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Grey Meets Green

Integrating Soil / Trees / Stormwater

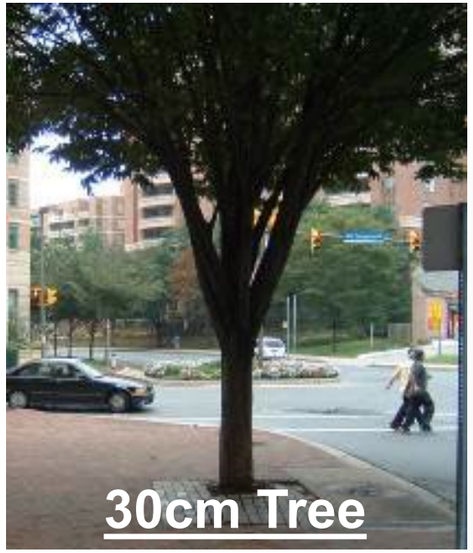
What are Soil Cells

Silva Cell 2

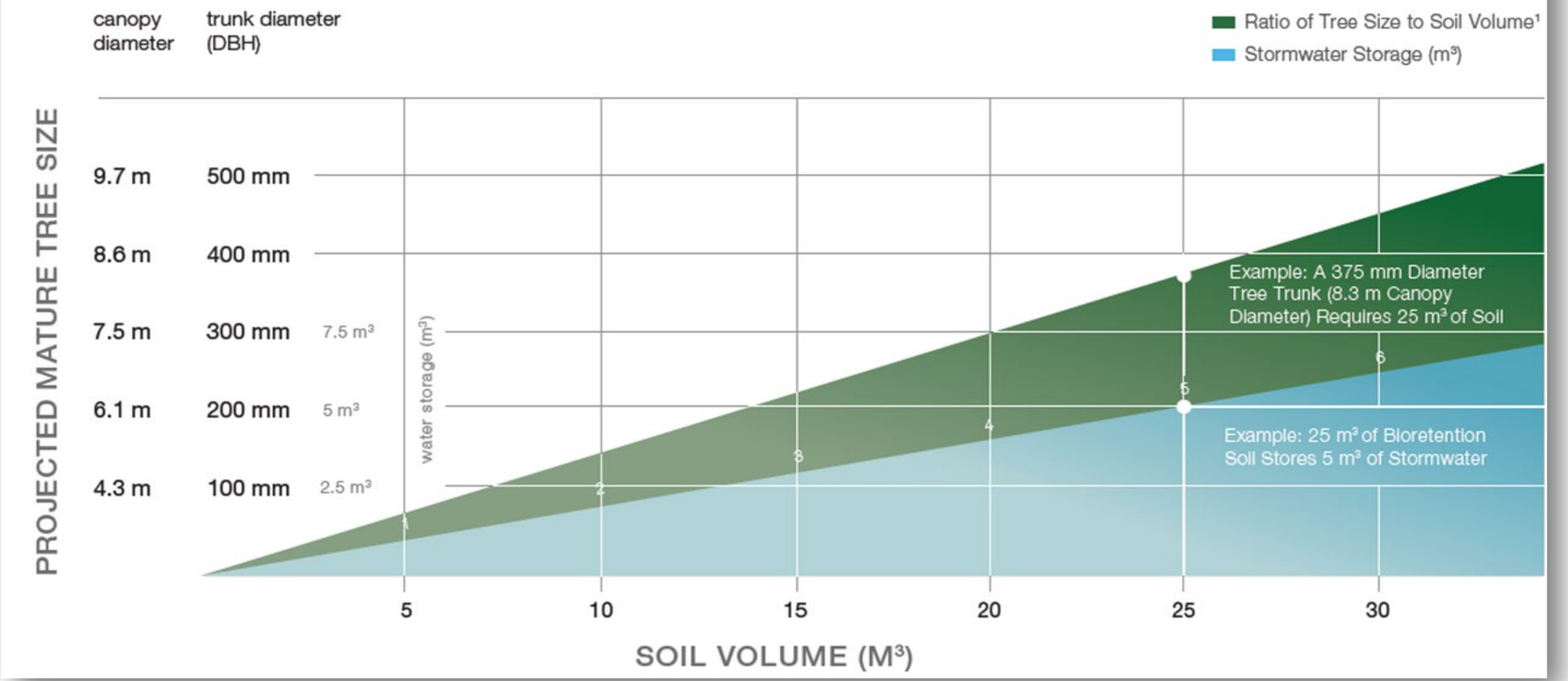
Soil Cells have two purposes:

Soil Volume for municipal trees

Stormwater management – LID Source Controls



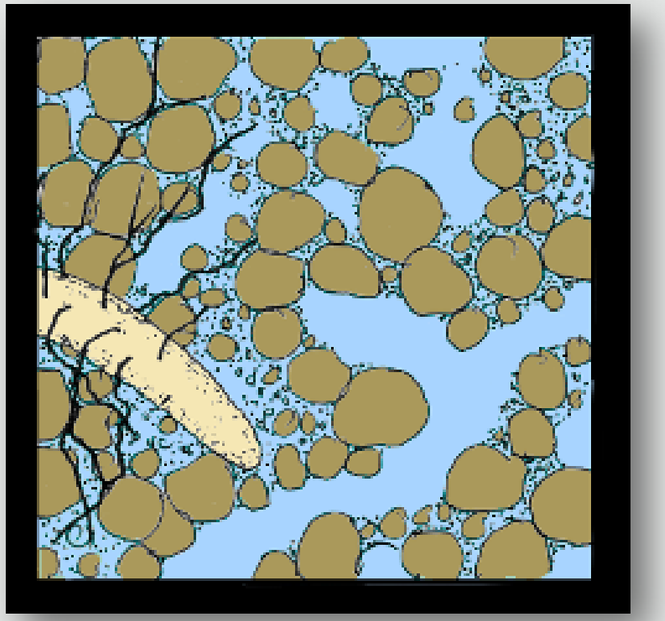
HOW MUCH SOIL TO GROW A BIG TREE?



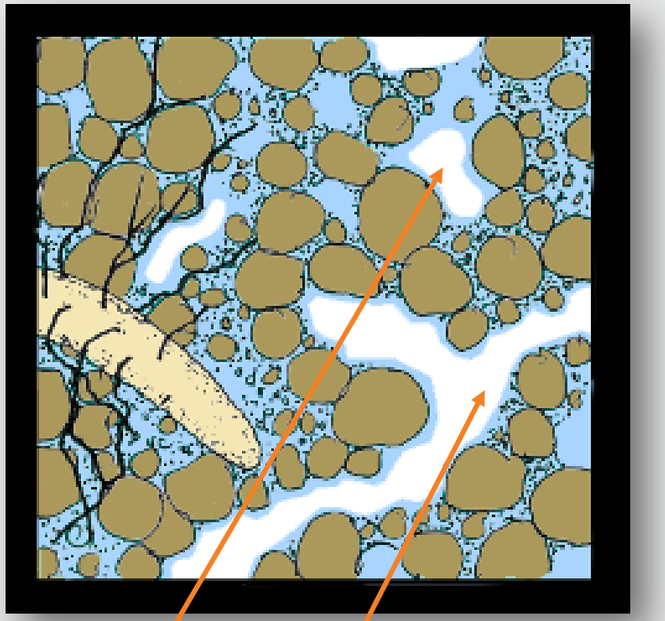
What’s so important about Soil?

Uncompacted Soil have a 20-30% storage capacity for water

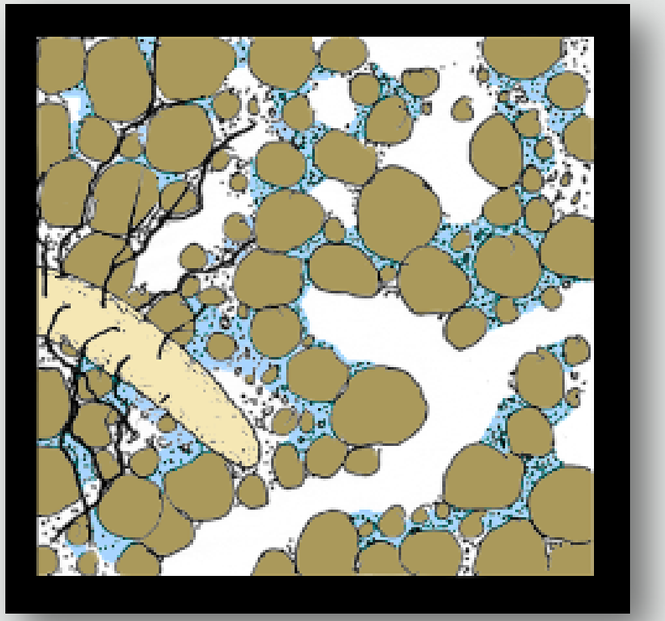
Saturation Point



Field Capacity



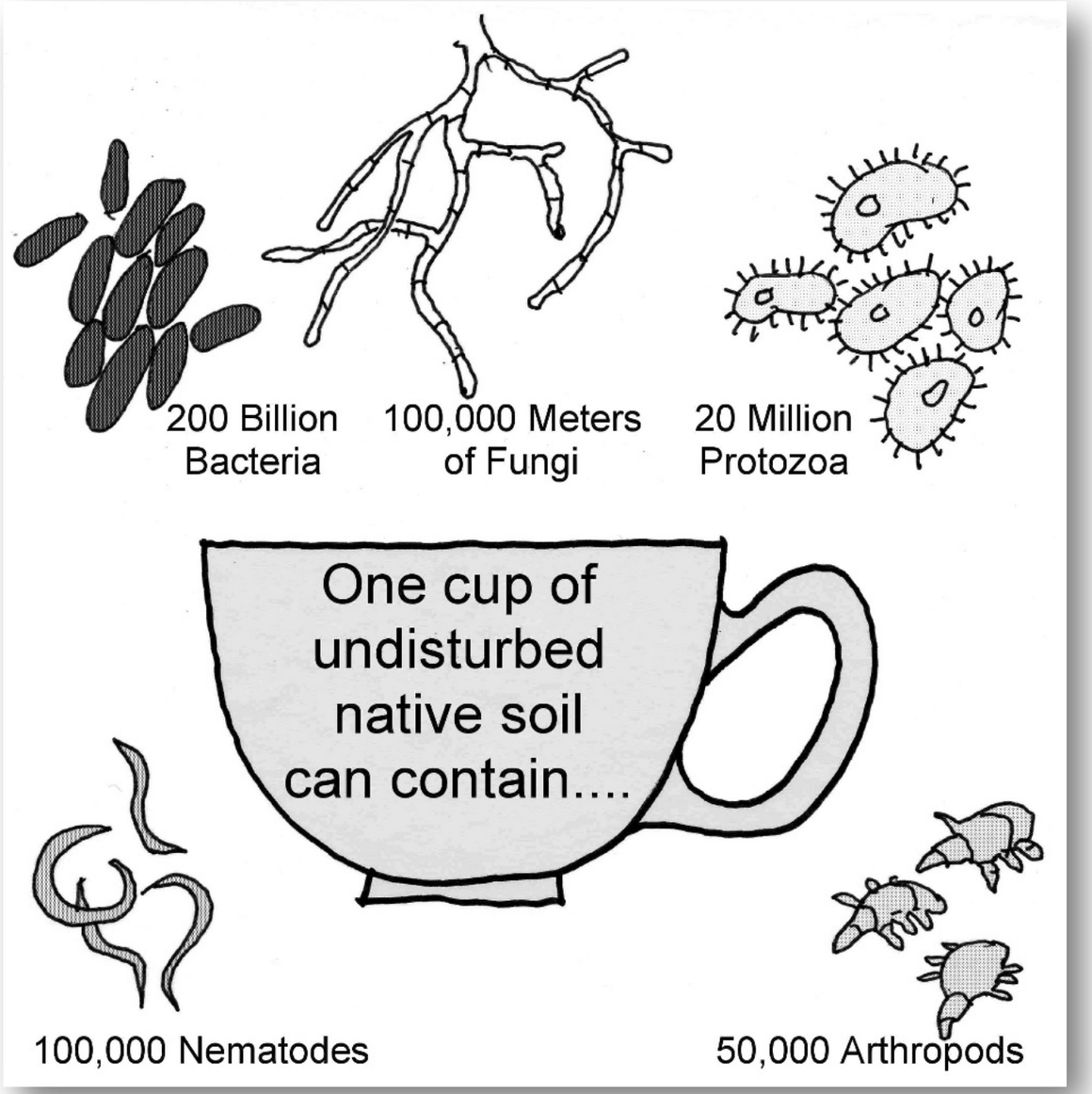
Wilt Point



Water movement is highly dependent on soil structure and soil ped retention

(Urban, 2008, Up By Roots)

