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# Addressing the Stormwater Management Crisis in Urban Ontario through Public-Private Land Retrofits (Southdown Grid Project)

*Presented by: Phil James, P.Eng, Rohan Hakimi, EIT and Shannon Malloy*

*Date: December 9, 2020*

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*The water component of STEP is a collaborative of:*

Lake Simcoe Region conservation authority

Credit Valley Conservation inspired by nature

Toronto and Region Conservation Authority

# Presentation Outline

- Introductions
- Background
- Drainage Act Processes
- Feasibility Study
  - Assessing the Technical Feasibility
  - Assessing the Financial Feasibility
  - Next Steps with Study - One Water Investigations
- Summary/Conclusion

# Implementing Green Infrastructure (GI) on Private Property in Existing Urban Areas

*This project is exploring the technical and financial feasibility of implementing communal stormwater management systems on private property*

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# Background

# Urbanization

# Post Development Stormwater Challenges

# Post Development Stormwater Challenges Continued

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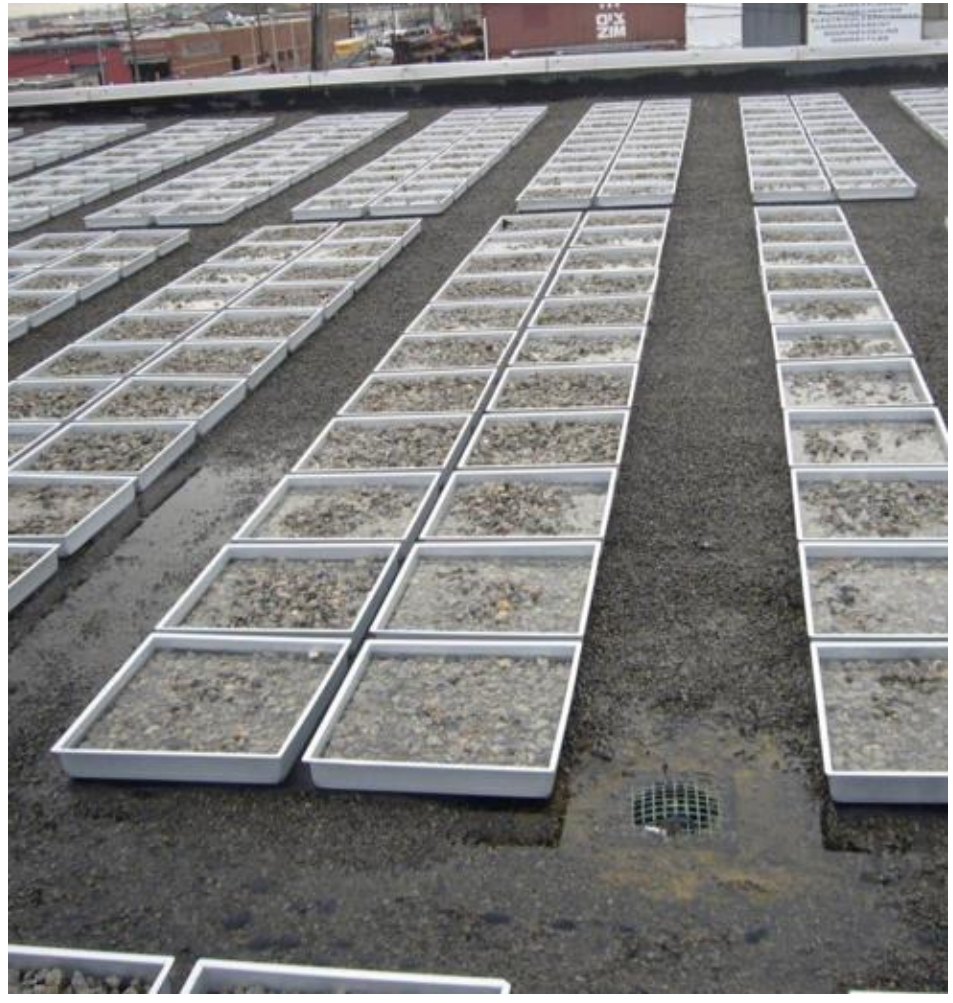
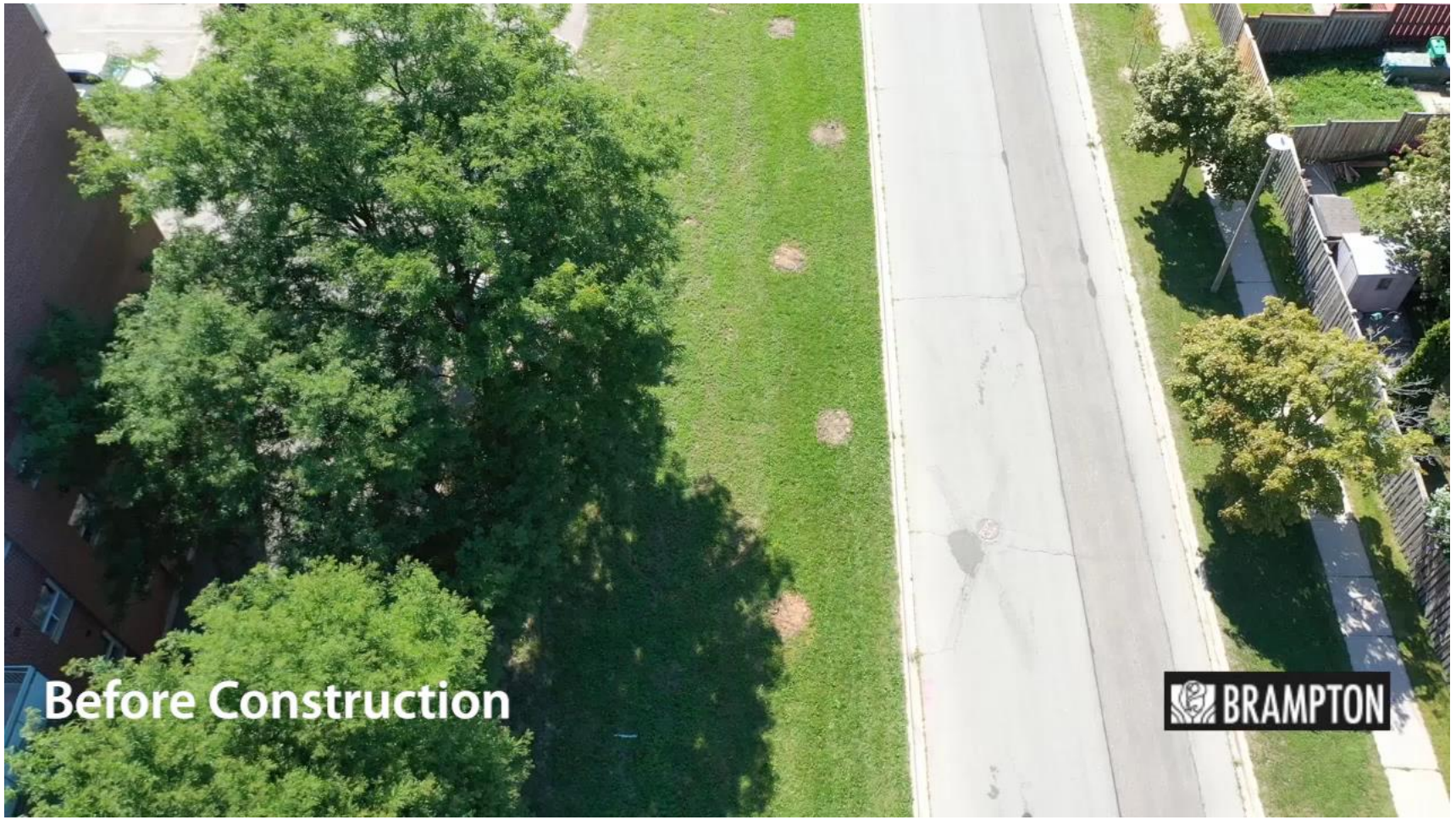
# Low Impact Development (LID)

*Is a Green Infrastructure approach to stormwater management to filter, store and infiltrate water where it falls*



# Restoring Hydrologic Pathways

# LID during construction – Haggert Ave bioretention



# LID In Action

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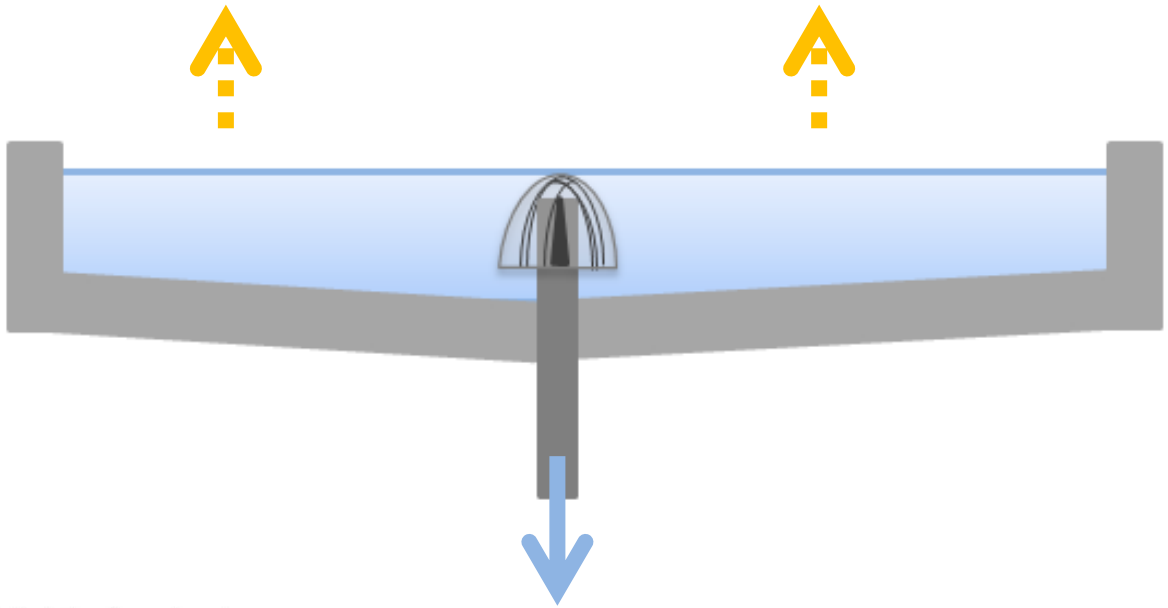
# Passive Flow Control - Shut off Valve

- Change in surface ponding after valve is opened
- Flow control valve to optimize performance


The **Intact Adaptation Action Grants** are
helping to build more resilient communities

# Smart Blue Roof

- Evolution towards smart systems with active controls



# Treatment Train Approach

- Need to take a treatment train approach to solve today's SWM challenges
- MECP's volume control targets cannot be achieved through end of pipe controls need to be looking at source and conveyance controls

# Barriers Stormwater Management on Private Property

Private Property Owner Barriers

- Cost
- Pay back period for SWM retrofits is poor

Municipal Barriers

- Protecting asset from damages
- Ensuring features are maintained

# Benefits of Aggregation


- Economies of scale
  - One designer
  - One contractor
  - One maintenance contractor
- Maximize performance
- Maximize savings (stormwater, water, wastewater, energy)

Is there a process for implementation?

