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Smart Blue Roof Systems:

An Innovative Green Infrastructure Approach to Climate Change Adaptation

Presented by: *James Cowan, Engineering Specialist*

Date: *March 26th, 2024*

The water component of STEP is a collaborative of:

Lake Simcoe Region conservation authority

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Outline

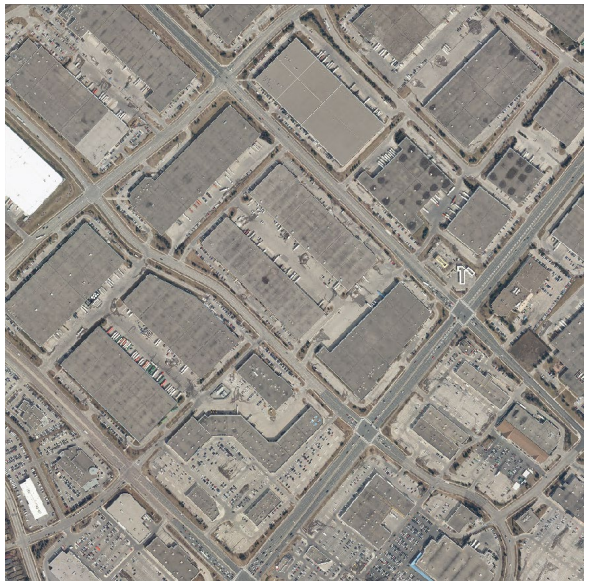
1) Introduction to Smart Blue Roofs
2) Design Overview
3) Construction Process
4) Benefits at Larger Scales

Introduction to Smart Blue Roofs

An Emerging Technology

Town of Erin

Town of Caledon



City of Mississauga

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Town of Orangeville

Town of Oakville

City of Brampton

Town of Halton Hills

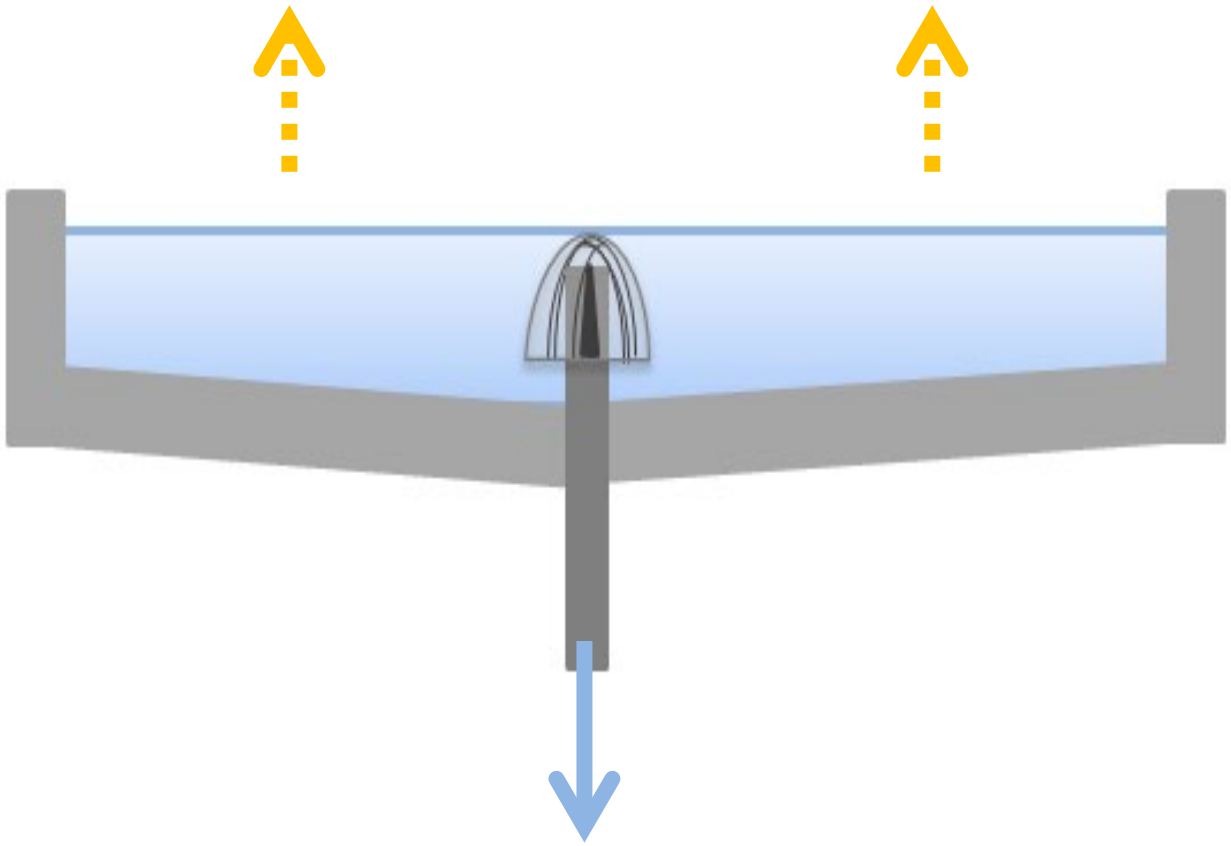
Flooding is the costliest natural disaster impacting Canadians and is the lead driver in rising catastrophic insurable losses for the property and casualty insurance sector in Canada.

- Insured losses averaged $1.8 billion annually from 2009 to 2018, compared to $405 million annually from 1983 to 2008.

[Intact Centre on Climate Adaptation]

Smart Blue Roof
–
A Dynamic Solution!

- Temporary detention of rainwater
- Logic-controlled storage
- Strategic and optimized water management
- Highly adaptable design