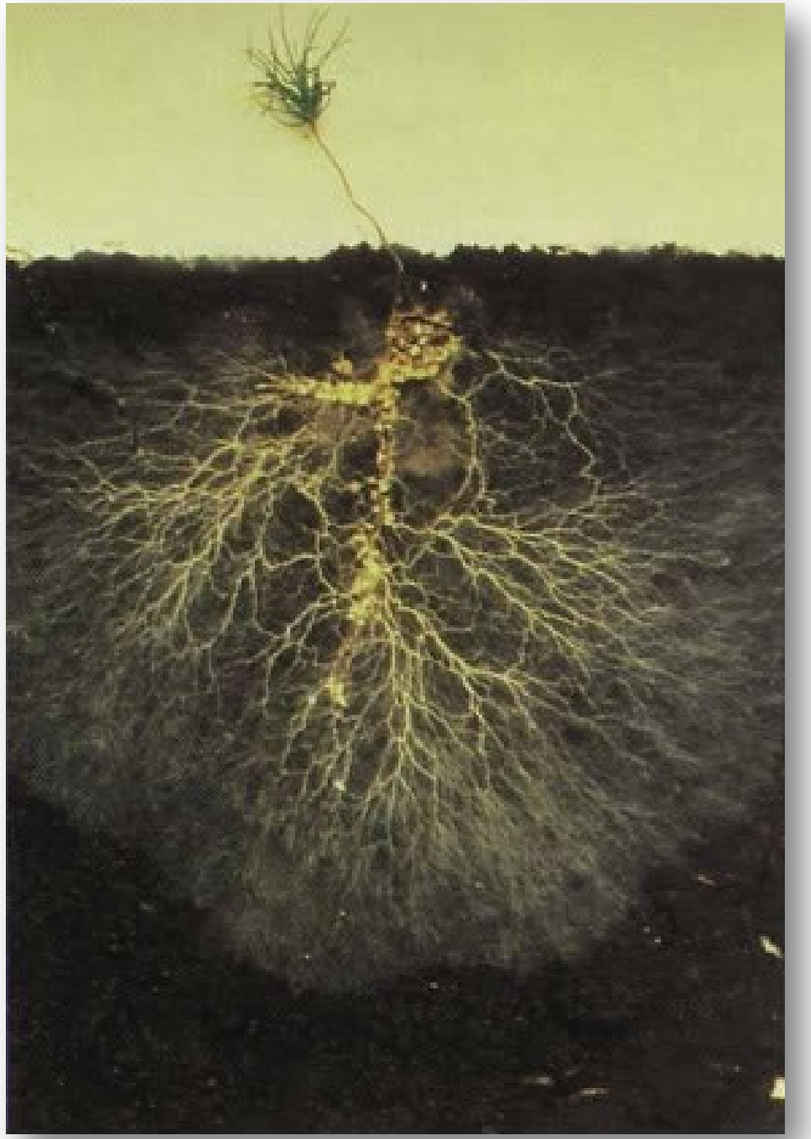
Glomus intraradices



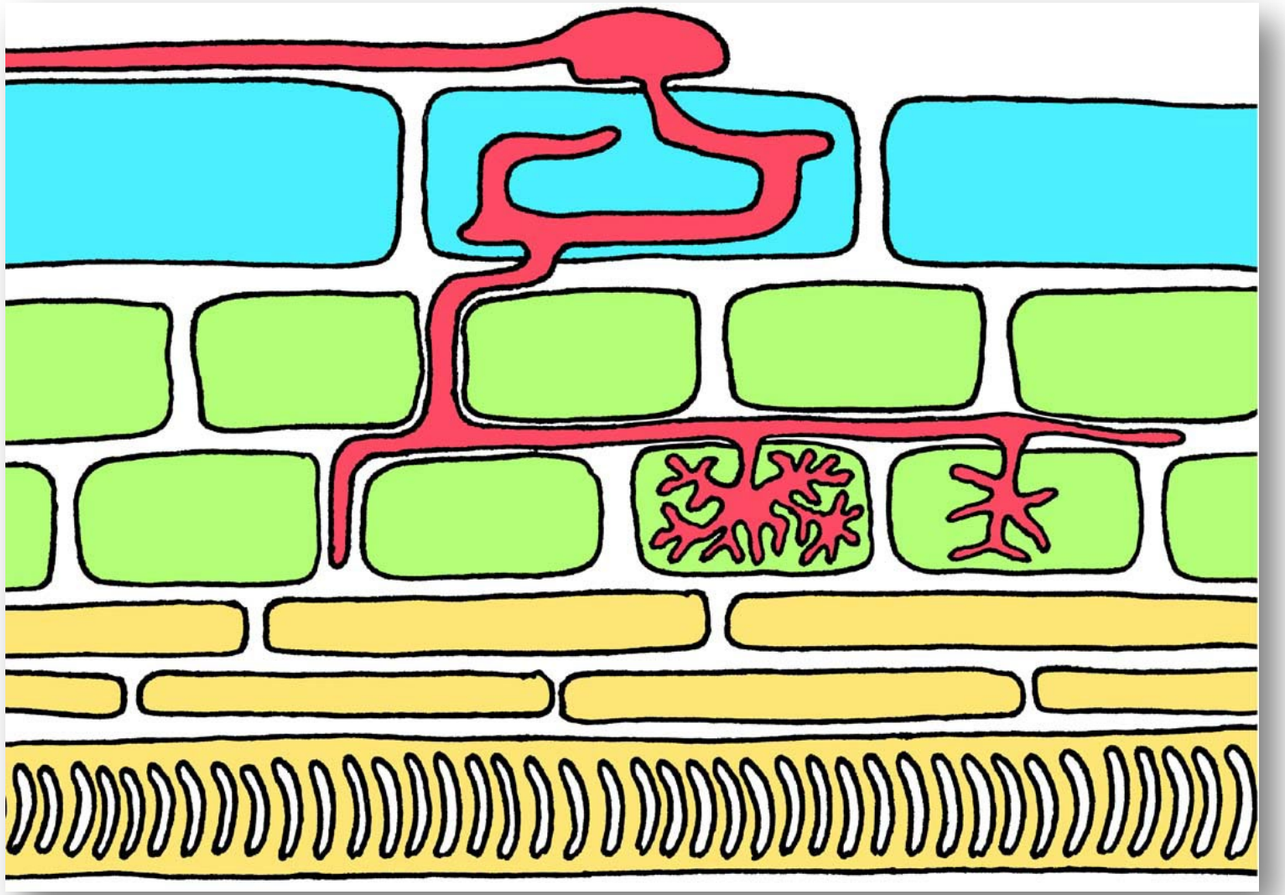
To this day most tree roots, in of themselves, cannot support a large canopy. Most of the oxygen, water, nutrient absorption that the successful tree harvests is via other organisms - fungi, bacteria, etc.

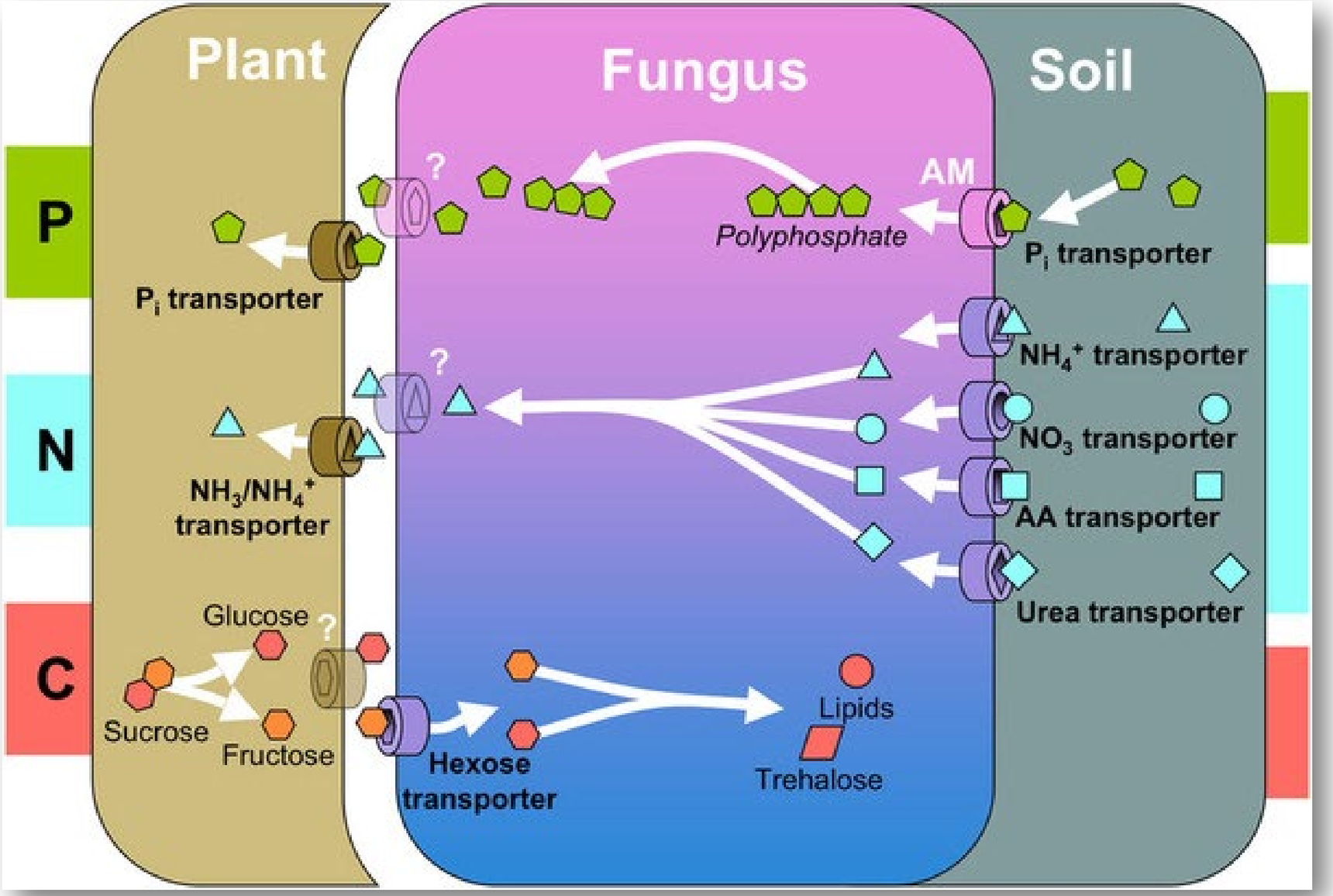
Tree roots have not had to become super efficient at harvesting water, oxygen, and nutrients, because the soil organisms have been doing this so well for so long.

Reach

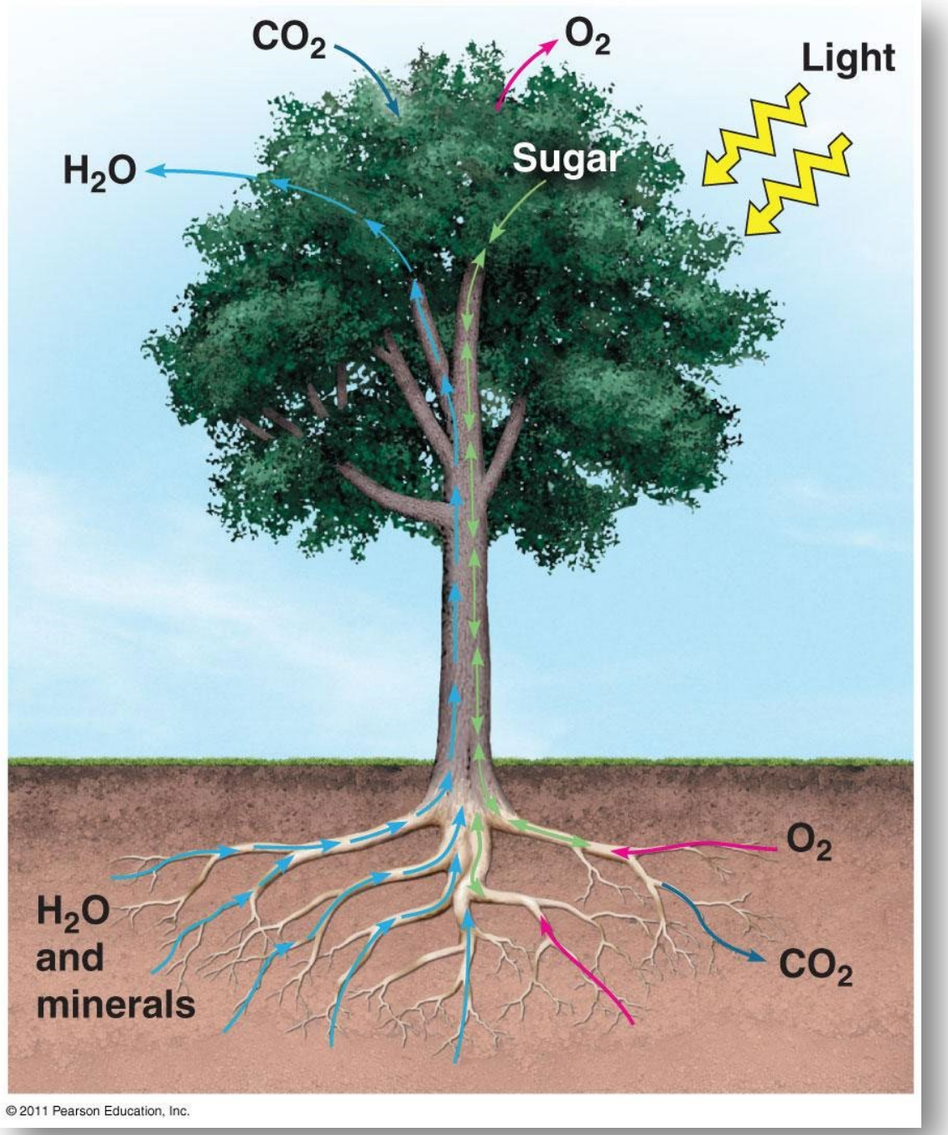


Fungi network

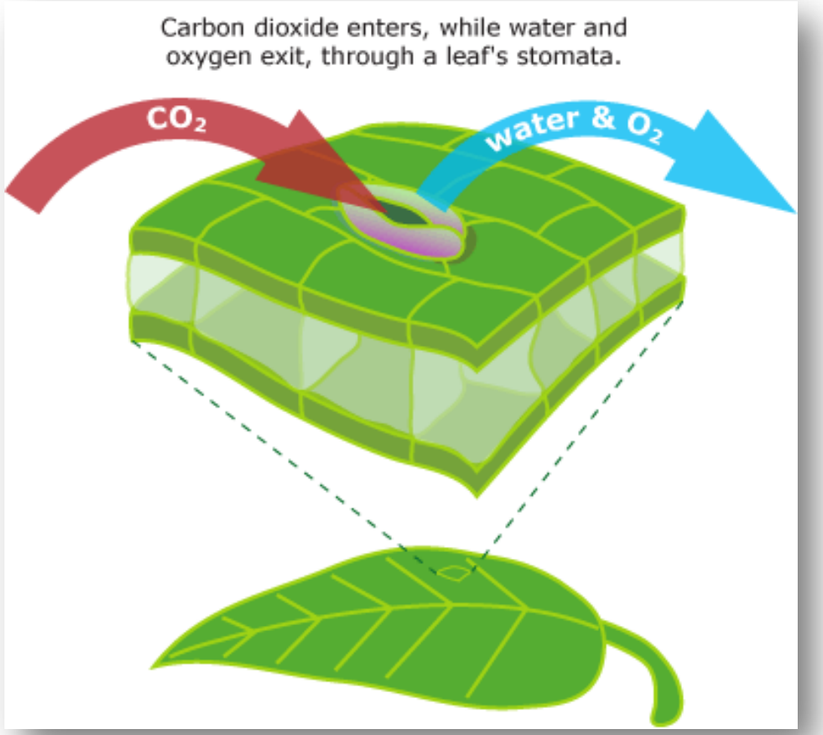




Transport



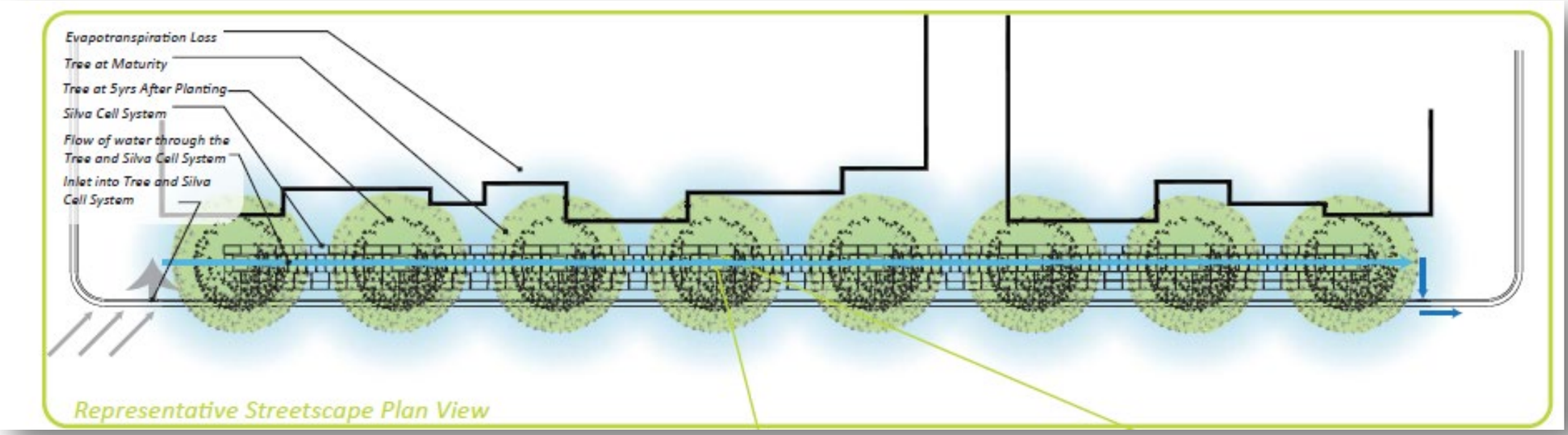
- Only 10% of water taken up by a tree is used for Photosynthesis
- The other 90% of the water is used to transport nutrients from the soil to the tree where they can be used



