofs, Gardens: 3 of 18
6. Urban Agriculture: 0 of 18

Other:

- Urban design and community or neighbourhood Building: 3 of 18
- Air/Water/Soil quality: 2 of 18
- Density/intensification: 2 of 18

Depth of GI integration:

- About 20% (3 of 18) of the official plans that mention GI do so in a way that lacks supporting policy context. For example, the plan might say that, "we should pursue GI opportunities", but there is no explanation of how, why or even what GI means.
- Many official plans reference the Provincial Policy Statement's definition of GI

103 Official Plans (total) were examined:

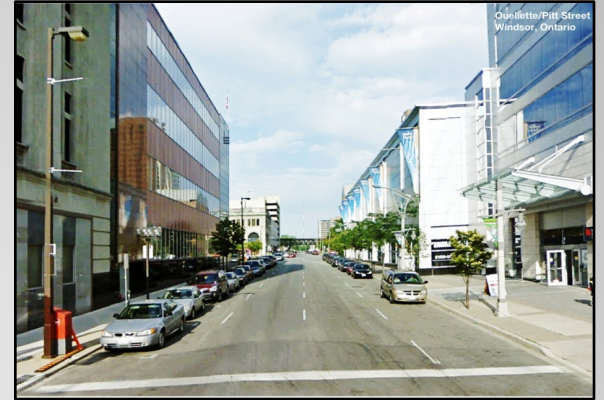
11 single tier municipalities, 6 different regions (along with their cities and towns – townships were not included), 17 counties (and 1-3 of their cities or separated towns), and 11 districts (along with their major city (s), or solely the district where there is a district plan and no major cities.)

Provincial Advocacy - Progress

- Updated Provincial Policy Statement
- Ministry of Environment and Climate Change – Stormwater LID Guidelines
- Climate Change Strategy – “Build Green Infrastructure”
- Coordinated Land Use Plan – Advisory Panel Recommendations

Provincial Advocacy - Focus

- Infrastructure Funding - \$130B committed
- Cap and Trade Program



Streetscape revitalization using green infrastructure intervention. Windsor, ON.

Federal Government – “Green Infrastructure”

- Major infrastructure funding for “Green Infrastructure”
 - Need to make sure LIVING green infrastructure is included in the funding program

Project Introduction

What does a billion dollars of infrastructure buy you these days?



Anywhere from 6 to 250 kilometres of highway



Project Introduction

What does a billion dollars buy you these days?



Approximately one F35 fighter jet

Project Introduction

What does a billion dollars buy you these days?



Security at the 2010 G20 Summit in Toronto, ON

Project Introduction

What would happen if you invested in green infrastructure in your community?



Before & After: Artist's rendering of a Philadelphia neighbourhood revitalization using green infrastructure intervention. Philadelphia, PA.

Project Introduction

CHALLENGES

- How would it transform our community?
- What would it look like?
- How many jobs would get created?
- What would it cost?
- What would the benefits be?
- What's the ROI?
- How do we answer these questions with limited resources?

Project Introduction

OBJECTIVES

- To **create compelling plans** of intense living green infrastructure applications in your community for specific sites
- To **generate a better understanding** of the potential costs and benefits that will result from green infrastructure implementation customized for your community
- To **pull together design and analysis** for a vision of green infrastructure investment in your community
- To **explore what it might mean to invest in green infrastructure** customized for your community

Project Introduction

- **Cost-Benefit Matrix:** To generate a more holistic understanding of the potential costs and benefits that will result from their realization using the customized Green Infrastructure Cost-Benefit Matrix for your community
- **Design Charrette:** To facilitate the creation of compelling plans of intense living green infrastructure applications on two to three real sites from within your community



Before & After: Artist's rendering of a Toronto neighbourhood with green infrastructure. Toronto, ON.

About the Cost-Benefit Matrix

The Matrix is an analytical tool

- A detailed description of fifteen green infrastructure technologies and two costs (capital and annual) and ten benefits for each in **dollars per square meter**
- Based on an extensive review of the literature, and direct input from you
- Provides return on investment: 1-year, 5-year, 25-year and 50-year analysis for the designs emerging from the charrette



City of Toronto extensive green roof at podium. Toronto, ON.



Kauffman Performing Arts Center intensive green roof. Kansas City, MO.

About the Cost-Benefit Matrix

- The Matrix is a tool that provides an **AGGREGATE cost-benefit analysis**, it is **not** for specifying **exact project based costs**
- The Matrix values are derived by **aggregating and simplifying costs and benefits** associated with **15 generic types of green infrastructure** in order to produce a rough estimate for **10 benefits and 2 costs**



Corus Entertainment interior living wall. Toronto, ON.