# The Drainage Act Processes

# Solution: DRAINAGE ACT
# RSO 1990, Chapter D.17, revised 2010

Ontario statute that provides **a process** for the construction and maintenance of communal drainage works on private lands and public roads

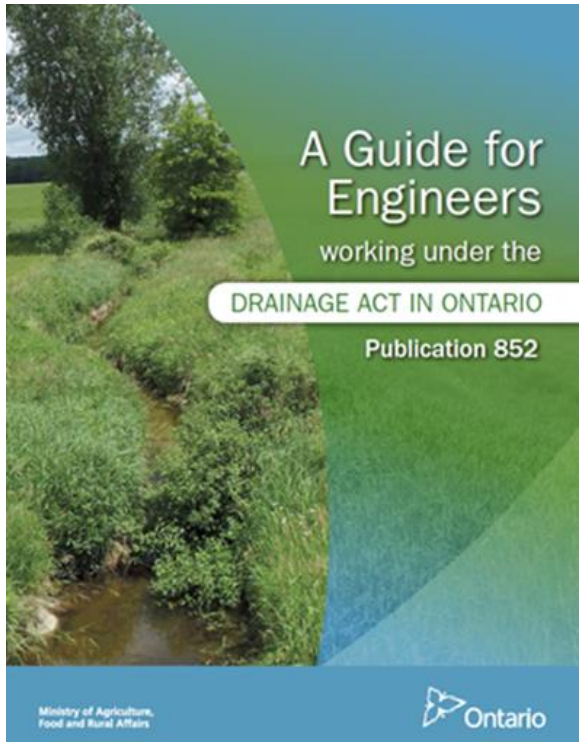
# Drainage Act Addresses Specific Municipal Concerns

- The Act speaks directly to many of the concerns that municipalities have about infrastructure on private property:
  - Movement of water across (multiple) property boundaries
  - Ability to enter (S.12, 63, 95), inspect and maintain (S.93)
  - Who pays, and how much?
  - Power to protect (S.80-82)
  - Infrastructure improvement and optimization (S.78)

# Drainage Act in Urban Areas

**A Guide for Engineers working under the Drainage Act in Ontario, Publication 852** is designed to help engineers navigate through today's challenges and opportunities in resolving drainage issues.

- Focuses on traditional stakeholders and approaches but also includes environmental and societal interests including:
  - Natural channel design
  - Fish and wildlife habitat
  - Water quality
  - Wetlands
  - Water Retention
  - Climate Change Adaptation
- References to using the Drainage Act in an Urban Context throughout the document including:
  - Surveying in urban areas
  - Challenges and issues in urban areas
  - Rural and urban hydrology
  - Low impact development
- Dedicated Chapter on Urban Areas



# Part B, Chapter 5 – Urban Areas


CHAPTER 5
URBAN AREAS .....202
5.1 Introduction.....202
5.2 Using the *Drainage Act, 1990* in Urban Areas .....202
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5.3.3 Stormwater Services.....205
5.3.4 Municipal Design Criteria .....205
5.4 Construction Considerations.....205
5.5 Resources.....205


## Low Impact Development

**Figure B5–1. A bioswale is an example of a LID technique used to reduce surface water runoff.**

- **DRAFT** - **A Guide for Drainage Superintendents**
  **Working under the Drainage Act in Ontario** will:
  - Focus on traditional stakeholders and approaches
  - Include Case Studies such as the Southdown District Stormwater Servicing and Environmental Management Plan


- **Tim Brook, P.Eng.**
  Drainage Program Coordinator
  Ontario Ministry of Agricultural, Food and Rural Affairs
  timothy.brook@ontario.ca


- **OMAFRA's drainage website:**
  www.ontario.ca/drainage

**Figure B5–2. Permeable paving is used to increase infiltration of water.**



Ontario

# MECP System Wide ECA

**ENVIRONMENTAL COMPLIANCE APPROVAL (ECA)**
**For a Municipal Stormwater Management System**

**ECA Number: 0X0-SWM601**
**Issue Number: 1**

Pursuant to the *Environmental Protection Act*, R.S.O 1990, c. E. 19 (*Environmental Protection Act)*, and the regulations made thereunder and subject to the limitations thereof, this Municipal Stormwater Management System to:

**${OWNERNAME}**

**${OWNERUNITID}**
**${OWNERSTNO}${OWNERSUFFIX} ${OWNERSTREET} ${OWNERSTTYPE}**
**${OWNERSTDIR}**
**${OWNERPBOX}**
**${OWNERMUNICIPALITY}, ${OWNERPROV}, ${OWNERPCODE}**

For the following Municipal Stormwater Management System:

**${SYSTEMNAME}**

This Municipal Stormwater Management System ECA includes the following:

| Schedule | Description |
|---|---|
| Schedule A | System Information |
| Schedule B | Municipal Stormwater Management System Description |
| Schedule C | All documents issued as Schedule C to this Environmental Compliance Approval which authorize alterations to the System |
| Schedule D | General |
| Schedule E | Operating Conditions |
| Schedule F | Residue Management |
| Appendix A | Stormwater Management Criteria |

DATED at TORONTO this ${DAY} day of ${MONTH}, ${YEAR}

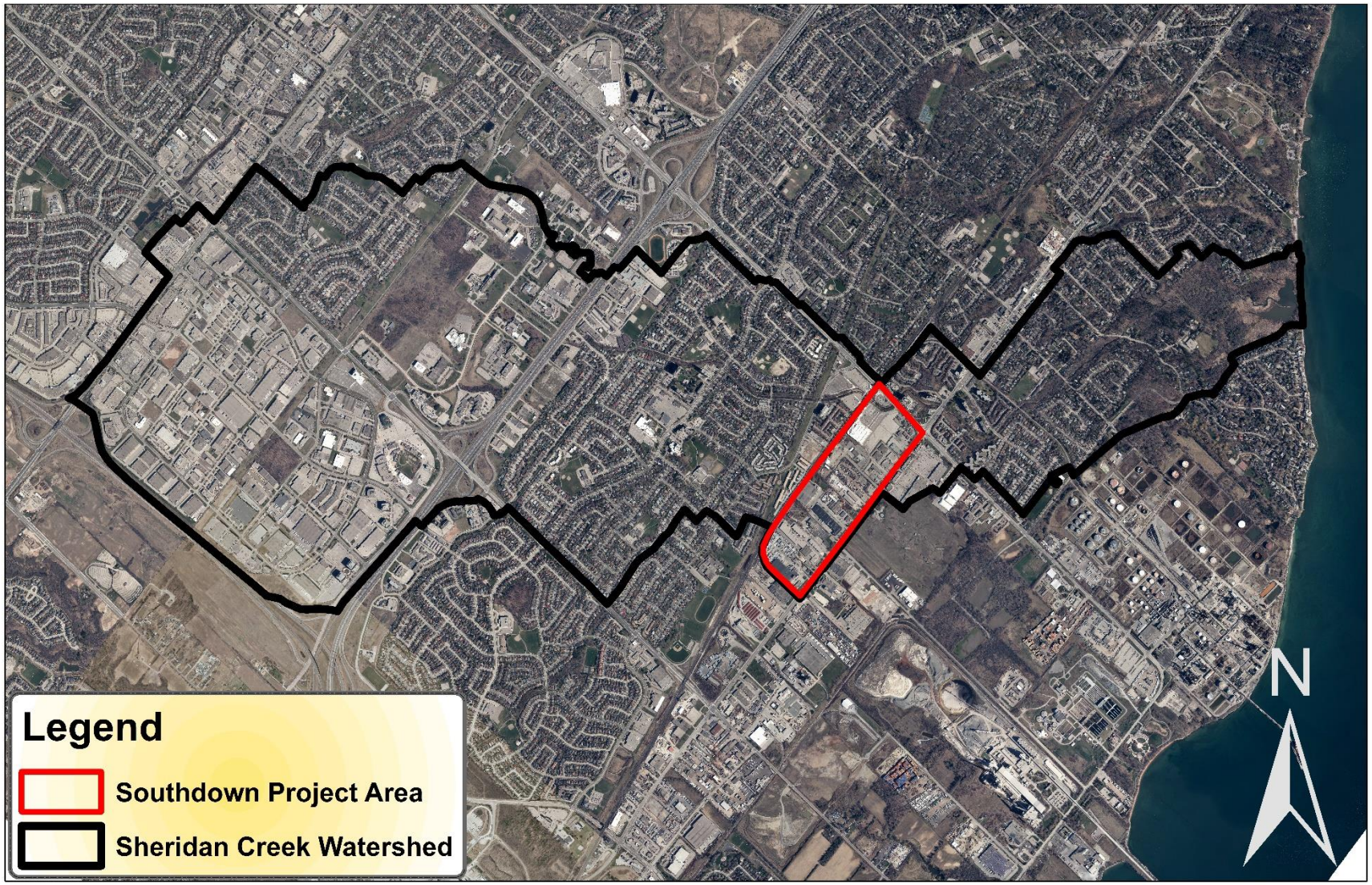
Signature

${CURRENTUSER}, P.Eng.
Director, Part II.1, *Environmental Protection Act*

- MECP is proposing to modernize Ontario's environmental approval process for low-risk municipal sewage works
- Implementing a Consolidated Linear Infrastructure Permissions Approach.
- Recognizes the potential to use the DA for protecting infrastructure on private property

