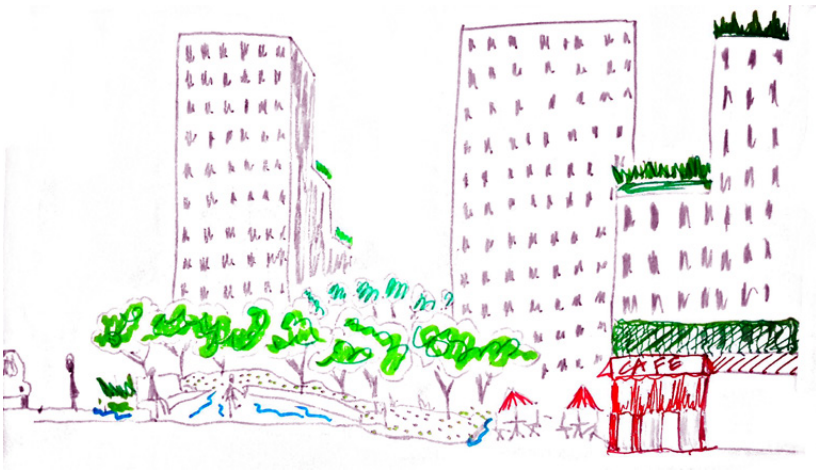

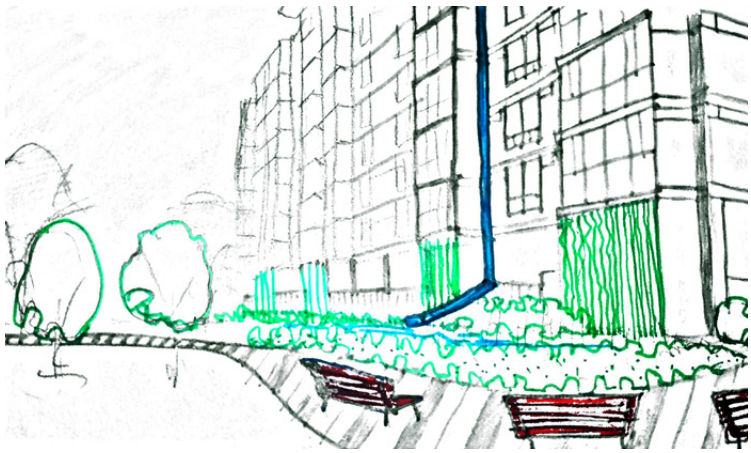

Green Infrastructure in Mississauga, Richmond Hill, and Toronto

A Visualization and Cost-Benefit Analysis

GREEN INFRASTRUCTURE FOUNDATION

ONTARIO PARKS ASSOCIATION
Protecting Tomorrow Today

A Project By

The **Green Infrastructure Foundation** (GIF) partners with communities to shape healthy, resilient, and sustainable places using living green infrastructure.
greeninfrastructurefoundation.org

ONTARIO PARKS ASSOCIATION
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Ontario Parks Association (OPA) is committed to civic beautification, the advancement, protection and conservation of parks, open space and the environment.
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Fondation Trillium de l'Ontario

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Thank you to all participants and municipal staff involved with this project (listed within each chapter)

Contact: Rohan Lilauwala, Program Manager, Green Infrastructure Foundation (rlilauwala@greenroofs.org)

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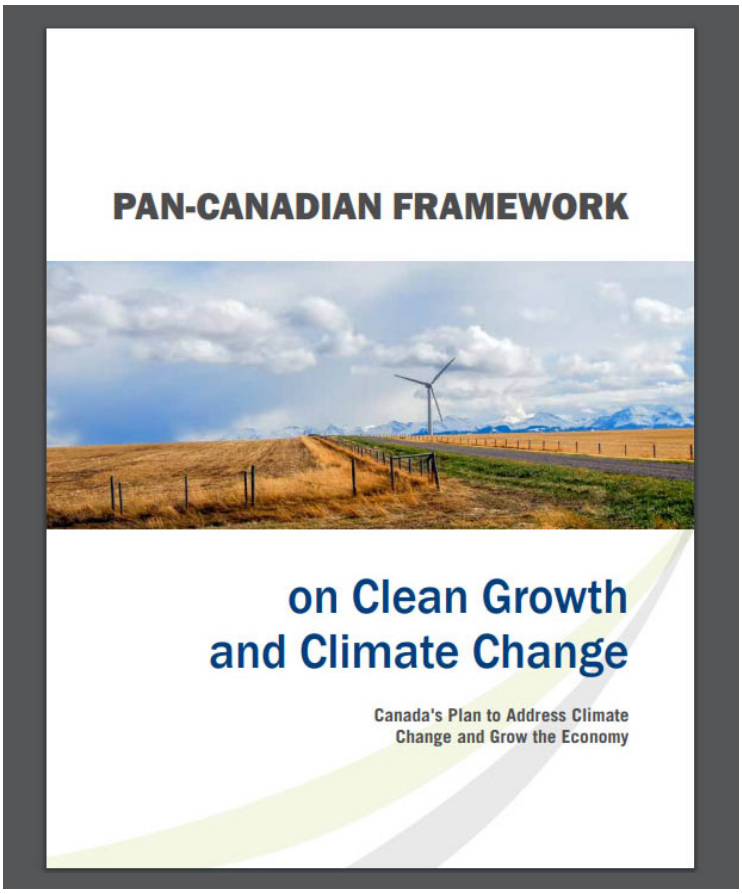
Introduction

Living green infrastructure like street trees, bioswales, green roofs, living walls, and rain gardens helps manage stormwater while providing a myriad of other benefits, including improved water quality, reduced stress on grey infrastructure, groundwater recharge, improved air quality, and greenhouse gas sequestration. The Federal Government's Pan-Canadian Framework on Clean Growth and Climate Change and Ontario's Climate Change strategy both support green infrastructure, identifying its ability to reduce flooding, improve health, reduce emissions, and increase resilience of communities and ecosystems.

Green infrastructure is increasingly being used in the US; the EPA advocates using green infrastructure for climate resilience, and cities like Philadelphia, New York, and Seattle are investing billions in it. Despite supportive policy changes in Canada, green infrastructure is still an under-utilized approach, even though it is an accepted practice in the US, and effectively complements traditional grey infrastructure.

Municipal governments have identified a lack of capacity about how to envision, value, create policy for, and implement green infrastructure as the biggest obstacle to its widespread use.

The *Green Infrastructure Engagement, Valuation, and Training Program*, supported by the Ontario Trillium Foundation aims to overcome these obstacles and build capacity in the municipal sector and beyond to use and realize the benefits of green infrastructure.



The program is composed of two main elements:

- A green infrastructure cost-benefit matrix
- A one-day green infrastructure charrette

Green Infrastructure Cost-Benefit Matrix

The Green Infrastructure Cost-Benefit Matrix is a tool that allows for an aggregate-level economic analysis to be conducted. It includes two costs and ten benefits for fifteen different types of green infrastructure.

Costs and Benefits

- Construction Cost
- Maintenance Cost
- Stormwater Management
- Urban Heat Island Reduction
- Energy Savings
- Air Quality Improvements
- Creation of Habitat/Biodiversity
- Greenhouse Gas Sequestration
- Increase in Roof Lifespan
- Food Production
- Construction Jobs Created
- Maintenance Jobs Created

An example of a rain garden used to manage stormwater runoff in a residential area. Photo: US EPA

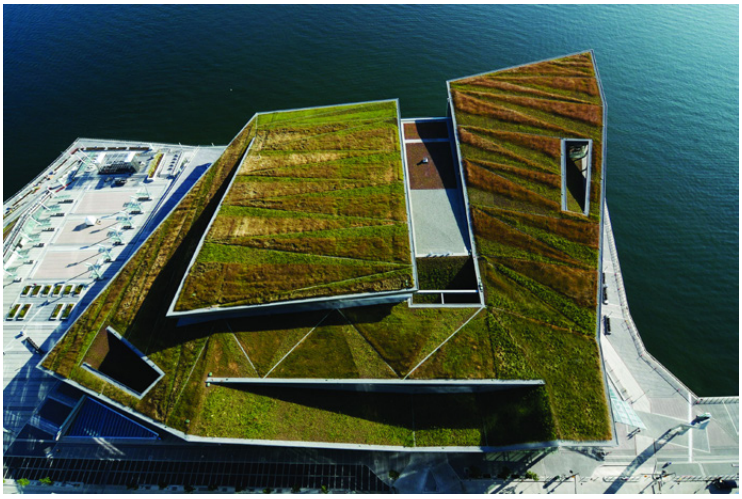
Types of Green Infrastructure

- Extensive Green Roofs
- Intensive Green Roofs
- Exterior Living Walls
- Interior Living Walls
- Green Facades
- Bioswales
- Rain Gardens/Bioretention
- Wetlands
- Planting Beds
- Small Trees
- Medium Trees
- Large Trees
- Naturalized Turf
- Active Turf
- Permeable Paving

The green infrastructure cost-benefit matrix is an aggregate-level tool, meaning it is not designed to analyze a specific project, but to start a discussion and set the stage for detailed study. It has many limitations - the largest one is that many benefits are not monetized, leading to a very cautious analysis. These benefits include improved health, reduced need for grey infrastructure, and increased resilience in the face of climate change - all benefits that could have an immense impact at a large scale. For more information about the green infrastructure cost-benefit matrix, see Appendix A.

Green Infrastructure Charrette

Green Infrastructure Charrettes brought together teams of interdisciplinary experts and local stakeholders. The participants were provided information about the site, including maps, photos, aerials, relevant policies, opportunities, and constraints. They were then tasked with creating conceptual plans for actual sites, using a menu of different green infrastructure technologies.



The Vancouver Convention Centre is an extensive green roof. 2010 GRHC Award Winner: PWL Partnership Landscape Architects Inc.

Following the charrette, the redesigns were then subjected to the cost-benefit matrix to conduct an aggregate economic analysis. The visuals and narratives created by the participants were combined with the economic analysis to develop this report.

Two charrettes were held, examining sites from three Ontario communities: Mississauga, Toronto, and Richmond Hill. Public sector employees from different municipal departments were engaged, as well as private sector individuals in the architecture, landscape architecture, planning, sustainability, engineering, land development, academic, and non-profit fields.

Mississauga: ‘Central Park’

Size: Approx 12 Hectares

This site is located just south of Mississauga City Centre, adjacent to Hurontario street, a major corridor that will be home to a planned Light Rail line. The site surrounds Cooksville Creek and has flooding issues. There are proposed plans to turn this area into a park.

While the site is already home to park facilities and established vegetation (above), there is potential to both improve ecological function and increase use and access. The site is also located adjacent to the planned Hurontario LRT (below).

Opportunities & Strengths

- Existing southbound creek flow
- Established tree canopy and vegetation community
- Ecological linkage to adjacent parkland
- Large park property adjacent to established neighbourhood
- Lots of road frontage
- Part of city wide trail networks
- Future rapid transit station within 200m of the site
- Anticipated future growth in the neighbourhood

Constraints & Weaknesses

- Receives runoff from impervious upstream area
- Regularly flooded during storm event

Cooksville Creek is channelized in some areas (top), contributing to erosion issues on the banks (above)

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CANOPY COVER

OPEN SPACE

SITE PLAN **SITE A**

SCALE: 1:1000

0 50 100m

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Toronto | May 8-10, 2017

CONTEXT PLAN **SITE A**

SCALE: 1:2000

0 100 200m

The site plan (top), and its context (above).

Team members

- Paul Ronan, Ontario Parks Association (facilitator)
- Geoff Bayne, City of Mississauga
- Omar Davis, City of Detroit
- Katie Hanrahan, Niagara College
- Marina Haufschild, City of Markham
- Jordan Lambie, City of Barrie
- Charles Ormsby, Arup
- Rick Scaffidi, Environmental Quality Resources Inc.

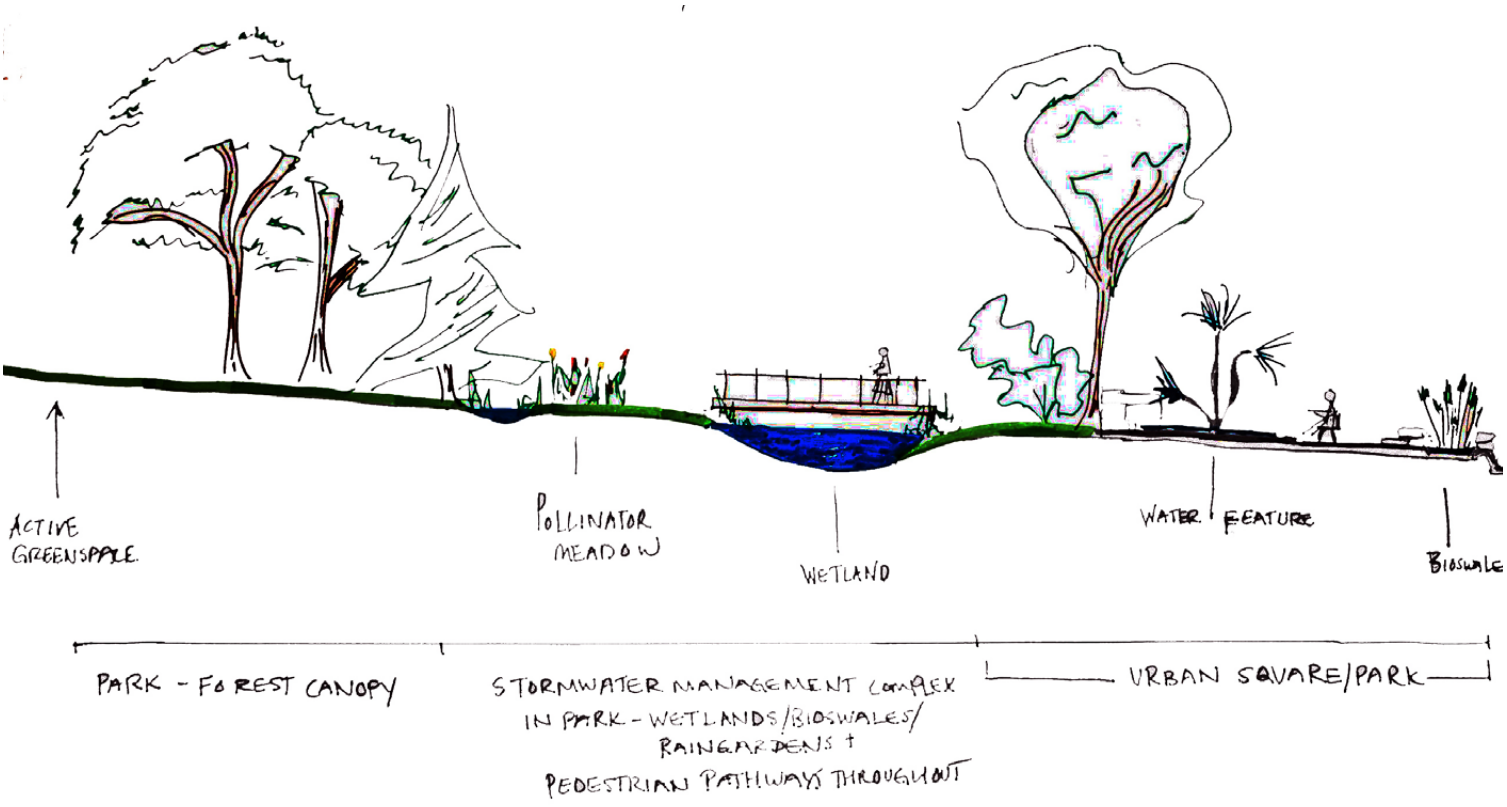
Planning Goals

To imagine a connected public space with flexible programs and functional green infrastructure while preserving and enhancing the current local ecology.

Connected
Transportation & Trail Networks
Accessibility
Integration to Neighbourhood

Public space with flexible programs
Temporal
Multi-Functional
Active/ Engaging

Proposed cross-section through the park.