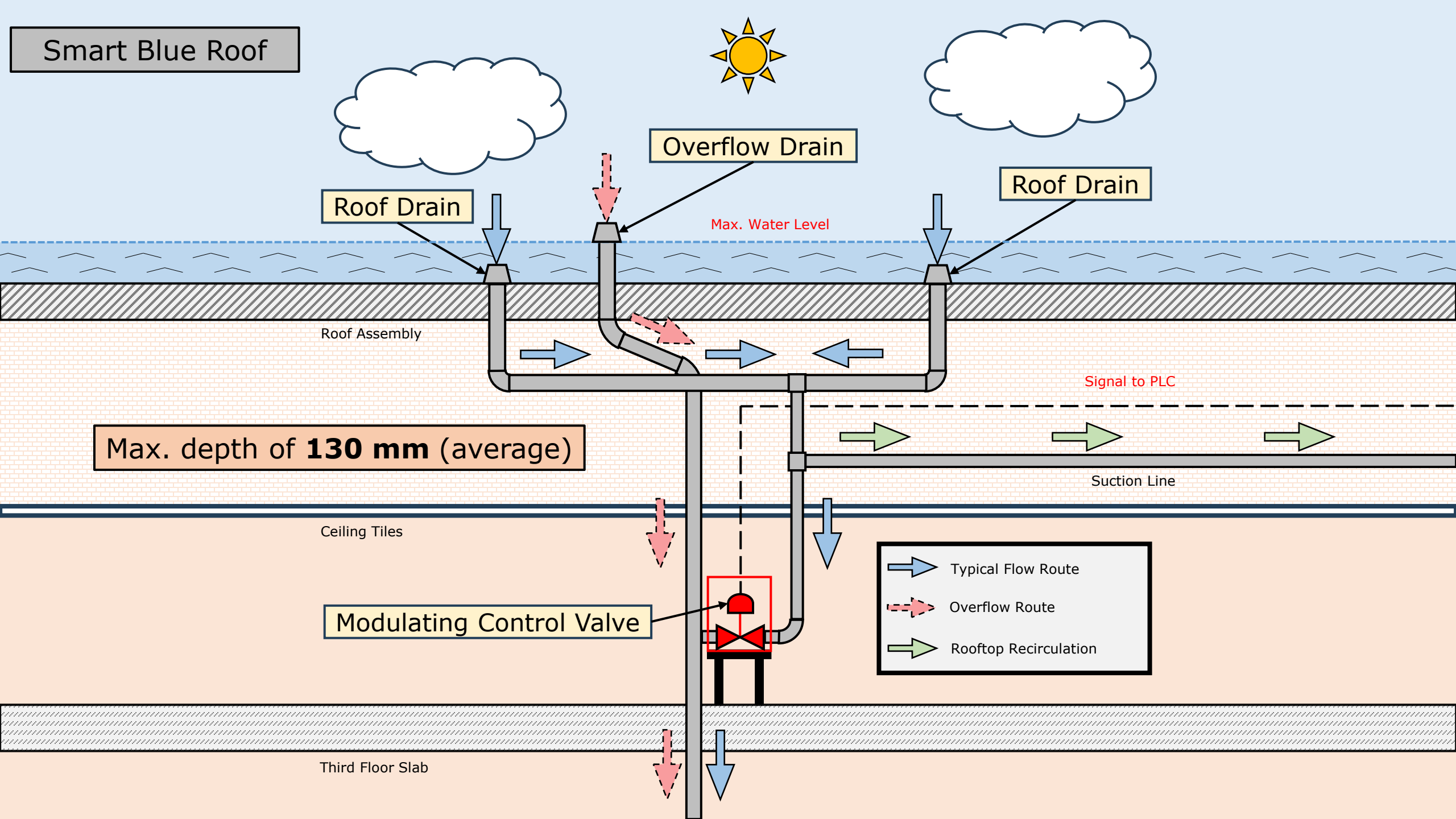
Benefits of Smart Blue Roofs

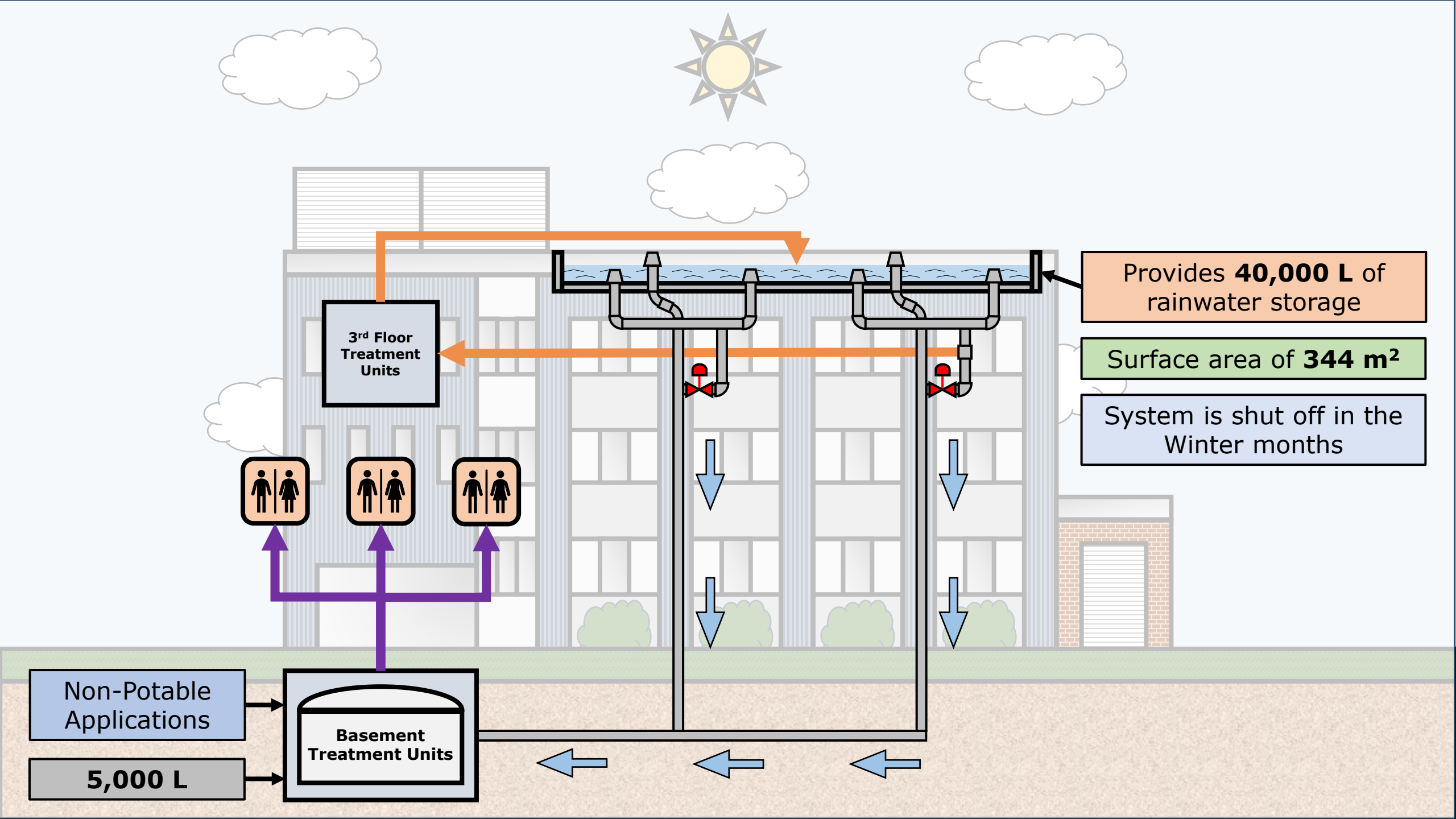
- Peak runoff reduction
- Rainwater harvesting – non-potable
- Evaporative cooling – energy savings
- Water balance – evaporation
- Utility cost savings

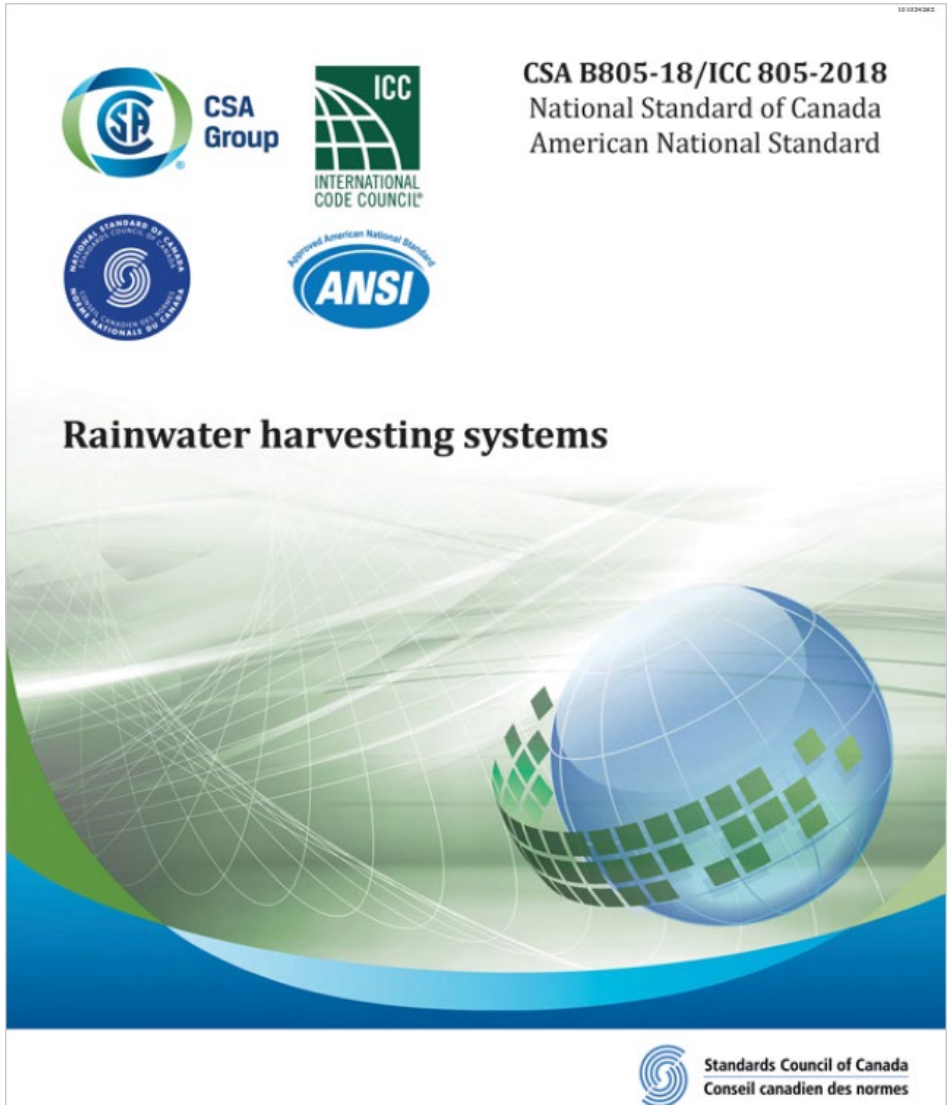
Design Overview

Credit Valley Conservation's Smart Blue Roof Design (Building A)


Storage Building
Parking Lot 1
Portable Building
Credit Valley Conservation
Credit Valley Conservation Authority
Building B
Building A
Parking Lot 3
Parking Lot 2
Driveway