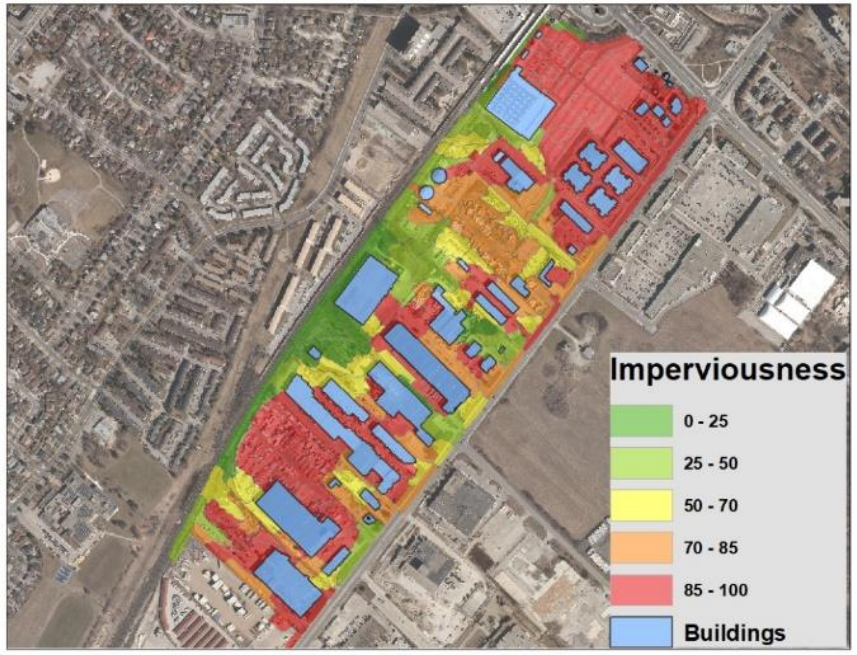
# Applying the Drainage Act approach to Branch F in Southdown, Mississauga

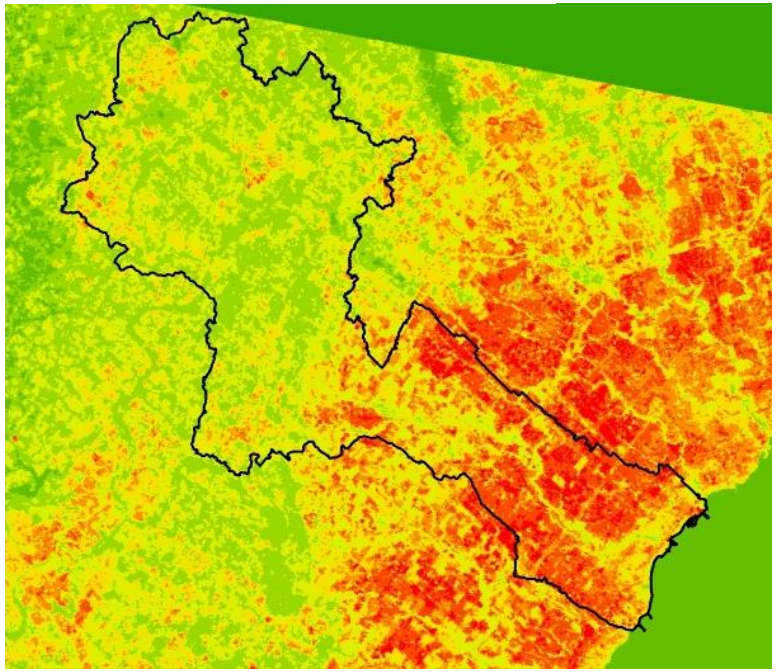
# Background - Southdown Project



# Reduce Urban Heat Island Effect

- 85 % Impervious Area
- Cool stormwater
- Can we provide passive cooling benefits?
- How  can we help reduce pressures on the power grid?



# Extreme rainfall and flooding

Southdown Study Area – “Royal Windsor Lake”