Infrastructure
Stormwater management
Flood Mitigation

Ecology
Canopy coverage
Flora & Fauna
Aquatic Species

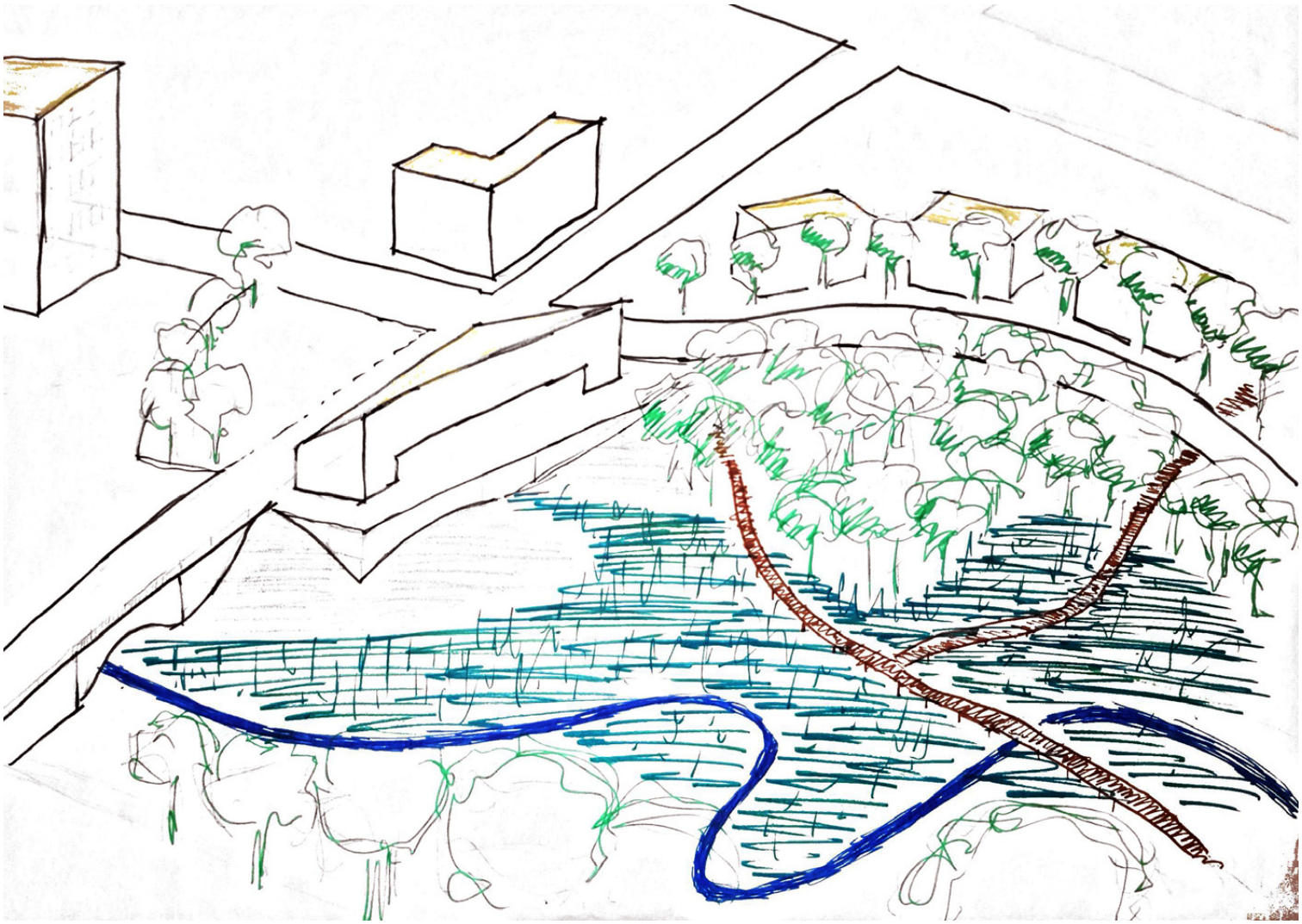
Strategy

The team's strategy was focused on creating a dynamic and engaging park space that could function as Mississauga's 'Central Park'. They embraced the idea of restoring ecosystem function to the site, and embracing water instead of battling it. To that end, the idea of using green infrastructure as a public amenity that could be beautiful and engaging, while protecting downstream and surrounding areas from damage from flooding or compromised water quality. They aim for accessibility and inclusiveness to appeal to Mississauga's diverse population.

Some of their design interventions included:

- Establish a trail system through floodplain
- Create an interpretive environmental centre with exterior green walls and facades

Mississauga 'Central Park' Site Plan

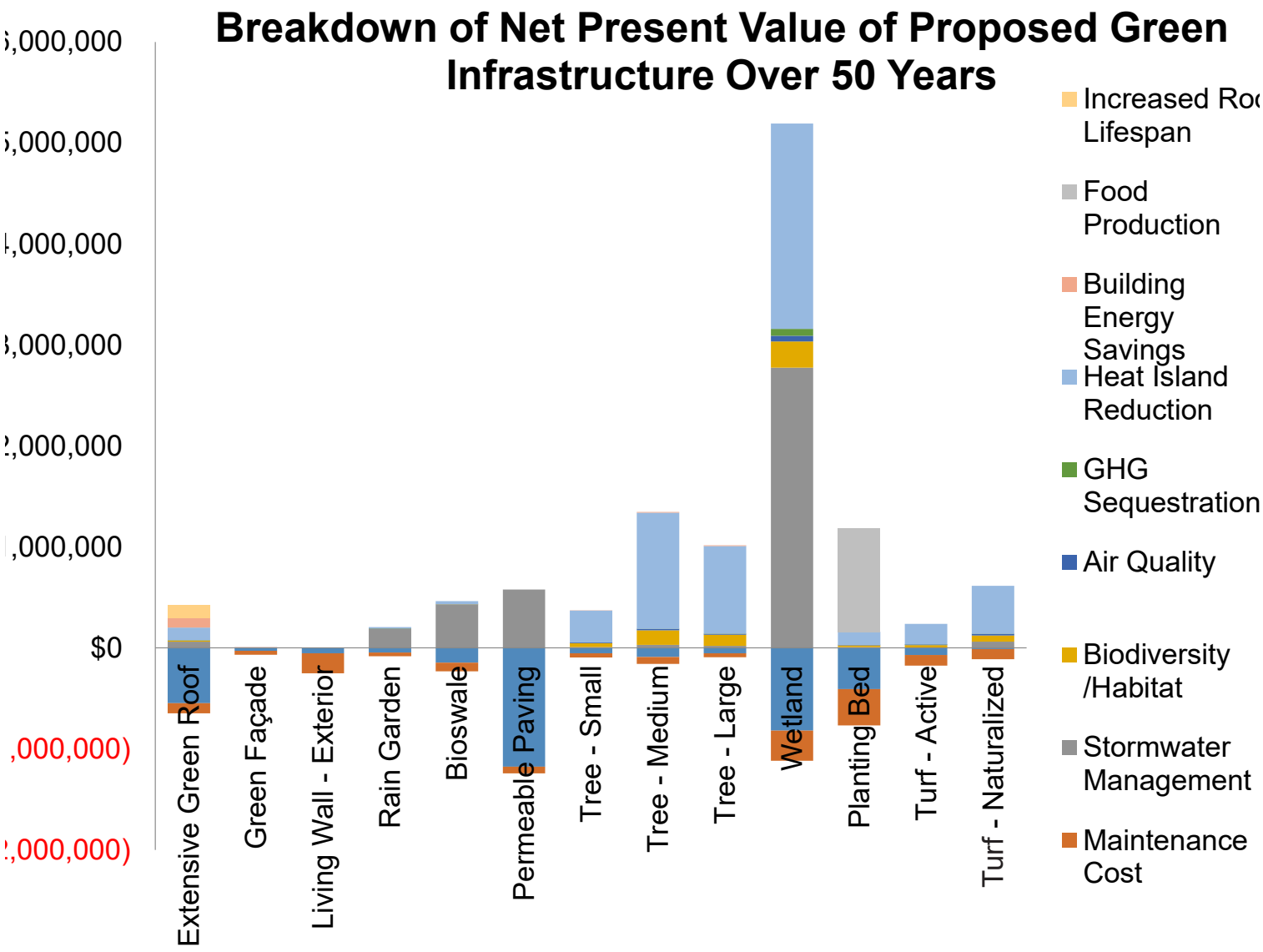


The proposed wetland, trails, and environmental centre in the park.

- Build an amphitheater and urban square adjacent to the environmental centre
- Establish wetlands in the floodplain; widen and lower the floodplain to buffer the creek; create meanders to slow the flow of water and mitigate against erosion
- Build sports fields with stormwater retention capacity
- Ensure all streets in the development are green streets with permeable paving, bioswales along roadways
- Establish an inviting entrance
- Establish a Memorandum of Understanding between Transportation and Parks departments, where runoff from Hurontario street could be captured in the park in exchange for certain benefits or compensation
- Establish vegetation in the LRT right of way

Cost-Benefit Analysis

- Construction cost: $3.5 million
- Annual maintenance cost: $81,500
- One-time benefits: $676,000
- Annual benefits: $581,000
- Job-years (one job-year is one person employed full-time for one year) in construction: 61.9
- Job-years in maintenance: 1.4 annually
- Total job years over a 50 year period: 103.7
- Net Present Value (25 years): $6.6 million
- Net Present Value (50 years): $11.7 million
- Payback Period: 6.2 years
- It is important to consider that many important benefits are not included: amenity space for residents, health impacts, increased property value, reduced flood risk, etc.
- See more information in Appendix



Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)						
Type of Green Infrastructure	**Area**	**NPV of Costs**	**NPV of Benefits**	**NPV**	**Job-years (Construction)**	**Job-years (Maintenance)**
Extensive Green Roof	2,735	($702,142)	$646,728	($55,414)	9.65	2.74
Green Façade	200	($86,725)	$8,254	($78,471)	0.53	1.00
Exterior Living Wall	50	($359,197)	$2,234	($356,963)	0.95	5.39
Rain Garden	400	($104,293)	$316,304	$212,011	0.81	1.04
Bioswale	900	($277,284)	$712,373	$435,089	2.56	2.33
Permeable Paving	15,600	($1,277,224)	$889,329	($387,895)	20.74	1.80
Tree - Small	9,290	($117,304)	$548,489	$431,184	0.95	1.12
Tree - Medium	33,920	($195,713)	$1,993,042	$1,797,328	1.59	1.87
Tree - Large	25,552	($111,892)	$1,504,261	$1,392,369	0.95	1.02
Wetland	60,000	($1,279,669)	$7,855,162	$6,575,492	14.47	8.11
Planting Bed	3,787	($962,932)	$1,818,037	$855,105	7.19	9.80
Active Turf	6,000	($232,045)	$351,940	$119,895	1.24	2.85
Naturalized Turf	14,000	($166,618)	$913,760	$747,141	0.21	2.73
TOTAL	**172,434**	**($5,873,039)**	**$17,559,910**	**$11,686,871**	**61.86**	**41.79**

Mississauga: City Centre Development

Size: Approx 1.8 Hectares

This site is located in Mississauga's rapidly growing City Centre. It is a prime development site located in close proximity to City Hall, Sheridan College, the City Centre Transit Terminal, and many new residential and commercial developments.

There is a significant amount of new development in the area.

Opportunities & Strengths

- Central location adjacent to activity centres
- Mixed use development with high density potential
- Extensive road frontage
- Part of city wide trail networks
- Major transit hub within 200m of the site
- Public park will be located on site
- Greenfield site

Constraints & Weaknesses

- 1500 residential units planned in four towers; expected to occupy 2/3^{rds} of the site

Team members

- David Yocca, Conservation Design Forum (facilitator)
- Alice Dixon, Infrastructure Ontario
- Tanya Lewinberg, City of Markham
- Erika Linenfelser, University of Michigan
- Bryan Macpherson, Land Active
- Tracey Steele, Town of Markham
- Stefan Szczepanski, City of Mississauga
- Kyle Yang, City of Mississauga

The site is a greenfield and largely a blank slate.

Planning Goals

To generate an integrated approach to maximize the need of high quality public space while fulfilling the environmental infrastructure demand.

High Quality Public Space

- Orientated to take advantage of microclimates for maximum pedestrian comfort
- Accessibility
- Integration to Neighbourhood
- Transportation & Trail Networks

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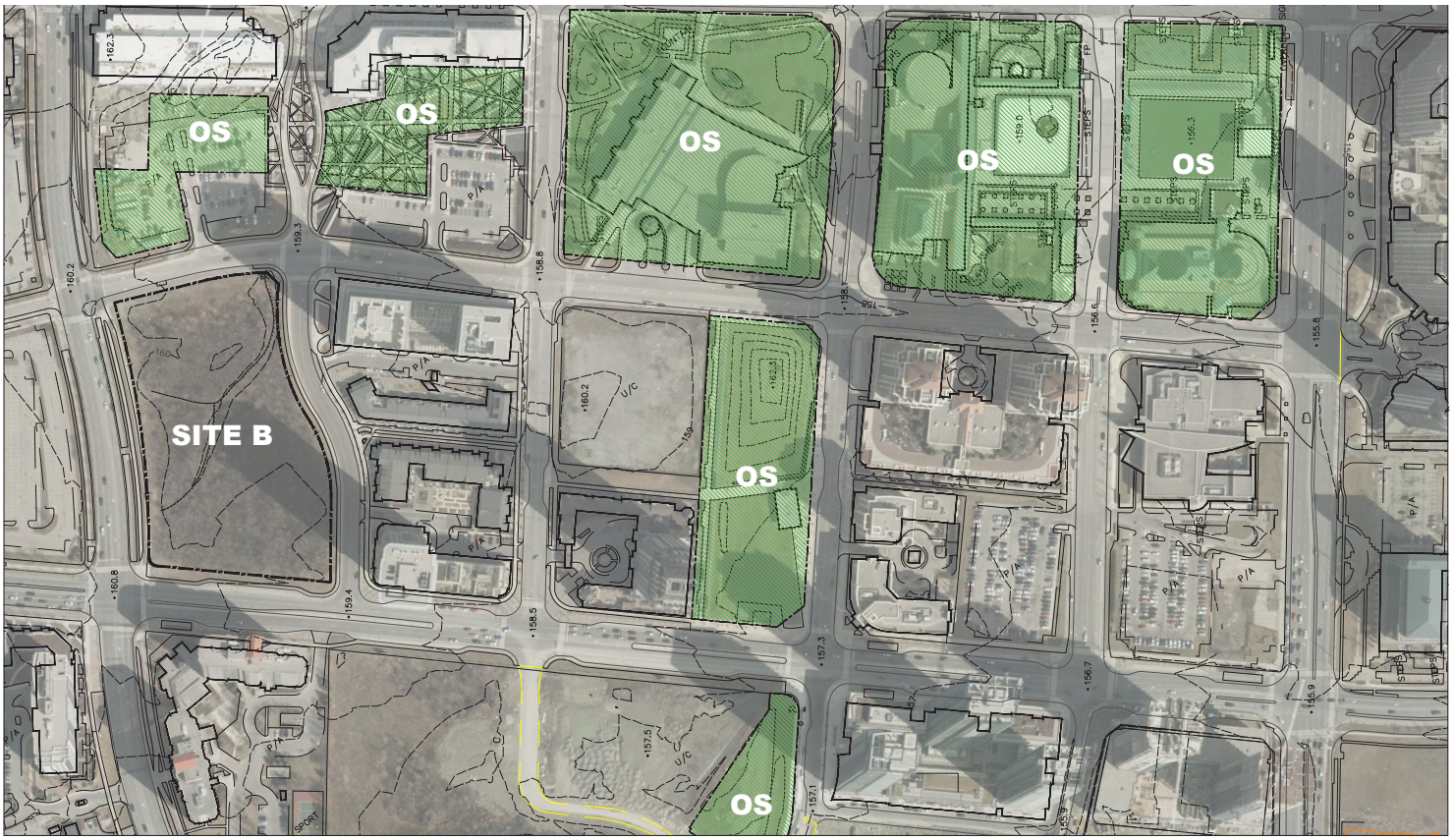
SITE PLAN **SITE B**

SCALE: 1:300

0 25 50m



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CONTEXT PLAN **SITE B**

SCALE: 1:1000

0 50 100m

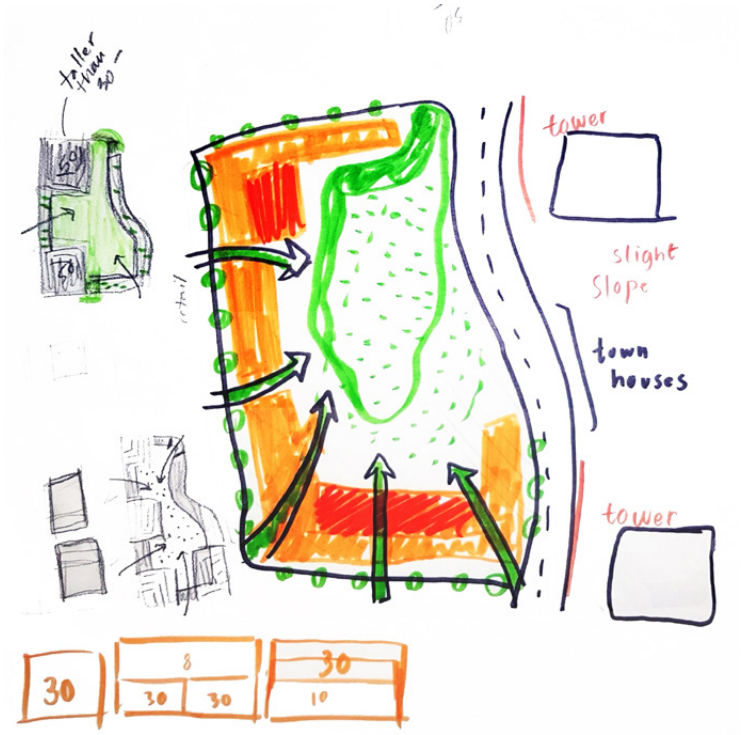
The site plan (top), and its context (above).

