Next Level™
STORMWATER MANAGEMENT

# Strategies to Meet Policy and Design Goals in City of Toronto

## Learning Objectives

1. Understand how various components create green roof systems to achieve design intents
2. Learn local policies aimed at enhancing sustainable development using green roofs
3. Identify green roof systems that can successfully address a policy requirement
4. Understand how a multi-disciplinary approach to designing green roofs is key


Two Old Mill, Toronto, ON

# 80 years combined Green Roof experience

Technical advice, design and planning

Budgetary estimates and quotes

Certified installer training

Single source solutions – one stop shop

Coordinate delivery of all products to site

Supervise, inspect and review final installation

Warranty

# NLSM Green Roof System Portfolio Overview

LiteN'Less® Classic II
LiteN'Less® Classic III
Xeroflor® XF301
SpongeBase

StormCap®
StormCap®+Detention
TerraEXT®

Alpine Meadow
Alpine Meadow +
Roof Turf

0 — 7.5 cm — 15 cm — 20+ cm

Growing medium depth (3") (6") (8+")

Weight: 50 kg/m² (10 psf) | 100 kg/m² (20 psf) | 150 kg/m² (30 psf) | 200+ kg/m² (40+ psf)

**Extensive**
$170 – $270 /m²
($16 – $25 /sf)

**Semi-intensive**
$210 – $320 /m²
($20 – $30 /sf)

**Intensive**
$270 – $650 /m²
($25 – $60 /sf)

Introduction to Vegetated Roof Systems

Green Roof By-Law

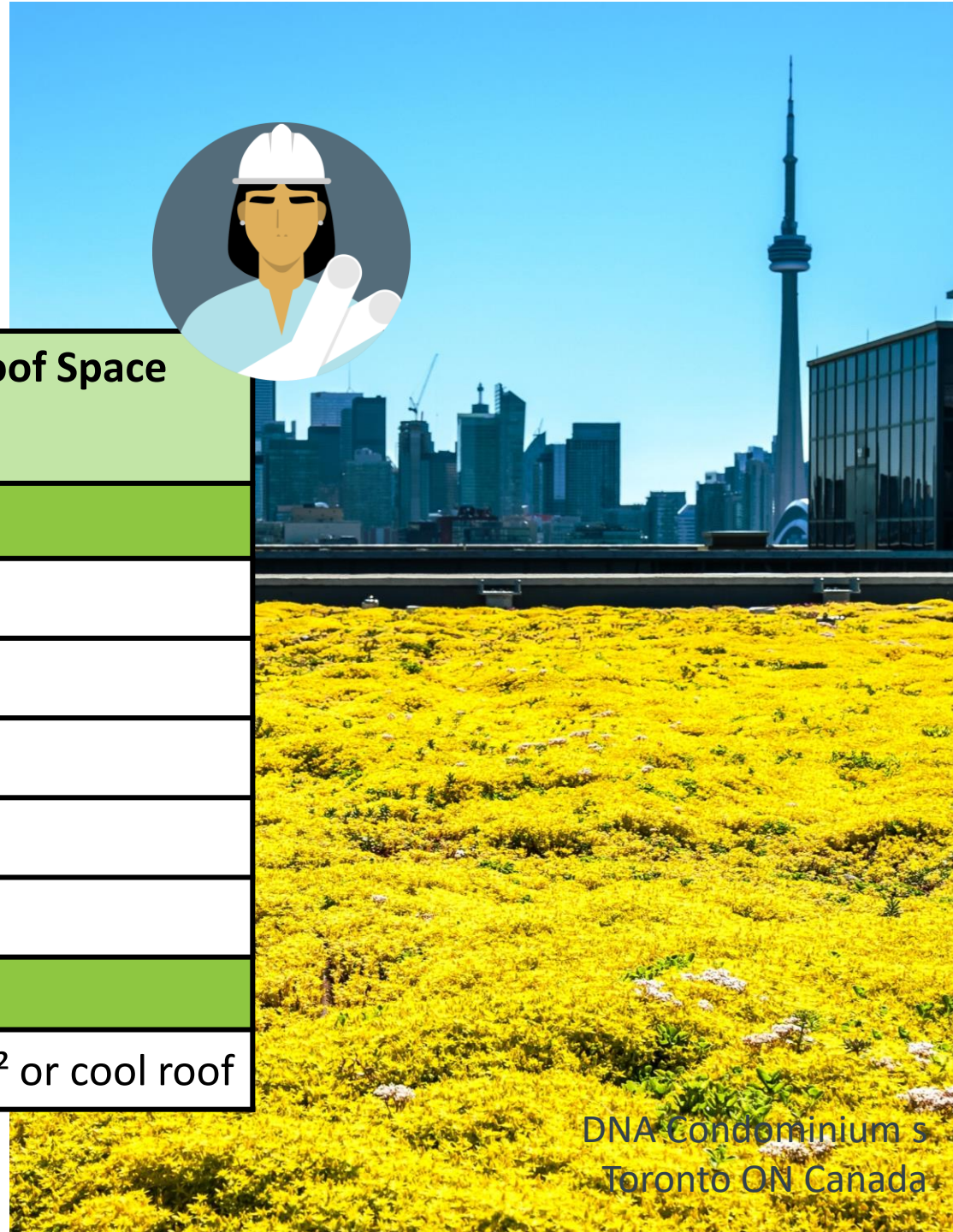
TGS v4 W.Q. 1.1

TGS 4v W.Q. 1.3

Private residence, White Rock, BC

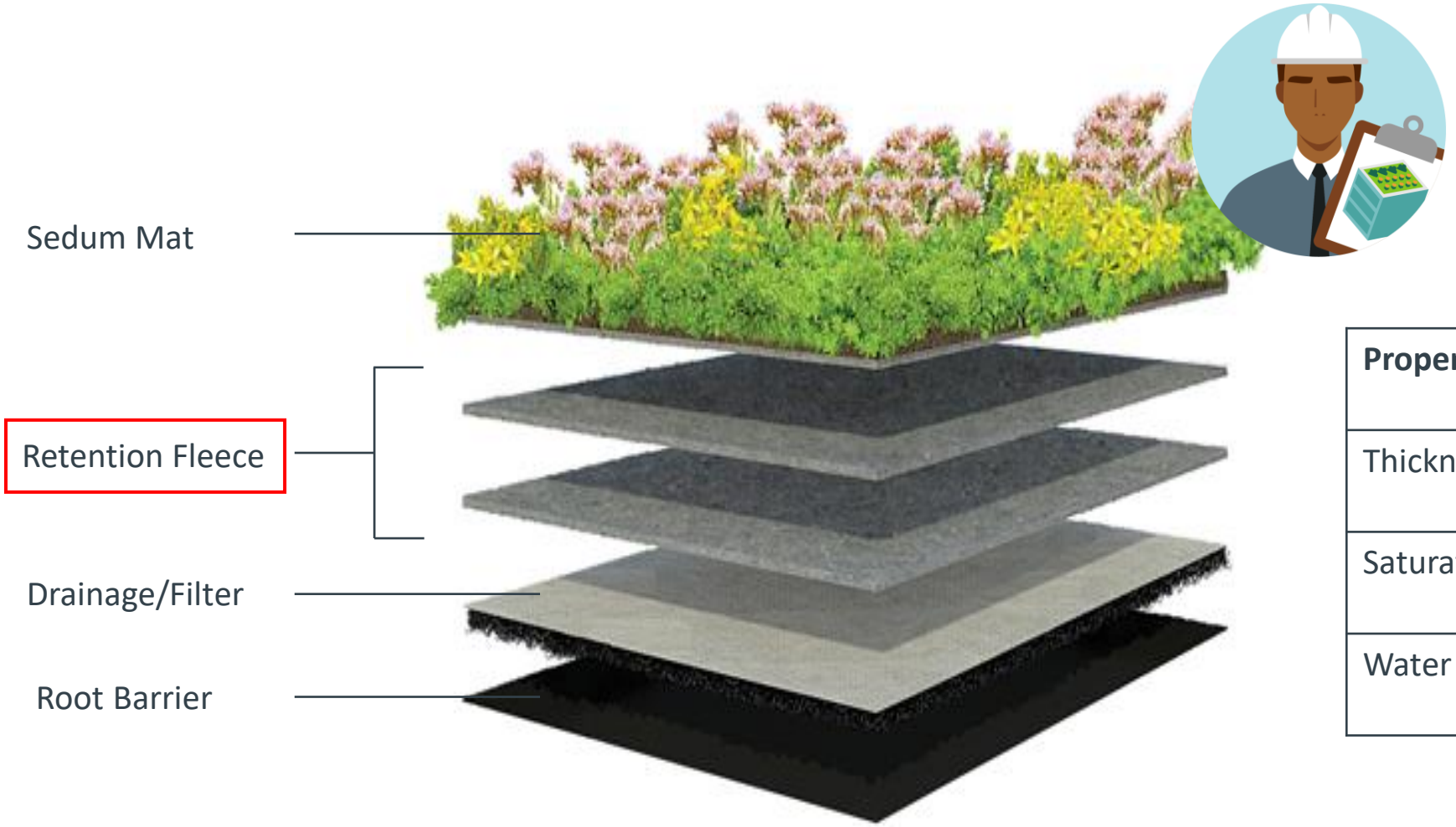
# Toronto's Green Roof Bylaw

| Gross Floor Area (Size of building) | Coverage of Available Roof Space (Size of Green Roof) |
|---|---|
| **Residential/Commercial /Institutional** | |
| 2,000 - 4,999 m² | 20% |
| 5,000 - 9,999 m² | 30% |
| 10,000 - 14,999 m² | 40% |
| 15,000 - 19,999 m² | 50% |
| 20,000 m² or greater | 60% |
| **Industrial** | |
| >2,000m² | Lesser of 10% or 2,000m² or cool roof |