Brooklyn Grange urban agriculture green roof. Brooklyn NY.

About the Cost-Benefit Matrix

- **The costs and benefits currently covered include:**
 - Cost: Total Capital Cost
 - Cost: Annual Maintenance
 - Benefit: Capital - Biodiversity and Creation of Habitat
 - Benefit: Annual - Stormwater Management
 - Benefit: Annual - Increase in Air Quality
 - Benefit: Annual - Green House Gas Sequestration
 - Benefit: Annual - Reduction in Urban Heat Island
 - Benefit: Annual - Reduction in Building Energy
 - Benefit: Capital - Job Creation
 - Benefit: Annual - Job Creation
 - Benefit: Annual - Property Value/ Taxation Revenue
 - Benefit: Annual - Urban Food Production
- **Selected on the basis of ability to quantify, given current research**
- **Not all types of green infrastructure provide all of the listed benefits**
- **Costs and benefits are expressed as high, medium, low values**

About the Cost-Benefit Matrix

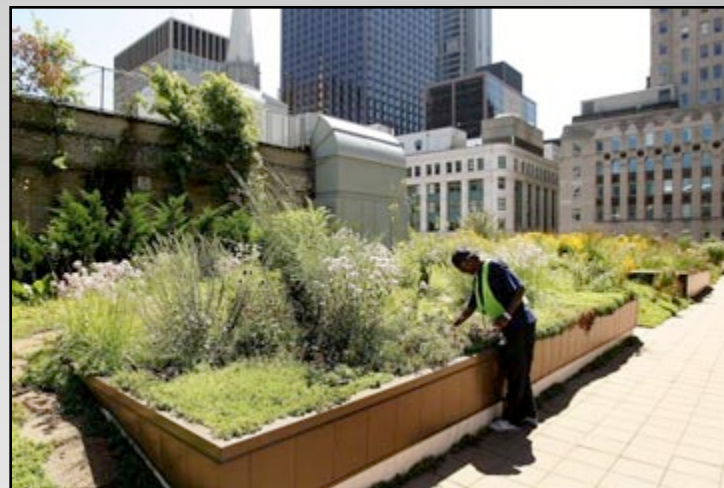
- We are not looking to score a perfect bull's eye with this tool



- We are looking to hit the board and start the conversation about the costs and benefits of green infrastructure investment in your community

About the Cost-Benefit Matrix

- **Sheet 1 – About the Matrix**
 - Project Overview and Introduction
 - How to use the Matrix
- **Sheet 2 – Green Infrastructure Types**
 - Decide if all forms apply to your community
 - Where does the cost lie? (Public or Private)
- **Sheet 3 – Benefits Overview**
 - Decide if all benefit apply to your community
 - Where does the benefit lie? (Public or Private)
- **Sheet 4 – Cost Customization**
 - Select our predetermined Low (L), Medium (M) or High (H) values or input a Custom value (C)
- **Sheet 5 – Calculating Property Tax Benefit**
 - Input average assessed price of a property in your community
 - Input your community's millage rate
 - Select Low (L), Medium (medium) or High (H) percentage increases for property value
- **Sheet 6 – Benefit Customization**
 - Select our predetermined Low (L), Medium (M) or High (H) values or input a Custom value (C)



Chicago City Hall. Chicago, IL.



EcoCenter at Heron's Head Park San Francisco, CA.

About the Cost-Benefit Matrix

➤ **Public or private? To date this is primarily a PUBLIC ROI focused tool**

Generic Green Infrastructure Type	Costs		Benefits									
	\$/m ² (Capital)	\$/m ² (Annual)	\$/m ² (Annual)	\$/m ² (Capital)	\$/m ² (Annual)	\$/m ² (Annual)	\$/m ² (Annual)	\$/m ² (Annual)	job years/m ² (Capital)	job years/m ² (Annual)	\$/m ² (Annual)	\$/m ² (Annual)
	Total Capital Investment	Annual Maintenance	Stormwater Management	Creation of Habitat/ Biodiversity	Increase in Air Quality	Green House Gas Sequestration	Reduction in Urban Heat Island Effect	Reduction in Building Energy	Job Creation from Capital Expenditure	Job Creation from Annual Expenditure	Property Value/ Taxation Revenue	Urban Food Production
Extensive Green Roof												
Intensive Green Roof												
Green Façade												
Living Wall - Interior												
Living Wall - Exterior												
Rain Garden												
Bioswale												
Permeable Surface - Porous paver												
Tree - Small												
Tree - Medium												
Tree - Large												
Wetland												
Planting Bed												
Turf - Active												
Turf - Naturalized												