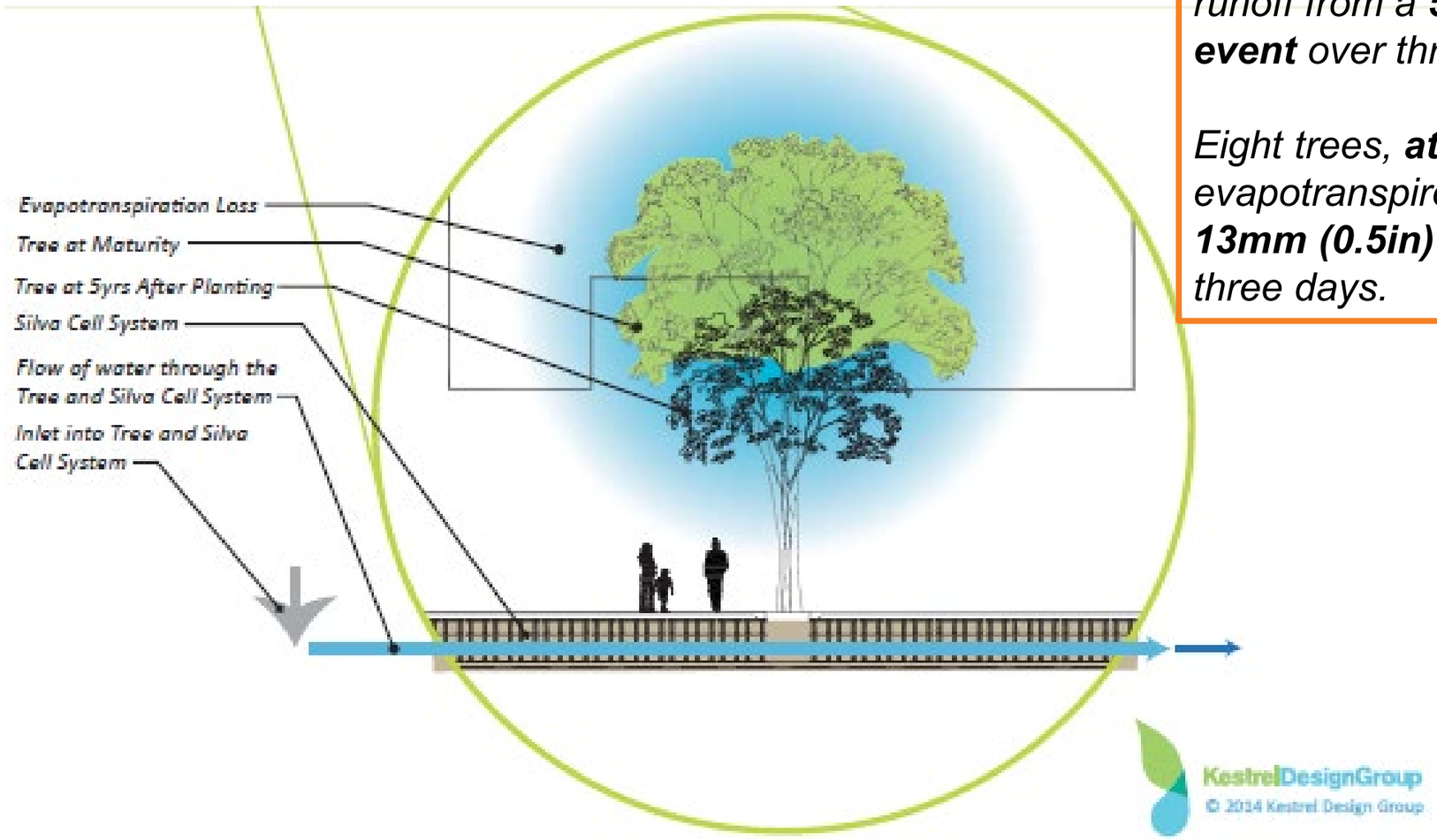
Evapotranspiration Model for City of Toronto

Sample Streetscape Assumptions

- 90m (295ft) length of street draining into 1 catch basin in Toronto, Ontario, Canada
- 0.066ha (0.16ac) of impervious surfaces draining into the catch basin, runoff coefficient is 0.9
- 0.024 ha (0.06ac) of pervious surfaces draining into the catch basin, runoff coefficient is 0.25
- Total runoff generated per catch basin from a 5mm (0.2in) storm is 3.27m^3 (115ft^3)
- Total runoff generated per catch basin from a 13mm (0.5in) storm is 8.5m^3 (300ft^3)
- Three days between rain events
- Eight Swamp White Oak *(Quercus bicolor)* were used in the calculations
- Each tree was provided with 33m^3 (1,165ft^3) of soil volume



Evapotranspiration Model for City of Toronto



*Eight trees, **five years after planting**, can evapotranspire all runoff from a **5mm (0.2in) rain event** over three days.*

*Eight trees, **at maturity**, can evapotranspire all runoff from a **13mm (0.5in) rain event** over three days.*

The End of Magical Thinking about Trees*

*Peter MacDonagh
The Kestrel Design Group

Soil Volume for Municipal Street Trees:

How are you going to grow that tree?

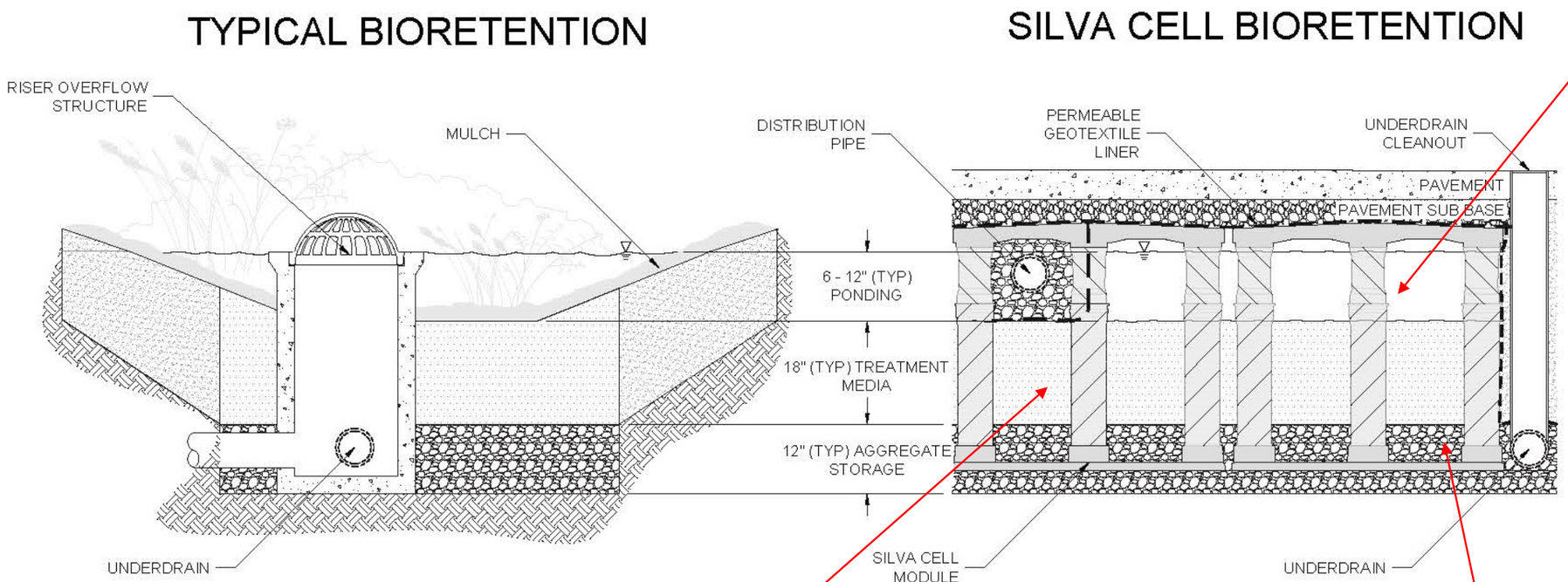
Municipalities need soil volume specifications for street tree plantings (shop drawing for trees)

Toronto, ON 30m3	**Edmonton, AB** 17m3	**Calgary, AB** 17m3	**Mississauga, ON** 17m3
Vancouver, BC 15 / 20 / 30	**Langley, BC** 10m3	**Kitchener, ON** 15m3	**Oakville, ON** 30m3
Chicago, IL	Charlotte, NC	Washington, DC	Fairfax County, VA
Seattle, WA	Columbus, OH		

Soil Volume standard connects Canopy Targets to Land Use

Stormwater Integration - LID

Up to 300mm of ponding



20-30% storage in the media

Option to have additional storage at the bottom of the cells or below the Silva Cells. (dependent on geotechnical Report)

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The Tree is an integral part of the stormwater system

Silva Cell Dimensions

1X complete

2X complete

3X complete

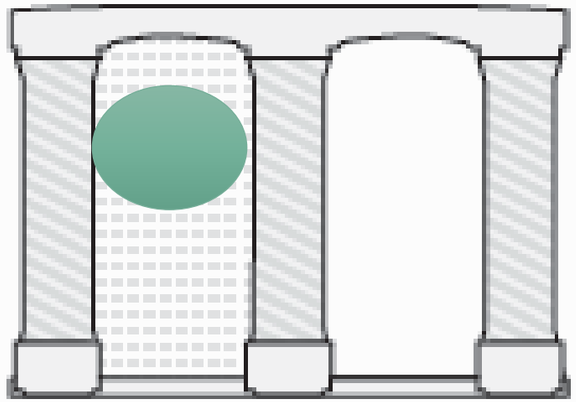
deeproot

Made in Canada

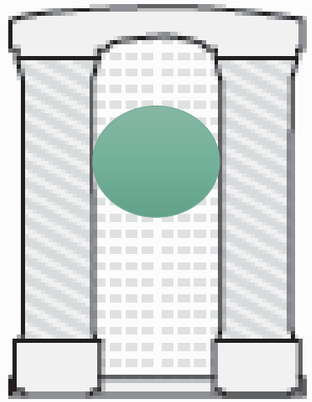
Maximum pipe dimensions running through Silva Cells

The most used option is to run utilities through Silva Cells. Due to the open design of the frames, they can accommodate pipes, conduits, and other underground utilities up to 347mm in diameter.

No horizontal Crossbeams to interfere with utilities

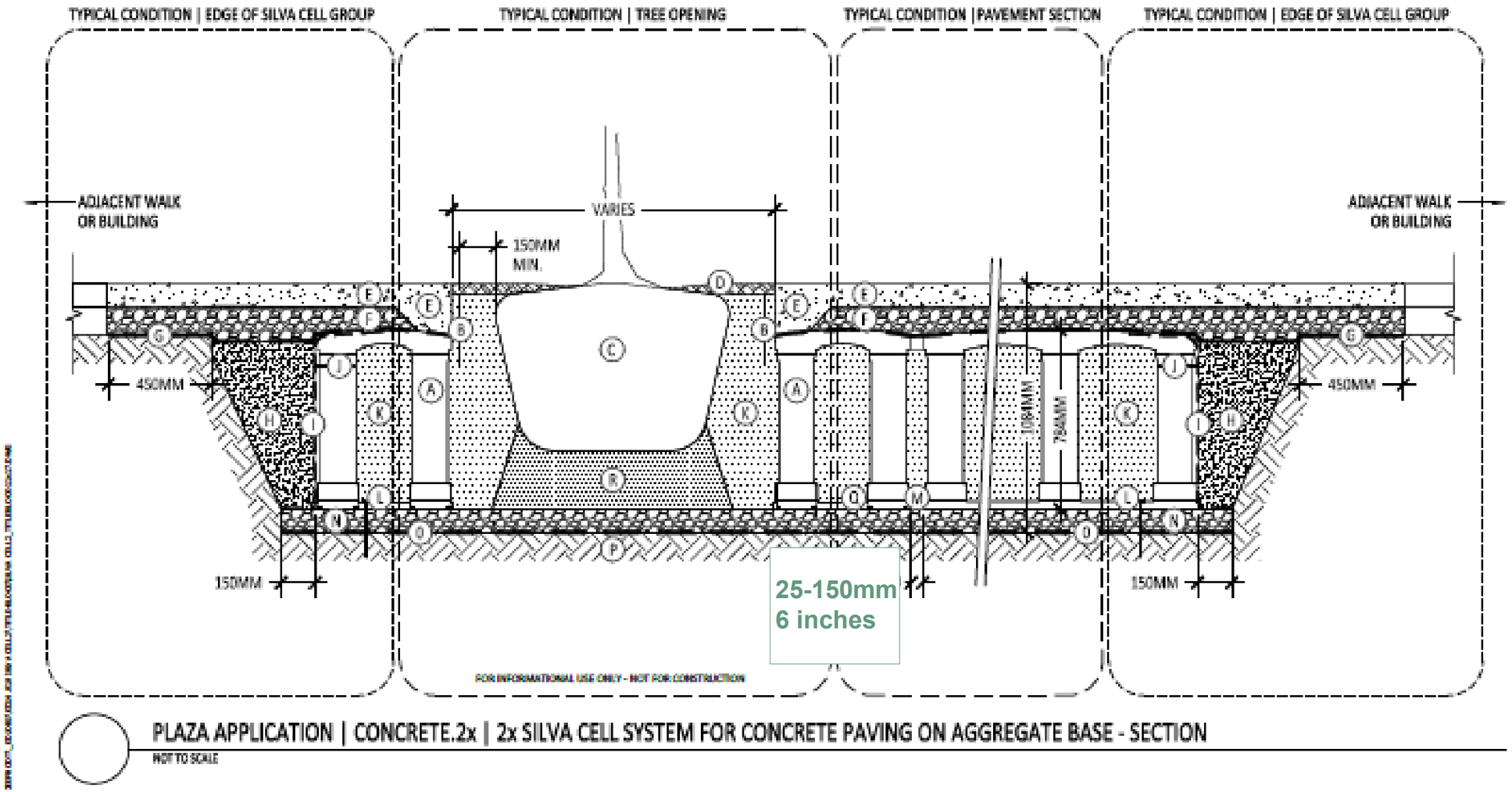


347mm



248mm

Sidewalk Assembly: Concrete | Asphalt | Pavers



Silva Cell: Unconnected Stacking Units

There is 25 – 150mm of space between each Silva Cell stack

Unconnected design enables:

- Ability to field-fit Silva Cells by adjusting spacing
- Ability to limit damage of unplanned excavation
- Easy removal for future utility work

Independent Engineering Report Available on Our Website

We stamp our drawings to meet:
Canadian bridge standard (87.5kn)
AASHTO- H20/HS20

Silva Cell 2 Ultimate Load Capacity

Silva Cell 2 System Type	Pavers 8 cm pavers 2.5 cm sand base 30.5 cm of aggregate	Asphalt 10 cm of asphalt 30.5 cm of aggregate	Concrete 10 cm of concrete 10 cm of aggregate	Pavers with Concrete 6 cm pavers 12.7 cm concrete
1X	147 kN	225 kN	165 kN	184 kN
	33,100 lbs	50,500 lbs	37,000 lbs	41,400 lbs
2X	162 kN	247 kN	181 kN	202 kN
	36,400 lbs	55,500 lbs	40,700 lbs	45,500 lbs
3X	137 kN	210 kN	154 kN	172 kN
	30,900 lbs	47,200 lbs	34,600 lbs	38,700 lbs

Table 3: Summary of ultimate wheel load by standard pavement section and Silva Cell 2 system based on contact surface area 250 x 600 mm rectangle.