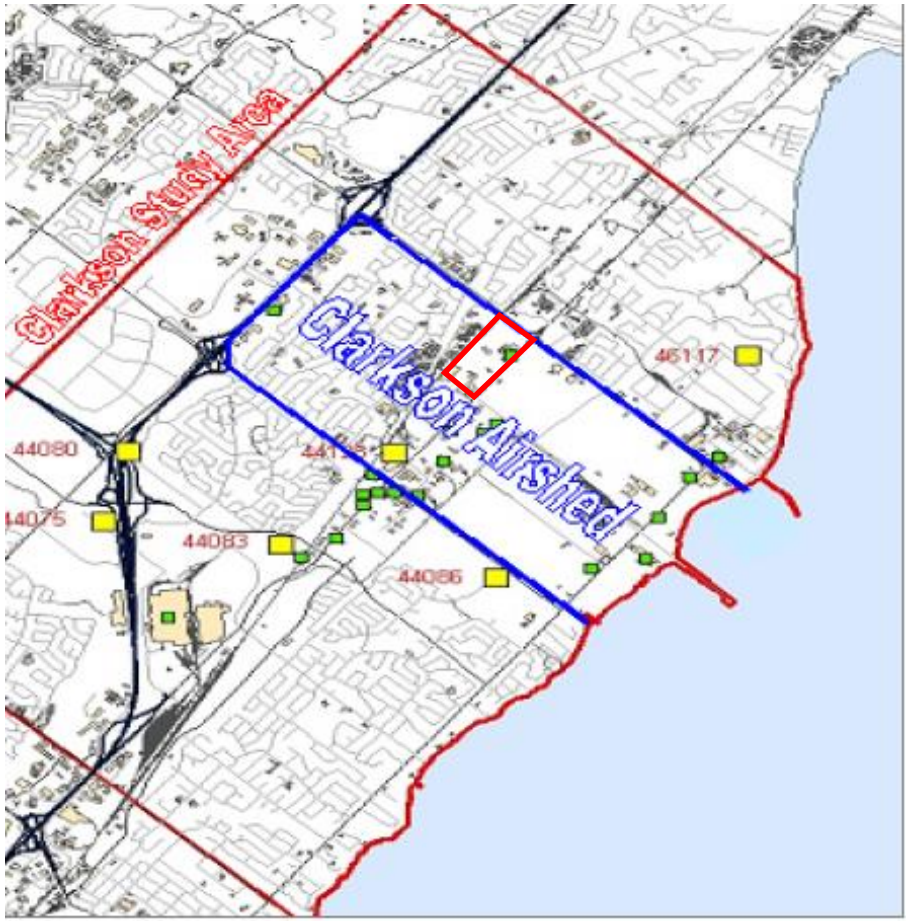

Cooksville Creek Flooding and Erosion

# Water Quality

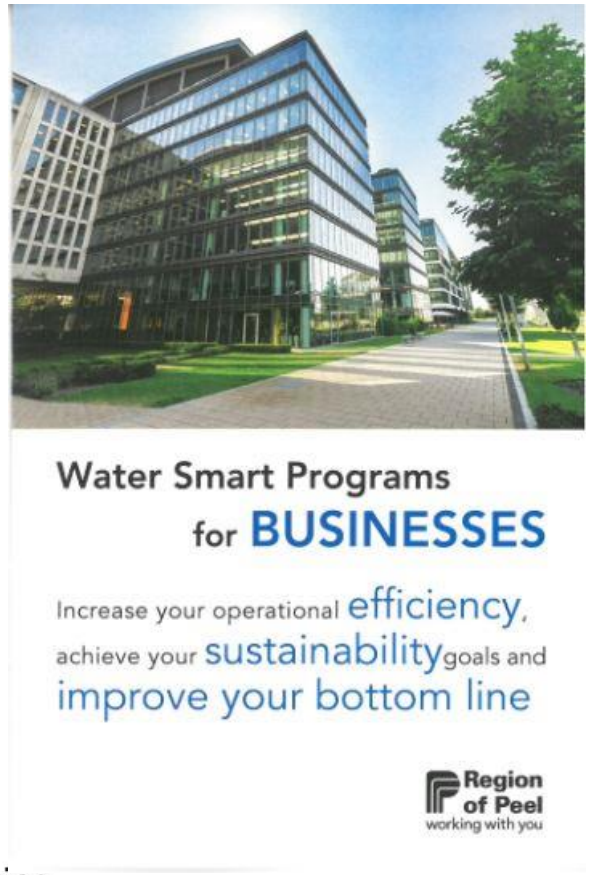
## Rattray Marsh

## Lake Ontario

# Air Quality - Clarkson Airshed

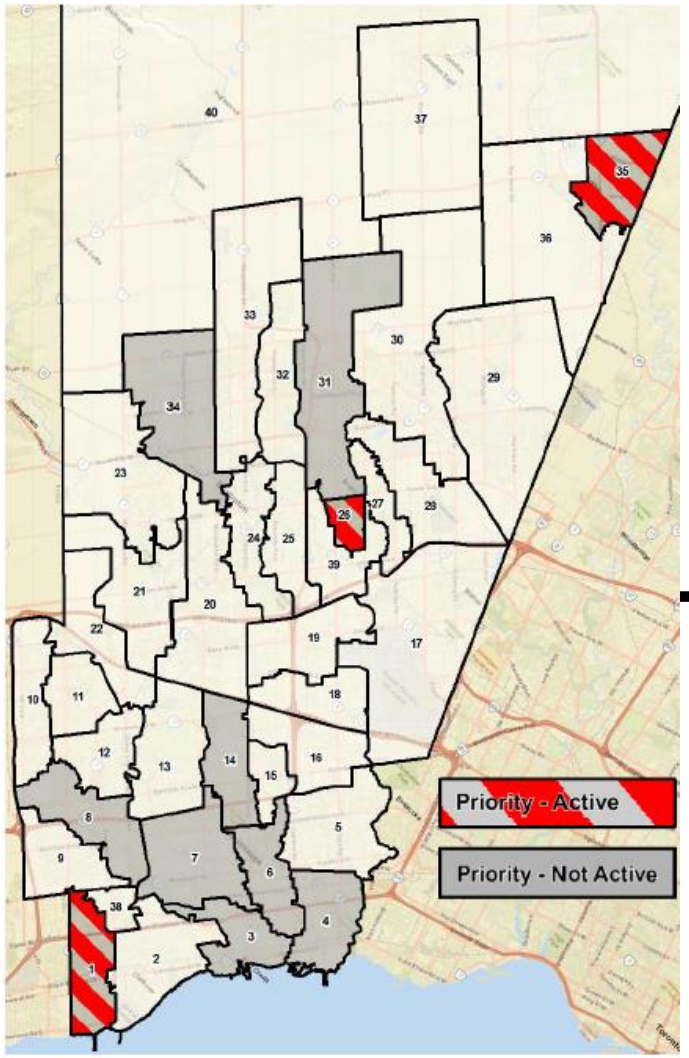


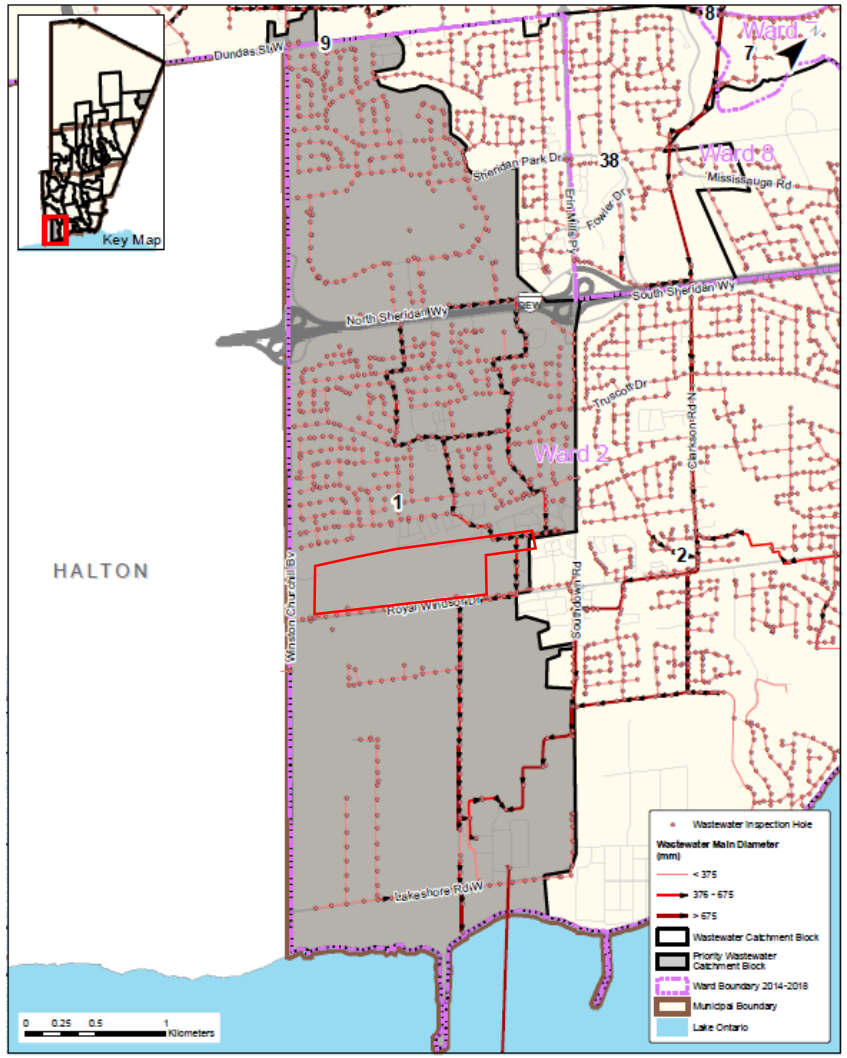

# Water Conservation




- Harvest stormwater to offset potable water use
- Save money on electricity and water bills
- Reduce operation costs for the municipality and private landowner
- Communal harvesting?

# Reducing Infiltration & Inflow to Sanitary System

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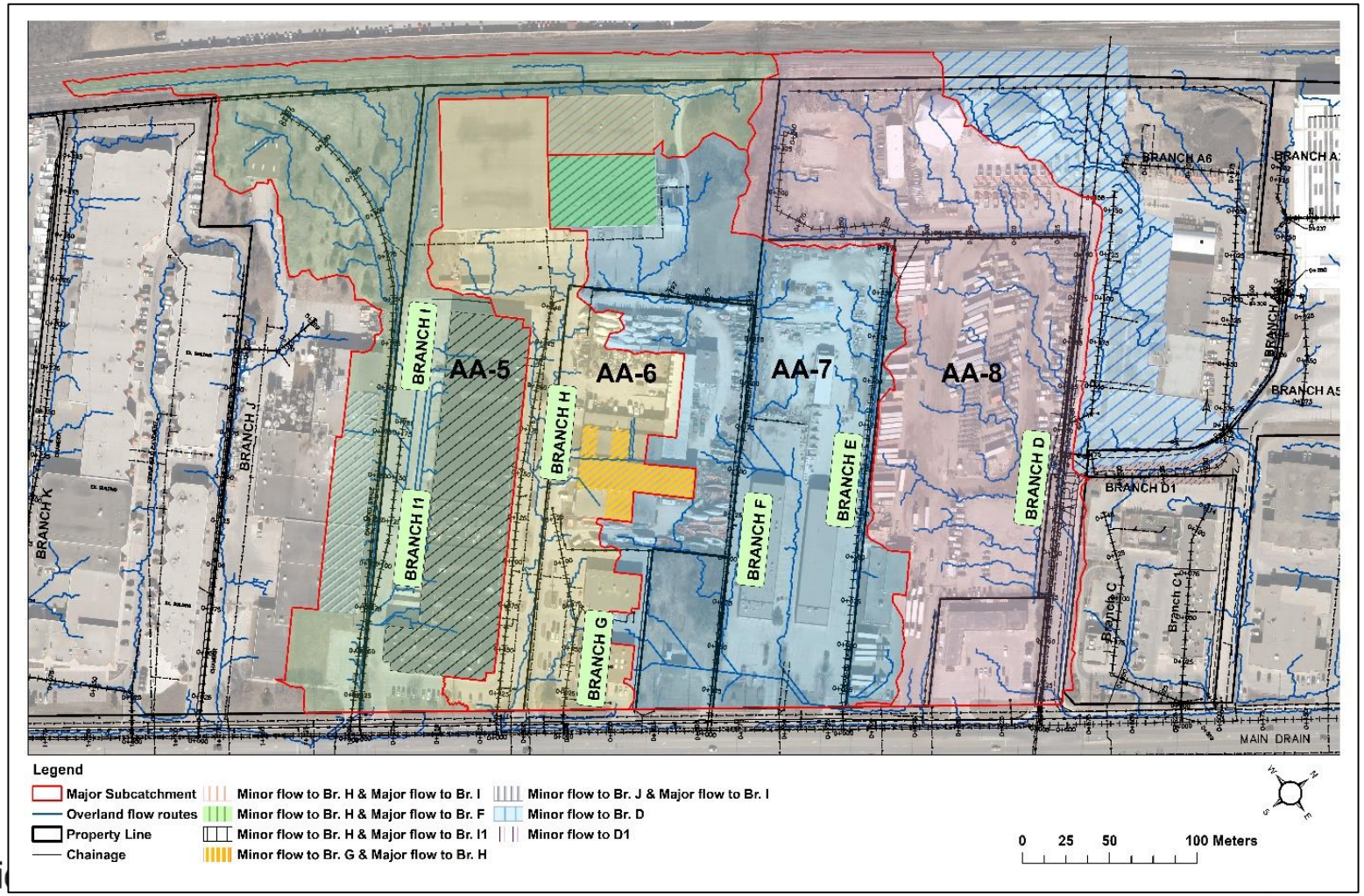
# Putting It All Together

- A new approach is needed to address complex issues
- Communal systems on private property
- Use a ‘One Water’ lens

# Key Steps - Applying Drainage Act Process to Southdown Area

- Site Survey/Characterization/Modelling
- Conceptual Design
- Estimating Total Cost
  - Construction, Engineering & Admin, Net HST
  - Allowances (Compensation for existing and proposed assets)
- Types of Assessments (Who is Benefitting?)
- Assessment Schedules (Dividing up the costs)
- Future Operation & Maintenance Schedules
- Engineer's Report (Adopted under By-law)

# Branches


AA-5
AA-6
AA-7
AA-8
BRANCH I
BRANCH H
BRANCH I1
BRANCH G
BRANCH F
BRANCH E
BRANCH D
BRANCH J
BRANCH K
BRANCH A6
BRANCH D1
MAIN DRAIN
Legend
Major Subcatchment
Overland flow routes
Property Line
Chainage
Minor flow to Br. H & Major flow to Br. I
Minor flow to Br. H & Major flow to Br. F
Minor flow to Br. H & Major flow to Br. I1
Minor flow to Br. G & Major flow to Br. H
Minor flow to Br. J & Major flow to Br. I
Minor flow to Br. D
Minor flow to D1
0 25 50 100 Meters