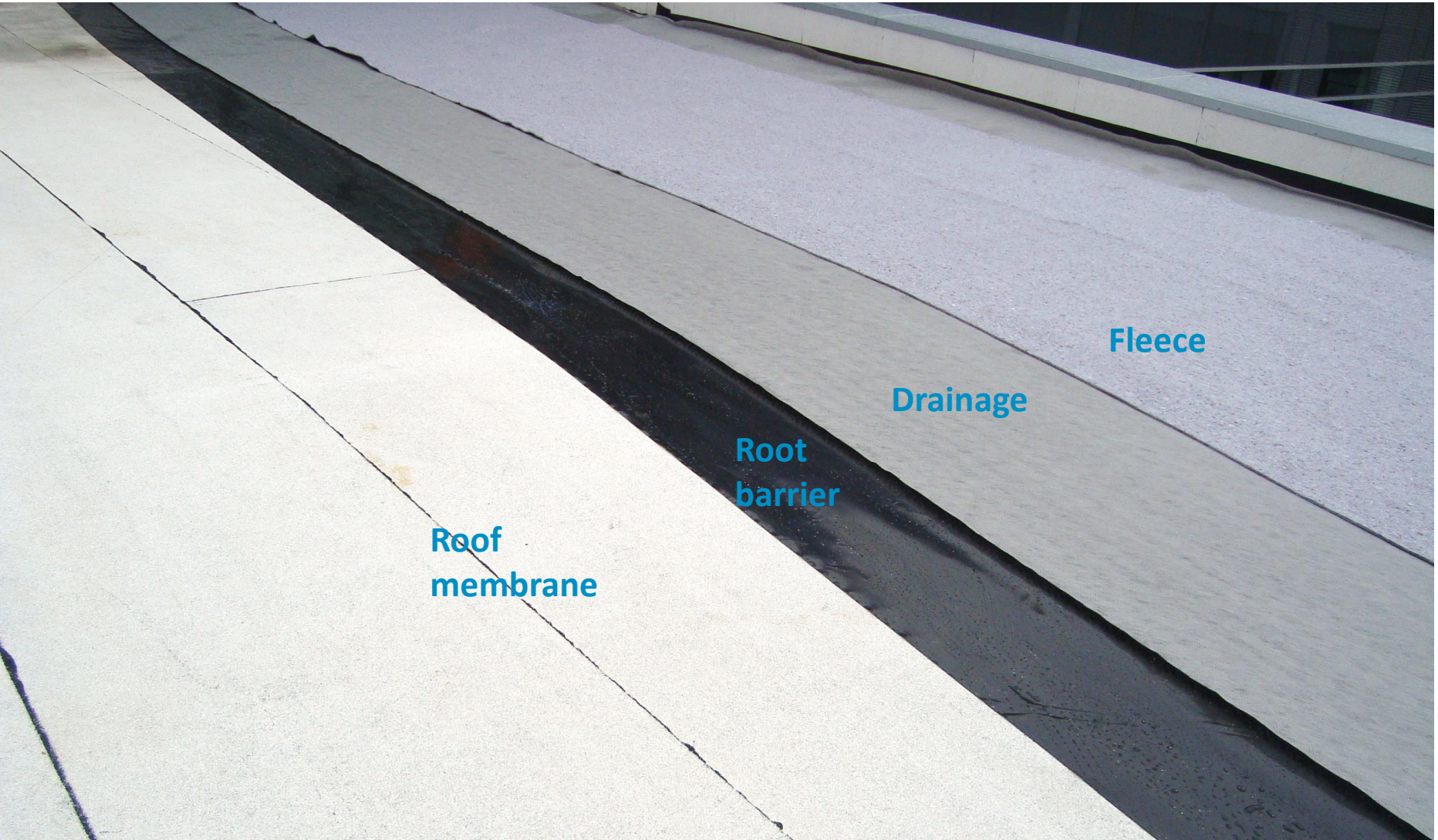
DNA Condominium s
Toronto ON Canada

# LiteN'Less: Value Engineered Extensive System




| Properties | |
|---|---|
| Thickness | 63 mm (2.5") |
| Saturated Weight | 57 kg/m$^2$ (11.7 lb/sf) |
| Water Retention | 34 l/m$^2$ (0.83 gal/sf) |

# Soilless System Installation




# Water Retention Fleece

# Soilless System Installation

Fleece

Hydro Blanket

# Sherway Gardens North Expansion


# Compliant with the Toronto Green Roof Construction Standard



E. Wind uplift.

The applicant shall provide a report, stamped by an engineer, providing wind uplift pressures being designed for (including a description of how the pressures were determined), and describing how the design addresses these pressures.

K. Vegetation performance.

In order to support plant survivability:

(1) When structurally possible, the growing media shall be at a minimum 100 mm; or

(2) The applicant shall provide a report confirming that the engineered system as designed provides plant survivability comparable to that of an un-irrigated system with growing media at minimum 100 mm.

# Compliant with the Toronto Green Roof Construction Standard

## Wind Resistance Letter

LorEng
CONSTRUCTION SERVICES INC.
STRUCTURAL ENGINEERING

2 Queen Elizabeth Blvd.
Suite 102
Toronto, Ontario, M8Z 1L8
T. (416) 255-4447
LorEng@bellnet.ca

Professional Engineers Ontario

**1. Xeroflor XF301 green roof system:**

**Green Roof Analysis Results:**

The proposed green roof assembly for the above mentioned roof levels is XeroFlor XF301 system for which the composition is as follows:

- Xeroflor XF301 system green roof is based on a minimum dry weight of 0.17 kN/m²;
- XF 301 Sedum Mat, Combi (ST) on XF159 water retention fleece layer;
- XF108 XeroDrain drainage layer and 20 mil. XF112 root barrier
- Approximate weight of total system as tested is 90.3 kg/m²;
- System installed over the prescribed roofing system.

The Xeroflor XF301 green roof system has been tested by the National Research Council of Canada in accordance with the CAN/CSA A123.24-15 "Standard Test Method for Wind Resistance of Modular Vegetated Roof Assembly" - Report No. A1-004442, dated Feb. 10, 2016. The report indicates a Wind Uplift Resistance of 6.4 kPa; and a Wind Flow Resistance of 113 km/hr. Report results are based on a safety factor of 1.5.

In comparing the aforementioned wind speed loading criteria with the reported factored wind flow capacity of the XeroFlor XF301 planting system, it is noted that the system is sufficient to resist anticipated wind flow forces which do not exceed speeds of 113km/hr and is adequate for use over the intended green roof areas.
The green roof system uplift resistance (6.4 kPa) is also noted to be sufficient to resist anticipated uplift forces and is adequate for use over the intended green roof areas. It should also be noted that Wind Uplift Resistance of the roofing system in accordance with CSA A123.21 will apply.

We trust this information is satisfactory for your requirements. Should you require additional information or clarification kindly contact the writer at your earliest convenience.

Thank you for your attention in these matters.

Best regards,

LorEng Construction Services Inc.

LICENSED PROFESSIONAL ENGINEER
L. J. MOGENTALE
PROVINCE OF ONTARIO

Per.: Loris Mogentale, P.Eng.
Ljm/LM

## Plant Survivability Report

The XF301 extensive green roof system consists of 4 major components – a root barrier, a drainage/filter layer, a water retention layer and a pre-cultivated vegetation mat (Figure 1). It is designed, engineered and tested for long-term performance with low maintenance.

*Weight of growing media:* The saturated weight of the Xeroterr growing media within the XF301 Sedum Standard mat is 34 kg/m². The XF301 Sedum mat is composed of only 1.7cm of Xeroterr growing media (Figure 2). Calculation: $2000\ \mathrm{kg/m^3} \div 100\ \mathrm{cm} = 20\ \mathrm{kg/cm/m^2} \times 1.7\mathrm{cm} = 34\mathrm{kg/m^2}$

**Figure 1 Principal components of the XF301 system**

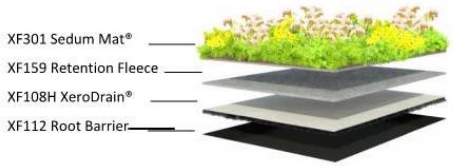



**Figure 2 Sedum mat detail**

The XF301 green roof system can be engineered to have different water retention capacity to meet the project requirements by incorporating different water retention layers in the build-up (Table 1). The water retention layers are made of lightweight, highly absorbent materials. They capture and store water effectively while keeping the weight of the green roof system low. The sedums grow and take up water and nutrients stored in the water retention layers.