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Installation

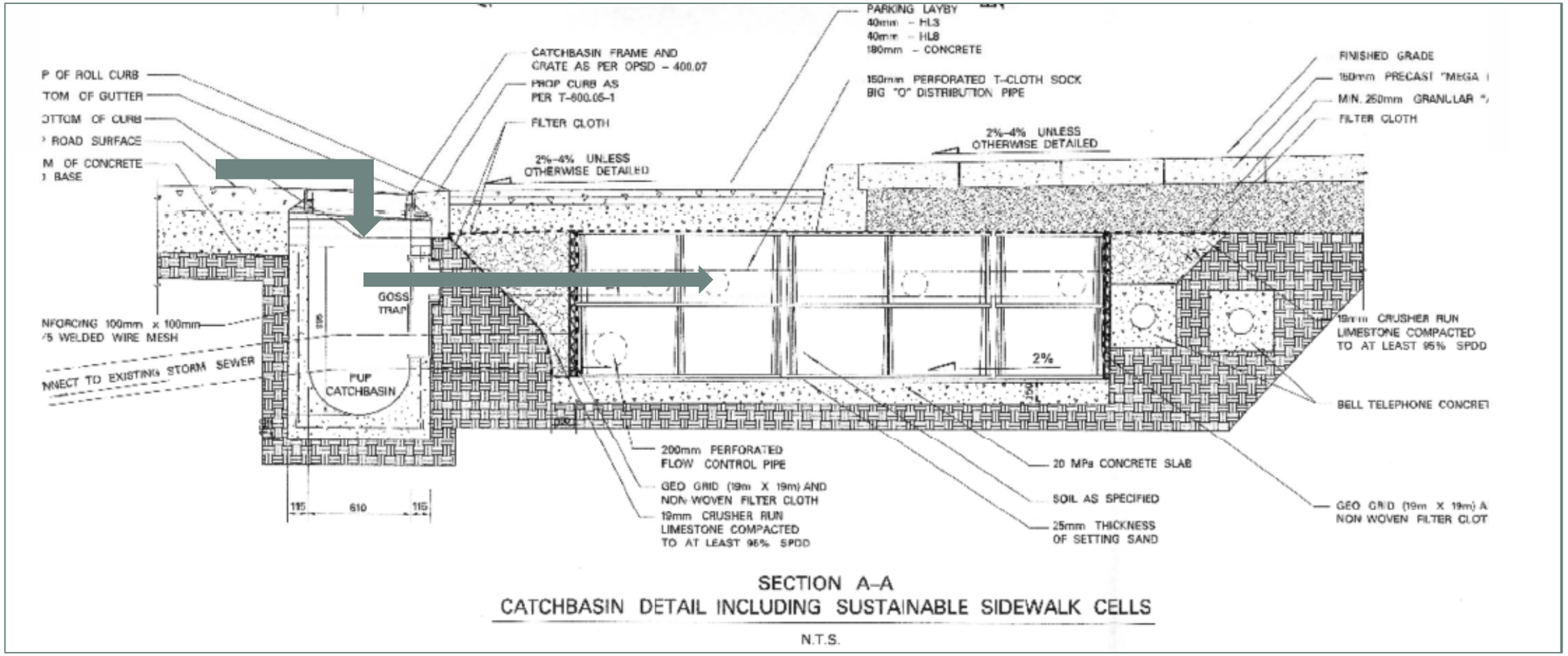
The Queensway Sustainable Sidewalk Pilot Project

City of Toronto and Toronto Water

Demonstration Site - 2008

Rainwater catchment area for the Soil Cells

Parking Bay

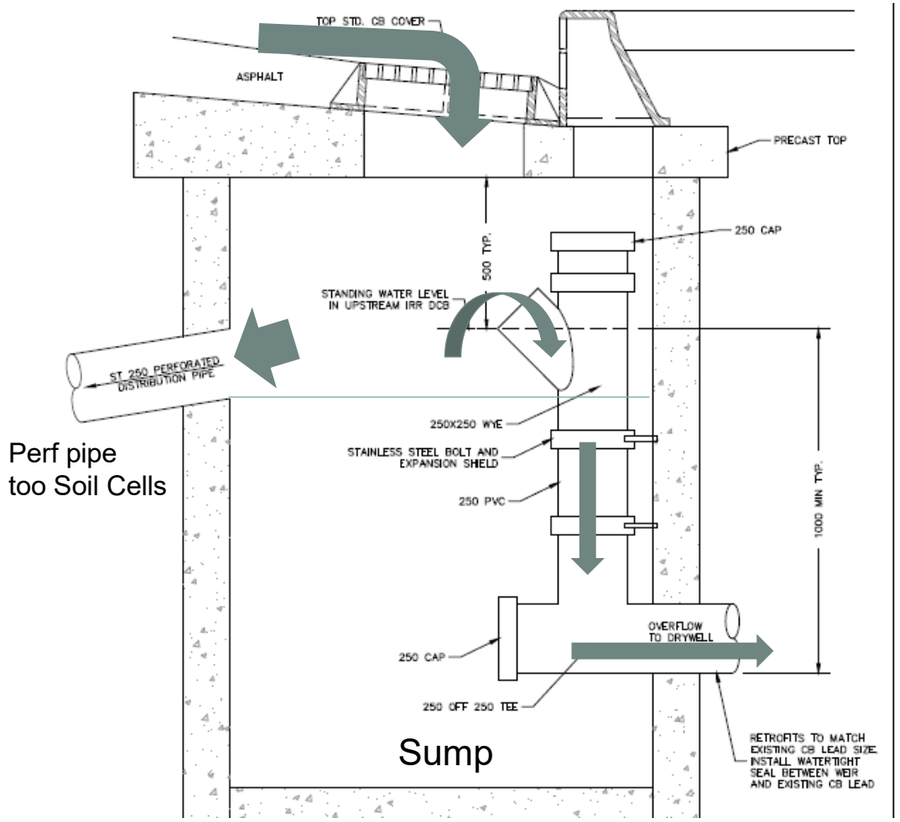


SECTION A–A

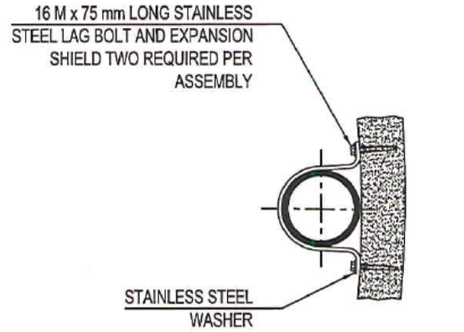
CATCHBASIN DETAIL INCLUDING SUSTAINABLE SIDEWALK CELLS

N.T.S.

Insert Example



Perf pipe
too Soil Cells



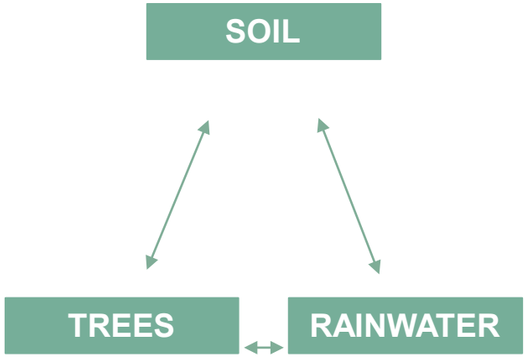
BRACKET TO BE MADE FROM MILD STEEL STRIP, 6 mm x 75 mm x 950 mm LONG. BRACKETS TO BE GALVANIZED AFTER BENDING.

Moose St., Banff


Intake
Catch Basin
Perforated
distribution pipe
Tree Pits
Clean out risers
Stormwater
drains to next CB

July 2010

1.5 years old




2014
654
CUSTOM FOOT ORTHOTICS
AUTO ACCIDENTS
WORK ACCIDENTS
• SPORTS INJURIES
• LASER THERAPY
• NUTRITIONAL ADVICE
L.L.B.D.

10 Years Later

Same tree, 10 years later

2018

The Queensway
Sustainable Sidewalk Pilot Project

6th Annual

TRIECA Conference

March 22, 2017

Presentation By:

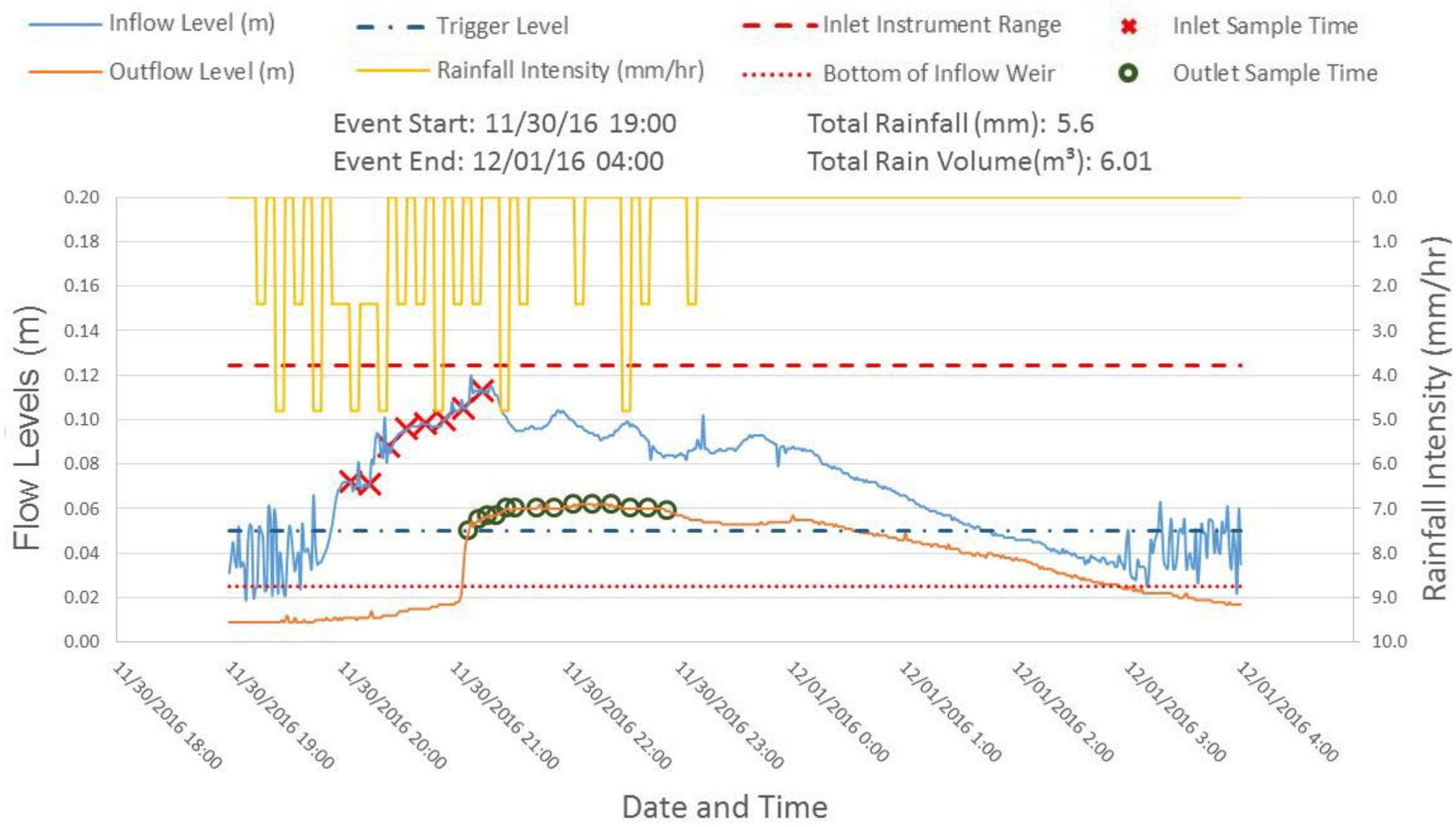
Patrick Cheung, Senior Engineer

Rod Anderton, Stream Restoration Supervisor

Toronto Water
Water Infrastructure Management

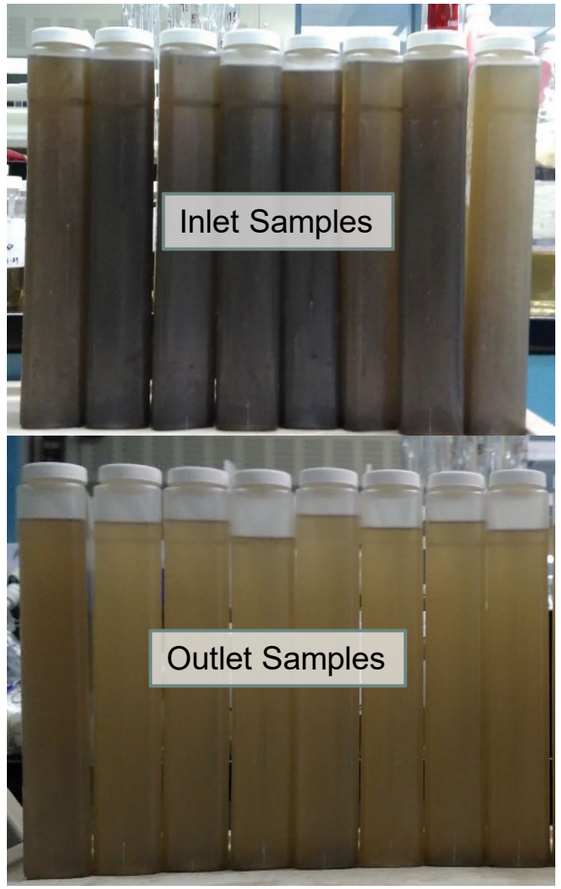
http://trieca.com/wp-content/uploads/2016/07/4-A-1-Patrick-Cheung-and-Rod-Anderton-The-Queensway-Sustainable-SW-Pilot-Project.pdf