# Scenarios

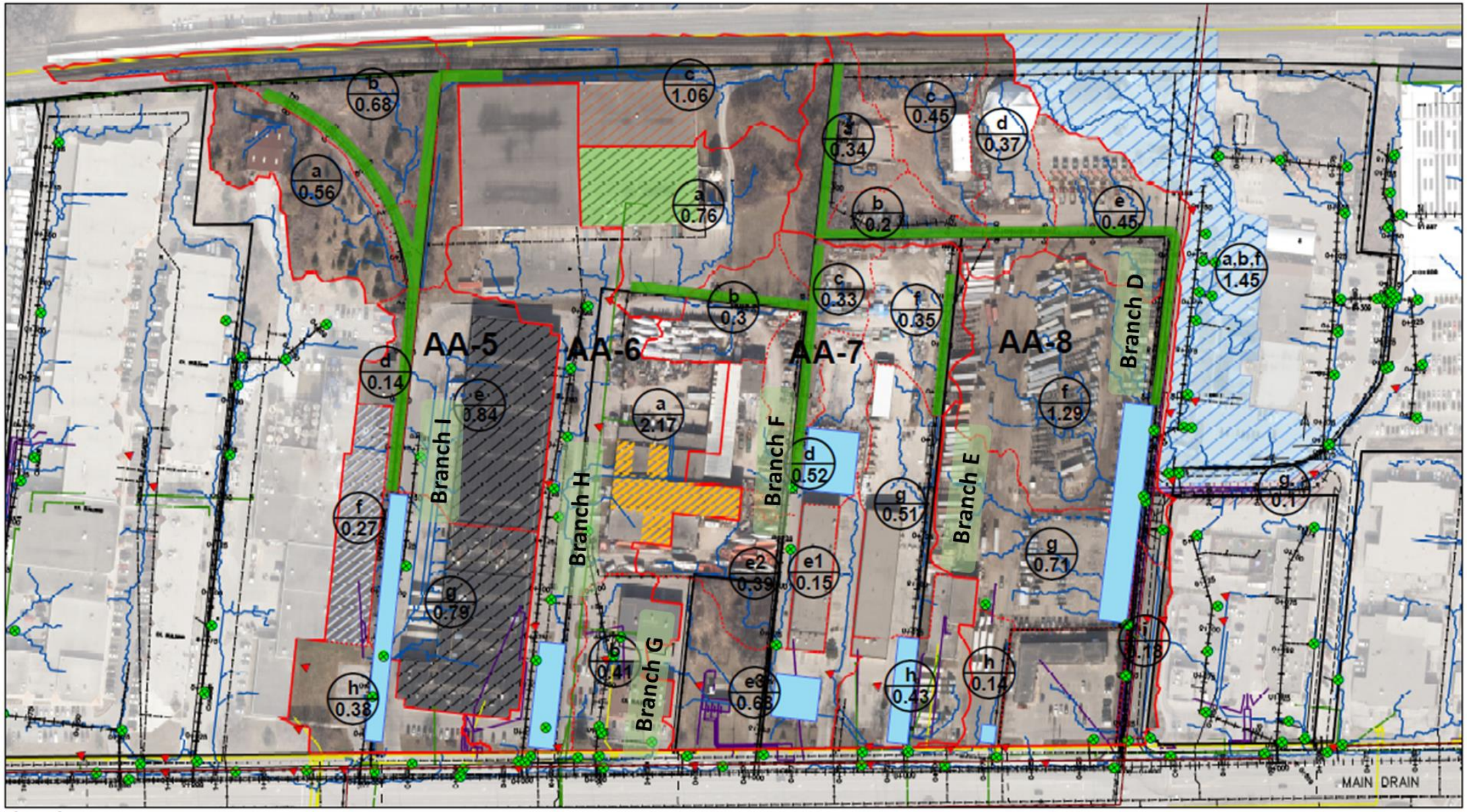
Predevelopment Conditions

Scenario 1 - Existing Conditions

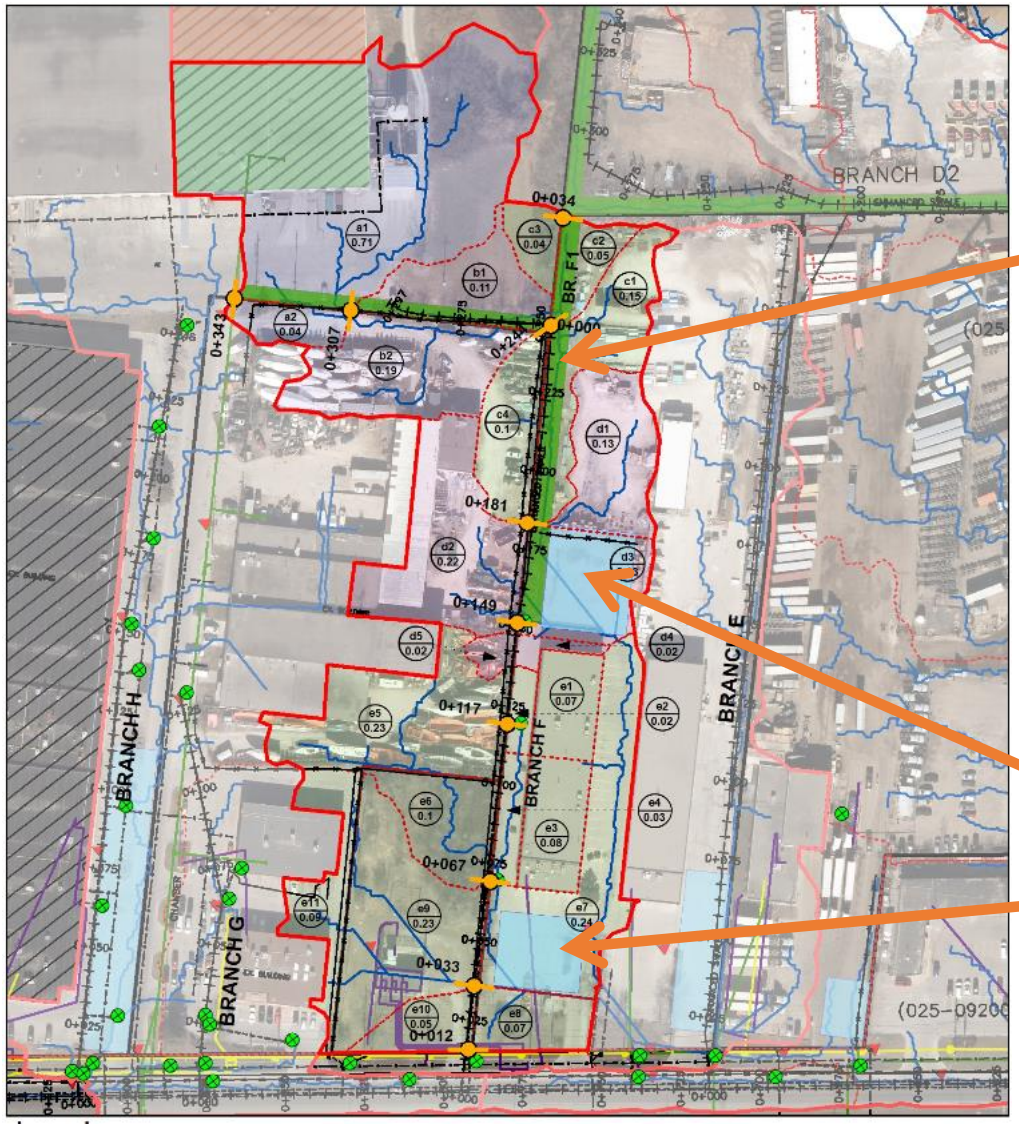
Scenario 2 –maximum stormwater user fee credit (50%) to landowners per credit guidelines.

Scenario 3 – maximize benefits/co-benefits

Scenario 4 - Provide equivalent stormwater management on public lands only (end of pipe)


AA-5
AA-6
AA-7
AA-8
Branch I
Branch H
Branch F
Branch G
Branch E
Branch D
MAIN DRAIN
b 0.68
a 0.56
c 1.06
a 0.76
c 0.45
d 0.37
e 0.34
b 0.2
e 0.45
a,b,f 1.45
c 0.33
f 0.35
b 0.3
d 0.14
e 0.84
a 2.17
d 0.52
f 1.29
g 0.1
f 0.27
g 0.51
g 0.71
e2 0.39
e1 0.15
g 0.79
b 0.41
h 0.38
e3 0.68
h 0.43
h 0.14
.18
Legend
Major Subcatchment
Minor Subcatchment
Overland flow routes
Property Line
Chainage
Sanitary Pipes
Water Line
EX. CB's
Sanitary MH
Bell
Alectra
Rogers
Minor flow to Br. H & Major flow to Br. I
Minor flow to Br. H & Major flow to Br. F
Minor flow to Br. H & Major flow to Br. I1
Minor flow to Br. G & Major flow to Br. H
Minor flow to Br. J & Major flow to Br. I
Minor flow to Br. D
Minor flow to D1
Storage Chambers
Enhanced Grass Swale
ID
Area (ha)
0
25
50
100 Meters