Smart Blue Roof
Overflow Drain
Roof Drain
Roof Drain
Max. Water Level
Roof Assembly
Signal to PLC
Max. depth of **130 mm** (average)
Suction Line
Ceiling Tiles
Modulating Control Valve
Typical Flow Route
Overflow Route
Rooftop Recirculation
Third Floor Slab


3rd Floor Treatment Units
Provides 40,000 L of rainwater storage
Surface area of 344 m²
System is shut off in the Winter months
Non-Potable Applications
5,000 L
Basement Treatment Units



New Standard

- Designed to be first Smart Blue Roof to meet rainwater harvesting standard
- To be implemented in future update of the Ontario Building Code (OBC)
- Treatment Requirements and Water Safety Plan (WSP)

Water Treatment Criteria from CSA B805-18

Table 8.3
Roof runoff water treatment requirements for multi-residential and non-residential applications

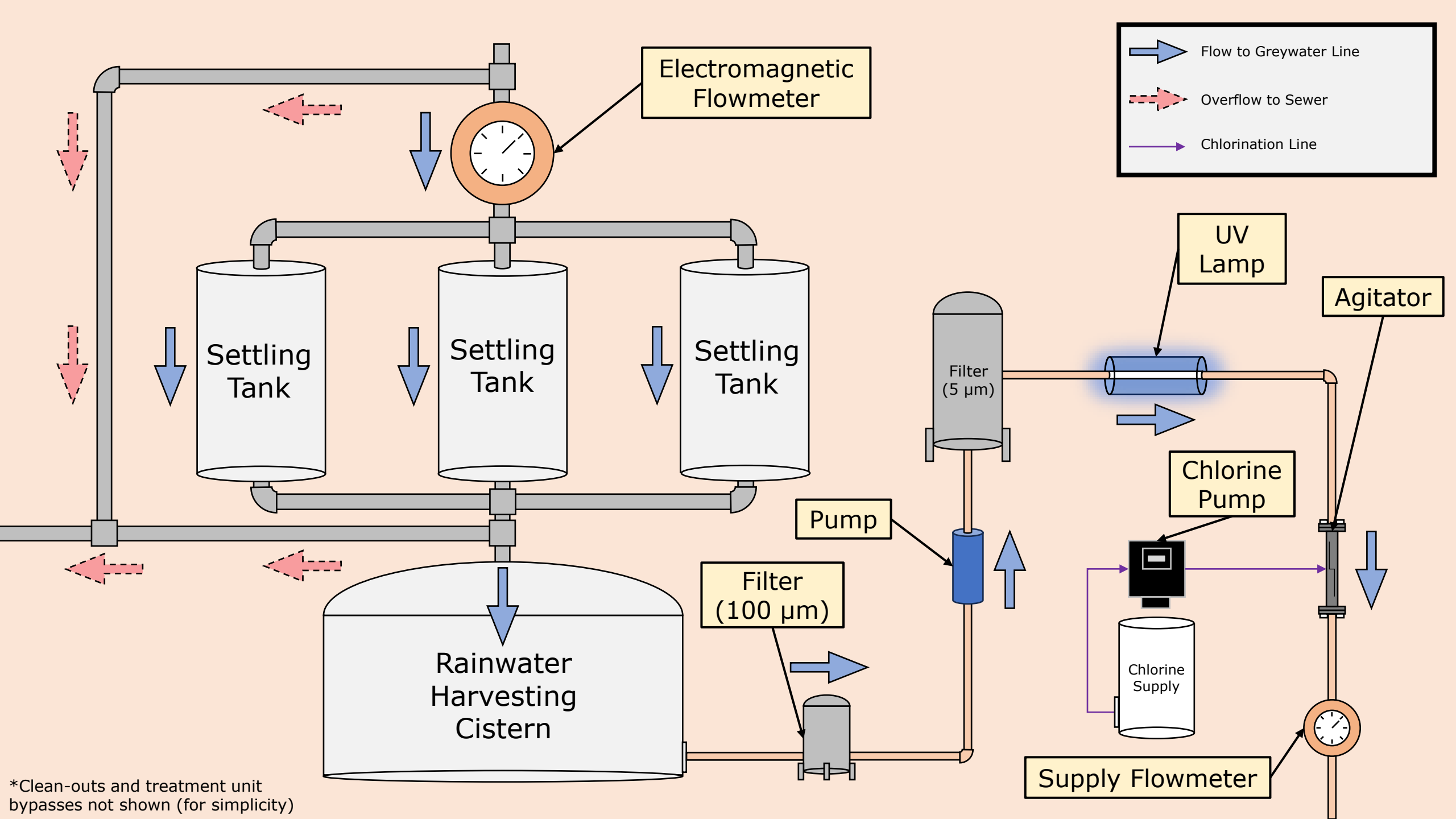
(See Clauses 8.1.1, 8.1.3, and 8.2.1.)

Application				Minimum performance criteria				Minimum prescriptive requirements				
				Log reduction (% reduction)				Options for post-storage treatment before end use				
								UV‡‡		Chemical-based disinfectants§§		
End use tier	Category	Potential for human contact	Examples of uses	Viruses	Bacteria**	Protozoa	pH	Filtration	Disinfection			tion or ultrafiltration
1	Non-potable	Low	• Trap primers • Spray irrigation (restricted access or exposure)*** • Surface and subsurface irrigation (drip, bubbler) • Fire protection • Ice rinks	0	0	0	—	None§				
2	Non-potable	Medium	• Toilet and urinal flushing • Clothes washing • Rooftop thermal cooling	0*	2(99%)	2(99%)	—	5 µm	16 mJ/cm²	1 µm absolute**	CT for 2 Log reduction for bacteria and at least 0.5 mg/L chlorine residual**	0.5 µm‡ with at least 0.5 mg/L chlorine residual
			ng	Treatment shall consider equipment manufacturer water quality requirements and be designed in accordance to ANSI/ASHRAE 188								

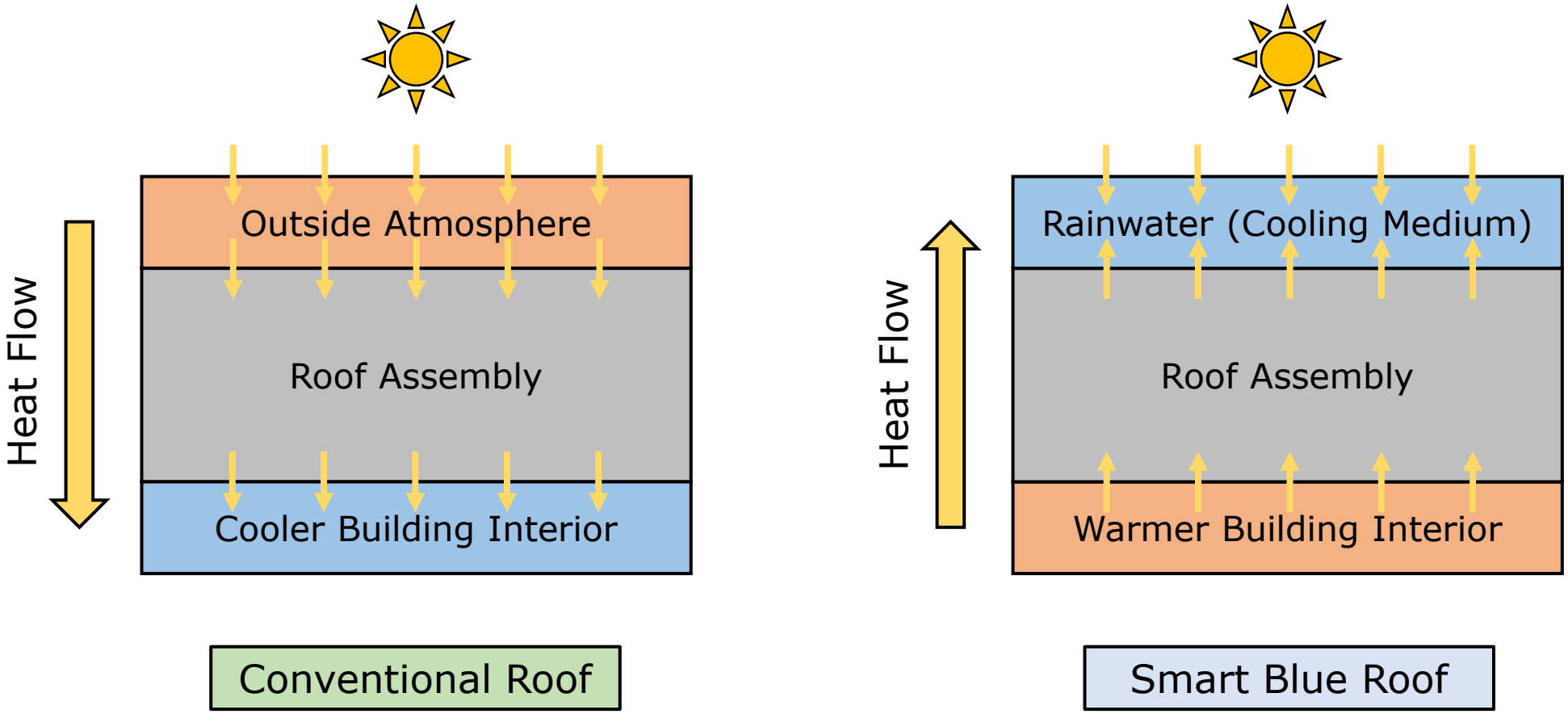
Table 8.3 outlines treatment requirements for roof runoff in non-residential applications