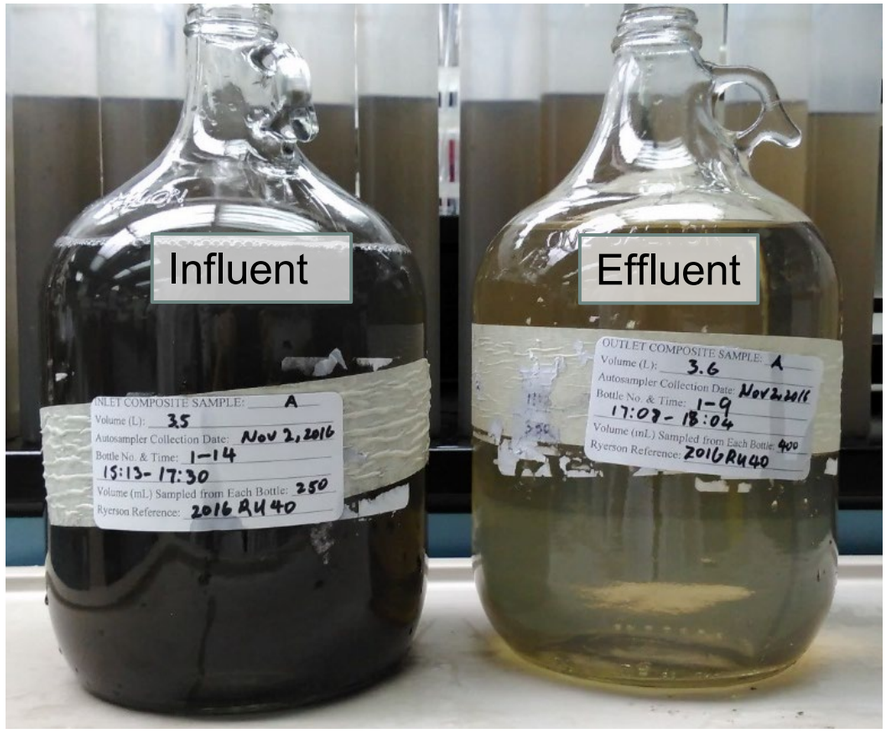
Sampling Event



Stormwater Sampling

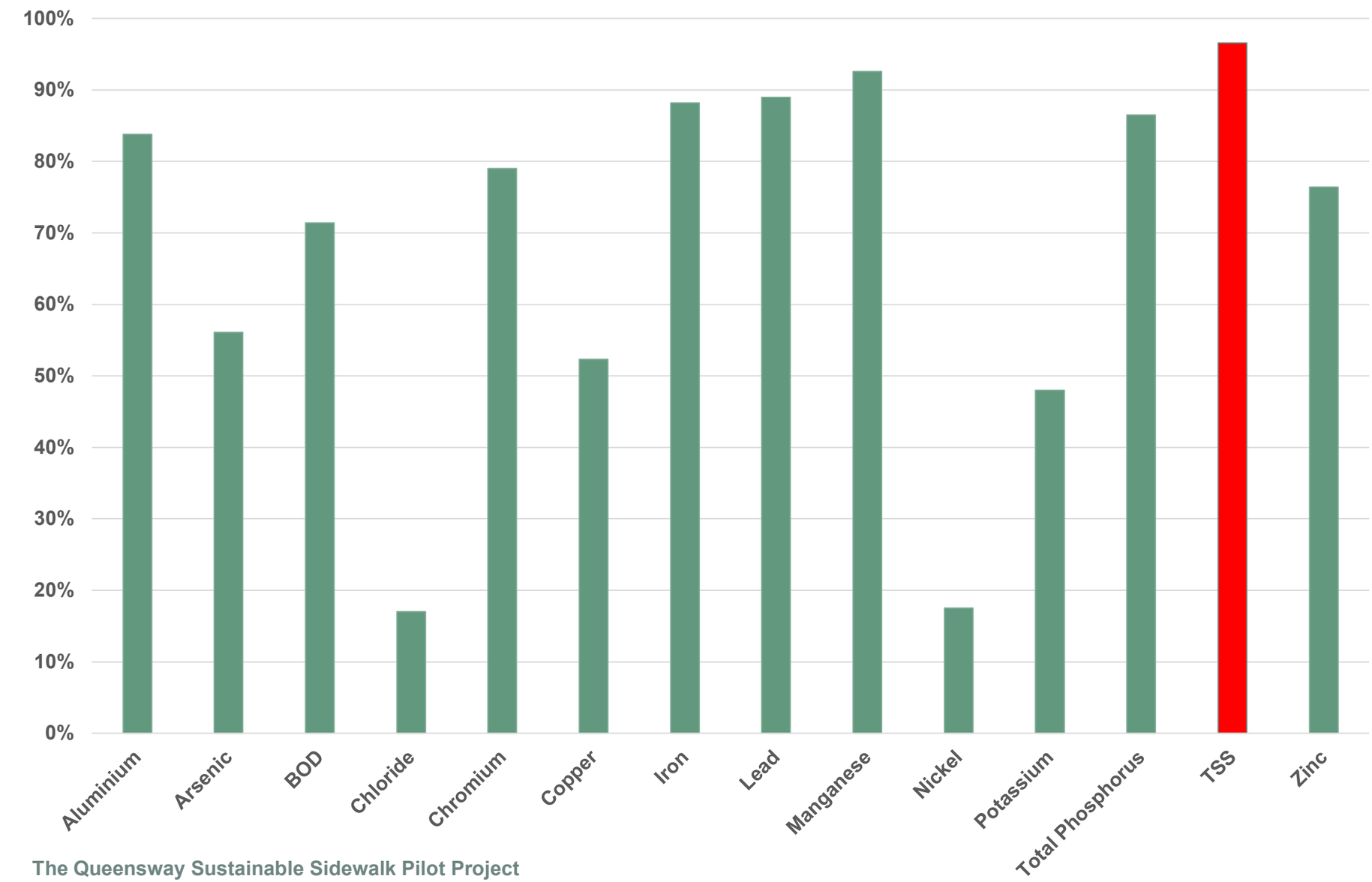
- Flow triggered with set minimum flow level to avoid sampling minor events;
- First 25 minutes of event captured in 6 bottles at 5-minute sampling intervals;
- Next 80 minutes of event collected in last 8 bottles at 10-minute intervals;
- Composite samples analyzed (not flow proportioned);





- Over 50 events sampled with both inlet and outlet samples collected for water quality comparison.

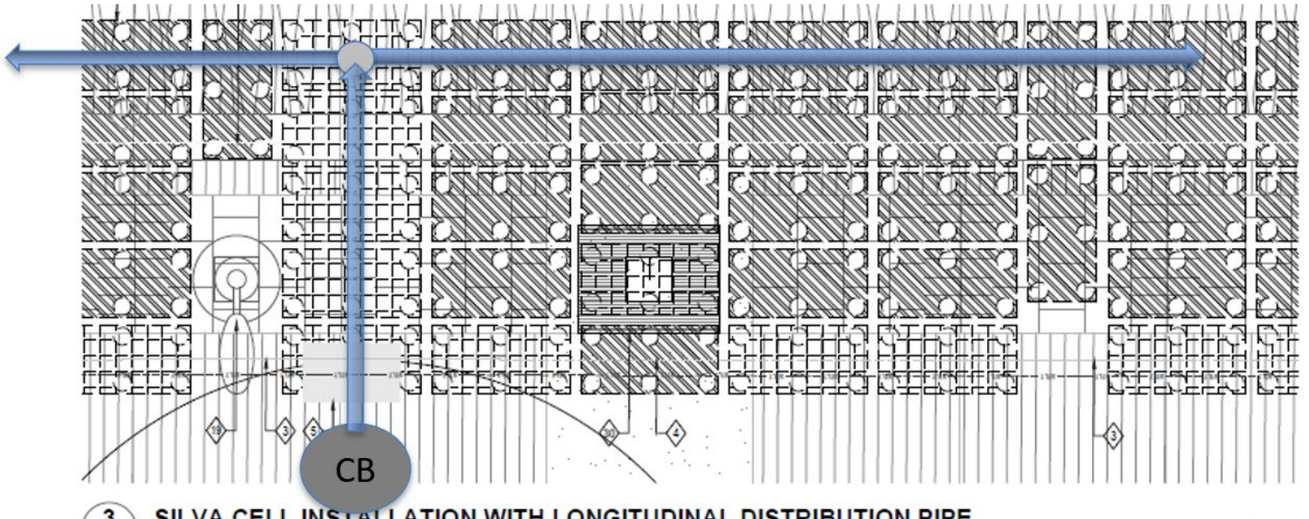
Queensway Water Quality Results
November 2, 2016



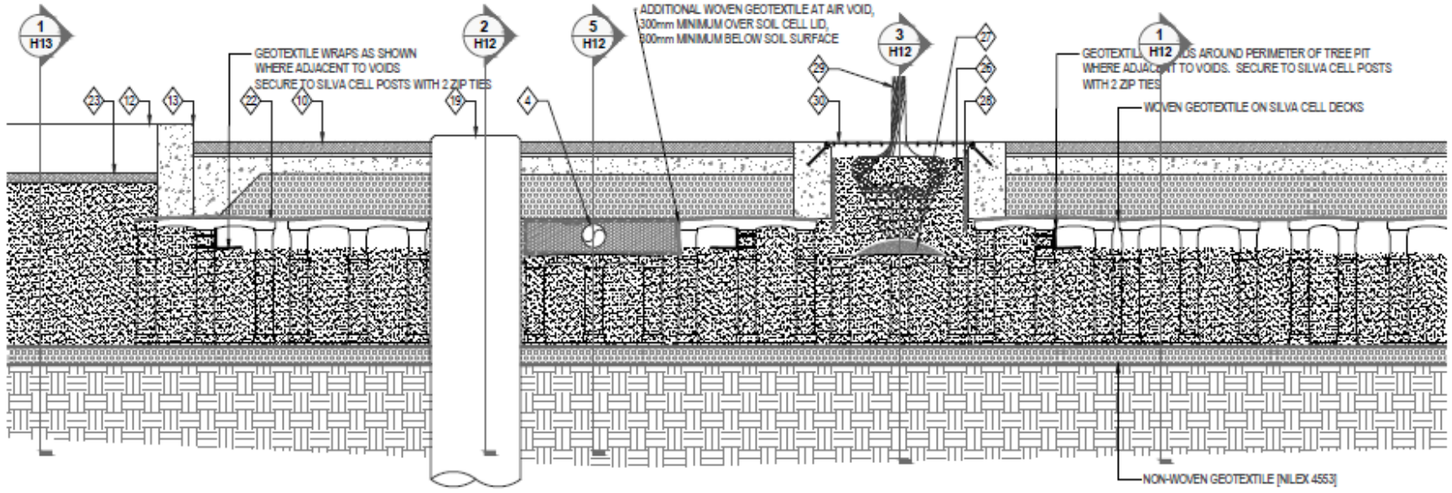
The Queensway Sustainable Sidewalk Pilot Project

Courtesy James Urban

Jasper Ave: 109 – 114th Edmonton



3 H11 SILVA CELL INSTALLATION WITH LONGITUDINAL DISTRIBUTION PIPE
TYPICAL PLAN
SCALE 1:30



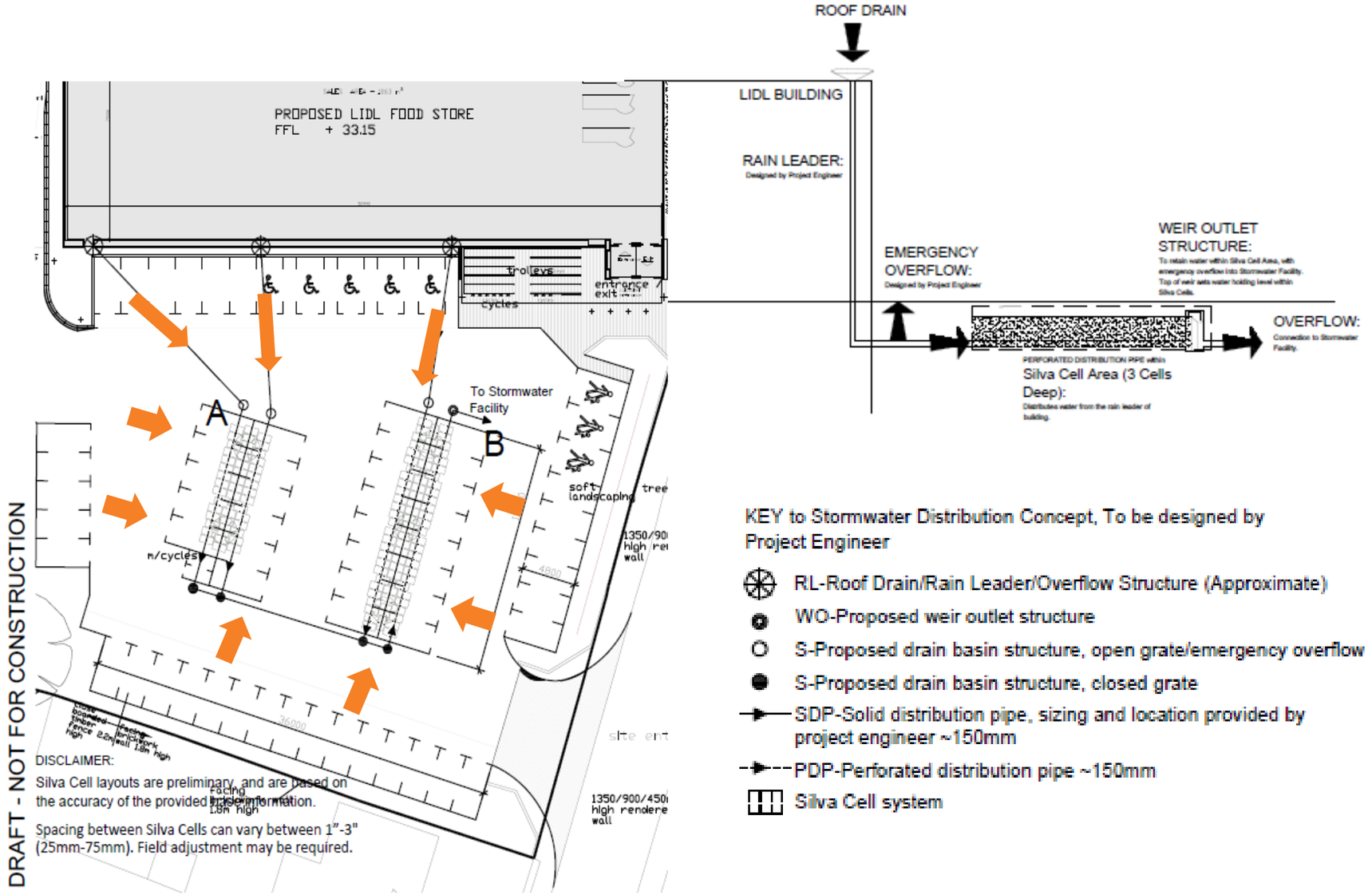
2 H11 SILVA CELL INSTALLATION
TYPICAL LONGITUDINAL SECTION
SCALE 1:30

EPCOR's primary design criteria was peak-flow reduction


11150


PCL
OPEN FOR BUSINESS
DURING CONSTRUCTION
112 ST

Lidl Store (New Milton, UK)



Triangle Tree Pit design allows for more parking spaces –no soil volume islands


Re-imagine the vast expanses of asphalt as forests that provide shade, manage stormwater, extend the life of the asphalt and provide an environmentally friendly space.