# Scenario 2– Branch F

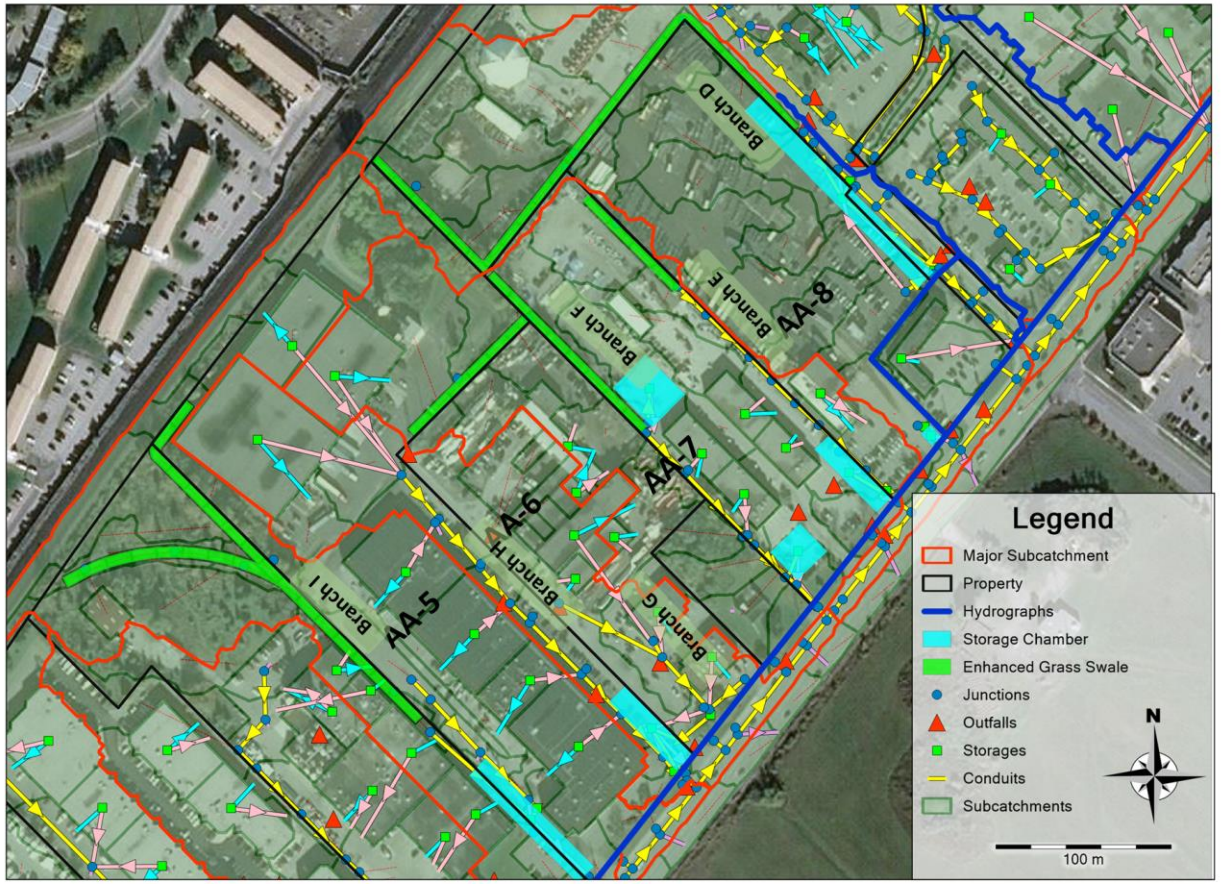



Meet minimum requirements to achieves 50% credit

Enhanced Grass Swale + OGS

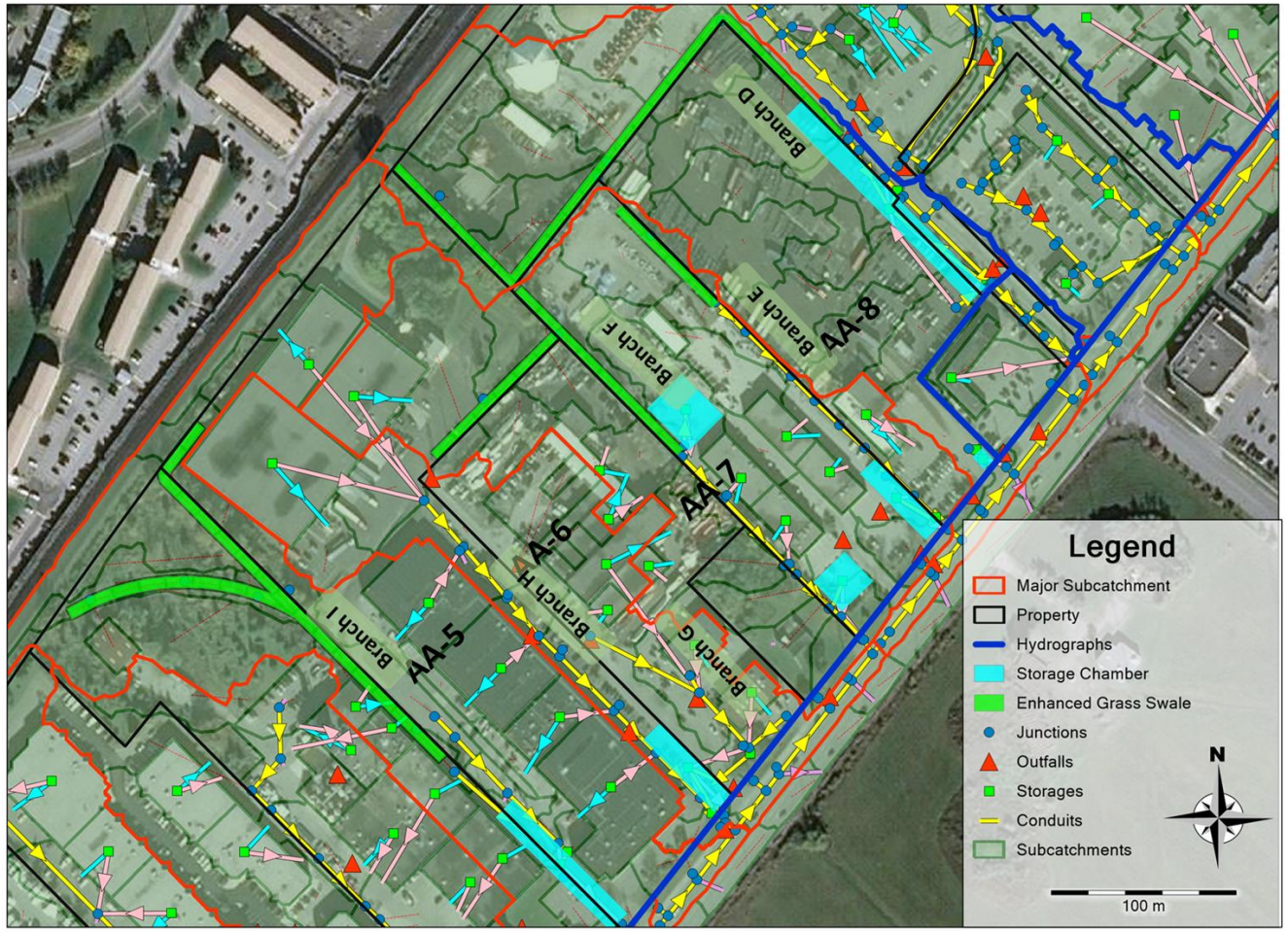
Underground Storage

# Peak Flow Control




| Branch | 100 Year Pre-Development | 100 Year Existing Condition | 100 Year Scenario 2 (Retrofit) |
|---|---|---|---|
| | $m^3/sec$ | | |
| Branch D | 0.12 | 0.77 | 0.12 |
| Branch E | 0.08 | 0.313 | 0.078 |
| Branch F | 0.134 | 0.224 | 0.112 |
| Branch G &H | 0.374 | 0.614 | 0.316 |
| Branch I | 0.204 | 0.554 | 0.185 |

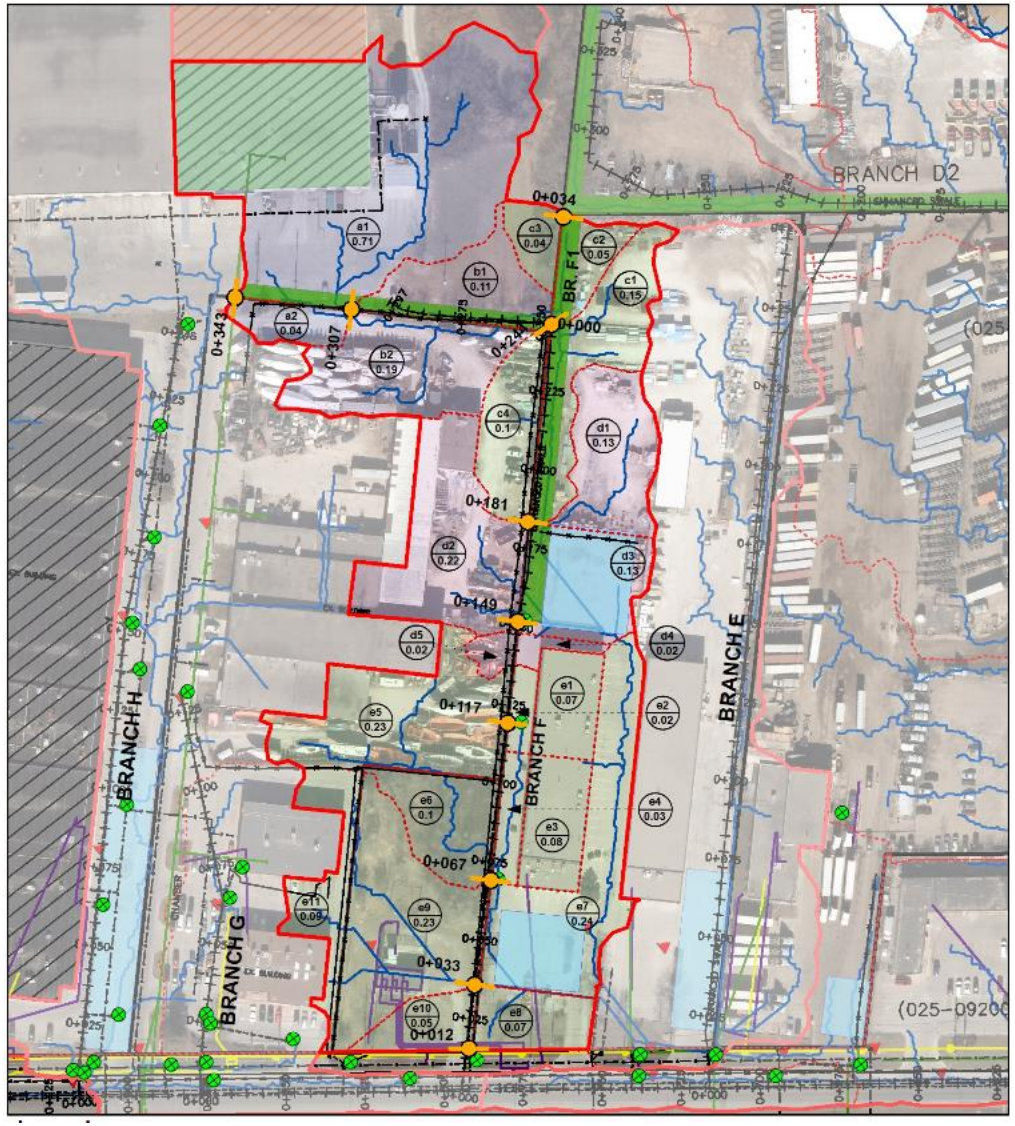
# Total TSS Loading in Minor Drainage System




| Branch | 5-year PreDev. (kg) | 5-year Existing (kg) | 5-year Scenario 2 (kg) | % Removal Scenario 2 |
|---|---|---|---|---|
| | $m^3/sec$ | | | |
| Branch D | 0.177 | 185.01 | 3.054 | 98.3 |
| Branch E | 0.365 | 65.25 | 0.292 | 99.6 |
| Branch F | 0.39 | 53.878 | 0.679 | 98.7 |
| Branch G &H | 2.357 | 59.96 | 2.683 | 95.5 |
| Branch I | 0.411 | 35.12 | 0.649 | 98.1 |