Environmental Infrastructure

- Stormwater management
- Energy Use Reduction

Strategy

Through its focus on living systems and integrated design the team aimed to bring multiple services to the site's immediate and surrounding communities. Located in the town centre of Mississauga, the team planned for a mixture of unique architectural morphology and publicly accessible green/blue landscapes to give it a strong identity and turn it into a social draw.

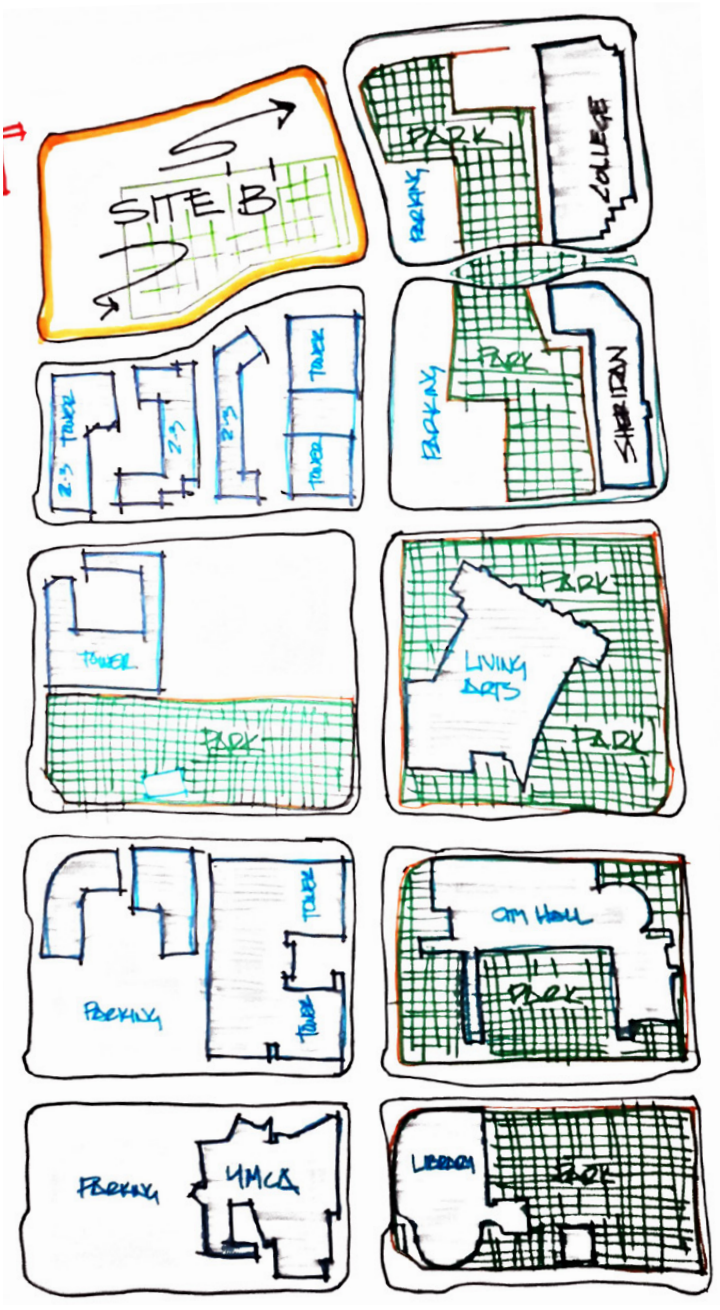


Concept for water flows on site.

The team planned for an active multi-functional site that prioritizes green views for residents and usable green space for recreation, food production and stormwater infiltration. Mixed-uses including residences, on-site retail, and active transport options could serve the daily needs of its users, making it a more complete community.

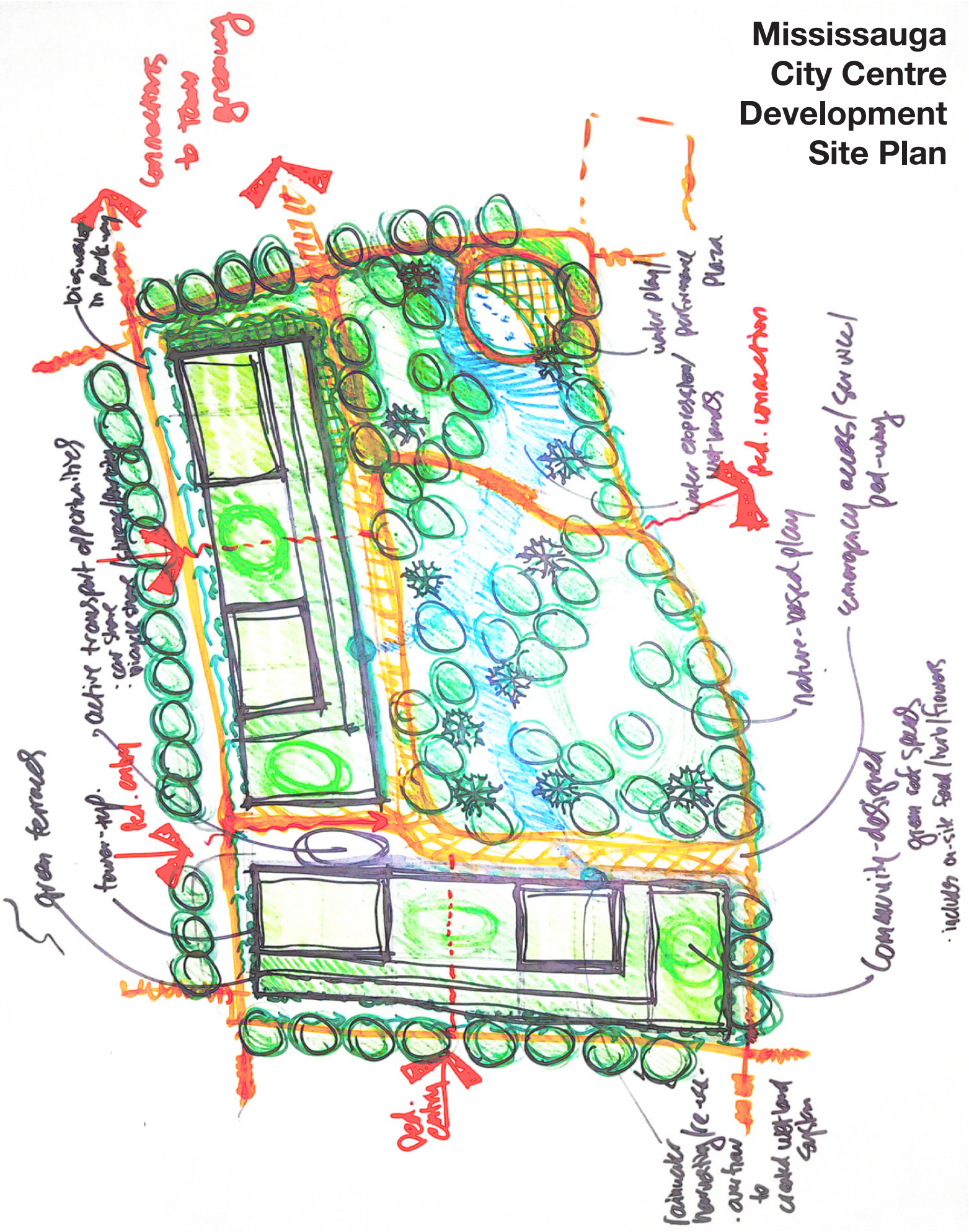
The design included:

- Four towers within two terraced buildings that top out at 30 storeys
- Multiple points of access in and out of the site that connect it with the surrounding community

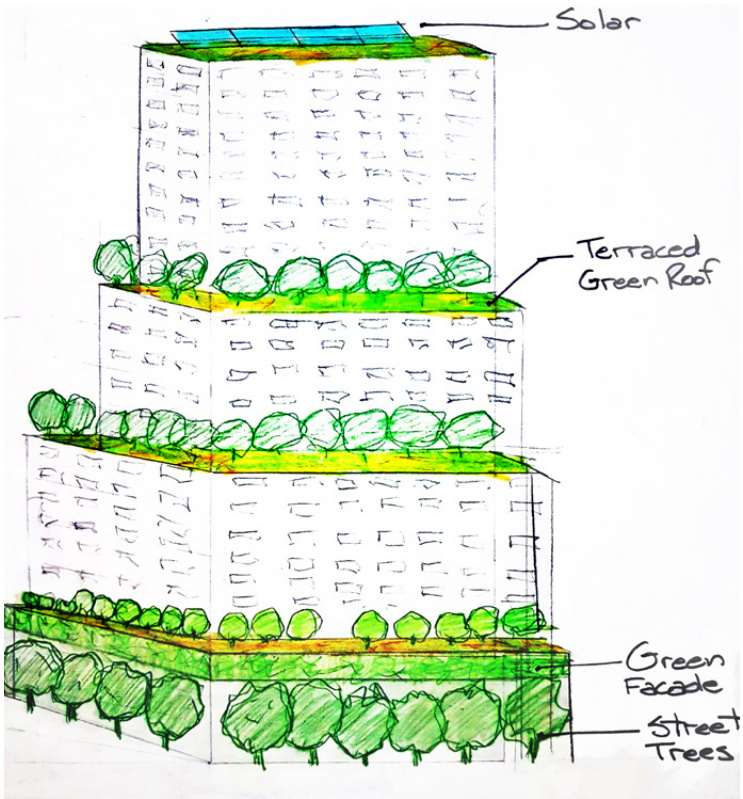


The site in context.

Mississauga City Centre Development Site Plan



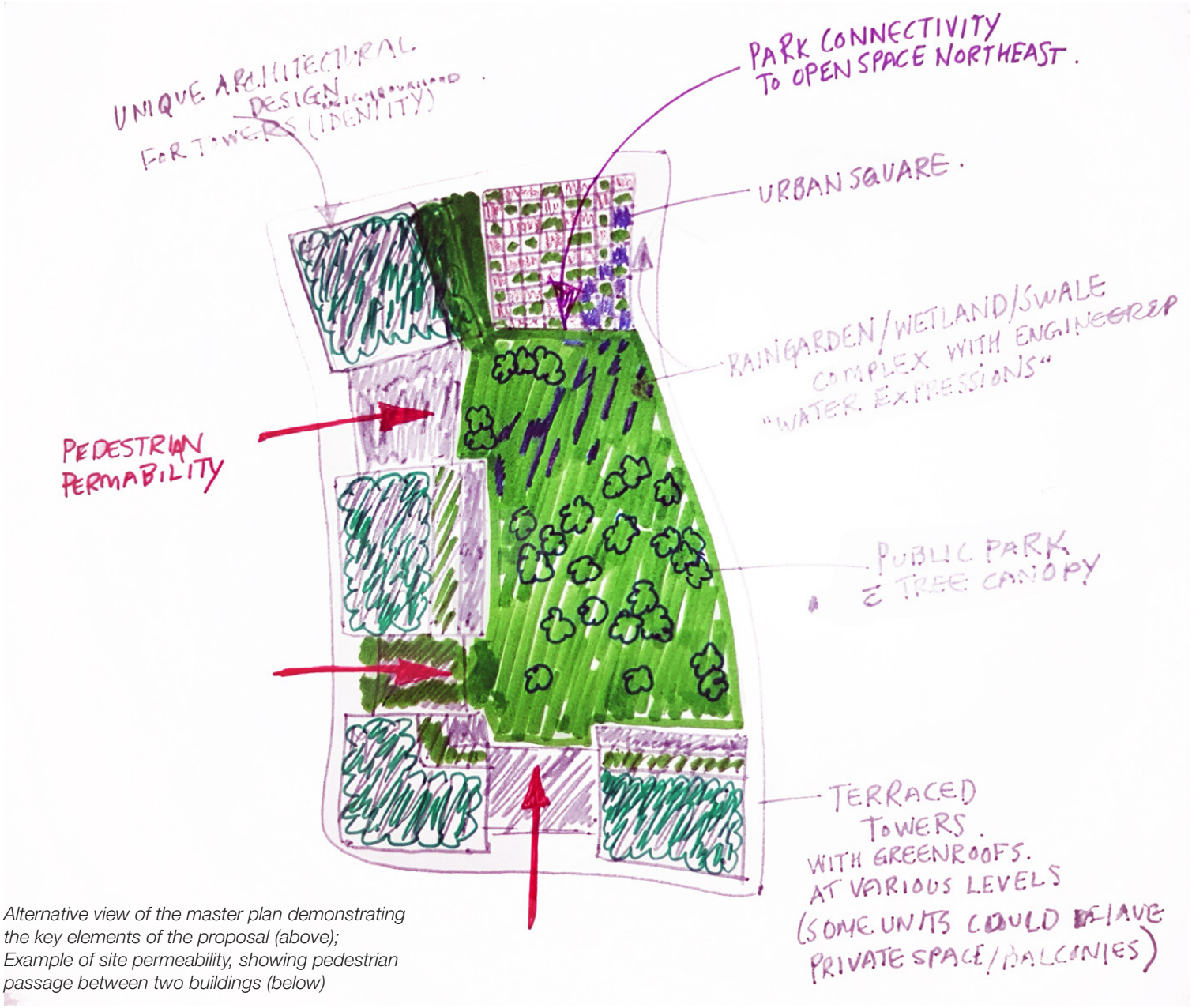
Concept for the public plaza on site, complete with water features, active uses, seating areas, and open access to the site (above); Concept for terraced buildings on site, incorporating green features like green roofs and facades, trees, and solar panels (below).



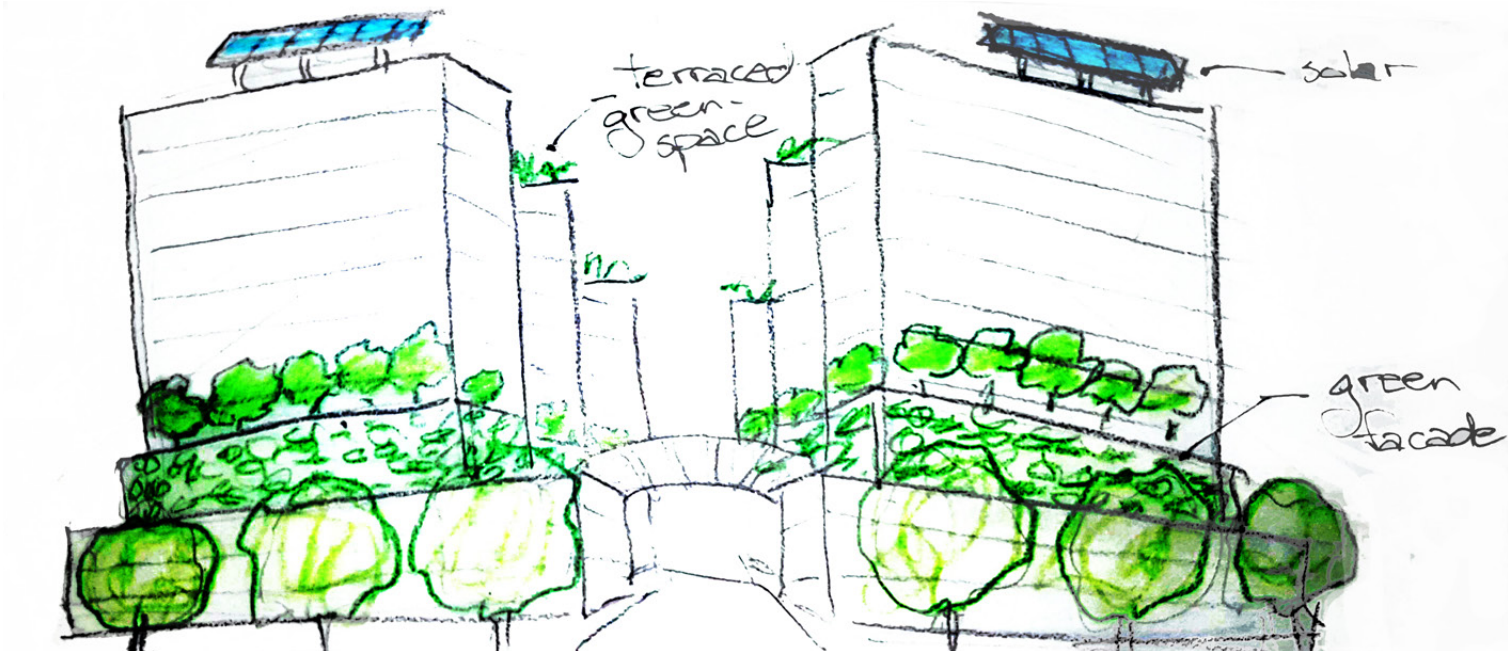
- All at grade green space is public, while over-grade green space is designated for residents and open to community design
- Native plantings and diverse local landscape typologies to support pollinators and biodiversity
- Water features to manage stormwater while providing for visual/auditory aesthetics and play
- Nature based play for children complements the town greenway
- A public plaza that serves multiple functions as a space for water play, outdoor seating, and performances
- Outdoor dining overlooking the park to add value for retail tenants