**Table 1 Comparison of XF301 pre-cultivated system to traditional plant-in-place system.**

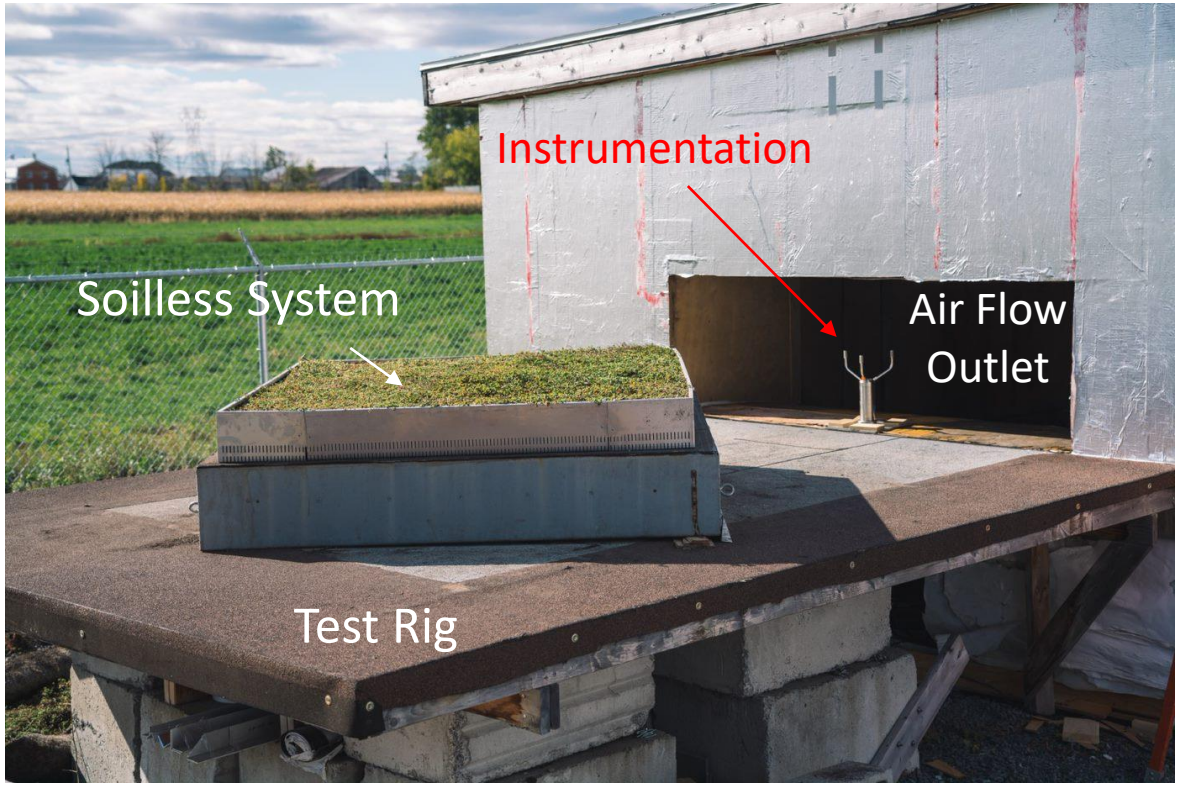
| Green Roof System | Saturated Weight (kg/m2) | Water Retention ($L/m^2$) |
|---|---|---|
| XF301 Standard Buildup | 59 | 35.9 |
| 100 mm of Growing Medium | 150 | 38.0 |

The XF301 Standard Build-up has similar water retention capacity as a green roof with 100 mm of growing medium. When un-irrigated, these systems capture and store similar amount of water for the plants to use and to tie the plants over until the next rainfall.

These succulents can survive with little water by nature but by adding a layer of stones as "mulch" to reduce water evaporation, even the XF301 pre-cultivated sedum mat and the XF301 Lightweight Buildup (with 17-26 $L/m^2$ water retention) can survive the hot and dry summer in the Greater Toronto Area (GTA).

The following pages show the plant growth and establishment of XF301 green roof systems with different water retention capacities over the years. All of these projects are un-irrigated. They are at least 5 years old and most of them are in the GTA. They are evidence of the long term plant survivability and success of un-irrigated XF301 green roof systems.

# Performing the CSA A123.24 Wind Flow Test on NLSM's Soilless System




Air Flow Machine (front): specimen on test rig

Air Flow Machine (back): powerful twin fans


Wind Speed @ 200 km/h (124 mph)

# Soilless System after passing 200 km/h: Minor leaf loss but otherwise unharmed


Before Test


After Test

# Test Results:

- Test stopped at 200 km/h (apparatus limit)
- After applying a generous safety factor of 1.5, the system's wind flow resistance is 133 km/h

**WIND RESISTANCE TESTS**
**ON MODULAR VEGETATED ROOF ASSEMBLY**
**AS PER CSA A123.24**

Prepared for: ***Next Level Stormwater Management***
**1, Yonge St. Ste 1801**
**Toronto, On, Canada**
**M5E 1W7**

**Attn: Ms. Sasha Aguilera**

Report no.: AS-01419-B

Date: December 22th, 2020
Revision Date: January 11th, 2021

Prepared by:
**Justin Chagnon-Lafrance, Jr. Eng.**
**Project Manager, Materials and Systems Testing**

Approved by:
**Jean Loubert, P.Eng.**
**Assistant Manager, Materials and Systems Testing**



Part B: Wind Flow Resistance

The wind flow resistance tests were performed by *UL Laboratory Canada Inc.*.

The time elapsed between vegetated roof assembly construction (October 5th, 2020) and wind flow testing (October 6th, 2020) is 1 day.