A UV-based approach selected, so specific filtration and disinfection treatment is required

Toilet flushing is a non-potable application with a medium human contact potential


Flow to Greywater Line
Overflow to Sewer
Chlorination Line
Electromagnetic Flowmeter
Settling Tank
Settling Tank
Settling Tank
Rainwater Harvesting Cistern
Filter (100 µm)
Pump
Filter (5 µm)
UV Lamp
Agitator
Chlorine Pump
Chlorine Supply
Supply Flowmeter
*Clean-outs and treatment unit bypasses not shown (for simplicity)

Evaporative Cooling Benefit (Summer)



Control Logic Scenarios (Example)

Scenario A: Prioritize Offsetting City Water

- Occurs on days where temperature is < 20°C
- Prioritize offsetting city water
- Ensure basement cistern is supplied

Scenario B: Maximize Evaporative Cooling

- Occurs on days where temperature is > 20°C
- Prioritize evaporative cooling
- Do not drain roof when avg. water level is less than 15 mm

Construction Process

Challenges to Implementation

Building Permit – Section 7

Nov 2021

7.4.10.4. Hydraulic Loads from Roofs or Paved surfaces

(2) *Flow control roof drains* may be installed provided,

(a) the maximum drain down time does not exceed 24 h,

(b) the roof structure is designed to carry the load of the stored water,

(c) one or more scuppers are installed not more than 30 m apart along the perimeter of the *building* so that,

(i) the scuppers are designed to handle at least 200% of the 15-minute rainfall intensity, and

(ii) the maximum depth of controlled water is limited to 150 mm,

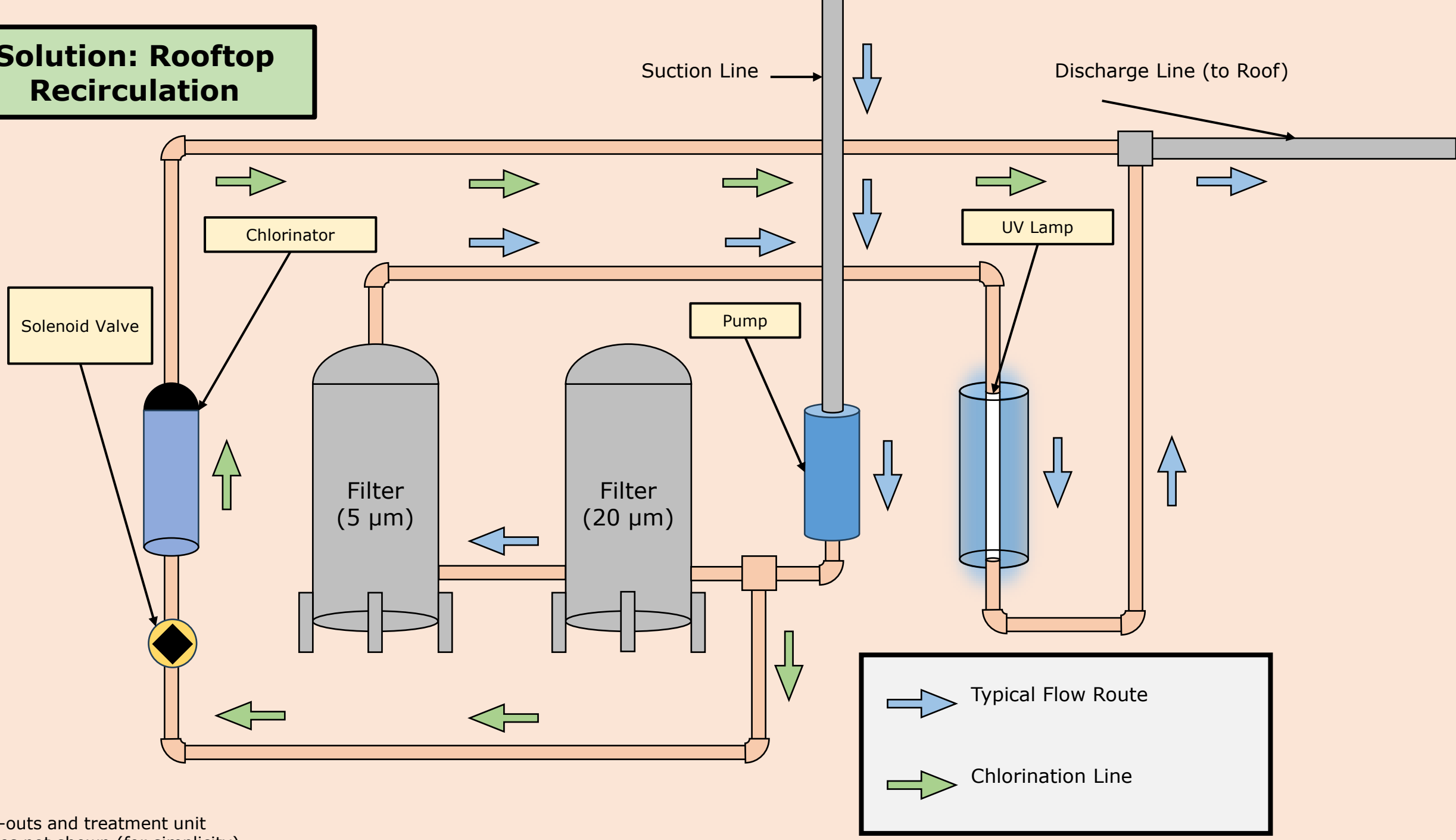
(d) they are located not more than 15 m from the edge of the roof and not more than 30 m from adjacent drains, and

(e) there is at least one drain for each 900 m^2.

Intent and Objective statements relating to 24hr drawdown (Health – Sanitation)

- limit the probability…a person…will be exposed to an unacceptable risk of illness due to unsanitary conditions caused by contact with **contaminated surfaces**.
- limit the probability…a person…will be exposed to an unacceptable risk of illness due to unsanitary conditions caused by **contact with vermin and insects**.
- To minimize the risk of **generation of contaminants**.
- To limit the probability that inadequate drainage will lead to **stagnant water remaining on roof tops, which could lead to the growth of mould or mildew**, which could lead to harm to persons.

Solution: Rooftop Recirculation



*Clean-outs and treatment unit bypasses not shown (for simplicity)