# Establish Water Balance Targets

| Subcatchment (Branch) | Total Area (ha) (Minor System) | Required Infiltration Volume for first 15mm (m3) |
|---|---|---|
| AA-8 (Branch D) | 5.67 | 850.5 |
| AA-7 (Branch E) (Branch F) | 4.18 | 627 |
| AA-6 (Branch G) (Branch H) | 4.01 | 601.5 |
| AA-5 (Branch I) | 3.26 | 489 |

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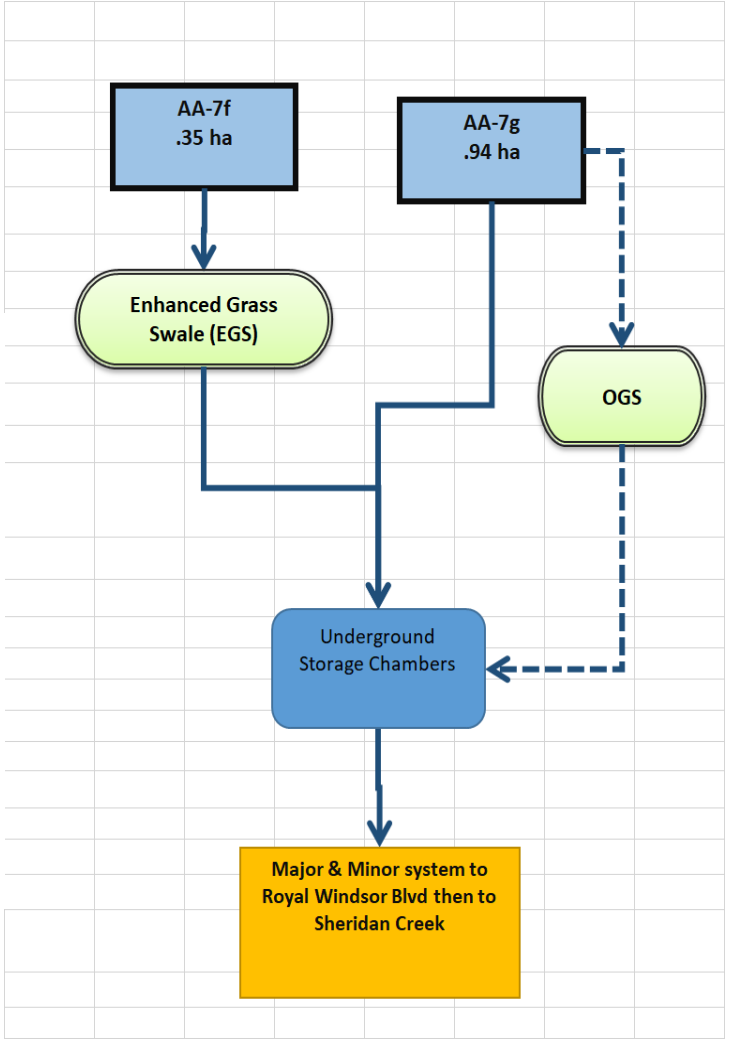
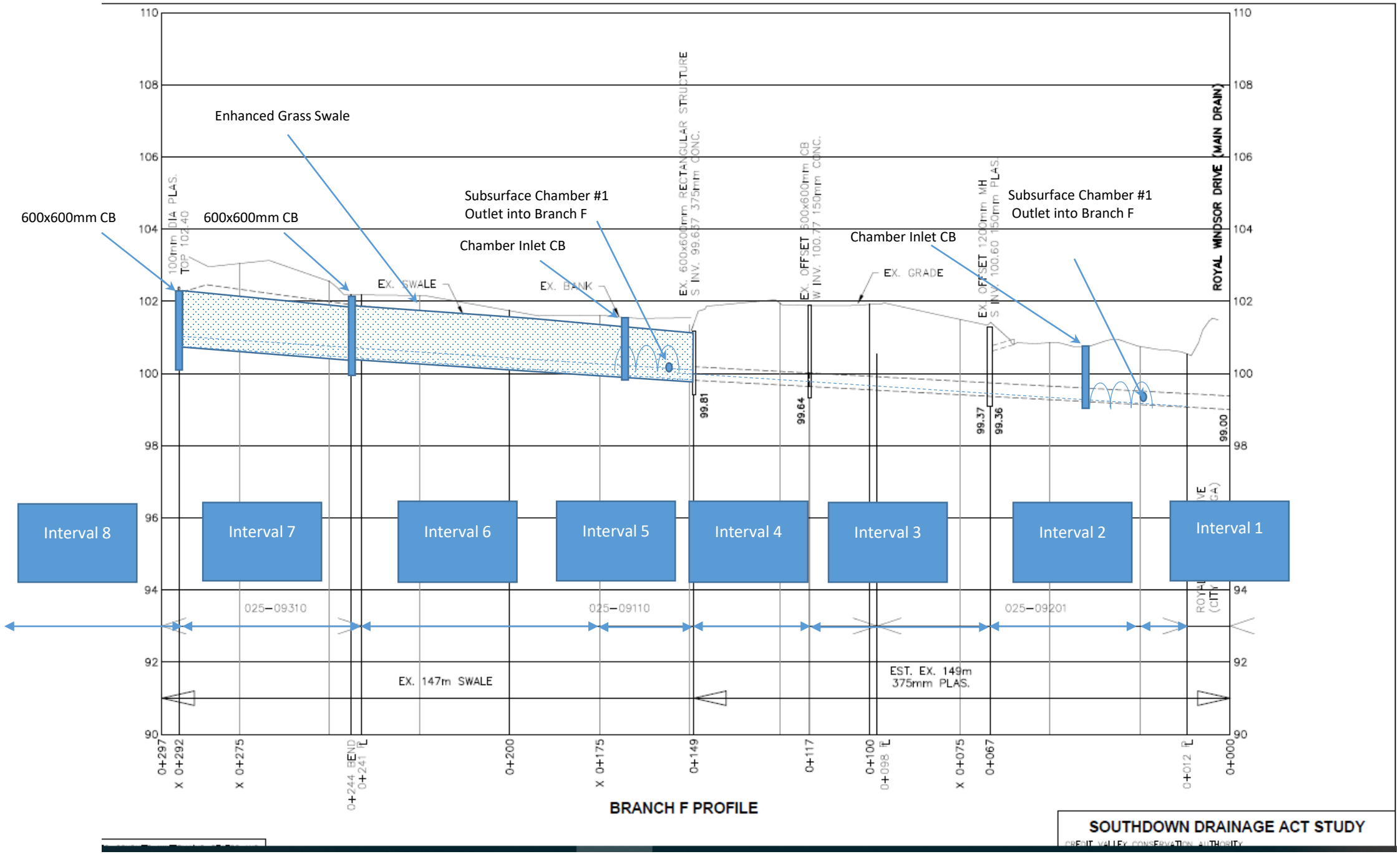
# Scenario 2 - 50% Stormwater Credit

| | Peak Flow Control | | | Runoff Volume Reduction | | | | Water Quality | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment (Branch) | Total Area (ha) (Major System) | Feature | Peak Flow Control Credit | Total Area (ha) Minor System | Feature | Capture Depth (mm) | Volume Control Credit | Feature | 80% TSS | Water Quality Credit | Total Credit |
| AA-8 (Branch D) | 4.5 | Chambers | 40% | 5.67 | None | 0 | 0% | EGS/OGS | Yes | 10% | 50% |
| AA-7 (Branch E) (Branch F) | 4.43 | Chambers | 40% | 4.18 | None | 0 | 0% | EGS/OGS | Yes | 10% | 50% |
| AA-6 (Branch G) (Branch H) | 2.57 | Chambers | 40% | 4.01 | None | 0 | 0% | OGS | Yes | 10% | 50% |
| AA-5 (Branch I) | 4.72 | Chambers | 40% | 3.26 | None | 0 | 0% | OGS | Yes | 10% | 50% |