Wind flow resistance: 133 km/h (83 mph)

Failure mode: No failure, test stopped at 200 km/h (124 mph) (Apparatus Limit)

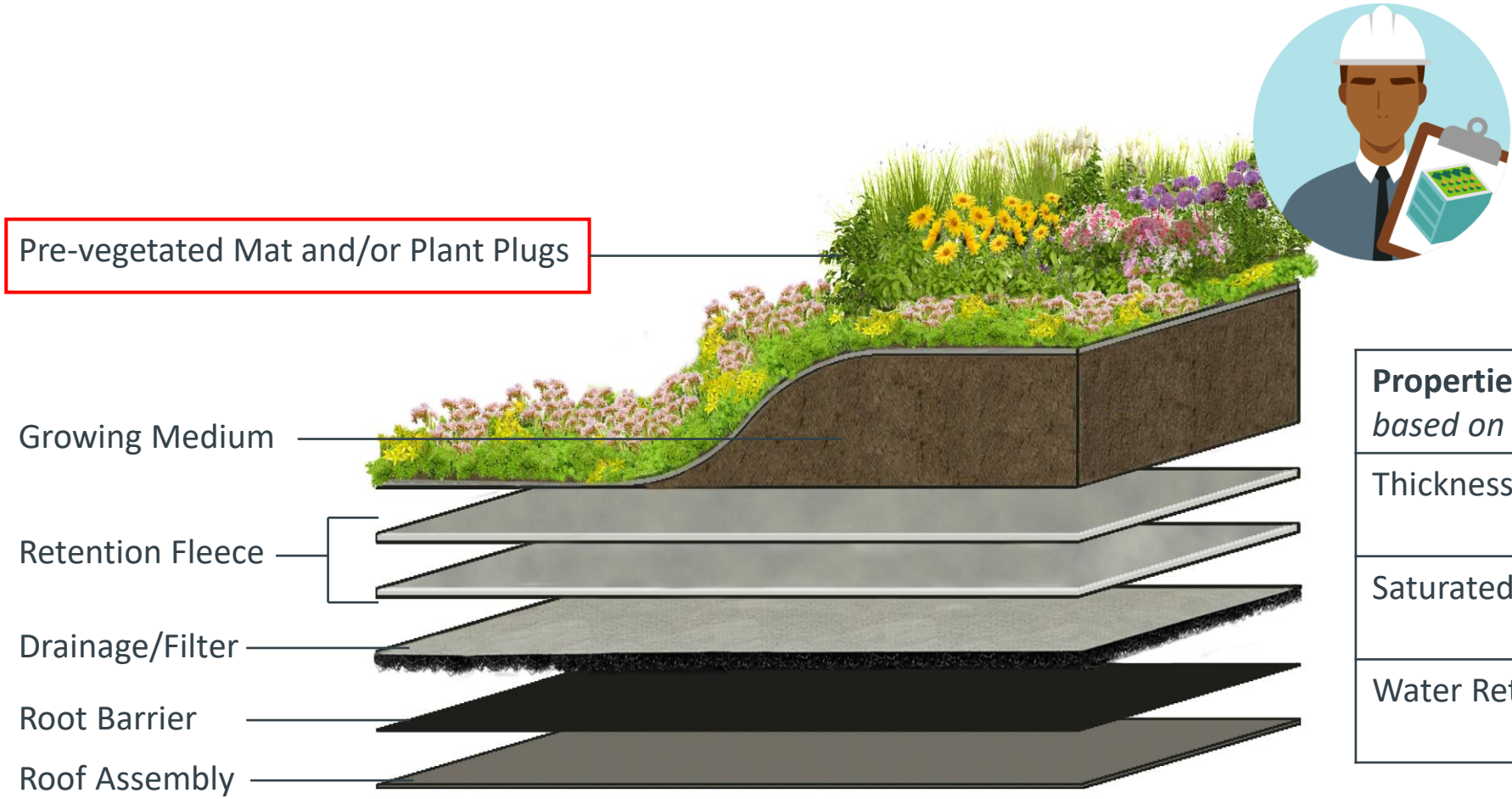
Note: See Appendix B for Wind flow rating curve

To see a video on the full testing protocol, copy and paste this link into your browser:
https://www.youtube.com/watch?v=uE5xz649ZxQ


Unionville Condominiums
Markham, ON


Unionville Condominiums
Markham, ON

# BioBerm: Enhancement with accent plants




| **Properties** *based on 15 cm (6”) GM* | |
|---|---|
| Thickness | 185 mm (7.3”) |
| Saturated Weight | 190 kg/m$^2$ (38.9 psf) |
| Water Retention | 68 l/m$^2$ (1.7 gal/sf) |

Introduction to Vegetated Roof Systems

Green Roof By-Law

TGS v4 W.Q 1.1

TGS v4 W.Q 1.3

Broadway Tech Centre, Vancouver, BC


# WATER QUALITY AND EFFICIENCY

Development Feature

## MANAGING STORMWATER

### TIER 1

**WQ 1.1 Water Balance, Quality Control & Quantity Control**

Design the site to achieve all Water Balance, Water Quality and Water Quantity control targets required by the Wet Weather Flow Management Guidelines:

1) Water Balance- Retain a minimum of 50% of the total average annual rainfall volume (or equivalent 5 mm from each rainfall event) generated from all site surfaces through infiltration, evapotranspiration, water harvesting and/or reuse, in accordance with the Wet Weather Flow Management Guidelines.

2) Water Quality- Provide an enhanced level of protection for water quality through the long-term average removal of 80% of Total Suspended Solids (TSS) on an annual loading basis from all runoff leaving the site, in accordance with the Wet Weather Flow Management Guidelines. Provide E.coli control for direct discharges to Lake Ontario or for discharges generated from waterfront sites, where deemed necessary and in accordance with the Wet Weather Flow Management Guidelines.

3) Water Quantity- Provide peak flow control following applicable Wet Weather Flow Management Guideline requirements for flood flow management, erosion control and discharge to municipal sewers.