Public/ Private	
Public	
Private	
None	

Generic Green Infrastructure Types

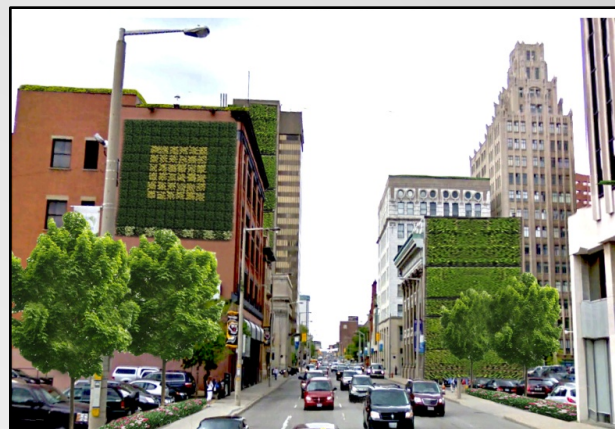
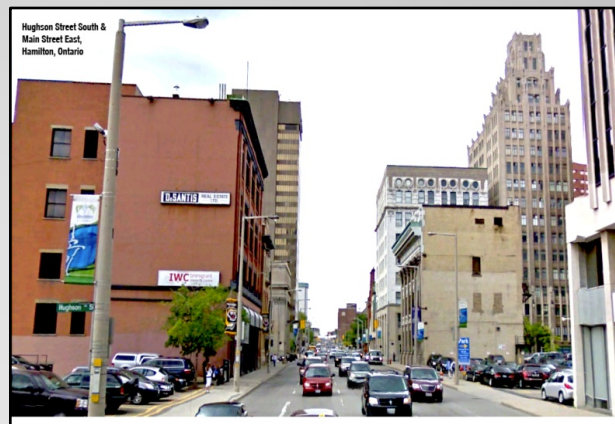
➤ **There are the following generic types of green infrastructure:**

- Extensive Green Roof
- Intensive Green Roof
- Green Façade
- Living Wall – Interior
- Living Wall – Exterior
- Rain Garden
- Bioswale
- Permeable Surface/ Porous Pavers
- Street Tree (Small, Medium, Large)
- Wetlands
- Planting Beds
- Turf (Active and Naturalized)

➤ **These are generic types of living green infrastructure based on literature review and commonly accepted terminology**

Charrette Overview

- Attendees are divided into **two to three multidisciplinary working groups**, with the attendees being comprised of: architects, landscape architects, planners, academics, engineers, developers, decision makers, etc.
- Each group consists of **no more than 10 individuals per specific site**
- Various site design options will be identified **using the Green Infrastructure Cost-Benefit Matrix Types** and the **opportunities and constraints** presented by the site
- Area per type of green infrastructure will be used to allow for a cost-benefit analysis to be conducted the with the Green Infrastructure Cost-Benefit Matrix

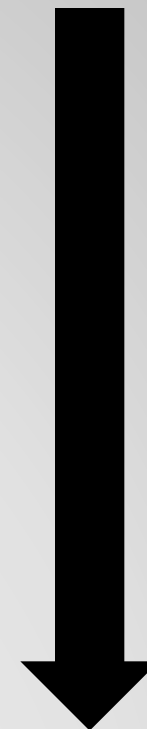


Streetscape revitalization using green infrastructure intervention. Hamilton, ON

Charrette Agenda At A Glance

1. **REGISTRATION AND COFFEE/ LIGHT BREAKFAST** 8:45am – 9:15am (30min)
2. **OPENING REMARKS, OVERVIEW AND INTRODUCTIONS** 9:15am – 10:00am (45min)
3. **WARM-UP EXERCISE** 10:00am – 10:10am (10min)
4. **SITE INTRODUCTIONS AND Q&A SESSION** 10:10am – 10:40am (30min)
5. **VISIONING POST-UP EXERCISE** 10:40am – 11:00am (20min)
6. **APPLICATION OF POST-UP EXERCISE TO SITE CONTEXT** 11:00am – 11:30am (30min)
7. **DEVELOP KEY OPTIONS AT PLAN-VIEW PERSPECTIVES** 11:30am – 1:00pm (90min)
8. **KEY OPTIONS PLAN AND MATRIX EVALUATION EXERCISE** 1:00pm – 2:00pm (60min)
9. **DEVELOPMENT OF FINAL SITE PLAN AND PRESENTATION** 2:00pm – 3:30pm (90min)
10. **DESIGN PRESENTATIONS AND TAKE AWAYS** 3:30pm – 4:15pm (45min)
11. **CLOSING SESSION AND REMARKS** 4:15pm – 4:30pm (15min)
12. **NETWORKING AND TRICKLE OUT** 4:30pm – 5:00pm (30 min)