Building Permit – Section 7
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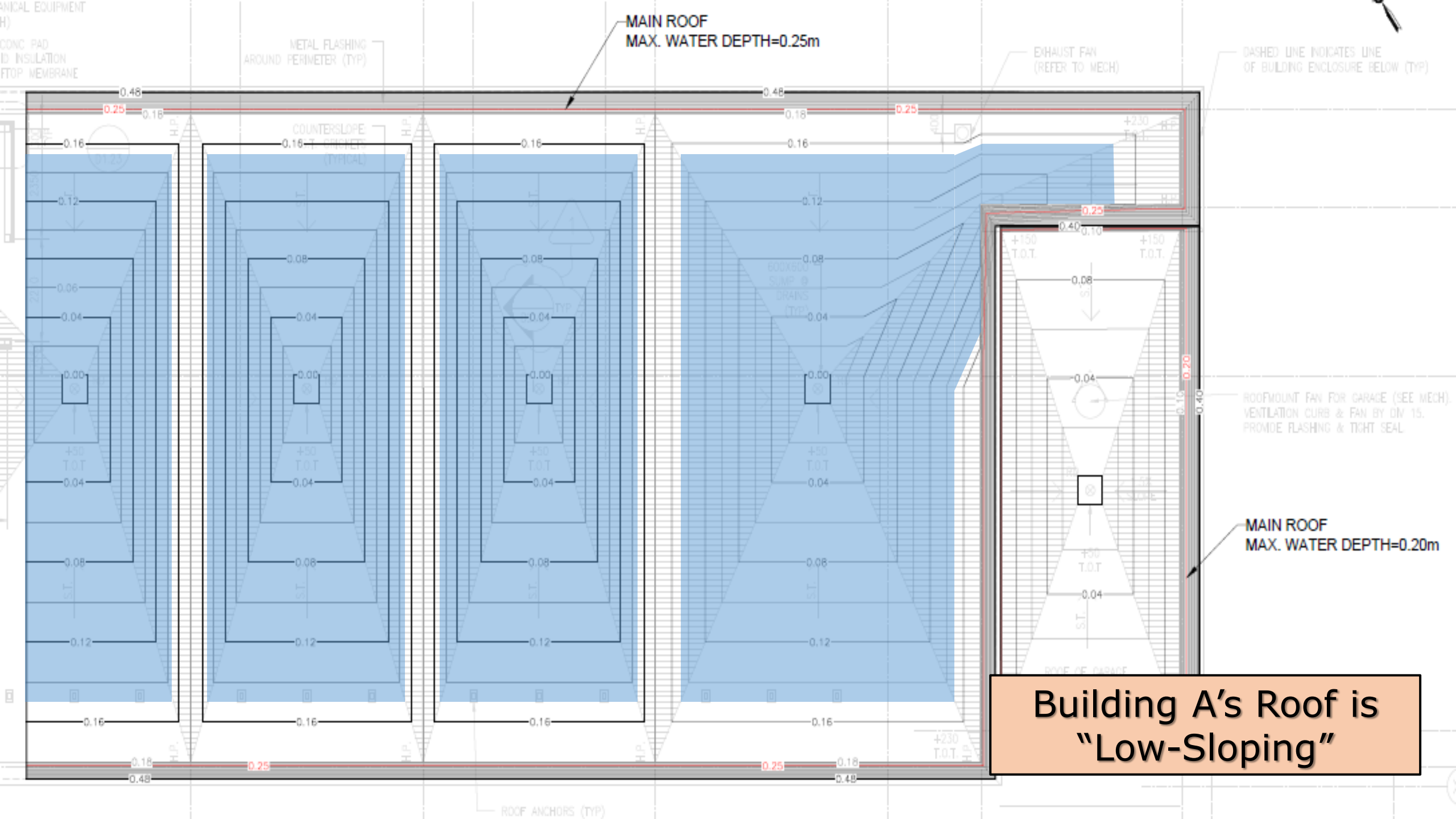
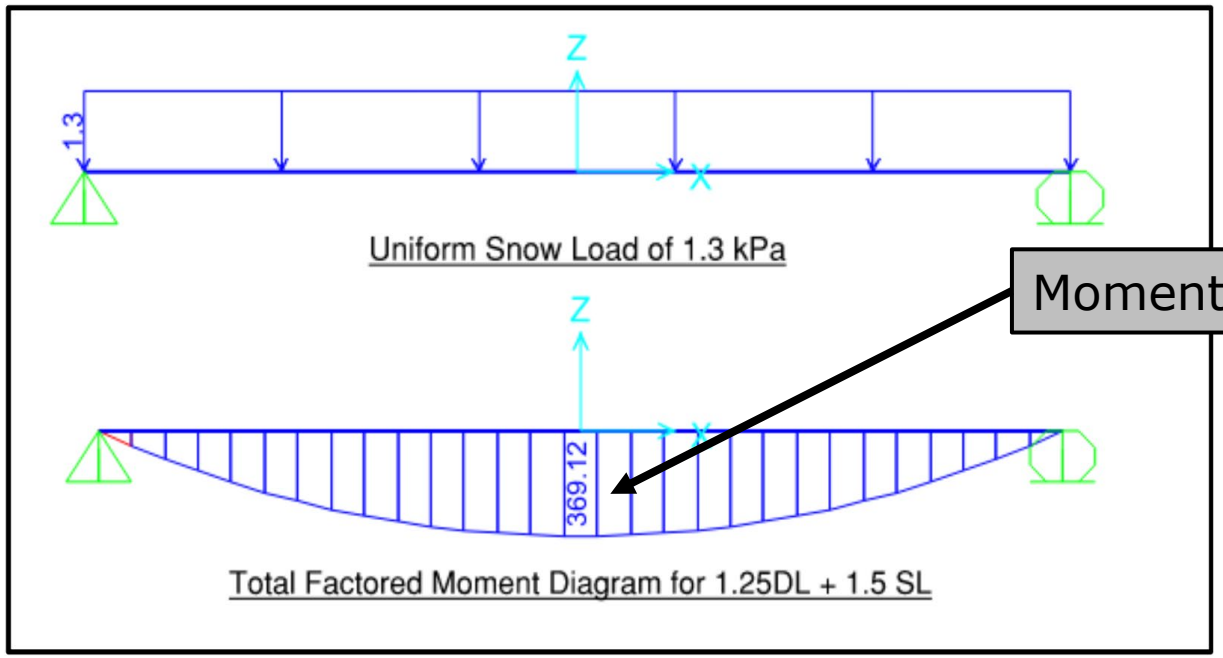
(e) there is at least one drain for each 900 m^2.

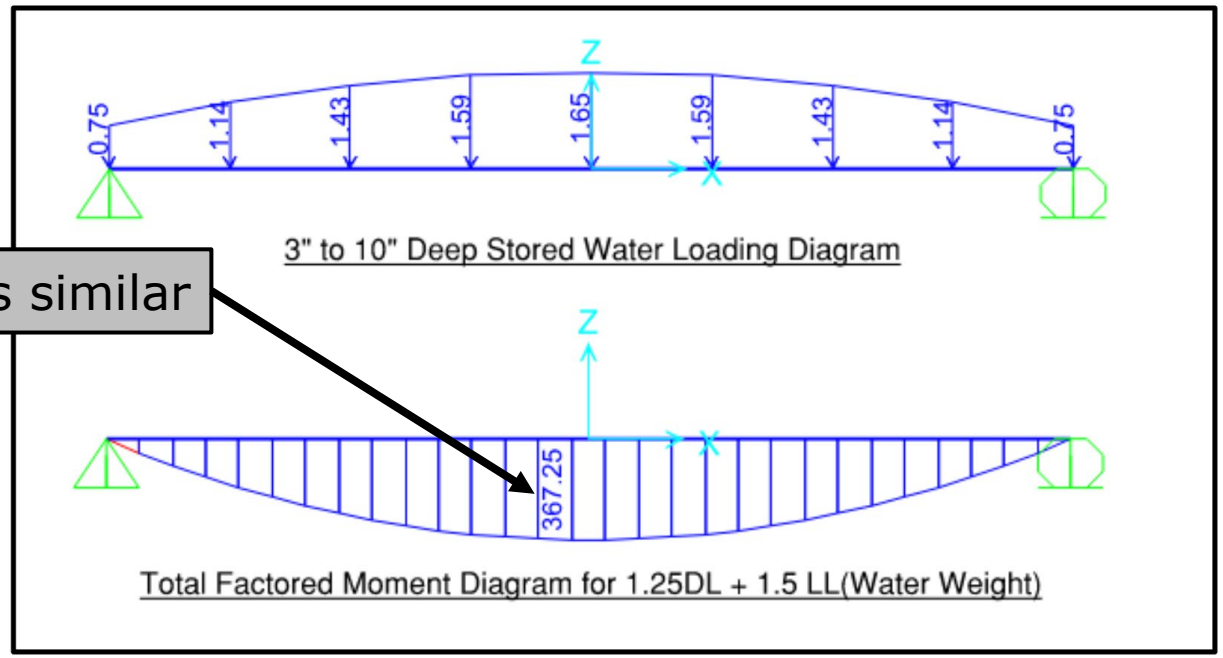
Intent and Objective statements relating to 150mm max depth (Safety – Structural Safety)

- To limit the probability that an **inadequate load carrying capacity for a roof** or excessive depth of water on the roof will lead to an inability of roofs to support gravity loads imposed by standing water, which could lead to structural collapse, which could lead to harm to persons.


MAIN ROOF
MAX. WATER DEPTH=0.25m
MAIN ROOF
MAX. WATER DEPTH=0.20m
Building A's Roof is "Low-Sloping"

Solution: Structural Load Assessment





Moment is similar

130 mm of Rainwater on a Perfectly Flat Roof

75 mm (Shallowest) and 250 mm (Deepest) on CVC's Roof

Build Permit Issued!