Rainfall

Initial Abstraction

**Water Reuse**

- Toilet flushing
- Irrigation

Runoff

Storage

Must be used up within 72 hours

# Initial Abstraction (IA)

Accounts for all losses prior to runoff and consists mainly of infiltration and evaporation

| Surface Type | Initial Abstraction |
|---|---|
| impervious | |
| Impervious Roof | 1 mm |
| Asphalt Pavement | 1 mm |
| Concrete Pavers | 1 mm |
| pervious | |
| Permeable Pavers | 5 mm |
| Landscape | 5 mm |
| Green Roof - Extensive | 5 mm |
| Green Roof - Intensive | 7 mm |

## Water Balance

| Surface Type | Area ($m^2$) | Initial Abstraction (mm) | Volume Abstracted ($m^3$) | 5 mm Volume ($m^3$) | Require Storage ($m^3$) |
|---|---|---|---|---|---|
| Impervious Roof | 500 | 1 | 0.50 | | |
| Green Roof - Extensive | 100 | 5 | 0.50 | | |
| Green Roof - Intensive | 100 | 7 | 0.70 | | |
| Asphalt Pavement | 200 | 1 | 0.20 | | |
| Landscape | 100 | 5 | 0.50 | | |
| **Total** | | 2.4 | 2.4 | 5.0 | **2.6** |

Storage Volume

## Irrigation Water Reuse/Demand

| Surface Type | Area ($m^2$) | Water Reuse ($m^3$) |
|---|---|---|
| Landscape | 100 | 0.70 |
| Green Roof - Extensive | 100 | 0.70 |
| Green Roof - Intensive | 100 | 0.90 |
| **72-hour average** | | **2.3** |

Water Reuse

***Storage Volume*** > ***Water Reuse***

## Water Balance

| Surface Type | Area ($m^2$) | Initial Abstraction (mm) | Volume Abstracted ($m^3$) | 5 mm Volume ($m^3$) | Required Storage ($m^3$) |
|---|---|---|---|---|---|
| Impervious Roof | 470 | 1 | 0.47 | | |
| Green Roof - Extensive | 130 | 5 | 0.65 | | |
| Green Roof - Intensive | 100 | 7 | 0.70 | | |
| Asphalt Pavement | 200 | 1 | 0.20 | | |
| Landscape | 100 | 5 | 0.50 | | |
| **Total** | | 2.5 | 2.5 | 5.0 | 2.5 |

Storage Volume

## Irrigation Water Reuse/Demand

| Surface Type | Area ($m^2$) | Water Reuse ($m^3$) |
|---|---|---|
| Landscape | 100 | 0.70 |
| Green Roof - Extensive | 130 | 0.93 |
| Green Roof - Intensive | 100 | 0.90 |
| **72-hour average** | | 2.5 |

Water Reuse

***Storage Volume*** $\leq$ ***Water Reuse*** ✓

# Water Balance - Irrigation Water Reuse/Demand

$$WR = (ET_O * K_L - R_e) * A / IE$$

*equation 1*

where

WR = Water Requirement/Demand (l/month)

$ET_O$ = Local Reference Evapotranspiration (mm/month)

$K_L$ = Landscape Coefficient (dimensionless)

$R_e$ = Effective Rainfall (mm/month), defined as 25% of average peak monthly rainfall

A = Area ($m^2$)

IE = Irrigation Efficiency (dimensionless)

# Irrigation Water Reuse – Landscape Coefficient

$$K_L = K_S * K_D * K_{MC}$$ *equation 2*

where

$K_L$ = Landscape Coefficient (dimensionless)

$K_S$ = Species Factor (dimensionless)

$K_D$ = Density Factor (dimensionless)

$K_{MC}$ = Microclimate Factor (dimensionless)

| Water Needs | $K_S$ |
|---|---|
| Very low | <0.1 |
| Low | 0.1 - 0.3 |
| Moderate | 0.4 - 0.6 |
| High | 0.7 - 0.9 |

| Density | $K_D$ |
|---|---|
| Low | 0.5 - 0.9 |
| Average | 1 |
| High | 1.1 - 1.3 |

| Water Needs | $K_{MC}$ |
|---|---|
| Low | 0.5 - 0.9 |
| Average | 1 |
| High | 1.1 - 1.4 |

# Tips to support the Civil engineer in meeting W.Q1.1 water balance requirements

- Ensure the landscape and green roof areas listed on the water balance table are accurate.
- Ensure the green roof area is listed under the appropriate category on the water balance table. Ex. Extensive GR = 5 mm IA, Intensive GR = 7 mm IA.
- Recommend irrigation as a means of water re-use where appropriate.
- Convert amenity space landscape into “Intensive Green Roofs” for an extra 2 mm IA.

Introduction to Vegetated Roof Systems

Green Roof By-Law

TGS v4 W.Q 1.1

TGS v4 W.Q 1.3

Golf Park Maisonneuve, Montreal, QC


# WATER QUALITY AND EFFICIENCY

Development Feature

## MANAGING STORMWATER

### TIER 1

**WQ 1.3 On-site Green Infrastructure**

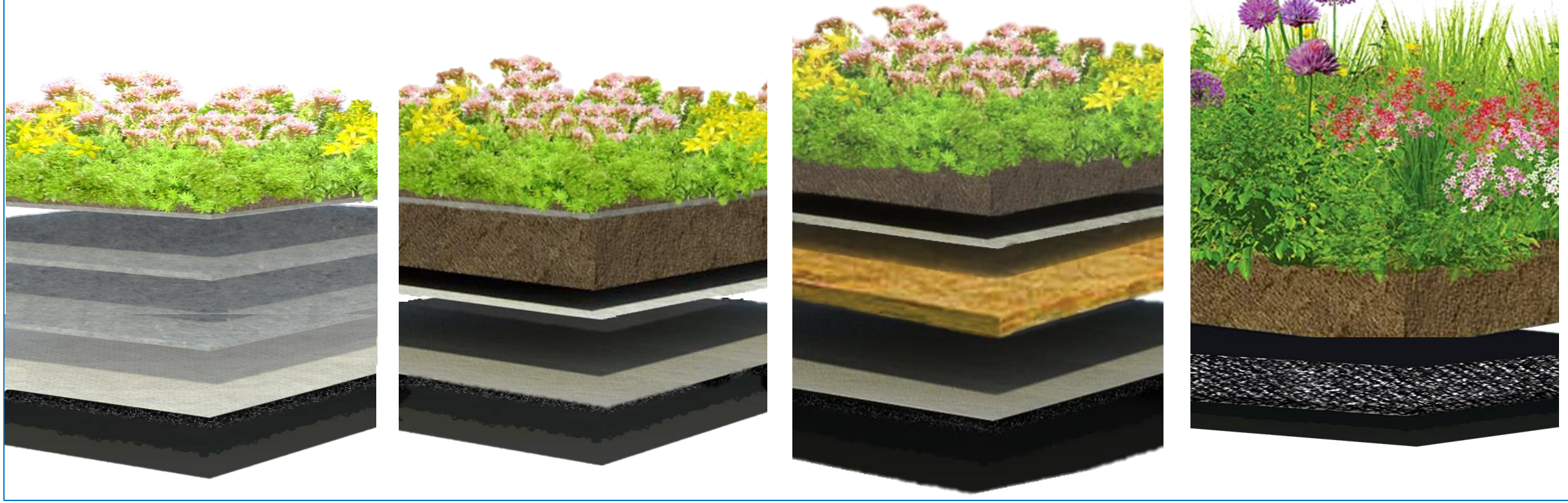
Ensure that the total landscaped site area, located at and above grade, includes at least one of the following features:

- A Green Roof covering at least 80% of Available Roof Space;
- An Intensive Green Roof for 80% of the Green Roof Area provided;
- Biodiverse green roof to support pollinator species covering a minimum of 50% Green Roof Area;
- 25% of the Lot Area at or above-grade, planted with native flowering/pollinator species;
- At-grade Bioretention facilities provided to capture and control 75% of runoff from on-site hardscape surfaces; or,
- Reforestation of a portion of the site (beyond the limit of a stewardship plan).

# TGS WQ 1.3: Option 1 - 80% Green Roof Cover

A green roof covering at least 80% of the Available Roof Space

**Extensive or Intensive Systems**



# TGS WQ 1.3: Option 1 - 80% Green Roof Cover

A green roof covering at least 80% of the Available Roof Space

# TGS WQ 1.3: Option 2 - Intensive Green Roof

An intensive green roof for 80% of the green roof area provided


Available Roof Space

- Deeper substrates that can support a greater variety of plant species.
- Minimum depth of 150 mm
- A diverse mix of plants
- Plants may include sedums. Grasses, drought tolerant perennials. And larger plants and trees where appropriate.

# TGS WQ 1.3: Option 3 - Biodiverse Green Roof

Biodiverse green roof to support pollinator species covering a minimum of 50% of the green roof area provided


Green Roof Bylaw (e.g. 60%)

Available Roof Space

- An intensive green roof
- Support pollinator species from Design Guidelines for Biodiverse Green Roofs – Appendix A
- Min. two pollinator species in bloom from May – Sep.
- Two or more applicable Design Strategies from section 4.2 of the Guidelines.
- Located on the 8th floor or lower

# Alpine Meadow

made easy with a hardy BIODIVERSITY & beautiful roll-out system


## Key Features

- Manages stormwater and supports biodiversity, simultaneously. Native hardy plants provide nourishing pollen and nectar, and nesting habitats
- Plants are pre-grown as a "blanket" with over 85% vegetation coverage upon installation; minimizing soil erosion, weed encroachment and irrigation needs.
- Highly absorbent Needled Mineral (NM) Hydro

# Green Roof Options to Meet TGS WQ 1.3

| TGS WQ 1.3 Green Roof Options | Compliance Requirements | NLSM Solutions |
|---|---|---|
| A Green Roof covering at least 80% of Available Roof Space | • Any green roof covering at least 80% of Available Roof Space | • LiteN'Less Classic II / III<br>• XF301 / XF300<br>• StormCap<br>• TerraEXT<br>• FloraEXT |
| An Intensive Green Roof for 80% of the Green Roof Area provided | • Minimum growing medium depth of 150 mm<br>• Diverse plant mix including sedum, grasses, perennials and trees | • Eco-Grass<br>• Flora Garden |
| Biodiverse green roof to support pollinator species covering a minimum of 50% Green Roof Area | • An intensive green roof<br>• Support pollinator species from Design Guidelines for Biodiverse Green Roofs – Appendix A<br>• Minimum two pollinators species in bloom from May to Sep<br>• Two or more applicable Design Strategies from Section 4.2 of the Design Guidelines above<br>• Located on 8th floor or lower | • Alpine Meadow<br>• Alpine Meadow+ |

# Meeting Requirements with Green Roofs

Requires coordinated efforts of a multi-disciplinary team

Engineer (Civil & Mechanical):

water balance calculations

Architect:

site surface types/areas

Landscape Architect:

landscape plan

Irrigation consultant:

Irrigation demand

Developer:

Costing

Green roof supplier:

System buildup

# Common Pitfalls

# Water Access Hose bibs or irrigations systems

Sherway Gardens
Toronto ON Canada


# Access Points

# Designated Access Paths and Vegetation- Free Zones

Sherway Gardens
Toronto ON

Blythwood at Huntington
Toronto ON Canada


Fall Arrest Anchors
Blywood Condo
Toronto ON Canada

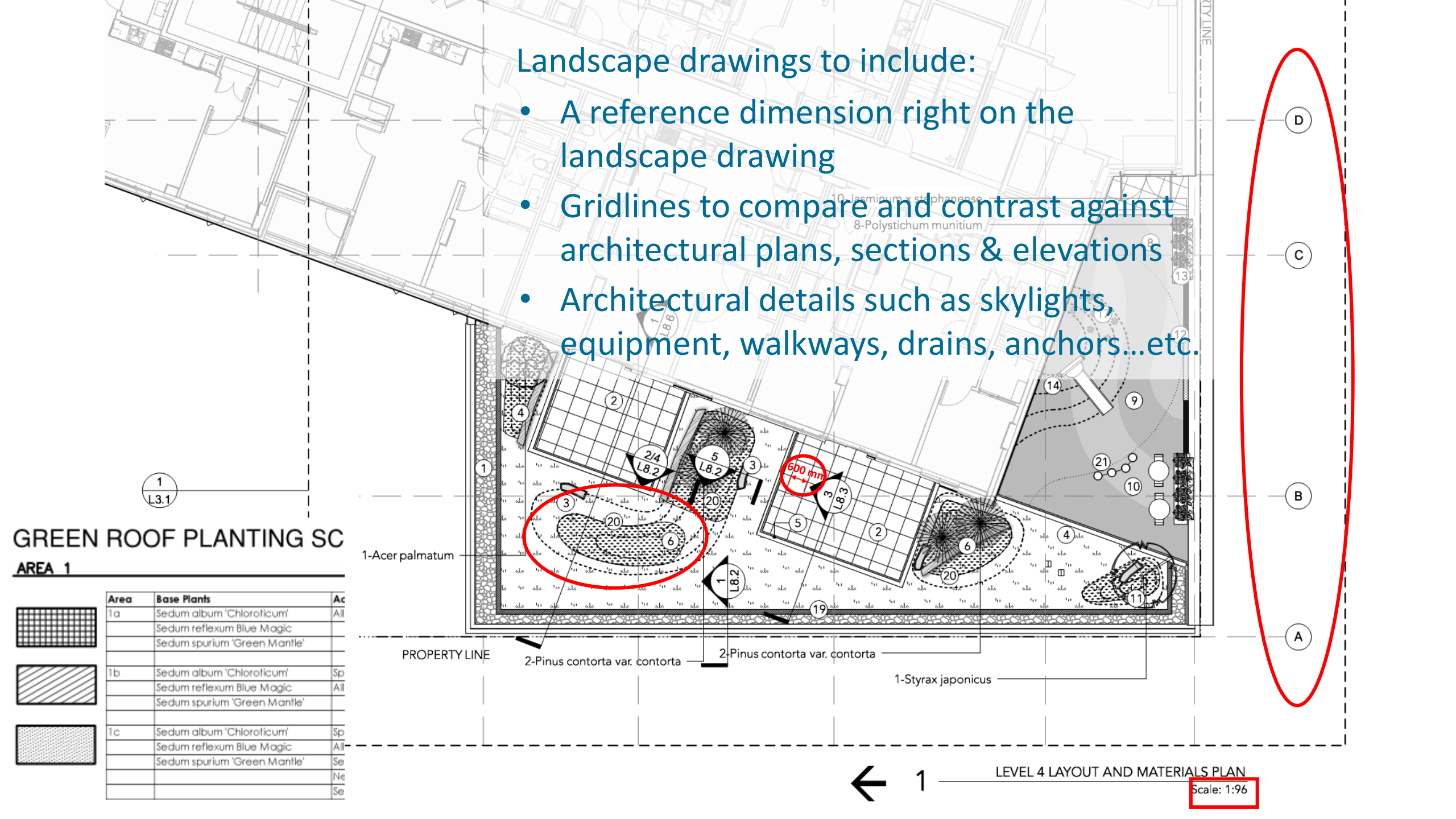


# Damage by Foot Traffic

Uptown Towers
Toronto ON Canada


# Canopies

Regent Park
Toronto ON Canada


Landscape drawings to include:
• A reference dimension right on the landscape drawing
• Gridlines to compare and contrast against architectural plans, sections & elevations
• Architectural details such as skylights, equipment, walkways, drains, anchors…etc.
GREEN ROOF PLANTING SC
AREA 1
Area
Base Plants
1a
Sedum album 'Chloroticum'
Sedum reflexum Blue Magic
Sedum spurium 'Green Mantle'
1b
Sedum album 'Chloroticum'
Sedum reflexum Blue Magic
Sedum spurium 'Green Mantle'
1c
Sedum album 'Chloroticum'
Sedum reflexum Blue Magic
Sedum spurium 'Green Mantle'
1-Acer palmatum
PROPERTY LINE
2-Pinus contorta var. contorta
2-Pinus contorta var. contorta
1-Styrax japonicus
600 mm
LEVEL 4 LAYOUT AND MATERIALS PLAN
Scale: 1:96

Next Level™
STORMWATER MANAGEMENT

# THANK YOU!

Sasha Aguilera – Design Ambassador sasha@nlsm.ca 647-466-5595

PV Integration

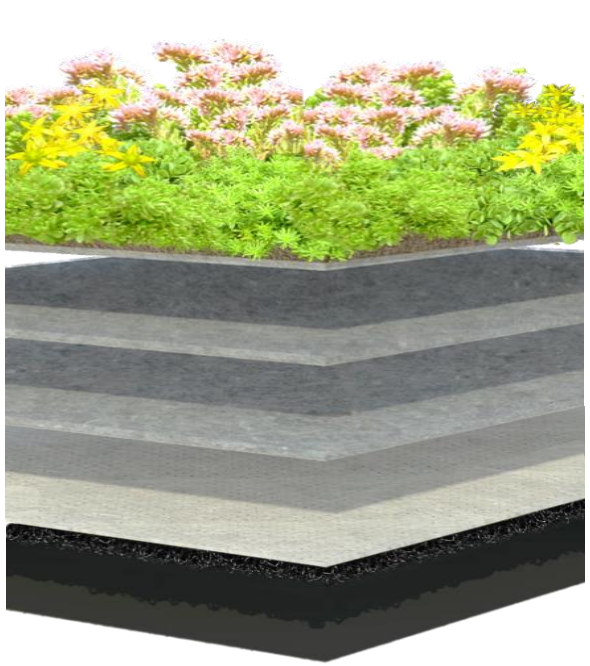
Stormwater Management

Amenity Space

Enhanced Biodiversity

Lightweight & Economical

Energy Saving



## Water Quality & Efficiency WQ 1.3 On-site Green Infrastructure - Mid-high Rise Residential & Non-Residential

**Ensure that the total landscaped site area, located at and above grade, includes at least one of the 6 features below:**

| | Feature Description | Min. 150 mm GM | located on ≤ 8 stories | Plant List Type | Bloom requirement | Design Strategy | 5 Yr. Mtnce. Program | Permanent Irrigation System | Mtnce. access |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A Green Roof covering at least 80% of Available Roof Space; [4] | | | | | | | | |
| 2 | An Intensive Green Roof for 80% of the Green Roof Area provided; [5,7] | Required | | Diverse mix* | | | Required | Required | Door or hatch |
| 3 | Biodiverse green roof to support pollinator species covering a minimum of 50% Green Roof Area; [6,7] | Required | Required | Appendix A† | Two at all times from May to Sep | Two Required [§] | Required | Required | Door or hatch |
| 4 | 25% of the Lot Area at or above-grade, planted with native flowering/pollinator species;[8] | | | | | | | | |
| 5 | At-grade Bioretention facilities provided to capture and control 75% of runoff from on-site hardscape surfaces; or, [9] | | | | | | | | |
| 6 | Reforestation of a portion of the site (beyond the limit of a stewardship plan). [10] | | | | | | | | |