Cost-Benefit Analysis

- Construction cost: $1.2 million
- Annual maintenance cost: $28,100
- One-time benefits: $220,000
- Annual benefits: $140,000
- Job-years in construction: 20.4
- Job-years in maintenance: 0.5 annually
- Total job years over a 50 year period: 34.7
- Net Present Value (25 years): $1.9 million
- Net Present Value (50 years): $2.3 million
- Payback Period: 9.2 years
- It is important to consider that many important

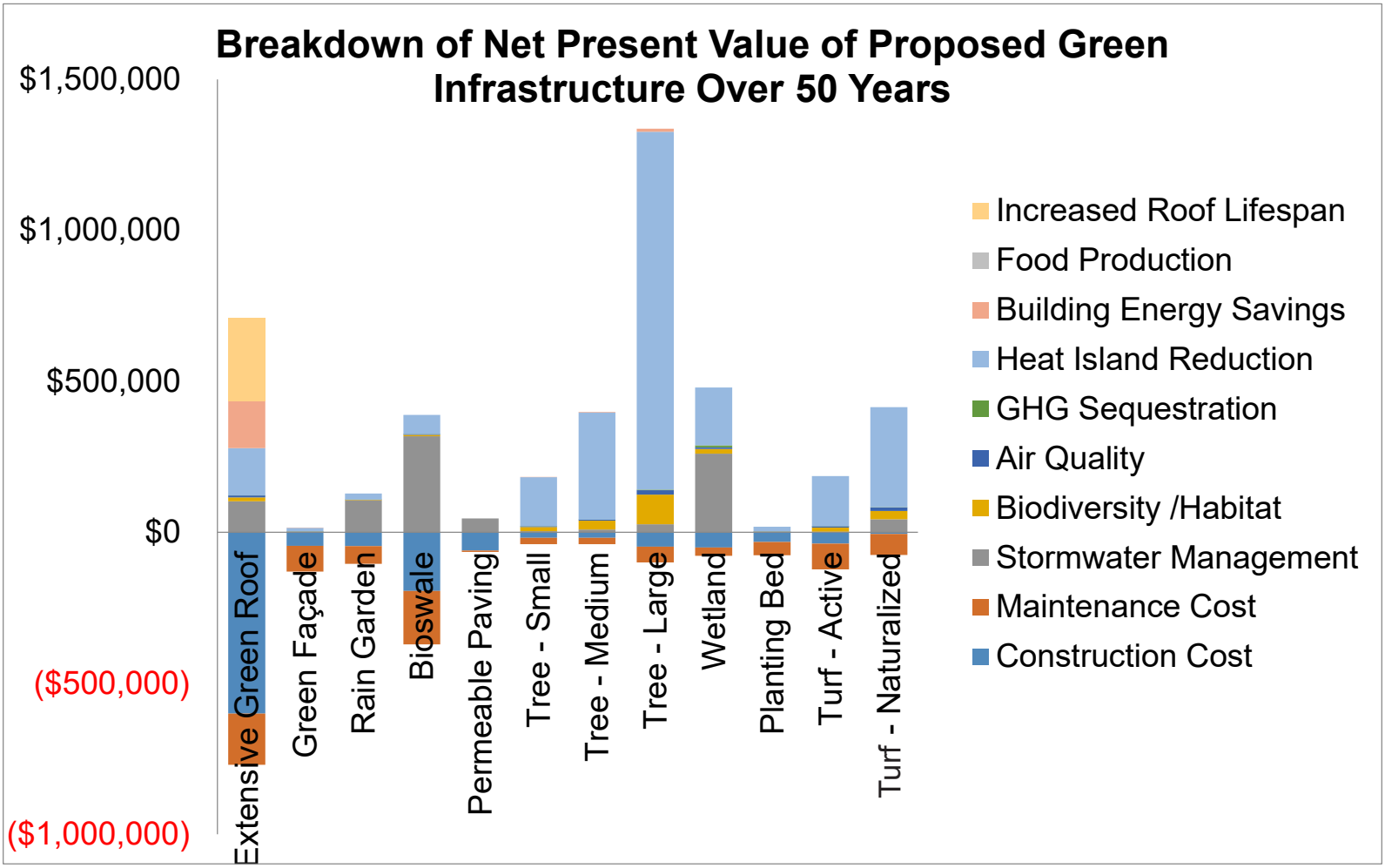


Alternative view of the master plan demonstrating the key elements of the proposal (above); Example of site permeability, showing pedestrian passage between two buildings (below)



benefits are not included: amenity space for residents, health impacts, increased property value, etc.

- Additionally, this is the cost-benefit analysis for the green infrastructure component only, and does not include a comparison to the alternative grey infrastructure approach which would conventionally be used for a development of this nature
- See more information in Appendix



Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)

Type of Green Infrastructure	Area	NPV of Costs	NPV of Benefits	NPV	Job-years (Construction)	Job-years (Maintenance)
Extensive Green Roof	3,000	($770,174)	$709,731	($60,443)	10.59	3.00
Green Façade	300	($130,087)	$14,763	($115,324)	0.79	1.50
Rain Garden	400	($104,293)	$128,720	$24,427	0.81	1.04
Bioswale	1,205	($371,252)	$388,735	$17,483	3.43	3.12
Permeable Paving	800	($65,499)	$45,607	($19,892)	1.06	0.09
Tree - Small	3,097	($39,101)	$182,826	$143,725	0.32	0.37
Tree - Medium	6,784	($39,142)	$398,602	$359,460	0.32	0.37
Tree - Large	22,713	($99,459)	$1,337,116	$1,237,657	0.85	0.91
Wetland	3,660	($78,060)	$479,165	$401,105	0.88	0.49
Planting Bed	300	($76,282)	$18,668	($57,614)	0.57	0.78
Active Turf	3,173	($122,713)	$186,118	$63,405	0.66	1.51
Naturalized Turf	6,346	($75,526)	$414,194	$338,669	0.09	1.24
TOTAL	**51,777**	**($1,971,587)**	**$4,304,243**	**$2,332,656**	**20.37**	**14.42**

Toronto: St. Dennis Drive Minto Property

Size: 2.2 hectares

31-35 St. Dennis Drive is located in the Flemingdon Park neighbourhood of Toronto. The area is extremely diverse, and home to large populations of recent immigrants, especially those from South Asia, South-East Asia, and Eastern Europe (especially the Roma people).

The large slab building was recently acquired by Minto Group Inc., a large real estate company. The building is also of interest to the City of Toronto's Tower Renewal Program, a program that aims to retrofit and revitalize the many postwar apartment towers that form the backbone of Toronto's rental housing stock. Zoning on site was recently changed to the Residential Apartment Commercial category, allowing for small-scale retail and community facilities on site.

Opportunities & Strengths

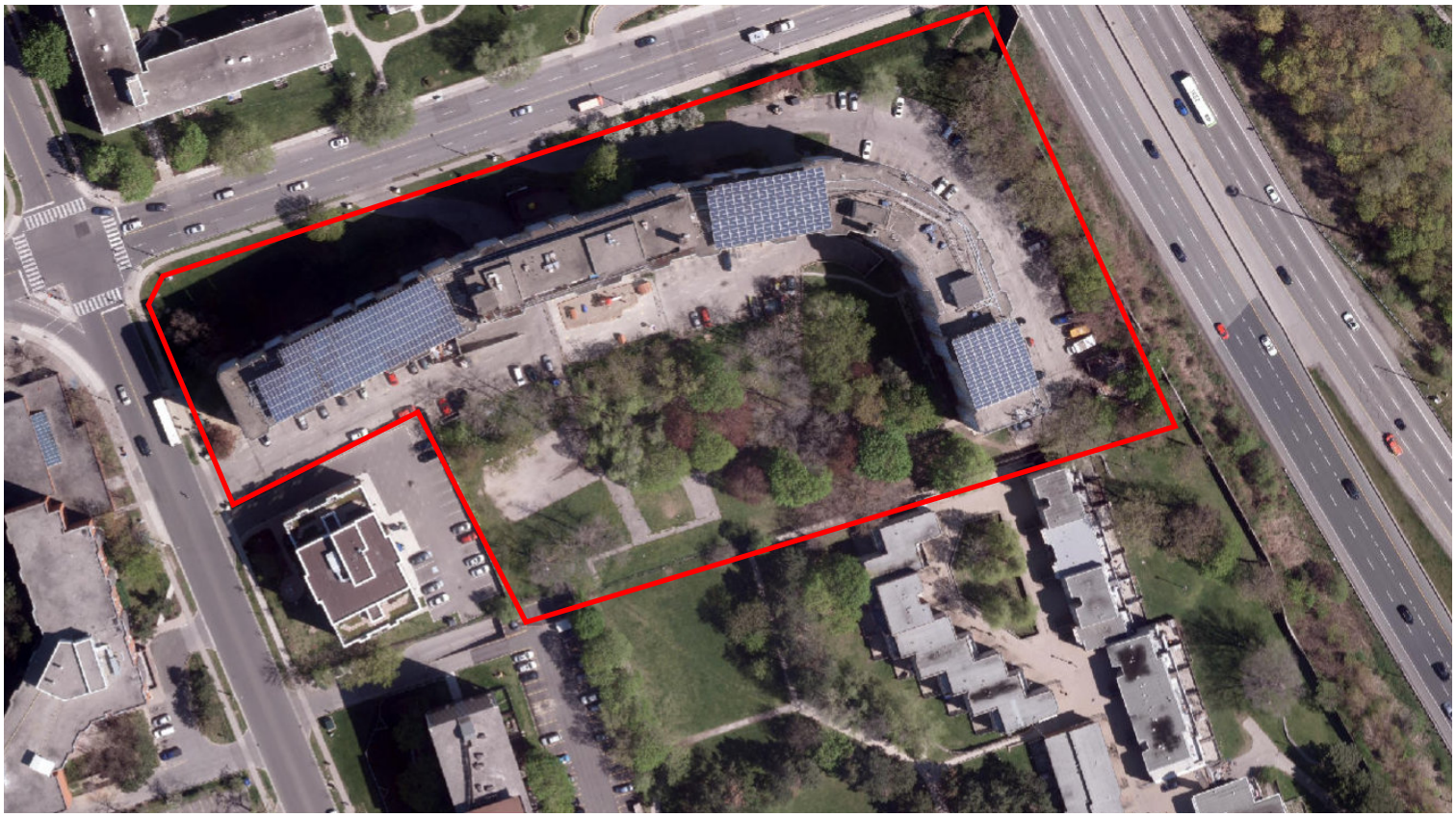
- Large areas of outdoor space with mature trees on site
- Daycare, mosque, and other amenities on site
- Residential Apartment Commercial zoning
- Large areas of parkland are in close proximity

Constraints & Weaknesses

- Vandalism and theft are concerns with daycare and property line fences being damaged repeatedly, new hockey nets getting damaged and stolen, and graffiti showing up on walls. Informal paths on site and adjacent sites could be contributing to fence damage
- Garbage and litter are issues as well with areas adjacent to parking lot being treated as dumping ground
- Safety concerns about loitering at night

Planning Goals

- The two main goals are improving security and improving the quality of the property
- The existing condition of the property encourages loitering at night, poor sight lines and vandalism - these will need to be addressed
- The recent transfer of ownership is based on the parameters that this is an asset with a five to seven year hold period. As part of the value-add






The landscape around the building is not particularly inviting and does not feature many amenities. There is no dedicated pedestrian access to the front of the building (top left), garbage areas are in the front (top right), the rear yard has poor sight lines (bottom left), and residents have created informal paths due to a lack of formalized walkways (bottom right).

fund there is intention to invest to reposition the asset to increase value multi-fold. This investment must solve the first existing problematic condition as well as adding value

- Minto plans to make improvements to the community by enhancing the outdoor spaces. Current plans include upgrades to exterior lighting, and garage ramp repairs. They also intend to make improvements to landscaping but negative experiences with previous improvements have been discouraging

Team members

- Lois Vitt Sale, Wight and Company (facilitator)
- Wells Baker, Minto Group Inc.
- Kathy Brislin, City of Barrie
- Wendi Goldsmith, Center for Urban Watershed Resilience
- Lauralyn Johnston, City of Toronto
- Natasha Kuperman, York University
- Ben Mullen, Minto Group Inc.
- Meredith Plant, City of Hamilton
- Sasha Terry, City of Toronto

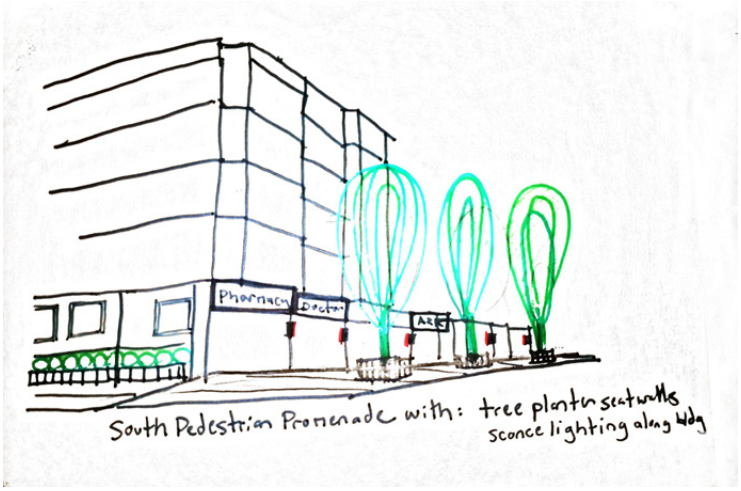
Strategy

The proposal hinges on the two major challenges that were identified on site: Security and Property Evaluation. The proposal does just this: in each physical solution, there are multiple advantages.

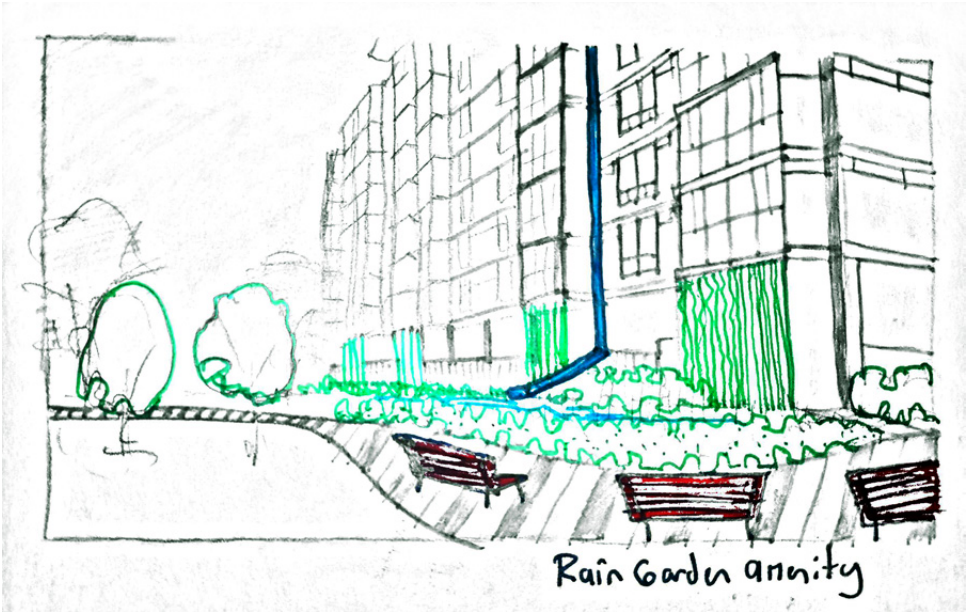
- Security Enhancement
- Stormwater Management,
- Tenant Amenity for Marketing