CONCEPTUAL



TANGIBLE

Charrette Agenda At A Glance



Charrette Deliverables

➤ By end of the day each group should aim to have the following tasks completed:

- To scale plan-view site plan (final polished copy)
- Renderings/ perspective sketches (can be created by hand or digitally)
- Design objectives/ site intervention write up
- Completion of *Green Infrastructure Workbook* (m² quantification of each type)
- Completion of individual feedback forms



Streetscape revitalization using green infrastructure intervention. Windsor, ON.

Project Milestones

➤ Held 4 Design Charrettes with 6 Cities:

- **Vaughan**

- Site 1: Berkeley
- Site 2: Zzen/ Goldpark
- Site 3: Expo

- **Oshawa**

- Site 1: Simcoe Street South 'A'
- Site 2: Simcoe Street South 'B'
- Site 3: Wentworth + Cedar

- **London**

- Site 1: Central Downtown London
- Site 2: Downtown London Gateway

- **Grey to Green Conference**

- **Toronto**

- Site 1: Carlaw + Dundas

- **Mississauga**

- Site 2: Rathburn District

- **Brampton**

- Site 3: Etobicoke River Revitalization



Mayor Maurizio Bevilacqua, Vaughan Design Charrette.



Mayor John Henry, Oshawa Design Charrette.

Vaughan – Site 2: Existing Site Plan



Vaughan – Site 2: Proposed Site Plan



Vaughan – Site 2: Concept Sketches



Vaughan – Full Site: Estimated Costs

Generic Green Infrastructure Type	INPUT		ESTIMATED TOTAL PROJECT COSTS	
	Area (m ²) (without intended agriculture use)	Area (m ²) of Agricultural Use Intended (added benefit, do not duplicate area)	Capital (cost to build)	Maintenance (annual cost to maintain)
Extensive Green Roof	3290	0	\$658,000	\$11,515
Intensive Green Roof	4730	500	\$1,961,250	\$156,900
Green Façade	6490	0	\$973,500	\$64,900
Living Wall - Interior	900	0	\$1,210,941	\$339,093
Living Wall - Exterior	900	0	\$968,751	\$339,093
Rain Garden	1775	0	\$202,528	\$9,177
Bioswale	920	0	\$148,543	\$4,756
Permeable Surface - Porous Paver	5775	0	\$683,818	\$1,328
Tree - Small	6915	0	\$40,245	\$1,660
Tree - Medium	2580	0	\$6,837	\$284
Tree - Large	37192	0	\$78,475	\$2,975
Wetland	930	0	\$15,782	\$251
Planting Bed	4210	0	\$611,797	\$21,766
Turf - Active	2250	0	\$26,393	\$2,138
Turf - Naturalized	5355	0	\$18,796	\$2,088
TOTAL	84212	500	\$7,605,656	\$957,924
	m ² of Green	m ² of Green	Capital (\$)	Annually (\$)

Vaughan – Full Site: Estimated Benefits

Generic Green Infrastructure Type	INPUT		ESTIMATED TOTAL BENEFITS	
	Area (m ²) (without intended agriculture use)	Area (m ²) of Agricultural Use Intended (added benefit, do not duplicate area)	Capital (one time)	Annual (on going)
Extensive Green Roof	3290	0	\$18,292	\$18,376
Intensive Green Roof	4730	500	\$188,960	\$132,044
Green Façade	6490	0	\$33,878	\$10,274
Living Wall - Interior	900	0	\$0	\$49
Living Wall - Exterior	900	0	\$4,392	\$1,533
Rain Garden	1775	0	\$64,131	\$4,917
Bioswale	920	0	\$33,240	\$4,594
Permeable Surface - Porous Paver	5775	0	\$0	\$6,872
Tree - Small	6915	0	\$249,839	\$25,272
Tree - Medium	2580	0	\$93,215	\$11,243
Tree - Large	37192	0	\$1,343,747	\$194,057
Wetland	930	0	\$33,601	\$5,203
Planting Bed	4210	0	\$21,976	\$13,358
Turf - Active	2250	0	\$11,745	\$4,629
Tuf - Naturalized	5355	0	\$193,476	\$14,594
TOTAL	84212	500	\$2,290,492	\$447,014
	m ² of Green	m ² of Green	Capital (\$)	Annually (\$)