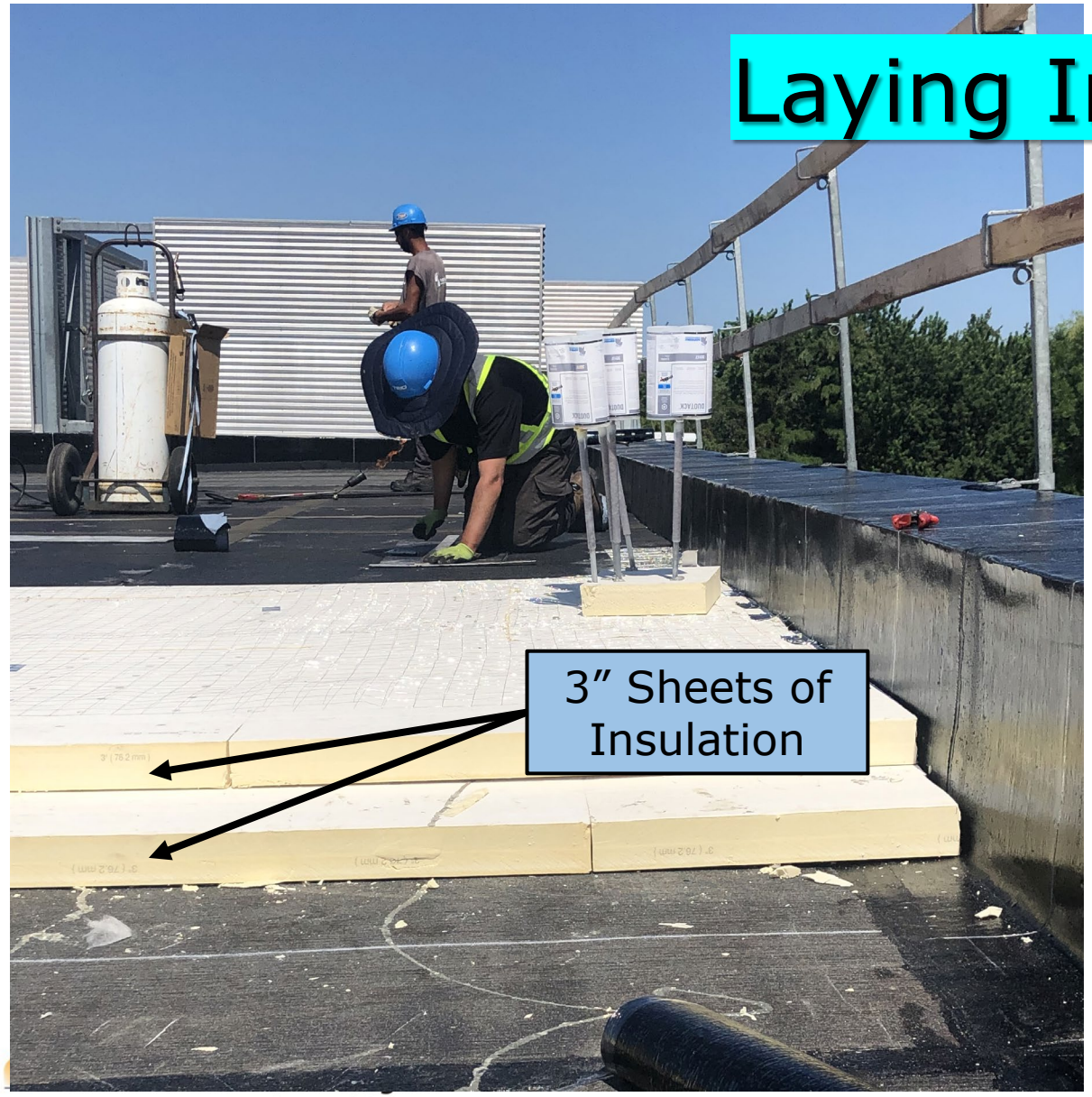
BUILDING PERMIT NOTICE

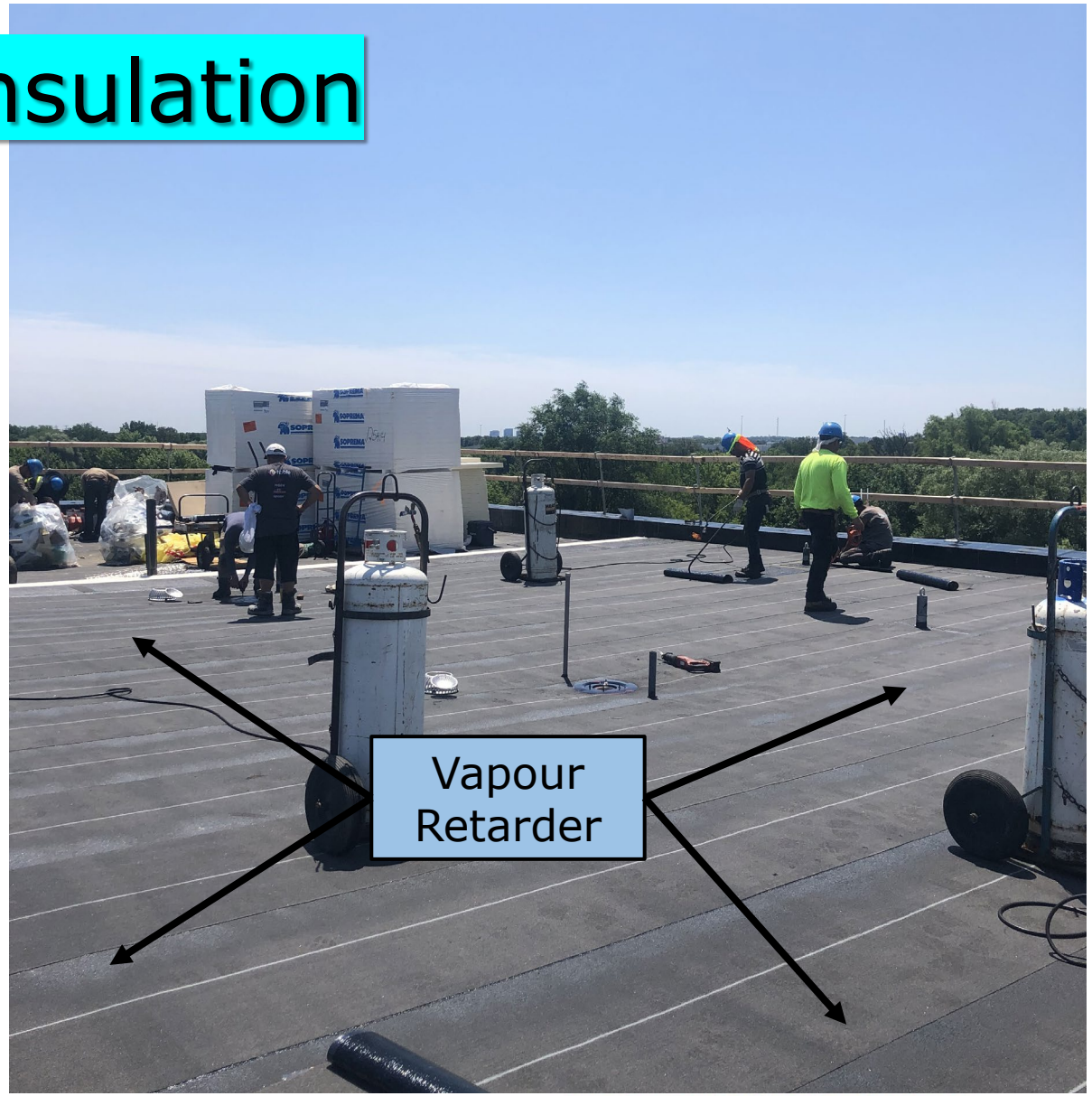
MISSISSAUGA

City of Mississauga
Planning and Building Department
300 City Centre Drive
MISSISSAUGA, ON L5B 3C1