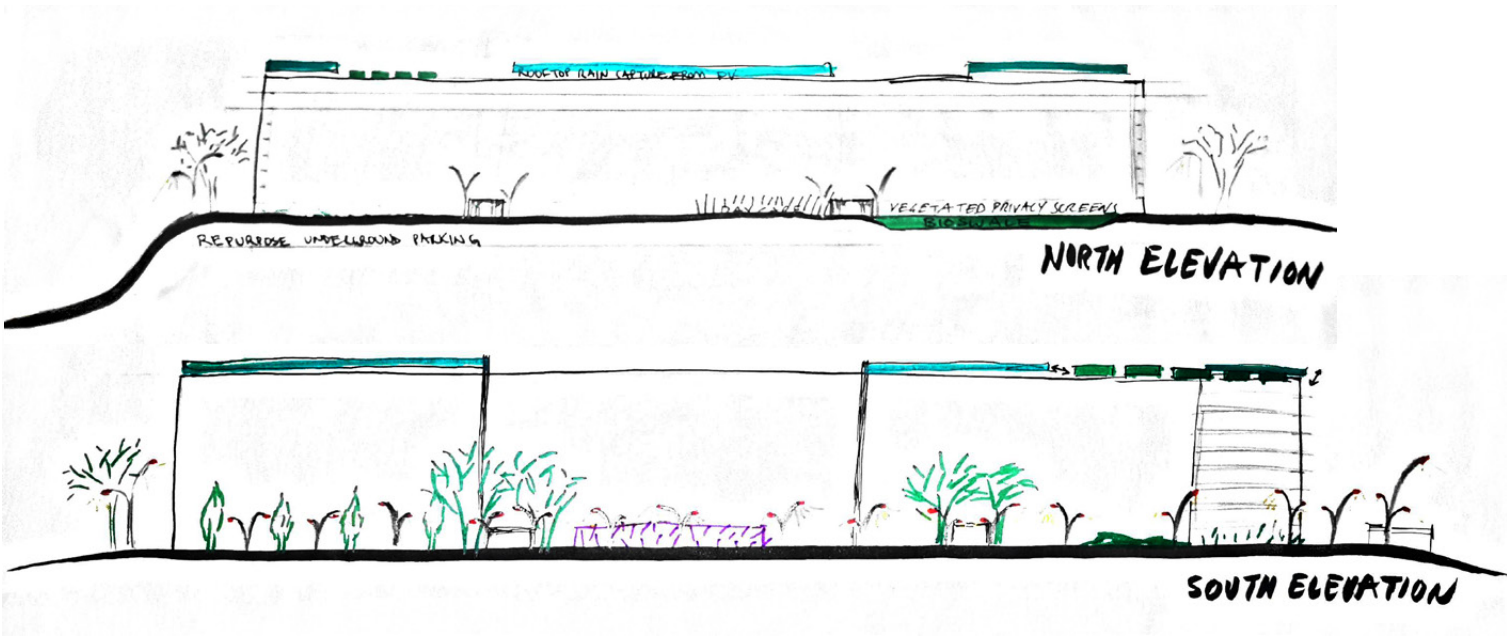
After writing a long list of potential interventions, the group drew through 6 or 7 of the pieces of green infrastructure. They further reduced their list to four areas to execute based on the priorities of cost, high level of impact, and the integrated and multiple benefits they would provide. These are:

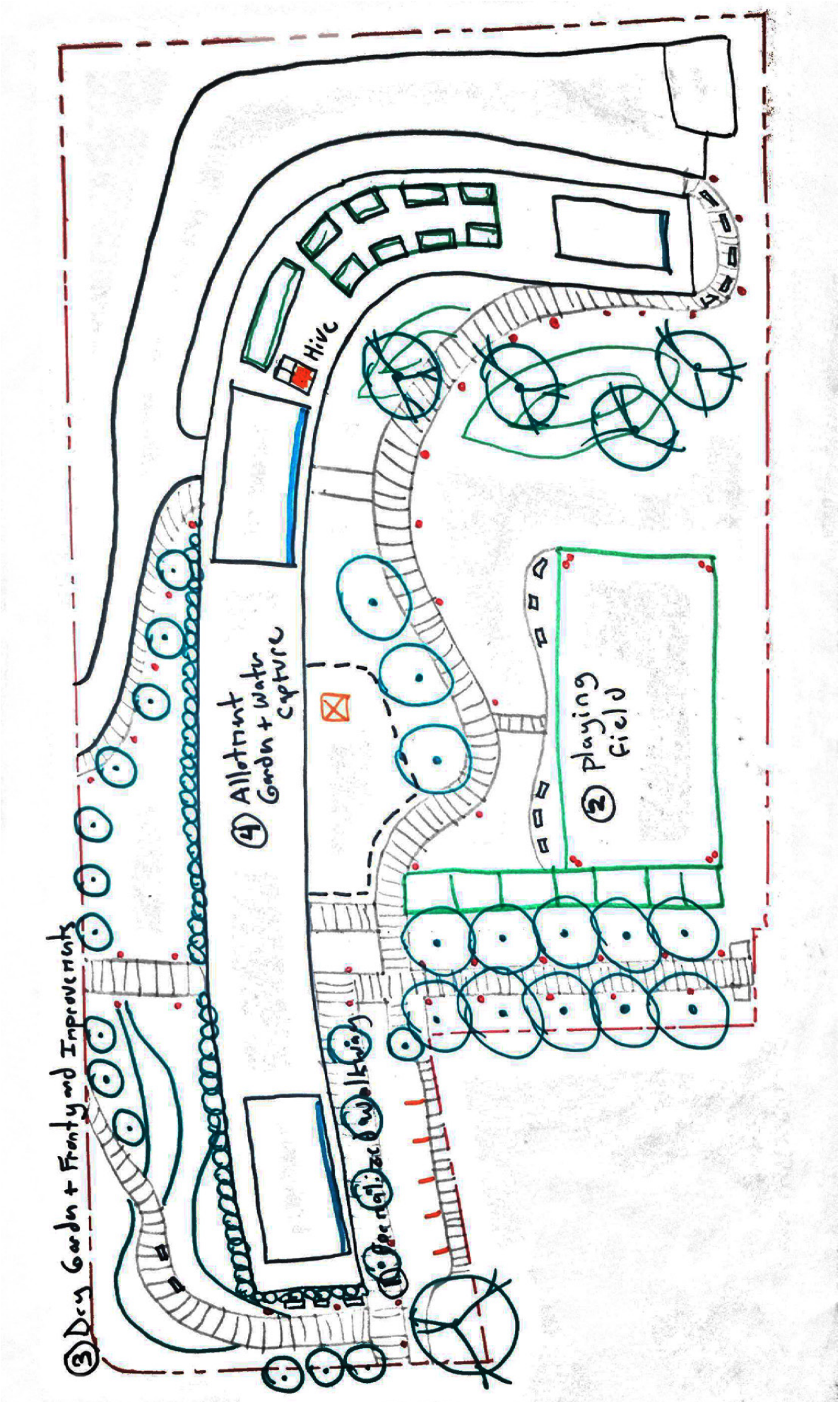
1. A formalized lit walkway with lighting, trees, seating. Benefits from this could include improved security from wider sight lines and better lighting, greater access to the site, and improved visual appeal of the building. Secondary walkways could connect other parts of the site and/or formalize existing pedestrian routes.



2. A playing field at the rear of the building; this would help improve the building's marketability, replace a sheltered area where individuals loiter with a more open active area that has better sight lines, and act as an area that can absorb stormwater runoff.
3. A rain garden at the front of the building that can manage stormwater, improve curb appeal, mitigate against basement flooding, and utilize overland sheet flow.
4. Allotment Gardens on both the roof, and on the ground. These can act as amenities, have marketing appeal, and can improve community cohesion and security through residents taking greater ownership of these areas. The roof gardens could feature an apiary, and capture water from the roof for irrigation. The ground-level gardens could be irrigated through a proposed cistern in the basement.



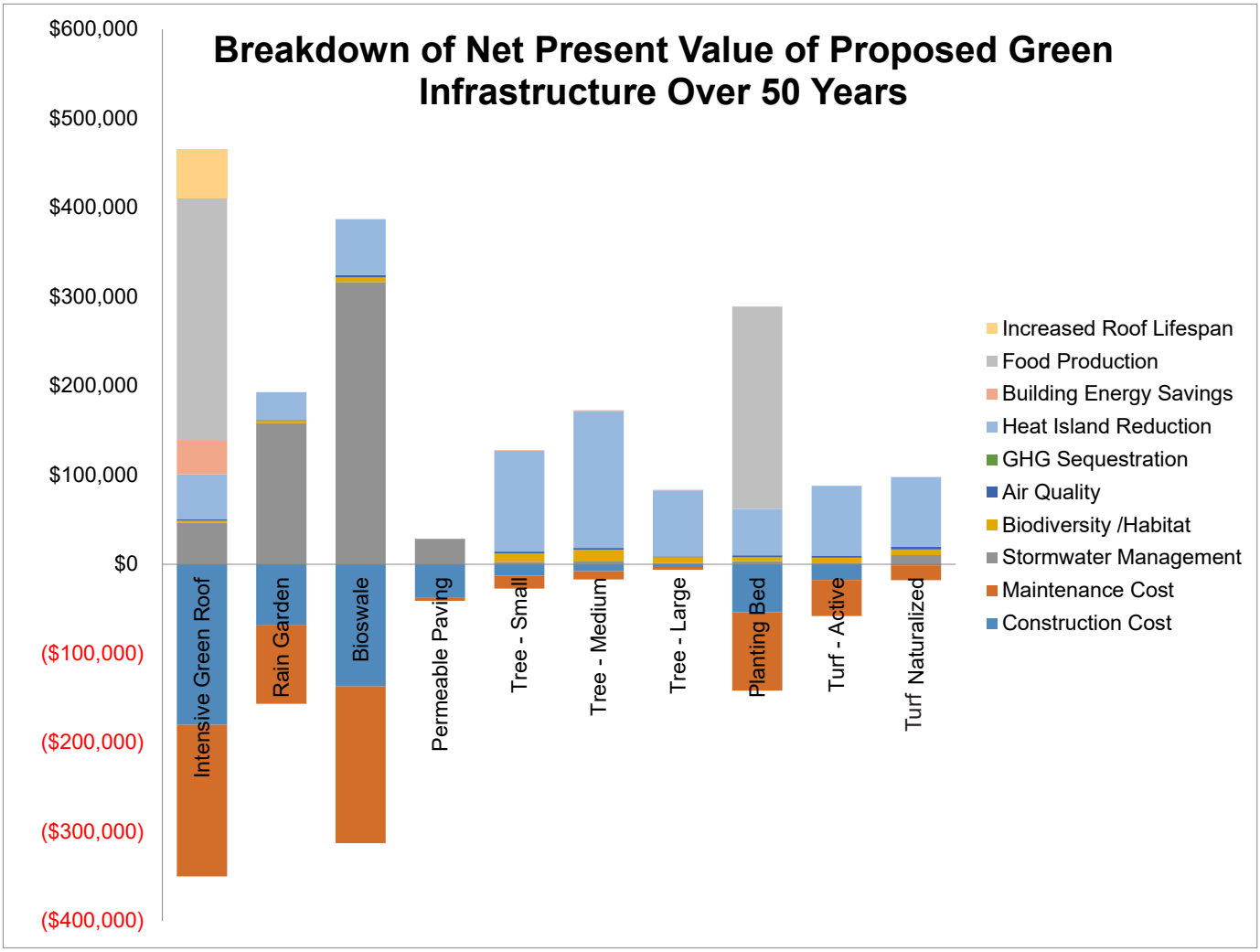




St. Dennis Drive Minto Property Site Plan

Cost-Benefit Analysis

- Construction cost: $519,000
- Annual maintenance cost: $21,700
- One-time benefits: $55,700
- Annual benefits: $64,600
- Job-years in construction: 9.16
- Job-years in maintenance: 0.37 annually
- Total job years over a 50 year period: 19.9
- Net Present Value (25 years): $360,000
- Net Present Value (50 years): $1.9 million
- Payback Period: 12.2 years
- It is important to note that many benefits that this proposal aims to achieve are not captured in this analysis: increased property value, increased community cohesion, improved property value, reduced crime, reduced flood risk, etc.
- See more information in Appendix



Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)

Type of Green Infrastructure	Area	NPV of Costs	NPV of Benefits	NPV	Job-years (Construction)	Job-years (Maintenance)
Intensive Green Roof	600	($350,174)	$465,805	$115,631	3.18	3.00
Rain Garden	600	($156,440)	$193,080	$36,640	1.21	1.55
Bioswale	1,200	($312,880)	$387,122	$74,242	2.42	3.11
Permeable Paving	500	($40,937)	$28,504	($12,433)	0.66	0.06
Tree - Small	21 trees	($27,370)	$127,978	$100,607	0.22	0.26
Tree - Medium	13 trees	($16,962)	$172,728	$155,766	0.14	0.16
Tree - Large	5 trees	($6,216)	$83,570	$77,354	0.05	0.06
Planting Bed	500	($141,743)	$289,124	$147,381	0.95	1.55
Active Turf	1,500	($58,011)	$87,985	$29,974	0.31	0.71
Naturalized Turf	1,500	($17,852)	$97,903	$80,051	0.02	0.29
TOTAL	**12,927**	**($1,128,585)**	**$1,933,798**	**$805,213**	**9.16**	**10.76**

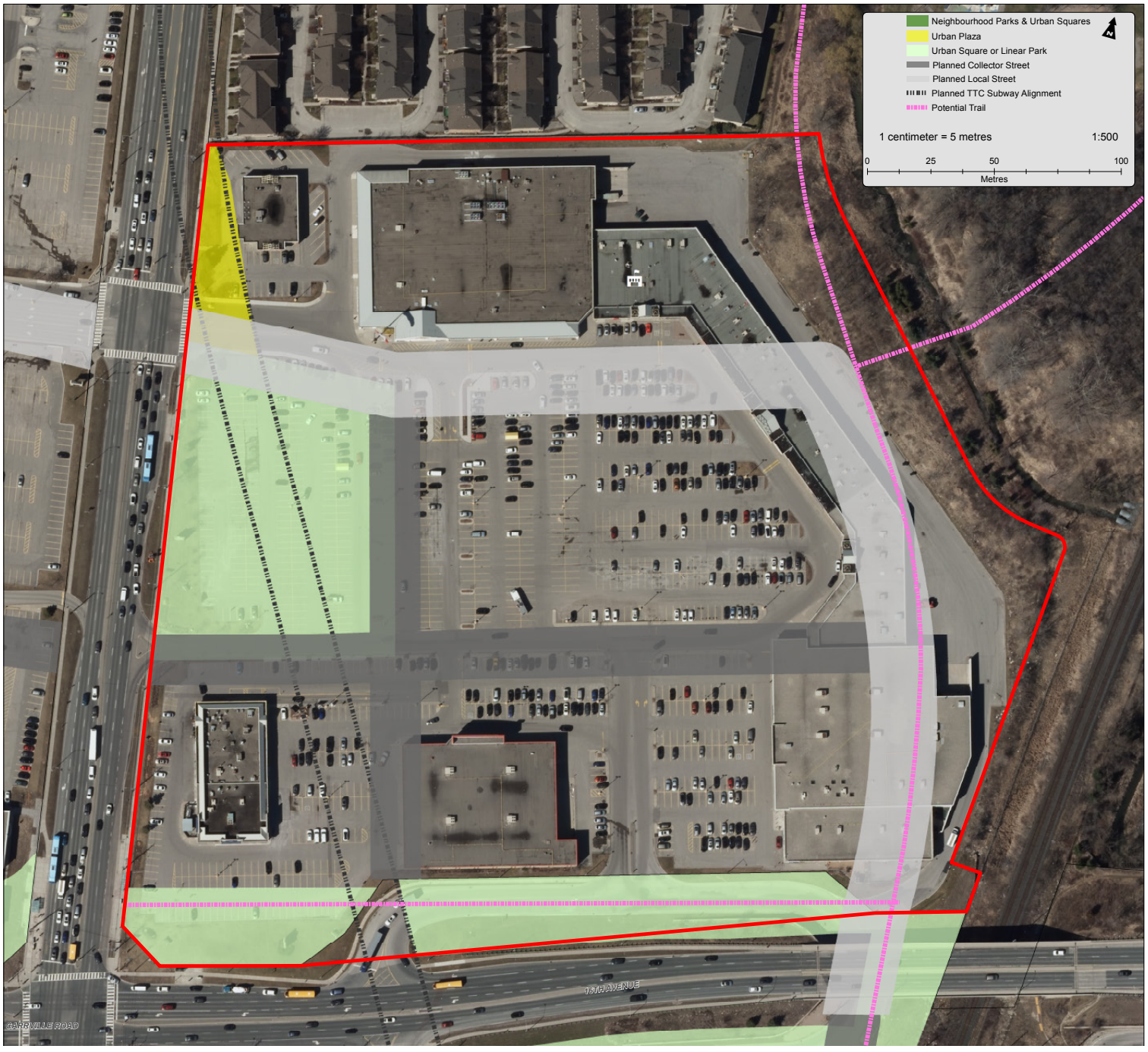
Richmond Hill: SmartREIT Site (Yonge and 16th)

Size: Approx 9 Hectares

This property is located in the Yonge Street and 16th Avenue Key Development Area (KDA). This is the town's second most dense intensification area and will remain a major node of retail and commercial activity anchored by Hillcrest Mall on the Yonge Street Regional Rapid Transit corridor.

The SmartREIT property is currently occupied by big box and strip mall type retail with a large surface parking lot. It is bordered by Yonge Street and Hillcrest Mall to the west, 16th Avenue to the south, a townhouse complex to the north, and the CN railway and German Mills Creek, a tributary of the Don River, to the east. Unique features of the site include the 16th Avenue access ramp to the south, the proximity to the Bridgeview Community Park and a significant forest to the northeast, and the potential to provide connections to the planned destination park at the David Dunlop Observatory.