Ontario (OME) accepts the DeepRoot Silva Cells as an equivalency to bioretention

Ontario

Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

ENVIRONMENTAL COMPLIANCE APPROVAL
NUMBER 3648-BB2N2S
Issue Date: April 12, 2019

Site Location: 344 Ahrens Street West
Kitchener City, Regional Municipality of Waterloo

- **Stormwater quality facility (catchment area 0.43 ha, imperviousness 50%):** four (4) bioretention cells located along Ahrens Street West on both sides of the municipal right of way, between Hartwood Avenue and Guelph Street and starting approx. 10 metres from Hartwood Avenue, receiving road runoff from Ahrens Street West via curb cuts, consisting of 1X, 2X and 3X silva cells systems with varying heights and having lengths of 9.0, 10.3, 24.6 and 29.8 metres, lined with vegetation and topsoil over engineered soil mix, sand and stone with the cells and stones wrapped in woven geotextile, providing a total retention volume of approximately 57.6 cubic metres, complete with 150 mm diameter monitoring wells at each facility, discharging excess runoff via overland flow towards the storm sewer system;

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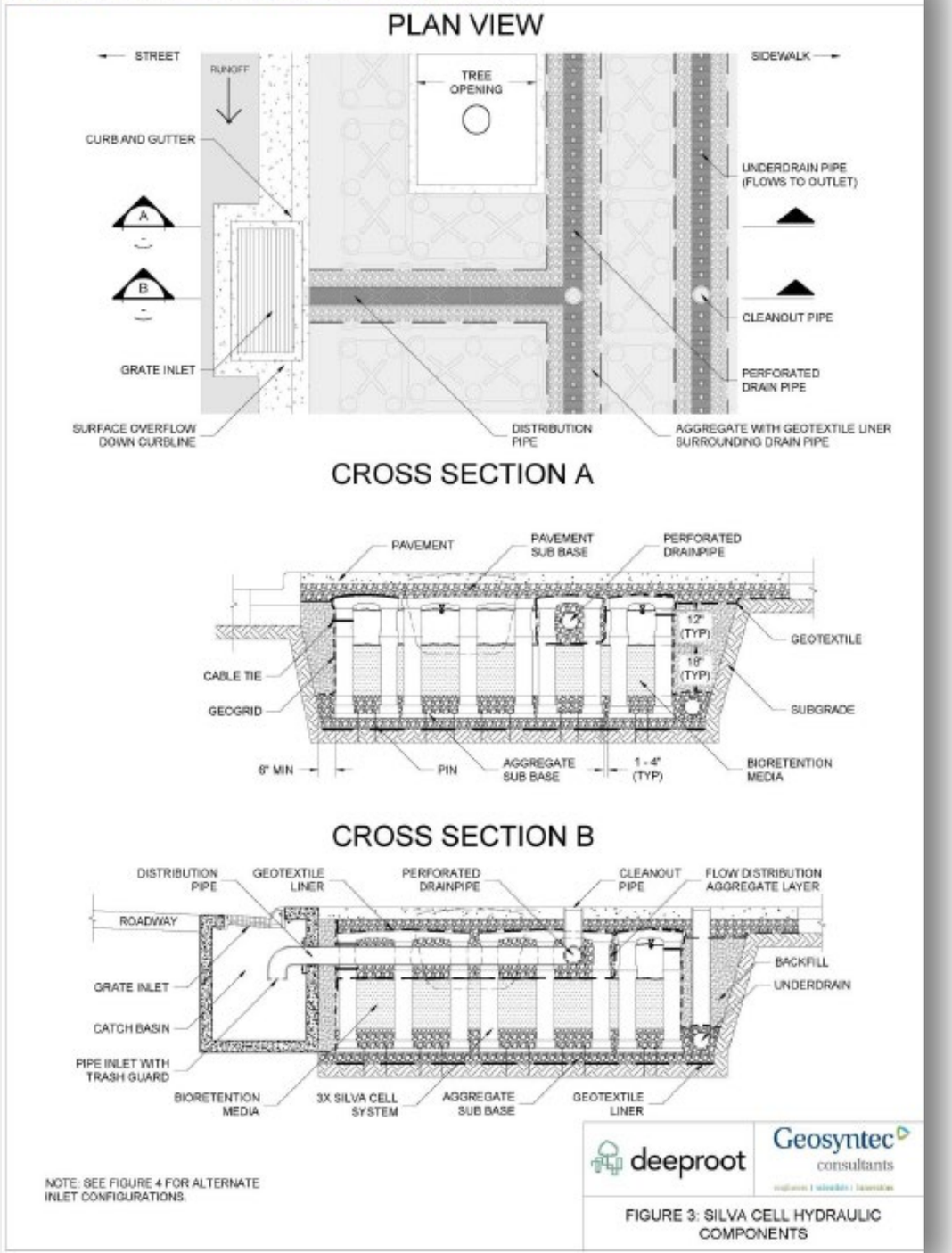
SILVA CELL FACT SHEET

A detailed guide and sizing manual for the application of Silva Cells to meet the requirements of bioretention under paving

Figure 3: Silva Cell Hydraulic Components



A Stormwater Sizing Tool to calculate the number of DeepRoot Silva Cells needed to manage a specific storm event

Other relevant information

- Meant to capture small storms and/or first flush
- Not meant to replace a site stormwater system
- Must drain down whether via an undrain of infiltration
- Must have an overflow / bypass mechanism
- Maximum depth of cover – structural 3m
- Maximum depth of cover at tree pit – re: tree health 600-700mm
- Can be designed for controlled release/water balance applications
  - Flow is controlled by the infiltration rate of the soil or in conjunction with a flow control device at the outlet
  - For optimum pollutant removal + tree health the recommended infiltration rate for the soil media is 25mm per hour

Maintenance

- Pre-treatment to remove sediment and floatables is key
- When designed and installed correctly there should be no maintenance required inside the system

Design Services:
DeepRoot can be your design partner

- Assist with Landscape and Stormwater layouts and sections
- Assist with Water-In and Water-Out design options and detailing
- Assist with utility conflicts and non-standard obstructions

Reconfiguration of The Six Points Interchange

pA planningAlliance HDR TORONTO

deeproot.com

Etobicoke Six Points: Toronto, Canada

Owner: City of Toronto
Design Team: HDR, SvN, Toronto Water
Design Objective: Meet the City of Toronto Green Standard
Project Area: 6.47 hectares
Silva Cell stormwater catchment Area: 3.56 hectares
Volume Target: Retain the 5mm rain event

Met Toronto Green Standard Canopy Targets: 40% Canopy

Silva Cells allowed the city to plant trees in hardscape areas that would not have supported healthy trees in the past.

Soil Volume Target: 30m3 (1200ft3) of soil per tree

Met and exceeded Project Stormwater Design Goals with Silva Cells:

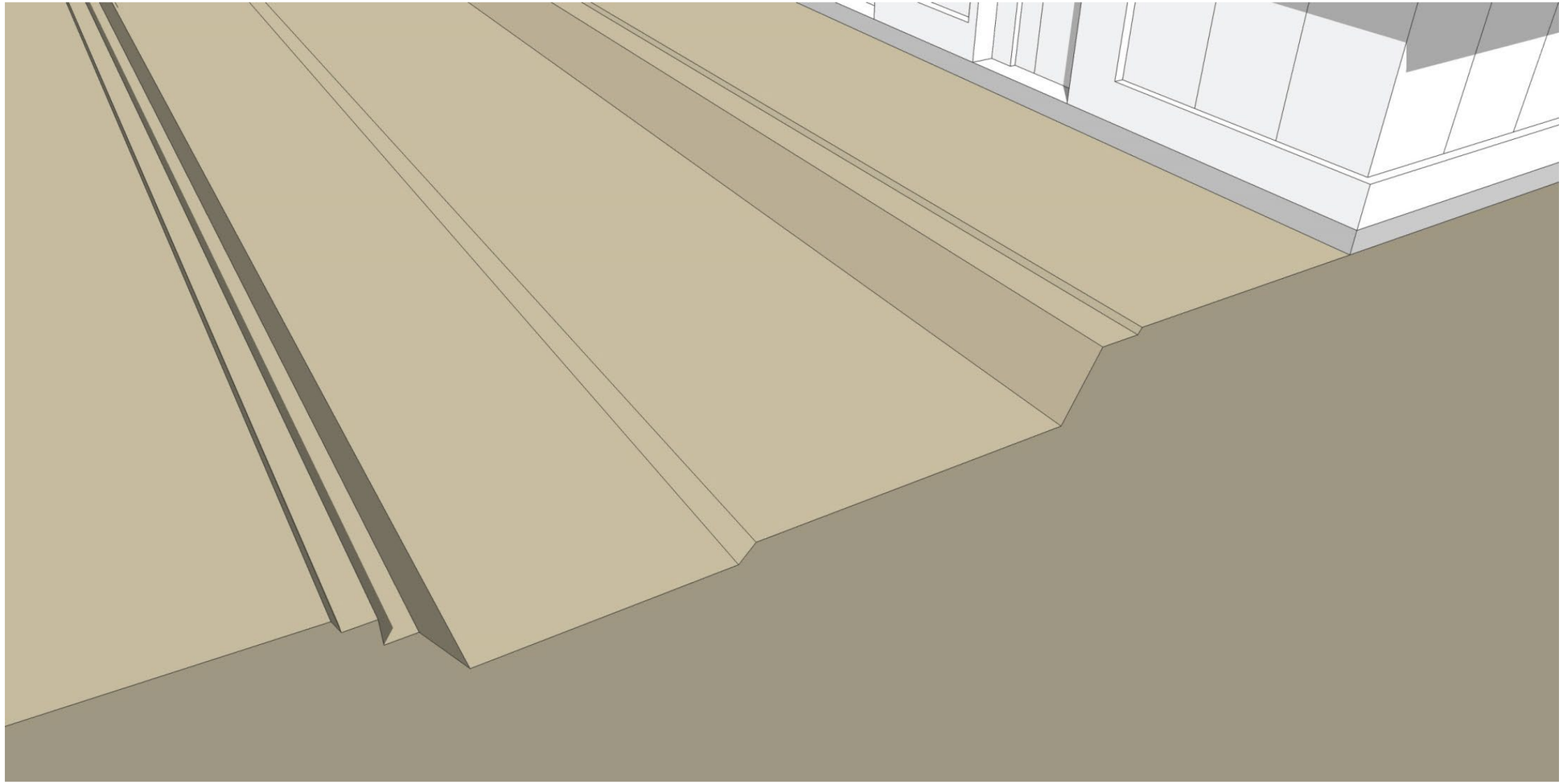
Percent of received stormwater volume removed towards performance goal 100 %*

(For 50% of the CB catchment areas the Silva Cells are managing 100% of the 100- year storm)

- **Percent annual runoff volume removed: 46%**
- **Percent annual total phosphorus removed: 74%**
- **Percent annual TSS removed: 83%**

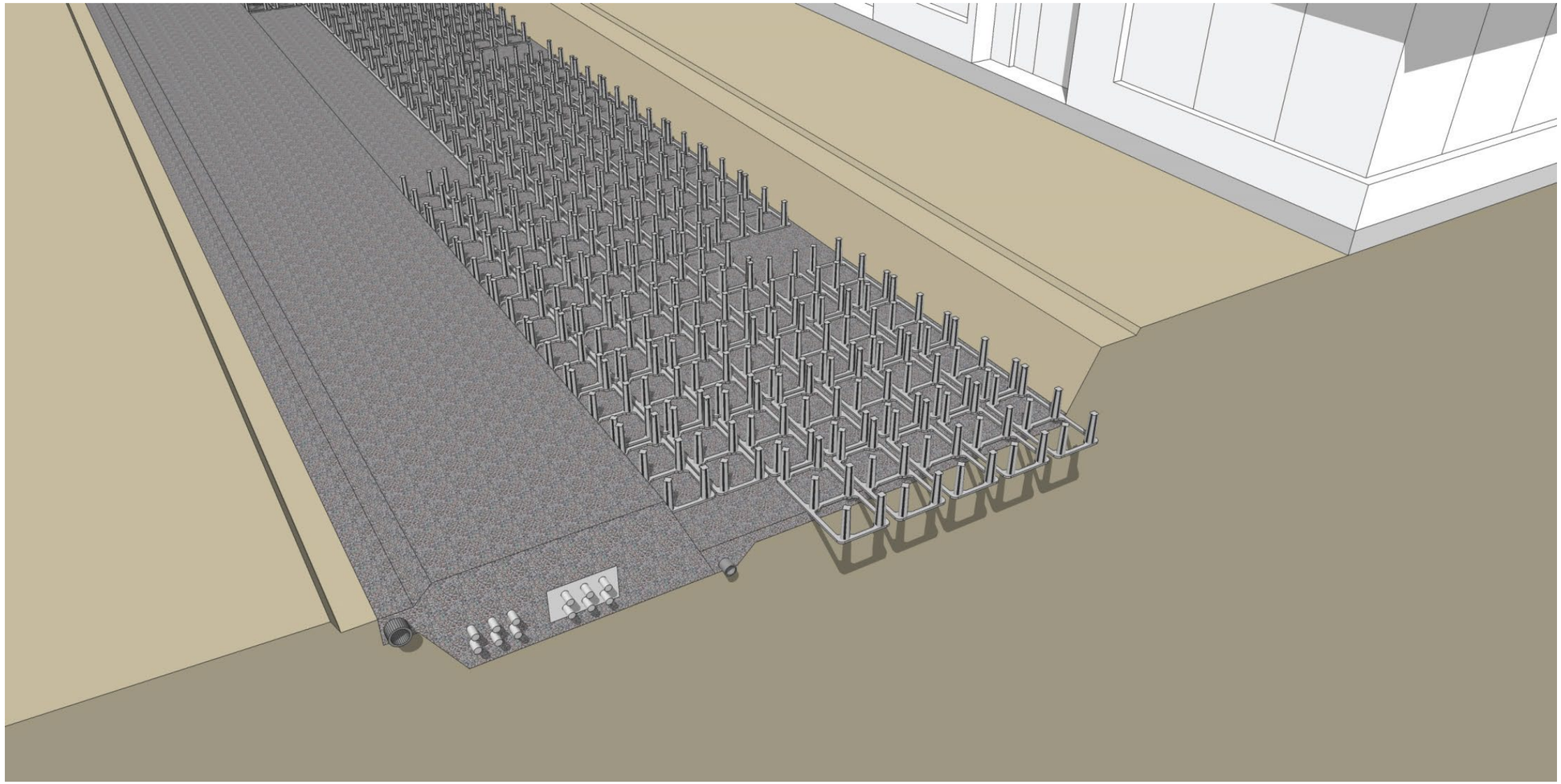
* Silva Cell stormwater capacity exceeded the volume target by 30%