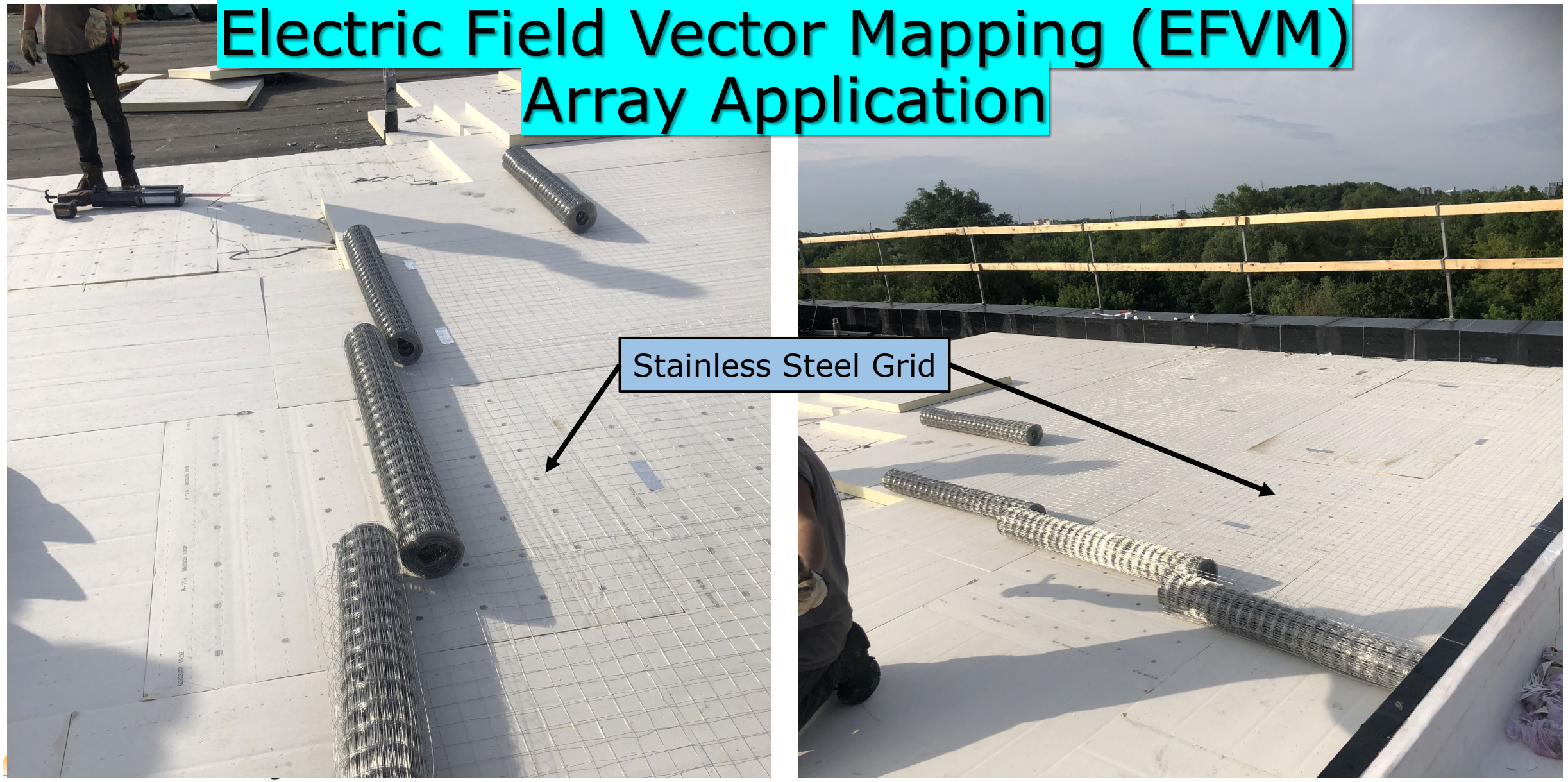
Permit# BP 3ALT 21 9123	Web Access ID 2VY6P7AE	Issuance Date 2022-01-05
Municipal Address 1255 OLD DERRY RD	Bldg	Unit