Vaughan – Full Site: Estimated Job-Creation

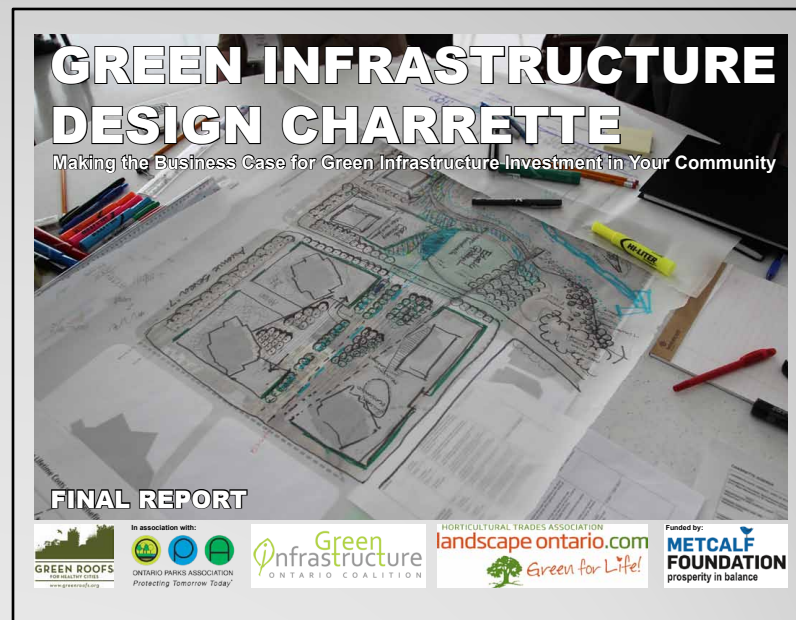
Generic Green Infrastructure Type	ESTIMATED JOB CREATION (person years of employment [direct, indirect and induced])			
	YEAR 1	YEAR 5	YEAR 25	YEAR 50
Extensive Green Roof	11.745	12.732	16.680	21.615
Intensive Green Roof	34.983	48.976	104.948	174.912
Green Façade	34.731	46.309	92.621	150.512
Living Wall - Interior	58.384	88.628	209.606	360.829
Living Wall - Exterior	43.200	73.445	194.423	345.645
Rain Garden	3.613	4.429	7.695	11.778
Bioswale	2.650	3.073	4.766	6.882
Permeable Surface - Porous Paver	12.197	12.312	12.774	13.352
Tree - Small	0.719	0.857	1.411	2.102
Tree - Medium	0.121	0.147	0.250	0.379
Tree - Large	1.413	1.599	2.343	3.273
Wetland	0.282	0.305	0.398	0.514
Planting Bed	10.912	12.849	20.595	30.278
Turf - Active	0.470	0.662	1.427	2.383
Turf - Naturalized	0.337	0.525	1.274	2.212
TOTAL JOB CREATION	215.76	306.85	671.21	1126.67

Vaughan – Full Site: Estimated ROI

Generic Green Infrastructure Type	ESTIMATED PUBLIC RETURN ON INVESTMENT (ROI)			
	YEAR 1	YEAR 5	YEAR 25	YEAR 50
Extensive Green Roof	18,292	80,067	327,164	636,036
Intensive Green Roof	188,960	559,933	2,043,824	3,898,688
Green Façade	33,878	84,957	289,272	544,667
Living Wall - Interior	0	243	1,217	2,434
Living Wall - Exterior	4,392	12,015	42,509	80,626
Rain Garden	-138,397	-159,696	-244,893	-351,390
Bioswale	-115,304	-116,116	-119,367	-123,430
Permeable Surface - Porous Paver	-683,818	-656,098	-545,218	-406,618
Tree - Small	209,594	327,380	798,527	1,387,460
Tree - Medium	86,378	141,045	359,710	633,042
Tree - Large	1,265,272	2,217,703	6,027,429	10,789,585
Wetland	17,819	42,580	141,625	265,431
Planting Bed	-589,821	-631,858	-800,007	-1,010,194
Turf - Active	-14,648	-2,192	47,630	109,908
Turf - Naturalized	174,680	237,207	487,316	799,951
TOTAL ROI FOR SITE REDESIGN	457,278	2,137,170	8,856,738	17,256,197

Executive Summary & Full Final Report

- Digital final report is available online at:
www.greenroofs.org/resources/Charrette_Final-Report.pdf



Measuring and Quantifying Our Living Green Infrastructure Assets

Thank you for your time.

Paul Ronan, Ontario Parks Association