Both the Town and property owner have undertaken



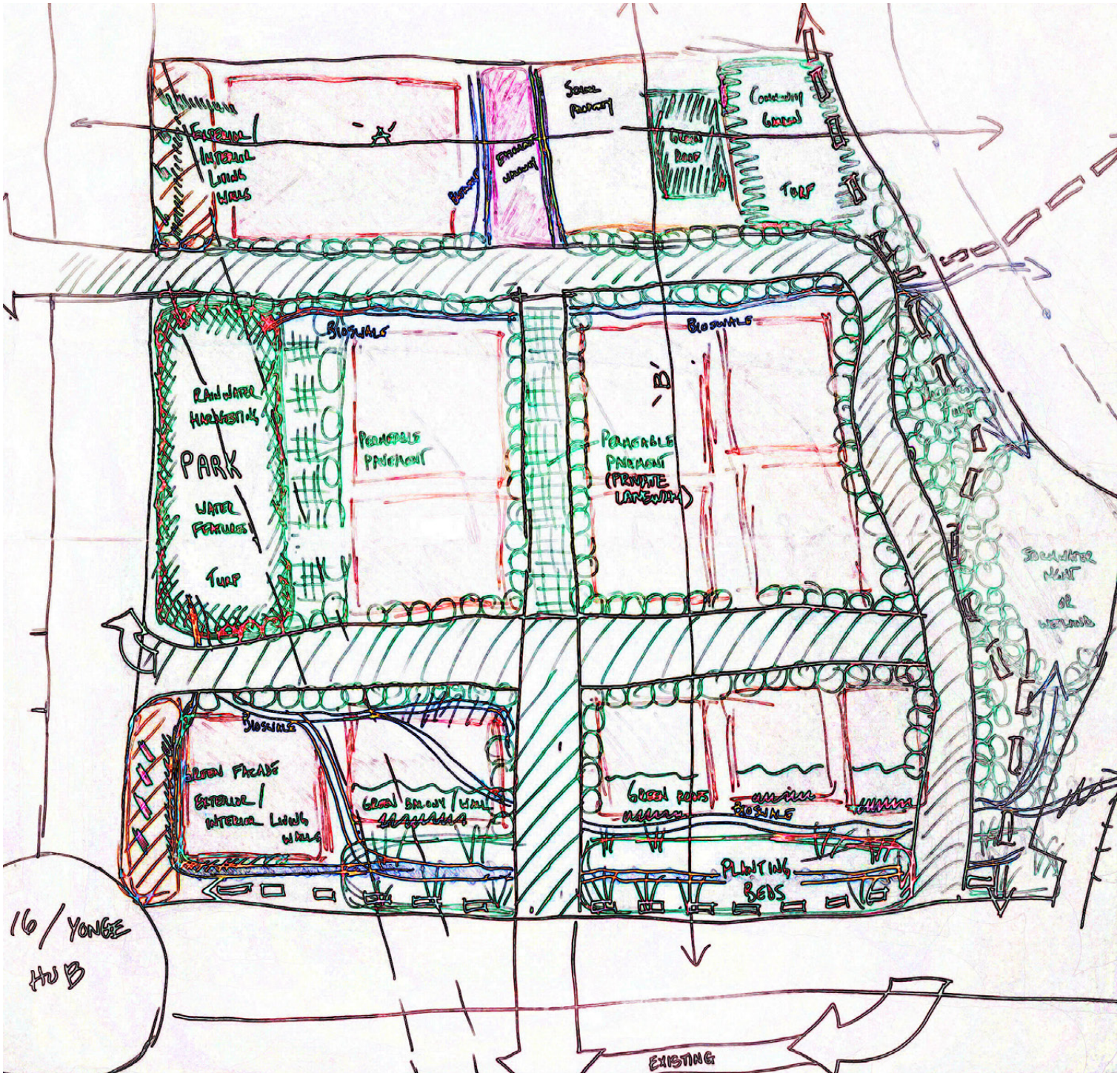
Yonge Street looking North from 16th Avenue.

The part of the site adjacent to German Mills Creek is occupied by garbage dumpsters and other site loading and servicing needs

The strip mall development that currently occupies the site is surrounded by a sea of parking.

preliminary planning exercises for the site. The draft Yonge-16th Secondary Plan (pending approval by council) sets out permitted heights, densities, road layouts, and park and open space locations. Development applications will need to conform to the policies of the Secondary Plan. Specific to this site, the Secondary Plan requires:

- Collector and local road right-of-ways with pedestrian and cycling facilities through the site



SmartREIT Site (Yonge & 16th) Plan

- A neighbourhood park along the north portion of the Yonge Street frontage
- A linear park with new trails along the 16th Avenue frontage
- A school site in the north of the site
- Subsurface easements for the future Yonge Street subway extension through the west of the site
- Maximum building heights of 20 storeys along the south, 15 storeys in the centre, and 8 storeys adjacent to the townhouses in the north

Opportunities & Strengths

- Potential for intensification and mixed-use development
- Planned Yonge Street BRT in the near future will connect to many destinations; long-term potential GO rail and TTC subway stations
- Opportunities to improve German Mills Creek connect with other green spaces

Constraints & Weaknesses

- Large areas of impervious surface on site
- Character of surrounding area is suburban

Team members

- Paul Ronan, Ontario Parks Association (facilitator)
- Michelle Dobbie, Town of Richmond Hill
- Rob Elliott, Town of Richmond Hill
- Annie Kwok, Town of Richmond Hill
- Ben Nagarajah, City of Vaughan
- Samuel Ng, Town of Richmond Hill
- Myles O'Brien, Town of Richmond Hill

Planning Goals

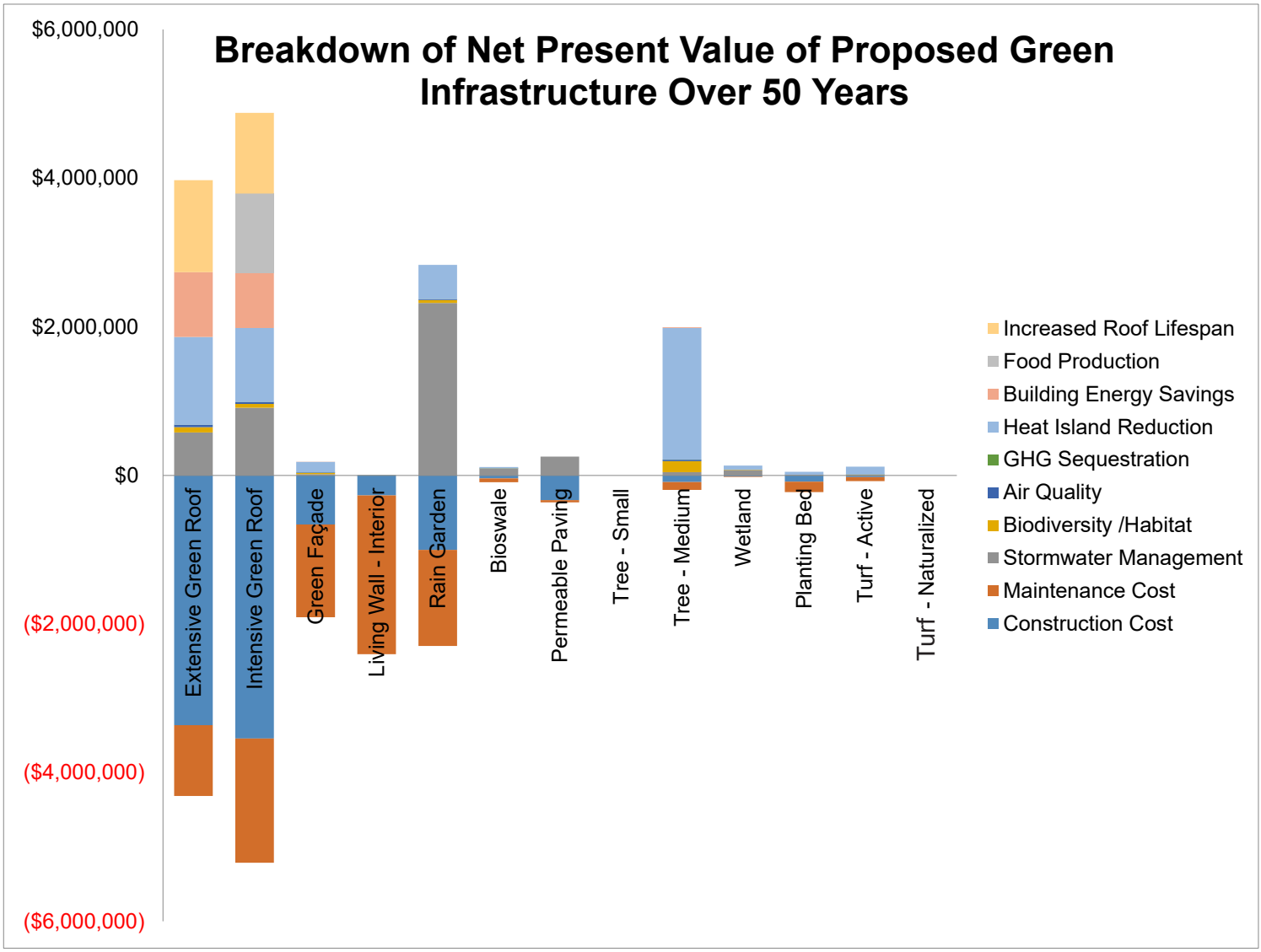
- Incorporate green infrastructure elements into a mixed-use community
- Zero runoff from site
- Protect German Mills creek
- Create features that add to a sense of place
- Take a people and environment first approach (vs current car-first approach)
- Encourage green energy use throughout the site

Strategy

- At Gateway of Yonge and 16th, establish a welcoming green edge
- Along 16th Ave, a series of green terraces and planting beds softens the new mixed-use towers
- Green infrastructure is used as a focal feature in the park along Yonge Street, creating a calming and tranquil oasis, lined with restaurants and other active uses on the east side of the park, and a water feature/rain garden at the west edge
- Green streets are used to link the park to the German Mills Creek and include a double row of trees and bioswales (or a double pipe if not feasible)
- A demonstration private street runs north-south and includes permeable paving, extensive trees, and infiltration galleries
- Underground - pedestrian corridor with living wall – daylighted with solar collectors/light tubes
- Silva cells for trees
- Treatment train
- Rooftop playground
- Living wall as gateway
- Outdoor education
- Bioswale parallel to Yonge St.
- Extensive green roof on transit hub
- Living wall in school
- Permeable parking lot

Cost-Benefit Analysis

- Construction cost: $9.6 million
- Annual maintenance cost: $270,000
- One-time benefits: $626,000
- Annual benefits: $609,000
- Job-years in construction: 168.7
- Job-years in maintenance: 4.8 annually
- Total job years over a 50 year period: 308
- Net Present Value (25 years): ($2.5 million)
- Net Present Value (50 years): $970,000
- Payback Period: 36.8 years
- It is important to consider that many important benefits are not included: amenity space for residents, health impacts, increased property value, etc.
- Additionally, this is the cost-benefit analysis for the green infrastructure component only, and does not include a comparison to the alternative grey infrastructure approach which would conventionally be used for a development of this nature
- See more information in Appendix



Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)

Type of Green Infrastructure	Area	NPV of Costs	NPV of Benefits	NPV	Job-years (Construction)	Job-years (Maintenance)
Extensive Green Roof	16,800	($4,312,974)	$3,972,586	($340,388)	59.29	16.82
Intensive Green Roof	11,800	($5,213,376)	$4,876,989	($336,387)	62.47	29.53
Green Façade	4,400	($1,907,942)	$181,581	($1,726,361)	11.65	22.02
Interior Living Wall	200	($1,490,606)	$307	($1,490,299)	4.75	21.56
Rain Garden	8800	($2,294,452)	$2,831,840	$537,388	17.72	22.77
Bioswale	350	($91,257)	$112,911	$21,654	0.70	0.91
Permeable Paving	4435	($363,108)	$252,832	($110,277)	5.90	0.51
Tree - Medium	150 trees	($195,711)	$1,993,012	$1,797,302	1.59	1.87
Tree - Large	230 trees	($285,945)	$3,844,208	$3,558,263	2.43	2.61
Wetland	1000	($21,328)	$130,919	$109,592	0.24	0.14
Planting Bed	790	($223,954)	$456,816	$232,861	1.50	2.45
Active Turf	2000	($77,348)	$117,313	$39,965	0.41	0.95
TOTAL	**149,794**	**($16,478,000)**	**$18,181,377**	**$1,703,377**	**168.66**	**122.13**

Richmond Hill: TSMJC Properties & Bernard Bus Terminal Site (Yonge and Bernard)

Size: Approx 6.2 Hectares

This site is located in the southeast quadrant of the Yonge Street and Bernard Avenue Key Development Area (KDA) by the Town of Richmond Hill. This KDA is the Town's third-most dense intensification area, and a major node of retail and commercial development on the Yonge Street Regional Rapid Transit Corridor in the Town of Richmond Hill.

The site is comprised of two properties: a privately-owned commercial property owned by TSMJC Properties Inc. and the Bernard Bus terminal owned and operated by York Region Transit. The site is predominantly occupied by big box and strip mall style retail, with a large surface parking lot. It is bordered by Yonge Street on the west, Bernard Avenue to the north, commercial development and a retirement residence to the south, and Yorkland Street and low density neighbourhood development to the east.

At the time of the Charrette, the town had undertaken preliminary planning exercises for the site and the

Yonge-Bernard KDA Secondary Plan was in draft form (it has since been adopted by Council). The draft Secondary Plan sets out permitted heights, densities, road layouts, and park and open space locations for the site. Policies include:

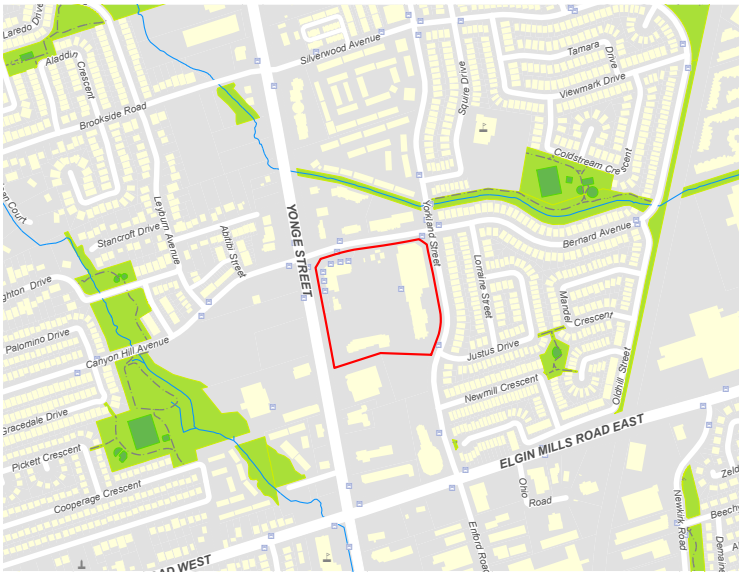
- Collector and local road right-of-ways with pedestrian and cycling facilities through the site
- "Enhanced streetscapes" (note that the enhancement options are flexible and this has not been determined. It could provide some combination of green infrastructure, low impact development features, and passive leisure opportunities.)
- An urban park with a linear park connection to Yonge Street just east of the bus terminal
- 10-15 storey heights along Yonge, 4-10 storeys in the central area, and 3 storey heights along the east edge of the site

The site is similar to the Yonge Street and 16th Avenue site in that it is dominated by low-density commercial development with massive parking lots - offering an opportunity for significant intensification (top). The site has a poor connection to Yonge Street, despite the presence of a busy bus terminal that serves both Viva and YRT buses (above).

Opportunities & Strengths

- Future transit connectivity (i.e. BRT on Yonge Street)
- Significant intensification potential of mixed-use development
- Opportunity to establish typology for enhanced right-of-way

Constraints & Weaknesses



Context of site.