Underground Assemblies



2. Continuous Trench

Underground Assemblies



8.Soil Cells

Integrated Soil and Stormwater system

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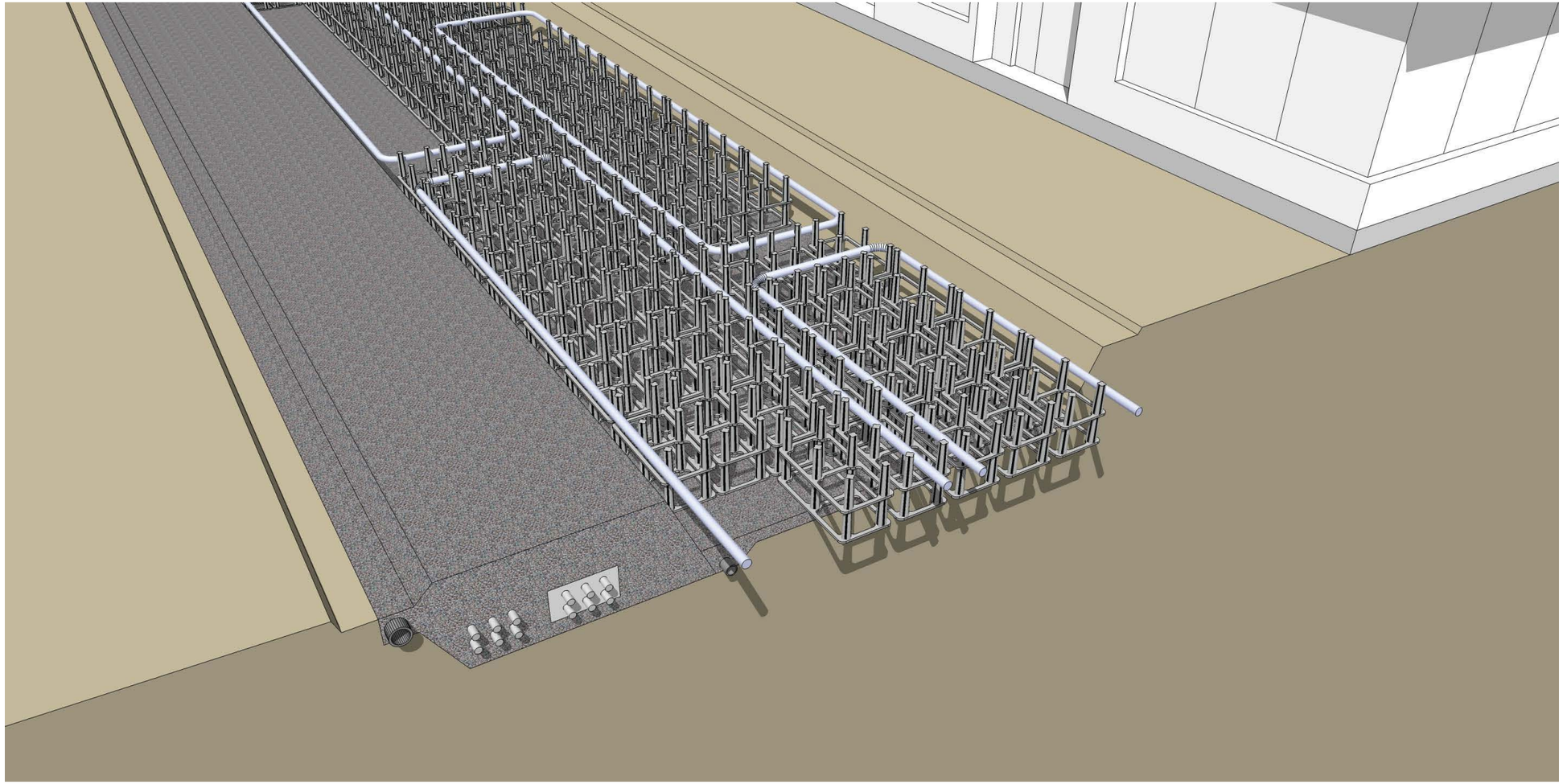
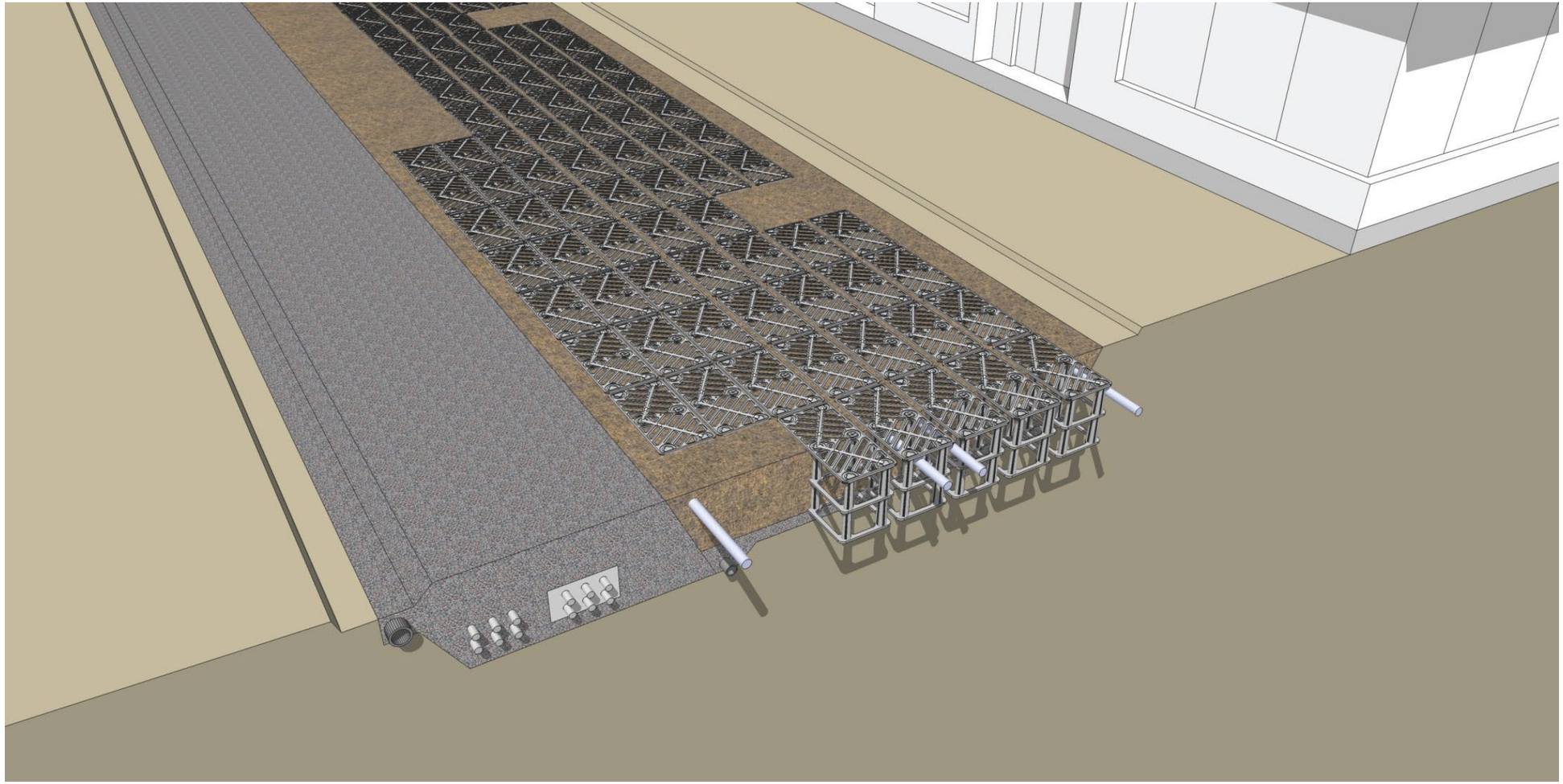
Underground Assemblies



9. Rainwater Pipes

Integrated Soil and Stormwater system

Underground Assemblies

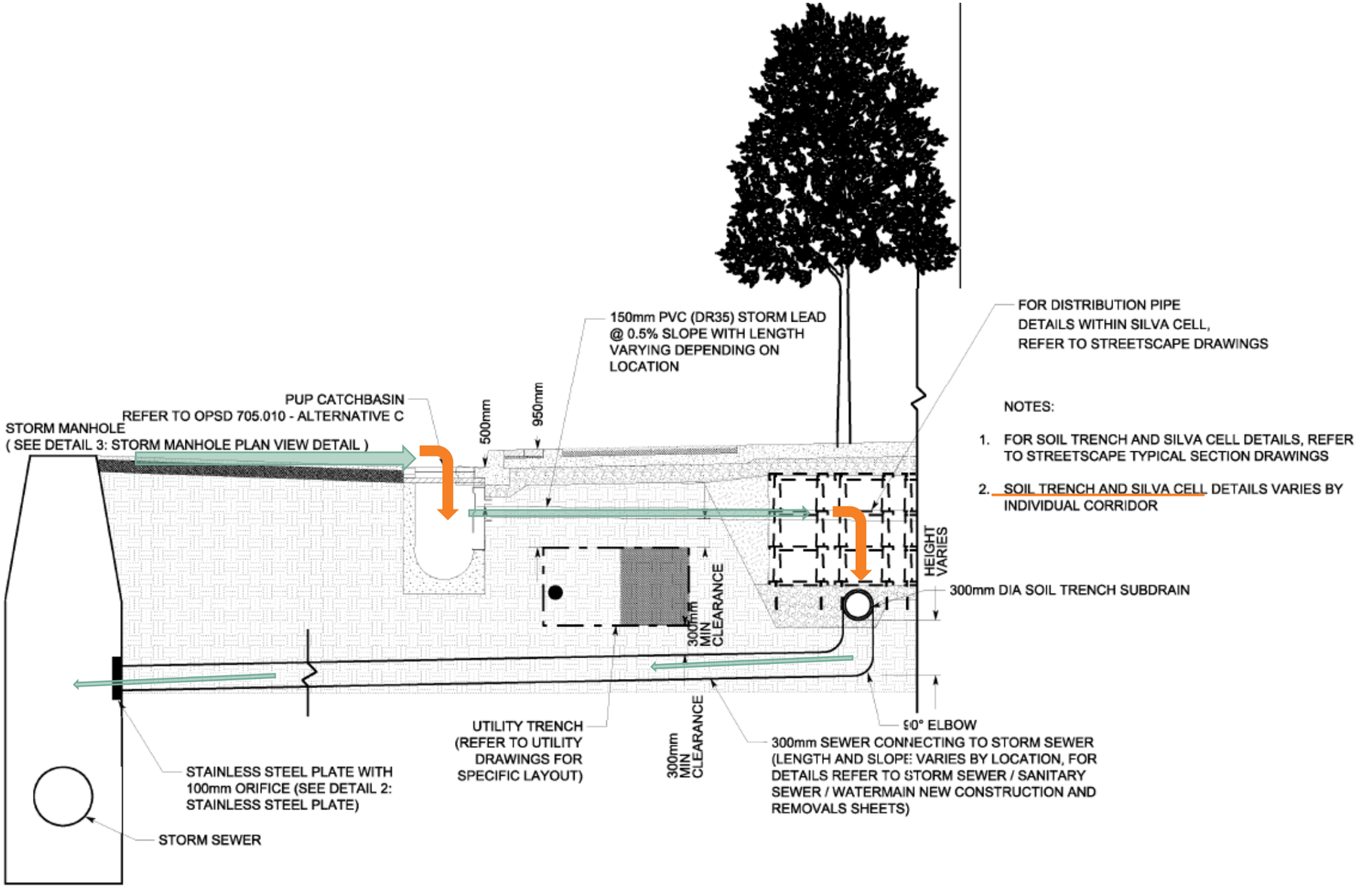


11. Completed Soil Trench

Integrated Soil and Stormwater system

Underground Assemblies

18. Street Furniture


150mm PVC (DR35) STORM LEAD
@ 0.5% SLOPE WITH LENGTH
VARYING DEPENDING ON
LOCATION
FOR DISTRIBUTION PIPE
DETAILS WITHIN SILVA CELL,
REFER TO STREETSCAPE DRAWINGS
PUP CATCHBASIN
REFER TO OPSD 705.010 - ALTERNATIVE C
STORM MANHOLE
(SEE DETAIL 3: STORM MANHOLE PLAN VIEW DETAIL)
500mm
950mm
NOTES:
1. FOR SOIL TRENCH AND SILVA CELL DETAILS, REFER TO STREETSCAPE TYPICAL SECTION DRAWINGS
2. SOIL TRENCH AND SILVA CELL DETAILS VARIES BY INDIVIDUAL CORRIDOR
HEIGHT VARIES
300mm DIA SOIL TRENCH SUBDRAIN
300mm MIN CLEARANCE
UTILITY TRENCH
(REFER TO UTILITY
DRAWINGS FOR
SPECIFIC LAYOUT)
300mm MIN CLEARANCE
90° ELBOW
300mm SEWER CONNECTING TO STORM SEWER
(LENGTH AND SLOPE VARIES BY LOCATION, FOR
DETAILS REFER TO STORM SEWER / SANITARY
SEWER / WATERMAIN NEW CONSTRUCTION AND
REMOVALS SHEETS)
STAINLESS STEEL PLATE WITH
100mm ORIFICE (SEE DETAIL 2:
STAINLESS STEEL PLATE)
STORM SEWER

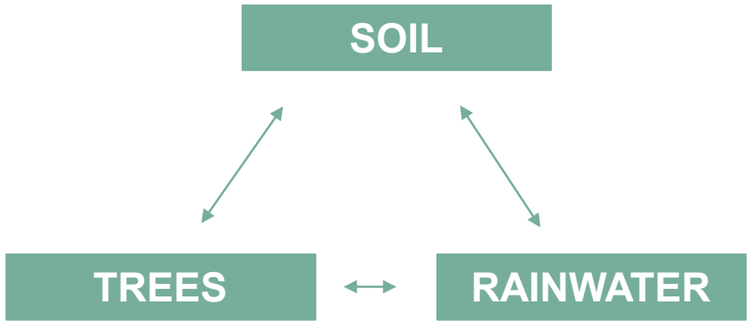
Trees in 2022

Planted 2018

deeproot.com

“Nearly all of the associated problems result from one underlying cause: loss of the water-retaining and evapotranspiration functions of the soil and vegetation in the urban landscape.”

EPA Report: Urban Stormwater Management in the US



Thank you!