Laying Insulation

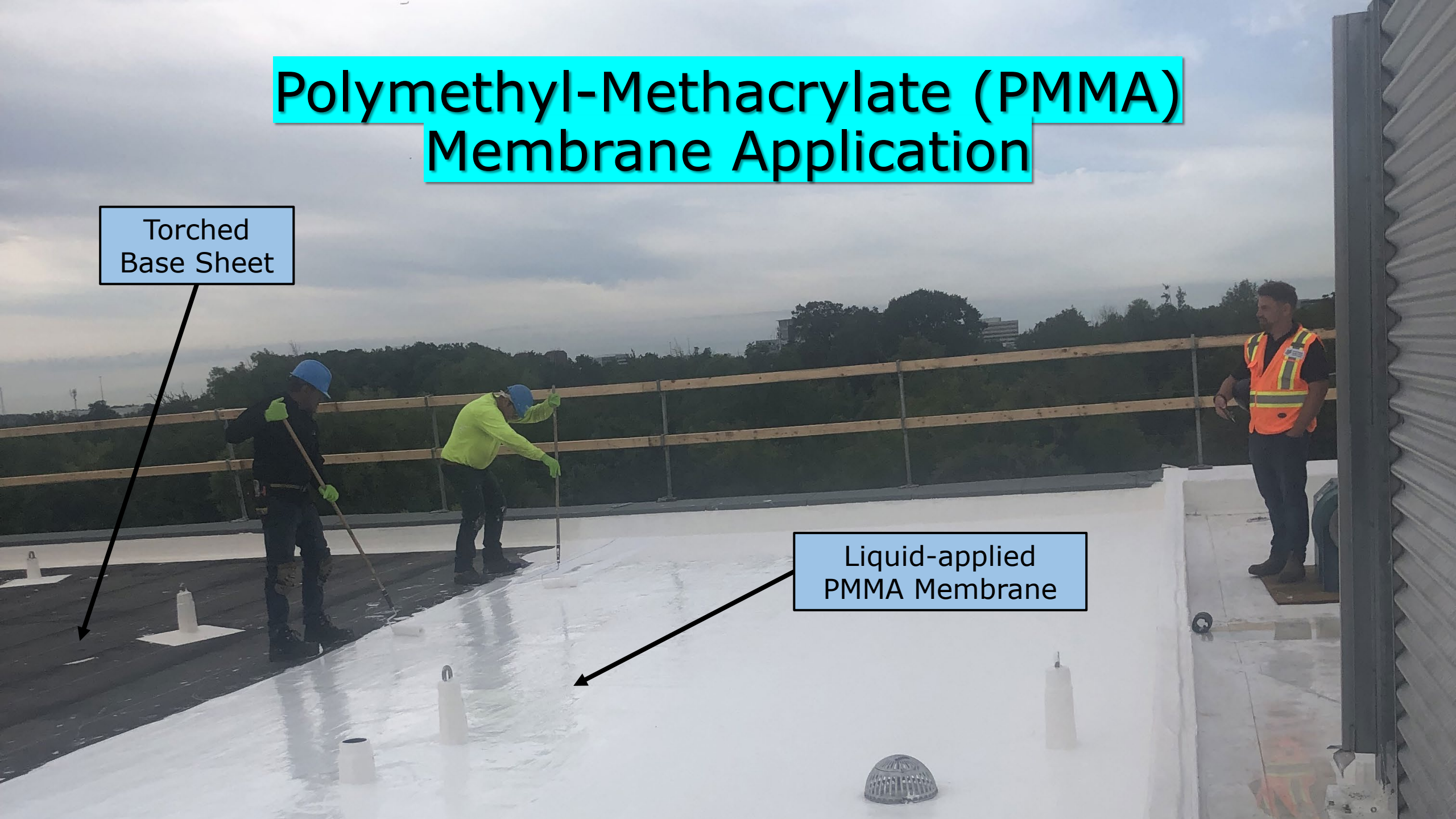




Electric Field Vector Mapping (EFVM) Array Application



Polymethyl-Methacrylate (PMMA) Membrane Application



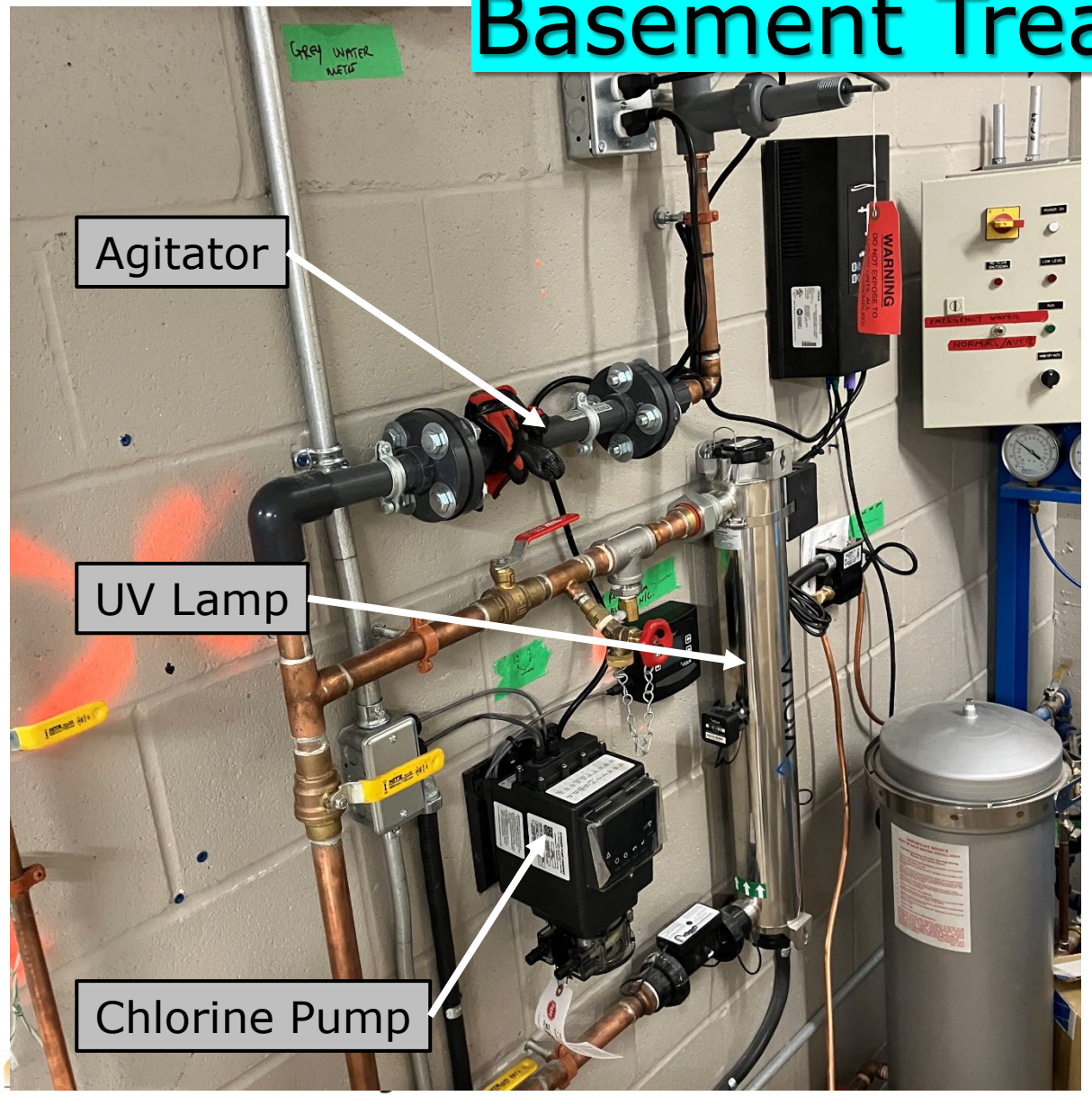
Finished Smart Blue Roof Surface

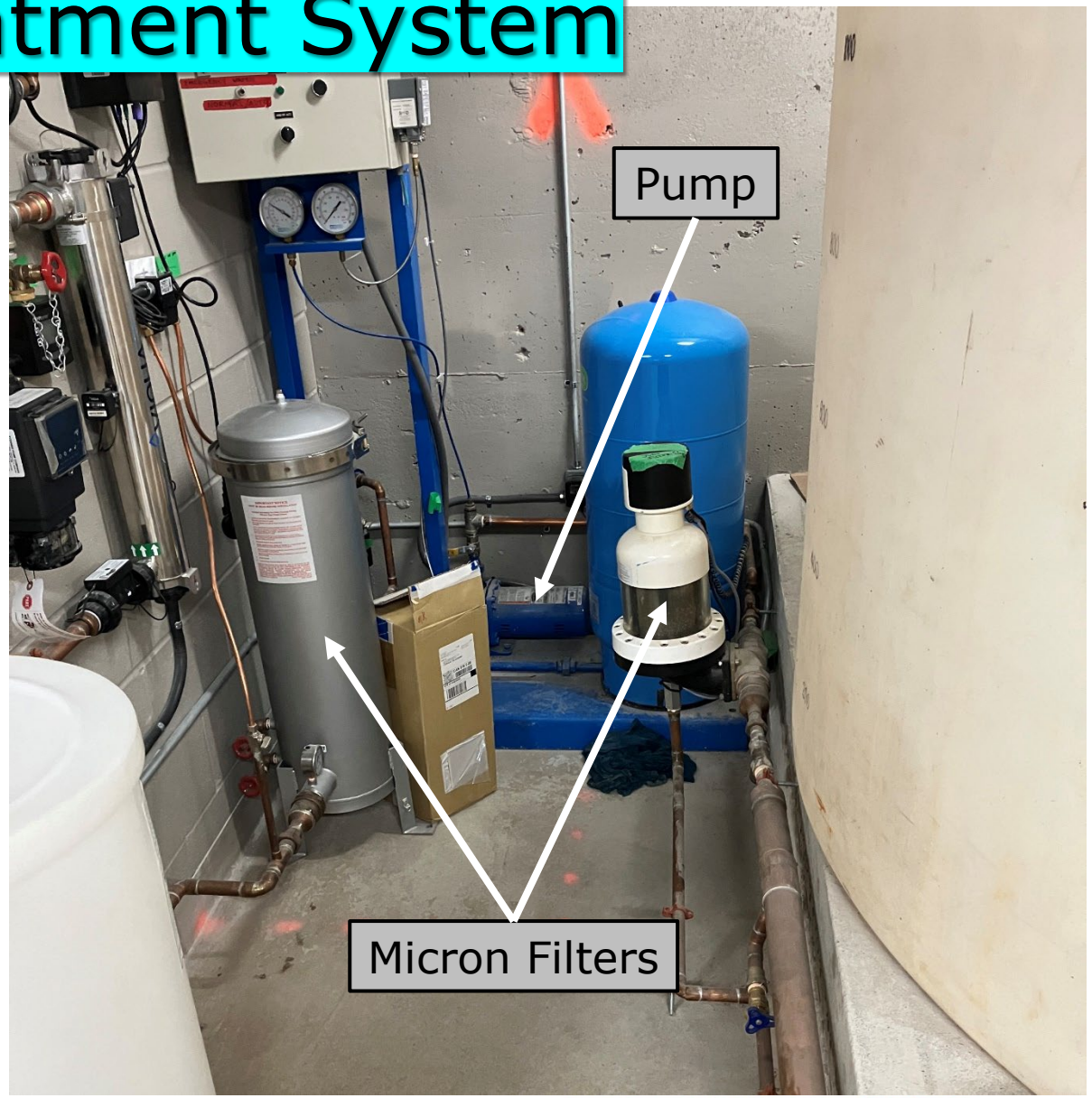
Finished Smart Blue Roof Surface

Modulating Control Valves

Basement Treatment System

Basement Treatment System





Programmable Logic Controller (PLC)

Project Costs (Overview)

Design	**$**	**101,109.00**
Design Consultant		
Permitting Process		
Equipment	**$**	**143,677.66**
System Components		
Commissioning		
Construction*	**$**	**243,289.82**
Construction Services		
Construction Oversight		
Leak Detection Test		
Total	**$**	**488,076.48**

*Smart blue roof construction occurred simultaneously with roof assembly replacement – The estimated added cost of using PMMA (instead of TPO) is reflected in this cost.

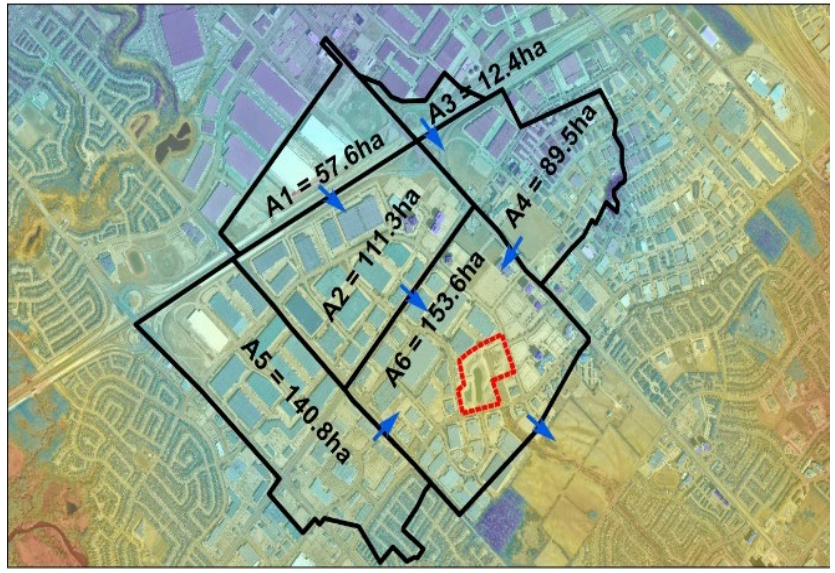
Benefits at Larger Scales

Broader Potential

Building Scale

Street Scale

Neighbourhood Scale



- Avoid land acquisition for stormwater ponds
- Logic controls tethered together
- Avoid flood damages

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EVALUATION PROGRAM

Other Possible Rainwater Applications

- Toilet Flushing
- Irrigation Applications
- Industrial Water Applications
- Vehicle Washing
- **Drinking Water (w/ Enhanced Treatment)**

Thank You

For more information:

Contact

Name: James Cowan, EIT
Phone: 437-221-8519
Email: james.cowan@cvc.ca

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