- Bus terminal likely to stay and must be accommodated
- Assumed high water table – only 1 storey of underground parking feasible despite anticipated parking demand
- Established residential neighbourhood on the east side of the site

Team members

- Rohan Lilauwala, Green Infrastructure Foundation (facilitator)
- Michelle Bourdreau, Town of Richmond Hill
- Katherine Faria, Town of Richmond Hill
- Gosia Farun, Terraplan
- Megan Kevill, Town of Richmond Hill
- Eric Loorand, Town of Richmond Hill
- Darlene Myrie, Town of Richmond Hill

Planning Principles

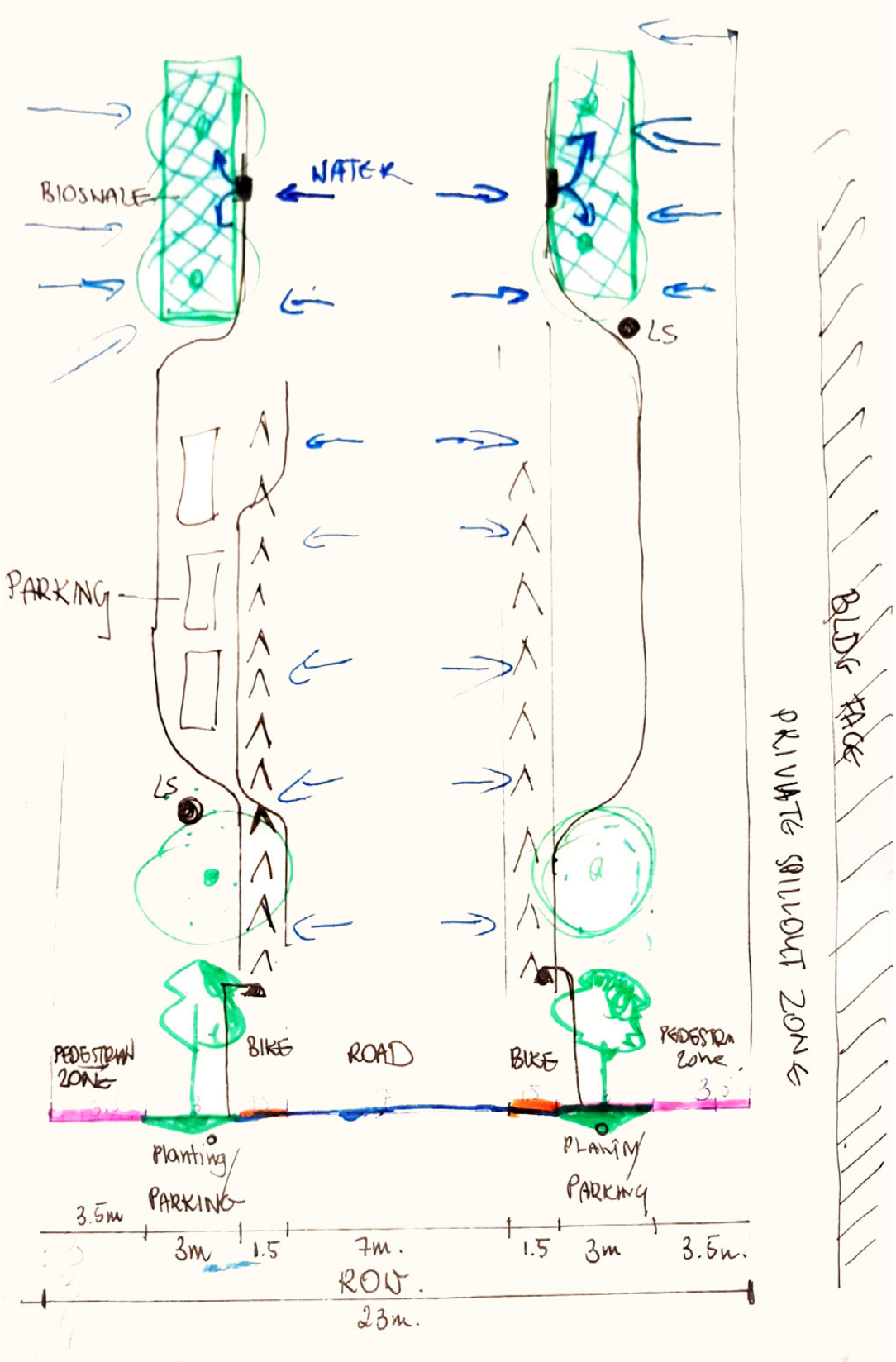
- Site permeability for different modes of

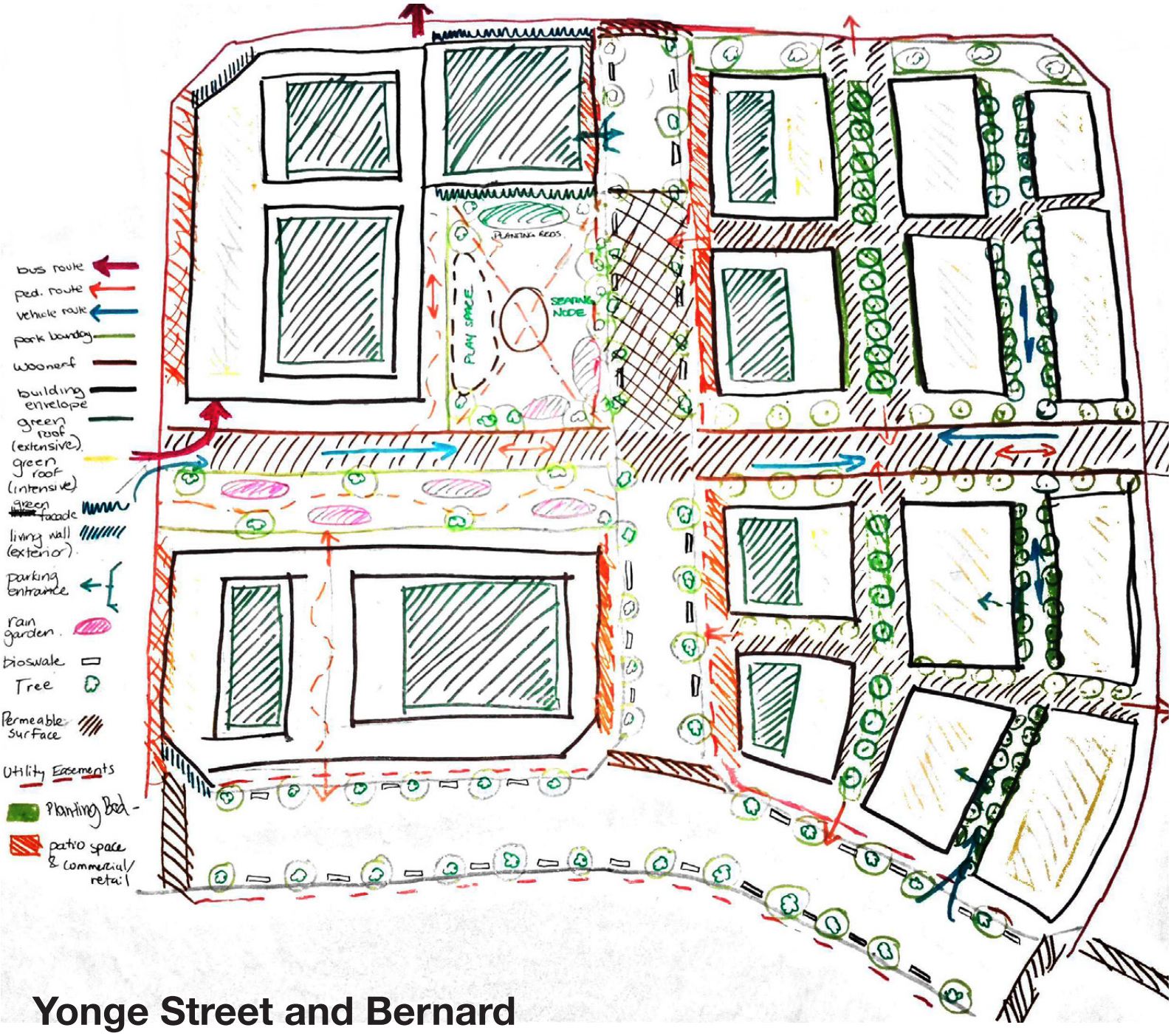
transportation, and establishing connectivity within the site and with adjacent neighbourhoods
- Integrated water management with amenity spaces
- Enhanced ROW as typology
- Vibrant, mixed-use environment
- Transit-supportive community
- Transition to adjacent neighbourhoods through appropriate built form

Strategy

- New building on north-west corner of site, integrating bus terminal
- Street wall along Yonge – 6 storeys with towers above (max 15 storeys)
- Most intensive uses near Yonge to take advantage of future BRT – retail, office, commercial, bus terminal
- Parking garage with green roof amenity space, appropriate integration with abutting built form
- Park with visual / potential physical connection to green roof. Potential for stepped connection. If that isn't possible, ground level retail and green facades where park meets garage
- Woonerf creates mid-block corridor and access for pedestrians, vehicles and active modes of transportation
- Mix of surface and underground parking. Short term and lay by parking will be incorporated on the public roads to serve the commercial needs of the neighbourhood. Some visitor parking may be incorporated within rear laneway areas, where provided
- Built form will feature a range of housing typologies
- Integration of green infrastructure initiatives with gateway features, amenity spaces and transportation corridors

Proposed Enhanced Right-of-Way typology for 23m wide ROW.

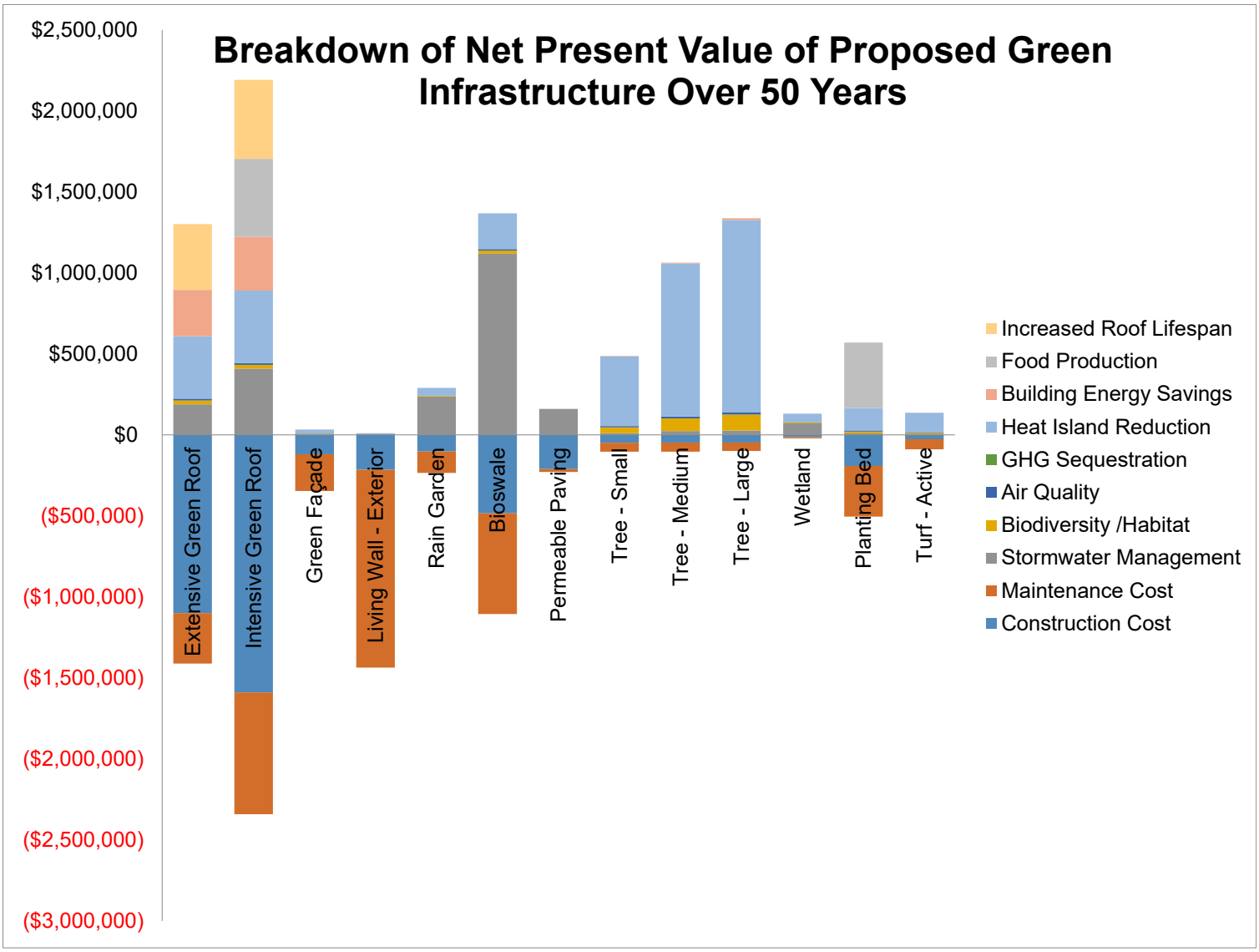




Yonge Street and Bernard Avenue Site Plan

Cost-Benefit Analysis

- Construction cost: 4.2 million
- Annual maintenance cost: $132,000
- One-time benefits: $310,000
- Annual benefits: $311,000
- Job-years in construction: 74.1
- Job-years in maintenance: 2.3 annually
- Total job years over a 50 year period: 308
- Net Present Value (25 years): ($684,000)
- Net Present Value (50 years): $1.04 million
- Payback Period: 33.2 years
- It is important to consider that many important benefits are not included: amenity space for residents, health impacts, increased property value, etc.
- Additionally, this is the cost-benefit analysis for the green infrastructure component only, and does not include a comparison to the alternative grey infrastructure approach which would conventionally be used for a development of this nature
- See more information in Appendix A



Net Present Value and Jobs of Green Infrastructure on Site (over 50 years)

Type of Green Infrastructure	Area	NPV of Costs	NPV of Benefits	NPV	Job-years (Construction)	Job-years (Maintenance)
Extensive Green Roof	5,500	($1,411,985)	$1,300,549	($111,436)	19.41	5.51
Intensive Green Roof	5,300	($2,341,601)	$2,190,512	($151,089)	28.06	13.26
Green Façade	800	($346,898)	$33,015	($313,884)	2.12	4.00
Interior Living Wall	200	($1,436,786)	$8,934	($1,427,852)	3.80	21.56
Rain Garden	900	($234,660)	$289,620	$54,960	1.81	2.33
Bioswale	4,240	($1,105,509)	$1,367,830	$262,322	8.54	10.97
Permeable Paving	2,800	($229,245)	$159,623	($69,622)	3.72	0.32
Tree - Small	8,258	($104,268)	$487,535	$383,267	0.85	0.99
Tree - Medium	18,090	($104,379)	$1,062,940	$958,561	0.85	1.00
Tree - Large	22,713	($99,459)	$1,337,116	$1,237,657	0.85	0.91
Wetland	1,000	($21,328)	$130,919	$109,592	0.24	0.14
Planting Bed	1,780	($504,606)	$570,021	$65,415	3.38	5.52
Active Turf	2,320	($89,724)	$136,084	$46,359	0.48	1.10
TOTAL	**73,901**	**($8,030,449)**	**$9,074,698**	**$1,044,249**	**74.10**	**67.61**

Conclusion and Next Steps

This project is an important initial step in valuing, conceptualizing, and implementing green infrastructure in not just Mississauga, Toronto, and Richmond Hill, but in municipalities across Ontario and the rest of Canada. Underpinning these goals is the aim to improve environmental performance and increase resilience to climate change impacts.

Despite its limitations, this project offers an opportunity for stakeholders to reconsider approaches to improvements of these communities. They could take the following steps:

- Incorporate green infrastructure benefits into more detailed cost-benefit analyses
- Identify strategies to increase benefits from green infrastructure in housing and other developments (e.g. using green roofs as event spaces, producing high value food products like micro-greens or honey, using green infrastructure to meet regulatory requirements or avoid other spending)
- Encourage long-term thinking when making decisions, for example, by considering the impact of climate change on any planned or existing infrastructure
- Capture other important benefits not incorporated into the cost-benefit analysis in this report
- While keeping in mind budgetary constraints, identify one or more design strategies and elements from the conceptual plans here for additional study, and implementation

By incorporating some or all of these recommendations, communities can use their limited resources to improve the efficiency of their infrastructure and receive a wider range of benefits from it. Green infrastructure also presents an opportunity to achieve environmental benefits and meet sustainability goals while cost-sharing with the private sector, reducing long-term costs for both sectors.

Green infrastructure's flexibility and decentralized nature makes it an ideal part of a climate change strategy, an area in which Federal and Provincial Funding is likely to be available in the coming years.. This project hopes to advance that discussion and encourage stakeholders to think about how to move towards greener, healthier communities.

Conceptualizing and valuing green infrastructure is an important step towards its widespread use and application.

In 2018 and 2019, Ontario Parks Association and the Green Infrastructure Foundation will continue to collaborate on capacity building activities around green infrastructure in Ontario. For more information on 2018 activities, visit greeninfrastructurefoundation.org or ontarioparksassociation.ca

Appendix A

Green Infrastructure Cost-Benefit Matrix (Background)

One of the challenges facing the greater utilization of green infrastructure is that society does not properly value the many benefits they provide. This lack of valuation means that green infrastructure is often not incorporated into decisions around investment or asset management.

The Green Infrastructure Cost-Benefit Matrix was developed to help policy makers and community leaders better understand the many costs and benefits associated with green infrastructure investment at an aggregate scale. It also provides a financial context and approximate values for the design work that emerged from the Charrette.

The values that the Matrix uses are averages, reflecting large-scale implementation, rather than project-specific values. Because of this, the goal of the cost-benefit analysis for the site redesigns is not so much about hitting the bullseye but rather about starting a conversation about the tangible benefits that green infrastructure can offer. The cost-benefit analysis aims to help spur and facilitate engagement with political leaders, community leaders and government officials in communities focused on the valuation of green infrastructure investments and future policy directions.

The Matrix is a unique and valuable tool that can help promote better infrastructure planning and investment. Monetizing the multi-dimensional benefits of green infrastructure is complex and challenging. These challenges can be addressed by conducting cost-benefit analyses at an aggregate level and focusing on dollars/square metre valuations.