Michael James
mjames@deeproot.com

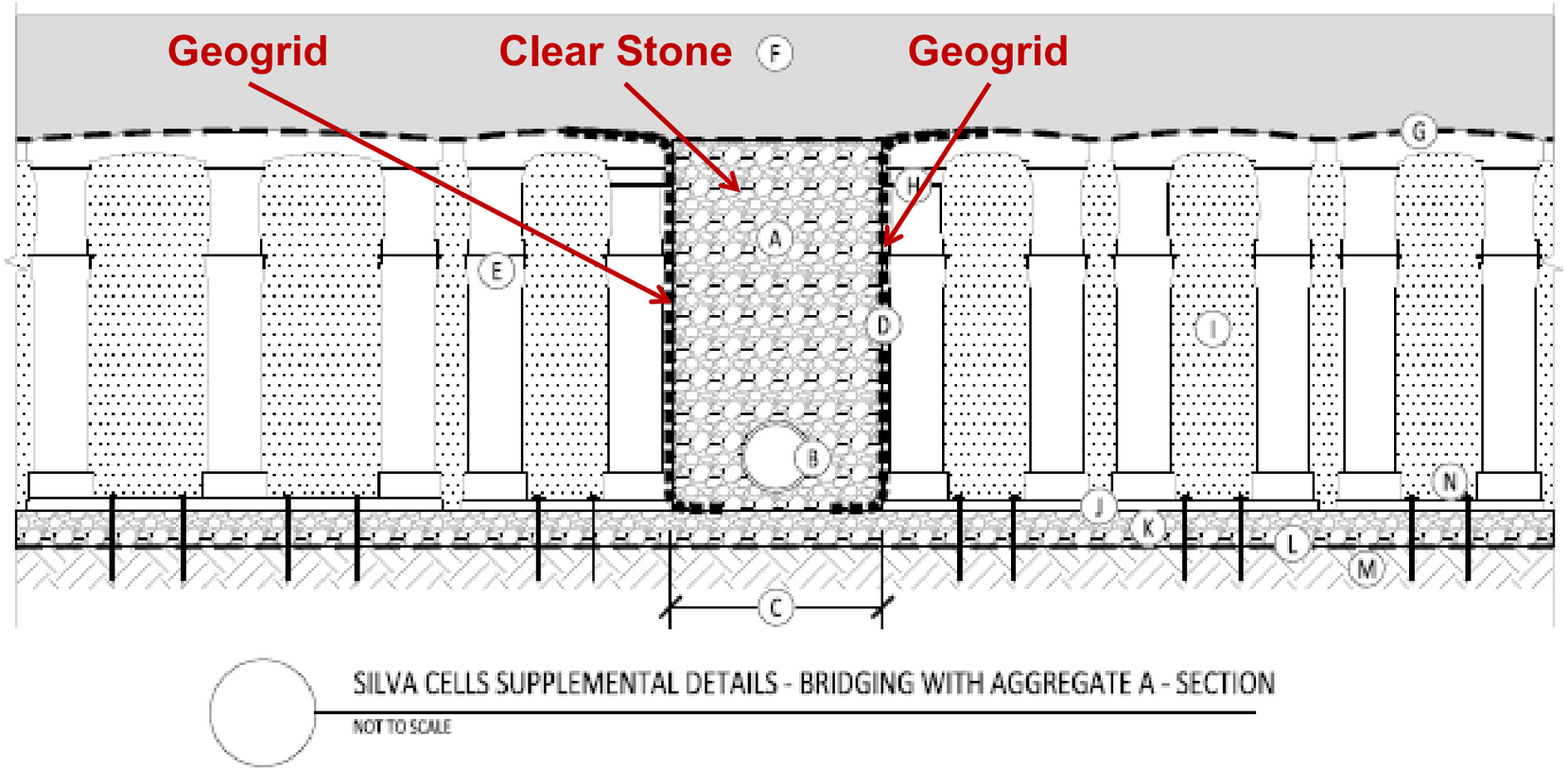
Integrating Silva Cells and Utilities

Integrating Silva Cells and Utilities

There are several different ways for integrating Silva Cells with both new and existing utilities

The largest unobstructed soil volume of any Soil Cell

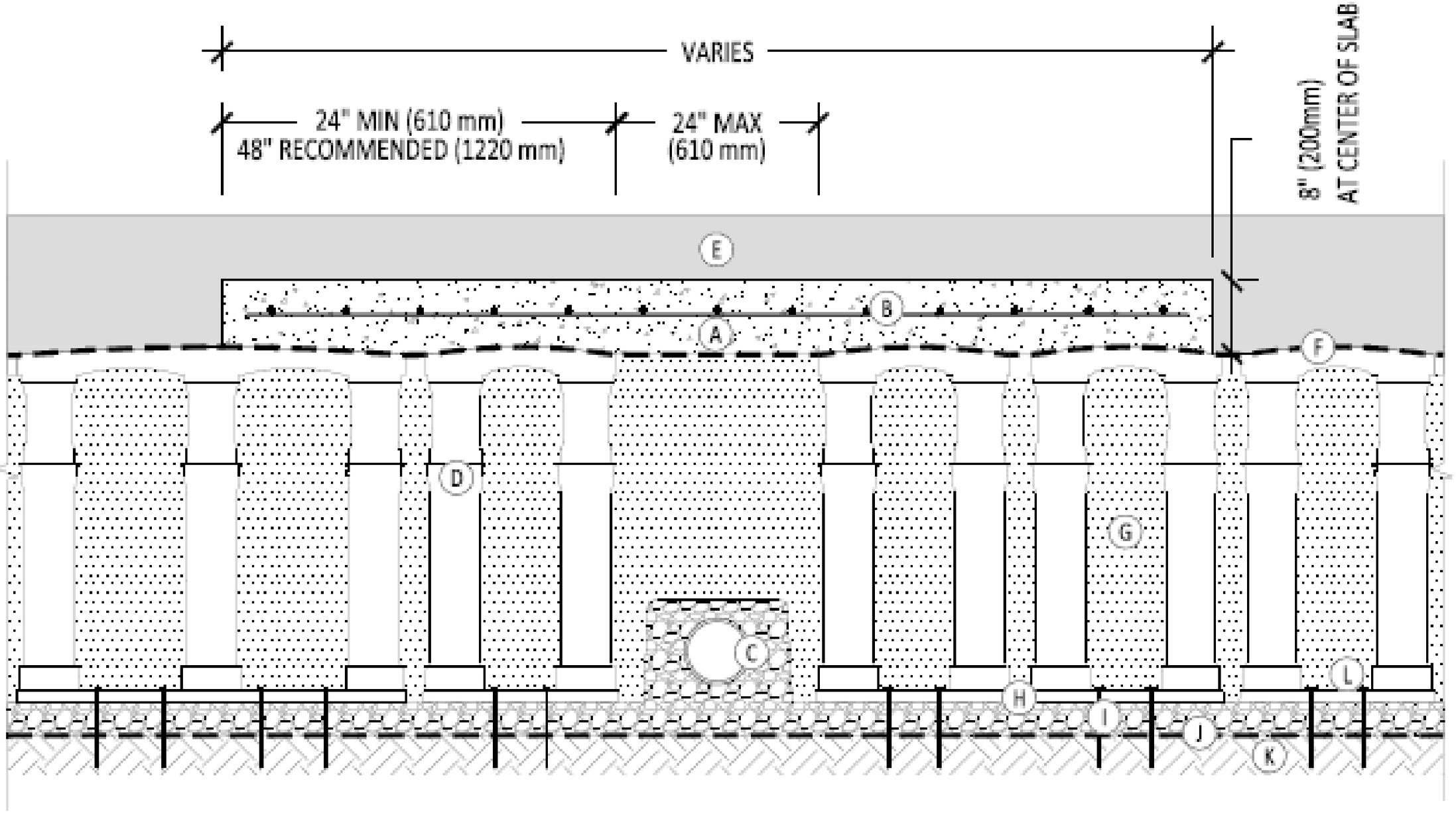
Utilities don’t always run in straight lines



Options for when utilities cannot be run through frames

Aggregate Gap Bridging

One of the simplest options is to leave a gap in the Silva Cells where the Utility is. Then wrap the inside of the gap with geogrid and fill the void space with clear stone (drain rock) to make a stone column. The tree roots will work their way through the stone.

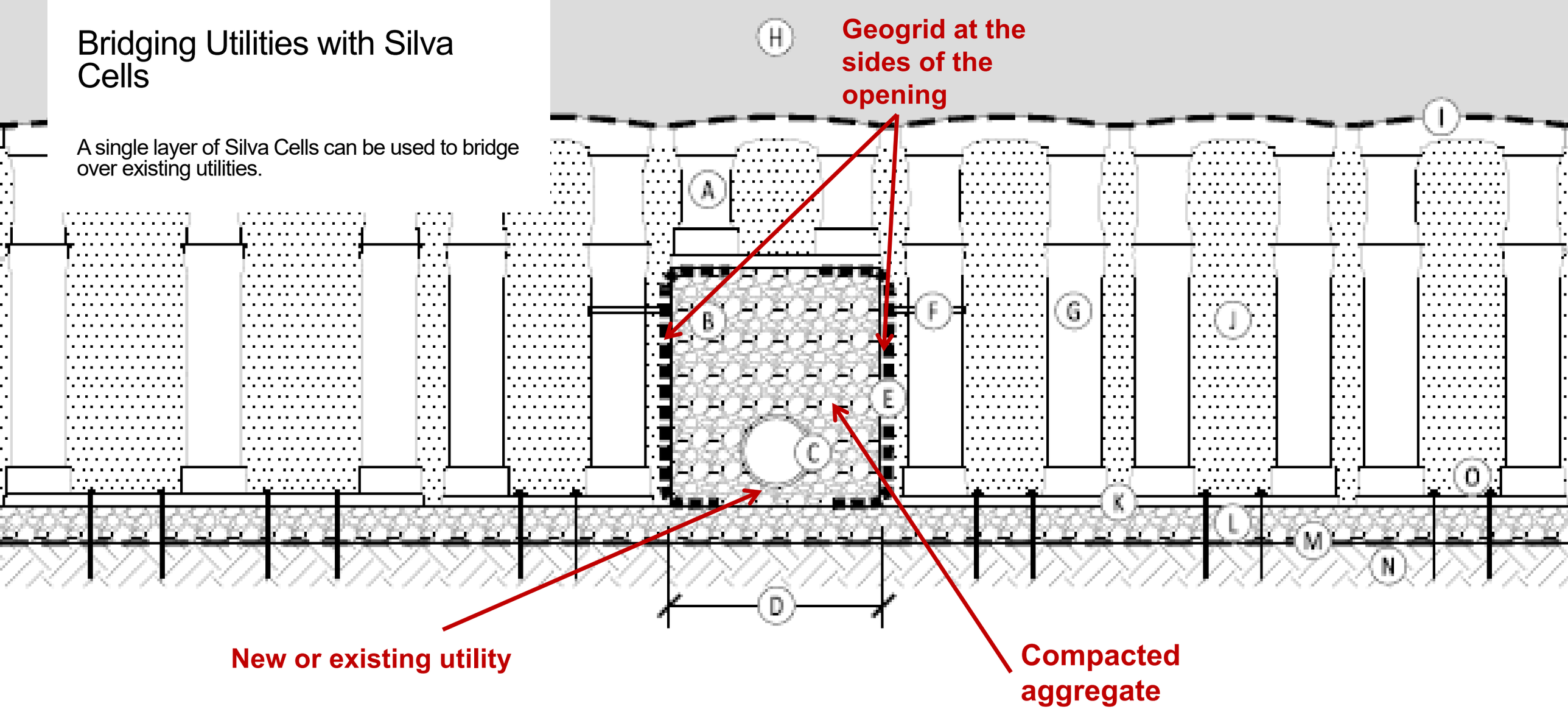


SILVA CELLS SUPPLEMENTAL DETAILS - BRIDGING WITH SLAB - SECTION

NOT TO SCALE

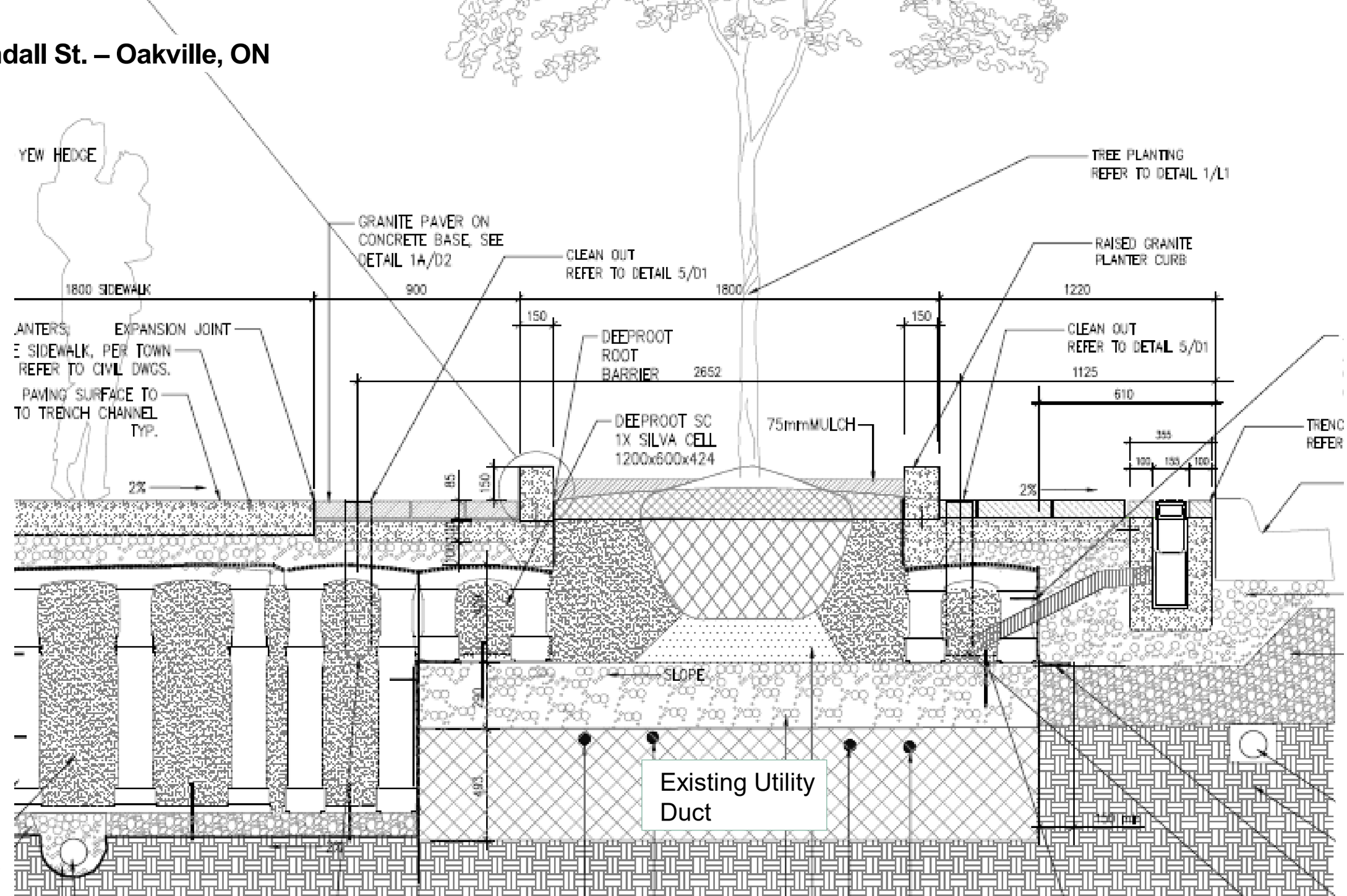
Bridging Utilities with Silva Cells

A single layer of Silva Cells can be used to bridge over existing utilities.



SILVA CELLS SUPPLEMENTAL DETAILS - BRIDGING WITH AGGREGATE B - SECTION

Randall St. – Oakville, ON



deeproot

SILVA CELL
OPERATIONS AND MAINTENANCE MANUAL