While the lack of precision is an acknowledged limitation of the cost-benefit matrix, the **financial analysis of benefits provided is extremely conservative.**

There are many limitations that must be taken into account when the plans and aggregate cost-benefit analyses are considered:

- Costs and benefits are on an aggregate basis, not a project basis, and are based on many assumptions and generalizations
- This is an extremely cautious analysis - all the costs (of the green infrastructure elements) have been included, but many important benefits (increased amenity space, health benefits, improved productivity, increased community cohesion, increased property value, etc.) have not been incorporated into the cost-benefit analysis
- Concepts were created with limited information, and may not be technically feasible (though many elements will be)
- The cost of conventional infrastructure was not considered - in many cases, a green approach will provide a multitude of additional benefits while also being more cost-effective
- The impacts of climate change and green infrastructure's ability to reduce vulnerabilities to its impact are not considered
- The fact that green infrastructure performance often improves over time is not factored into performance assessments

Despite these limitations, this project offers an opportunity for stakeholders to reconsider approaches to improvements of these communities.

The Green Infrastructure Cost-Benefit Matrix encapsulates a wide range of economic and biophysical research data tied to fifteen generic types of green infrastructure. The Matrix comprises the following components:

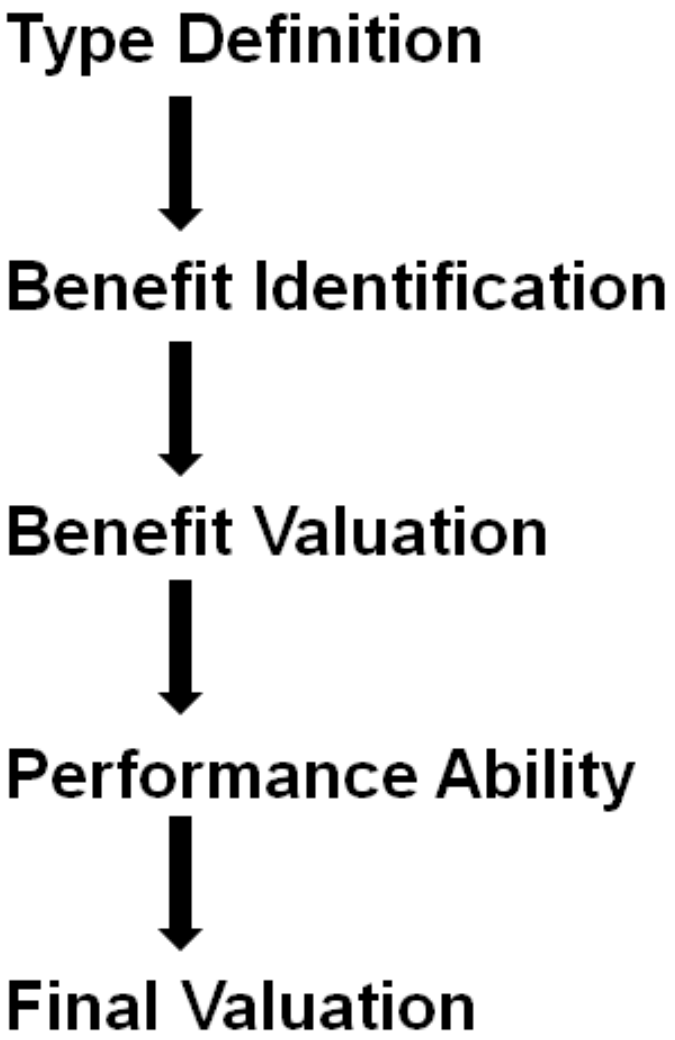
- Fifteen generic living green infrastructure types
- Two cost values per square metre derived from literature and peer reviews for capital and maintenance
- Ten benefit values for each type of generic green infrastructure
- Values for most costs and benefits are expressed in dollars per square metre of implemented green infrastructure
- Values for job creation are expressed in job-years (i.e. one job-year is equivalent to one person employed full-time for one year) based on the investment made
- Values are expressed as one time capital cost or benefit or an annual cost or benefit

The Matrix expresses most costs and benefits in dollars per square metre. This facilitates the ability to quickly provide aggregate estimates of significant green infrastructure deployment at various scales. Expressing monetary values in terms of area also provides the basis for calculating the cost and benefits of study area redesigns from the Charrette. For example, Charrette design teams may call for 1,000 square metres of extensive green roof to be developed. The area (1,000 square metres) provides the basis for estimating the resulting costs and benefits from the values ($/m^2) in the Matrix.

For purposes of the Charrette, a cost-benefit analysis is provided that is on a first cost basis, at five years, at twenty-five years, and at fifty years.

The Matrix assumes a real discount rate of 2.5%, similar to the discount rate used by the Ontario Government for capital projects. Monetary values presented in the literature have not been adjusted for currency differences or the

impact of inflation except where it has been deemed that the gap in time has become too significant.



Cost-Benefit Valuation Methods

The Green Infrastructure Cost-Benefit Matrix is based on five stages of data aggregation and simplification, which are described below:

1. Type Definition

The first stage of aggregation involves the identification of commonly accepted generic green infrastructure types drawn from the literature. Each type is simplified. For example, vegetated buffer strips were added into the typology of 'Turf' based on their similar properties. While there are hundreds of species of trees with different properties, the categories small, medium and large are used – the area of the canopy at maturity is used in value calculations. There are several categories of wetland in the literature but only one is used.

This is justified because the Charrette is not focused on one project, such as a building or a proposed park, but on a much larger area. Furthermore, in order to be able to administer the Charrette in one day, and to derive average values, the types of green infrastructure had to be simplified. Site-specific design and cost-benefit evaluation would require a level of design detail and performance research more appropriate to a later stage.

The generic types of green infrastructure included in the Matrix are as follows:

- Green Roofs (Extensive and Intensive)
- Green Facades (Climbing vines)
- Living Walls (Interior and Exterior)
- Rain Garden
- Bioswale
- Permeable/Porous Paver
- Small, Medium and Large Trees
- Wetlands
- Planting Beds
- Turf (Active and Naturalized)

2. Benefit Identification

The second stage of aggregation concerns a comprehensive identification of benefits associated with green infrastructure that are quantifiable and non-quantifiable as seen in the literature. The values included in the Matrix cover a very wide variety of public and private costs and benefits. Some benefits are common to all green infrastructure types while others are only applicable to certain types. For example, active recreational turf will not provide habitat value.

A comprehensive listing of public and private benefits resulting from green infrastructure is as follows:

- Waste diversion
- Aesthetic improvement
- New amenity spaces
- Increased property value
- Increased rental income
- Increased retail sales
- Horticultural therapy
- Increased productivity
- Increased recreational activity
- Reduction of the urban heat island
- Energy efficiency
- Carbon sequestration
- Blockage of electromagnetic radiation
- Improved air quality (particulates and chemicals)
- Shading
- Stormwater management: quality and quantity benefits
- Noise/ sound reduction
- Improved soundscape
- Increased biodiversity (flora and fauna)
- Integrated water management
- Improved marketability of development
- Educational opportunities

- Increased membrane durability
- Increased pavement durability
- Reduced grey infrastructure capital costs
- Improved human health and well-being (physical and mental)
- Fire retardation
- Local and regional job creation
- Enhanced photovoltaic panel performance
- Food production
- Biomass for energy production

Each of these benefits was evaluated according to its ability to be monetized. Only benefits that could be quantified and monetized were chosen for inclusion in the Matrix. It is however, a goal of the project to create a framework within which new benefits can be added as more research is published on quantitative data. Although all costs for green infrastructure can be quantified, not all benefits can be. The following costs and benefits are included in the Matrix at this stage in its development:

- Cost: Total Capital Investment
- Cost: Annual Maintenance
- Benefit: Annual - Stormwater Management
- Benefit: Capital - Biodiversity and Habitat
- 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 Use
- Benefit: Capital - Job Creation (Construction)
- Benefit: Annual - Job Creation (Maintenance)
- Benefit: Annual - Urban Food Production
- Benefit: Annual – Increase in Roof Lifespan

3. Benefit Valuation

The third stage of aggregation involves applying monetary values to performance. Average ecosystem, (biophysical) service values (such as litres of stormwater retained) are monetized. The literature referenced utilizes a variety of market and non-market valuation techniques to accomplish this. These values vary considerably from community to community, particularly given the different regulatory and economic approaches to financing and operating grey infrastructure such as stormwater management and electricity production.

4. Performance Ability

The fourth stage of aggregation involves estimates of performance. Generic performance values were derived from the literature about green infrastructure ecosystem services performance. The exact performance of green infrastructure technology may vary, because it is a function of its design characteristics as well as its location. For example, a tree on the north side of a building will provide less energy savings than one located on the south side. A green roof can eliminate anywhere from 40 to 90% of the total stormwater runoff, depending on its design and the duration and frequency of the rainfall events in the region. Hence, further simplification is necessary in order to arrive at average cost and benefit values used in the Matrix.

5. Final Valuation

The fifth stage involves a combining of both the third and the fourth stages. Performance values (litres of stormwater) are combined with monetary values ($/litre retained) for the benefit in question. When combined, a final valuation for each benefit specific to each form of green infrastructure's performance is obtained. These values are presented in a range of high, medium, and low values due to ranges in performance as well as ranges in benefit valuation.

During the Charrette process participants were asked to redesign neighbourhoods using the fifteen generic types of green infrastructure used in the Matrix. This process involved exact scaled measurements to properly allow for cost-benefit analyses following the Charrette.

Cost-Benefit Analysis for Mississauga - Central Park Site

Net Present Value and Jobs of Green Infrastructure on Site							
Type of Green Infrastructure	**Area (m^2)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Extensive Green Roof	2,735	($518,708)	($456,620)	($223,532)	($55,414)	9.65	0.09
Green Façade	200	($30,835)	($37,219)	($61,185)	($78,471)	0.53	0.03
Exterior Living Wall	50	($64,039)	($103,295)	($250,668)	($356,963)	0.95	0.19
Rain Garden	400	($35,113)	($1,994)	$122,336	$212,011	0.81	0.04
Bioswale	900	($121,604)	($46,999)	$233,079	$435,089	2.56	0.08
Permeable Paving	15,600	($1,148,369)	($1,046,455)	($663,852)	($387,895)	20.74	0.06
Tree - Small	9,290	$1,287	$58,899	$275,185	$431,184	0.95	0.04
Tree - Medium	33,920	$116,195	$341,491	$1,187,288	$1,797,328	1.59	0.06
Tree - Large	25,552	$102,176	$275,080	$924,191	$1,392,369	0.95	0.04
Wetland	60,000	($316,098)	$607,476	$4,074,710	$6,575,492	14.47	0.28
Planting Bed	3,787	($348,436)	($187,144)	$418,370	$855,105	7.19	0.34
Active Turf	6,000	($38,864)	($17,588)	$62,285	$119,895	1.24	0.10
Naturalized Turf	14,000	$72,609	$163,006	$502,371	$747,141	0.21	0.09
TOTAL	**172,434**	**($2,329,800)**	**($451,361)**	**$6,600,579**	**$11,686,871**	**61.86**	**1.44**

Cost-Benefit Analysis for Mississauga - City Centre Development

Net Present Value and Jobs of Green Infrastructure on Site							
Type of Green Infrastructure	**Area (m^2)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Extensive Green Roof	3,000	($568,955)	($500,807)	($244,969)	($60,443)	10.59	0.10
Green Façade	300	($46,170)	($55,438)	($90,230)	($115,324)	0.79	0.05
Rain Garden	400	($41,565)	($32,721)	$480	$24,427	0.81	0.04
Bioswale	1,205	($182,251)	($155,483)	($54,995)	$17,483	3.43	0.11
Permeable Paving	800	($58,891)	($53,664)	($34,044)	($19,892)	1.06	0.00
Tree - Small	3,097	$429	$19,633	$91,726	$143,725	0.32	0.01
Tree - Medium	6,784	$23,239	$68,297	$237,454	$359,460	0.32	0.01
Tree - Large	22,713	$90,822	$244,515	$821,500	$1,237,657	0.85	0.03
Wetland	3,660	($19,282)	$37,056	$248,557	$401,105	0.88	0.02
Planting Bed	300	($31,915)	($35,359)	($48,289)	($57,614)	0.57	0.03
Active Turf	3,173	($20,553)	($9,301)	$32,939	$63,405	0.66	0.05
Naturalized Turf	6,346	$32,913	$73,888	$227,718	$338,669	0.09	0.04
TOTAL	**51,777**	**($822,179)**	**($399,385)**	**$1,187,847**	**$2,332,656**	**20.37**	**0.50**

Cost-Benefit Analysis for Toronto - St. Dennis Drive Minto Property

Net Present Value and Jobs of Green Infrastructure on Site							
Type of Green Infrastructure	**Area (m^2)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Intensive Green Roof	600	($167,334)	($129,412)	$12,950	$115,631	3.18	0.10
Rain Garden	600	($62,348)	($49,082)	$720	$36,640	1.21	0.05
Bioswale	1,200	($124,662)	($98,006)	$2,065	$74,242	2.42	0.11
Permeable Surface - Porous paver	500	($36,807)	($33,540)	($21,277)	($12,433)	0.66	0.00
Tree - Small	2,168	$300	$13,743	$64,209	$100,607	0.22	0.01
Tree - Medium	2,940	$10,070	$29,595	$102,897	$155,766	0.14	0.01
Tree - Large	1,420	$5,676	$15,282	$51,344	$77,354	0.05	0.00
Planting Bed	500	($42,737)	($17,259)	$78,392	$147,381	0.95	0.05
Turf - Active	1,500	($9,716)	($4,397)	$15,571	$29,974	0.31	0.02
Turf - Naturalized	1,500	$7,780	$17,465	$53,825	$80,051	0.02	0.01
TOTAL	**12,927**	**($419,778)**	**($255,611)**	**$360,695**	**$805,213**	**9.16**	**0.37**

Cost-Benefit Analysis for Richmond Hill - SmartREIT Site

Net Present Value and Jobs of Green Infrastructure on Site							
Type of Green Infrastructure	**Area (m^2)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Extensive Green Roof	16,800	($3,186,214)	($2,804,831)	($1,373,065)	($340,388)	59.29	0.58
Intensive Green Roof	11,800	($3,400,986)	($3,069,345)	($1,824,315)	($926,323)	62.47	1.02
Green Façade	4,400	($678,369)	($818,815)	($1,346,071)	($1,726,361)	11.65	0.76
Living Wall - Interior	200	($311,105)	($469,134)	($1,062,400)	($1,490,299)	4.75	0.74
Rain Garden	8,800	($914,433)	($719,868)	$10,559	$537,388	17.72	0.78
Bioswale	350	($36,360)	($28,585)	$602	$21,654	0.70	0.03
Permeable Surface - Porous paver	4,435	($326,475)	($297,502)	($188,730)	($110,277)	5.90	0.02
Tree - Medium	150 trees	$116,193	$341,486	$1,187,270	$1,797,302	1.59	0.06
Tree - Large	230 trees	$261,114	$702,981	$2,361,812	$3,558,263	2.43	0.09
Wetland	1,000	($5,268)	$10,125	$67,912	$109,592	0.24	0.00
Planting Bed	790	($67,525)	($27,269)	$123,859	$232,861	1.50	0.08
Turf - Active	2,000	($12,955)	($5,863)	$20,762	$39,965	0.41	0.03
TOTAL	**149,794**	**($8,562,383)**	**($7,186,621)**	**($2,021,805)**	**$1,703,377**	**168.66**	**4.20**

Cost-Benefit Analysis for Richmond Hill - TSMJC Properties and Bernard Bus Terminal Site

Net Present Value and Jobs of Green Infrastructure on Site							
Type of Green Infrastructure	**Area (m^2)**	**1 year**	**5 years**	**25 years**	**50 years**	**Job-years (Construction) (One-time)**	**Job-years (Maintenance) (Annually)**
Extensive Green Roof	5,500	($1,043,106)	($918,248)	($449,515)	($111,436)	19.41	0.19
Intensive Green Roof	5,300	($1,518,447)	($1,335,201)	($647,268)	($151,089)	28.06	0.46
Green Façade	800	($123,340)	($148,876)	($244,740)	($313,884)	2.12	0.14
Living Wall - Exterior	200	($256,156)	($413,180)	($1,002,673)	($1,427,852)	3.80	0.74
Rain Garden	900	($93,522)	($73,623)	$1,080	$54,960	1.81	0.08
Bioswale	4,240	($440,474)	($346,289)	$7,295	$262,322	8.54	0.38
Permeable Surface - Porous paver	2,800	($206,118)	($187,825)	($119,153)	($69,622)	3.72	0.01
Tree - Small	80 trees	$1,144	$52,354	$244,604	$383,267	0.85	0.03
Tree - Medium	80 trees	$61,970	$182,126	$633,211	$958,561	0.85	0.03
Tree - Large	80 trees	$90,822	$244,515	$821,500	$1,237,657	0.85	0.03
Wetland	1,000	($5,268)	$10,125	$67,912	$109,592	0.24	0.00
Planting Bed	1,780	($171,647)	($139,877)	($20,609)	$65,415	3.38	0.19
Turf - Active	2,320	($15,028)	($6,801)	$24,084	$46,359	0.48	0.04
TOTAL	**73,901**	**($3,719,168)**	**($3,080,800)**	**($684,273)**	**$1,044,249**	**74.10**	**2.33**

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