BRANCH F PROFILE

SOUTHDOWN DRAINAGE ACT STUDY

CREDIT VALLEY CONSERVATION AUTHORITY

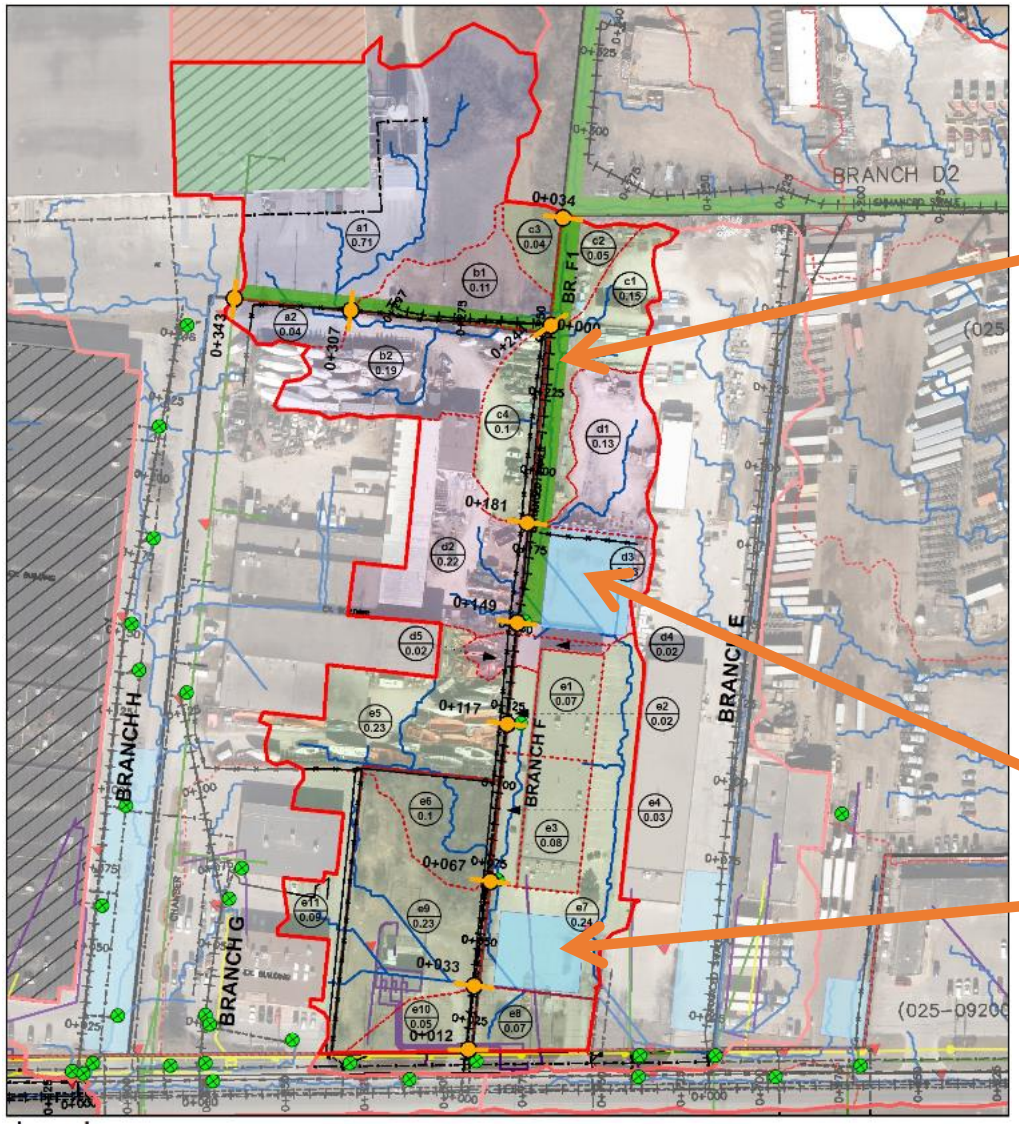
# BRANCH F

# Assessing the Financial Feasibility

The Drainage Act provides a clear process for cost sharing. The process determines who pays and how much according to:

- The benefit you derive from the shared system
- The amount of water your property contributes to the system

# Scenario 2– Branch F



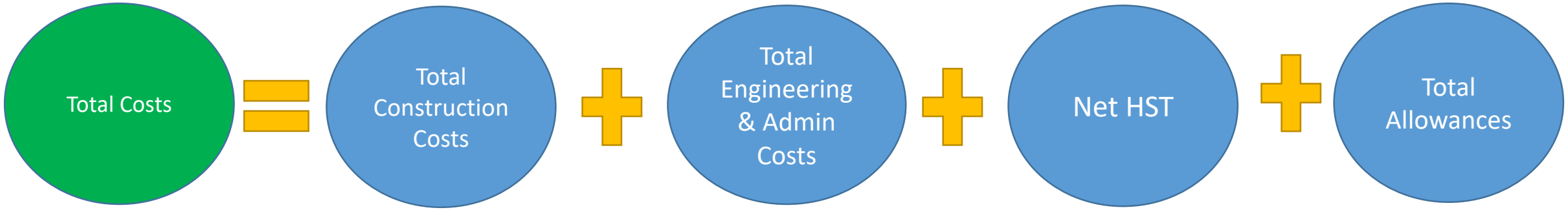

Meet minimum requirements to achieves 50% credit

Enhanced Grass Swale + OGS

Underground Storage

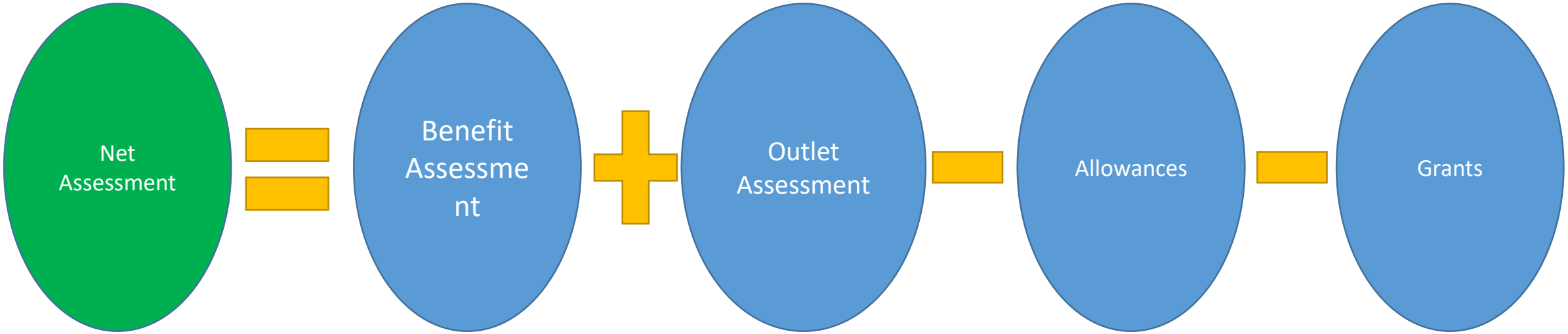
# Estimating Total Cost

The compensation that must be given to a property owner for the assets/land on their property incorporated into the drainage design




- Use Life Cycle Costing Tool: https://sustainabletechnologies.ca/lid-lcct/

# Net Assessment




Based on how much each property benefits from the system

Based on how much water each property outlets to the system

# Net Assessment Schedules

Schedule A - Total Net Assessment

| Con | Lot | Roll No. | Owner | Total Ha Affected | Benefit ($) | Outlet ($) | Total ($) | General Grants ($) | Allow-ances ($) | NET ASSESS. ($) | Annual SWM Credit for Branch F ($) | Payback Period SWM Credit [1] | Cost to Manage Br F using End of Pipe Controls [2, 3] | Savings to Municipality [4] ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 21-05-020-221 | Landowner 1 | 0.86 | 3,568 | 62,445 | 66,013 | | 40,981 | 25,032 | 2,188 | 11.44 | | |
| | | 21-05-020-222 | Landowner 2 | 0.89 | 7,582 | 49,012 | 56,593 | | 0 | 56,593 | 2,553 | 22.17 | | |
| | | 21-05-020-223 | Landowner 3 | 0.38 | 36,245 | 7,245 | 43,490 | | 0 | 43,490 | 243 | 178.86 | | |
| | | 21-05-020-224 | Landowner 4 | 1.00 | 143,376 | 35,975 | 179,351 | | 155,136 | 24,215 | 3,201 | 7.56 | | |
| | | Road Allowance | Municipality | | 456,912 | | 456,912 | | | 456,912 | - | | 1,257,443.27 | 800,531.03 |
| **Total Assessments for Branch F** | | | | 3.13 | 647,683 | 154,677 | 802,360 | 0 | 196,117 | 606,243 | 8,186 | | | |

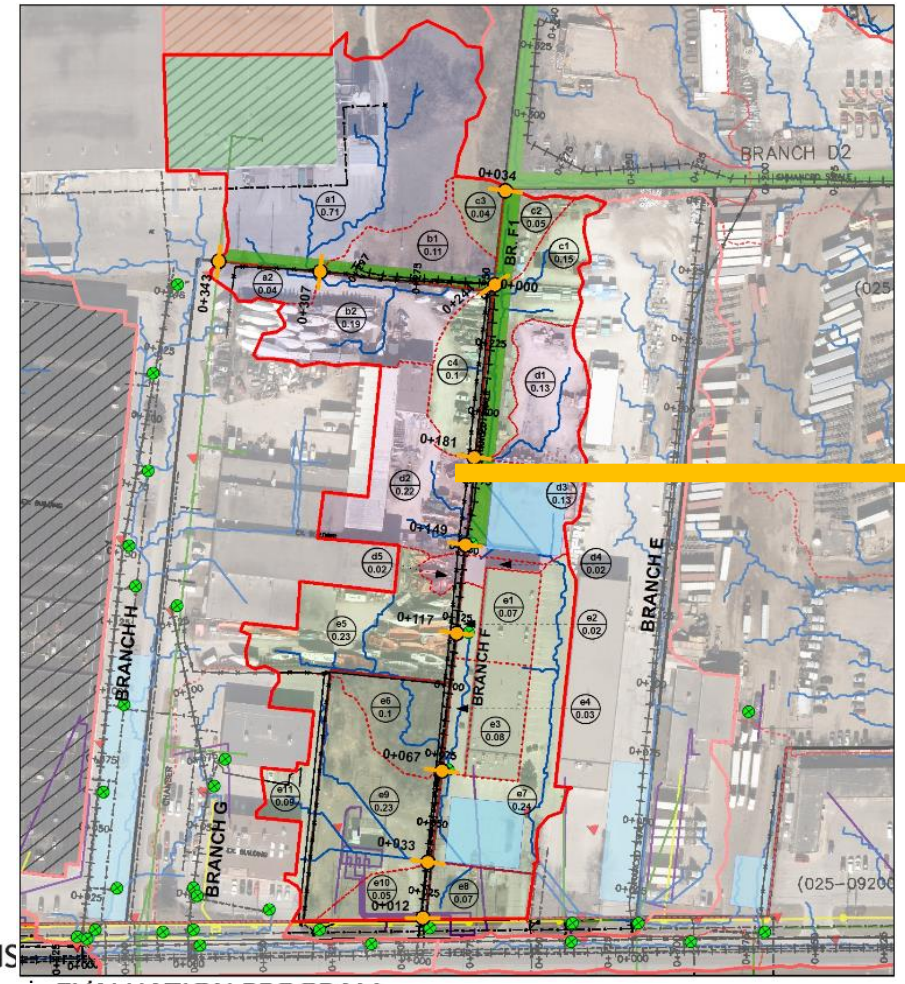
Note: This example is to help illustrate how the process works and the process of arriving at the net assessment.

It is the engineer's responsibility to fairly assess benefits and the landowners have the ability to appeal their assessment if they don't agree.

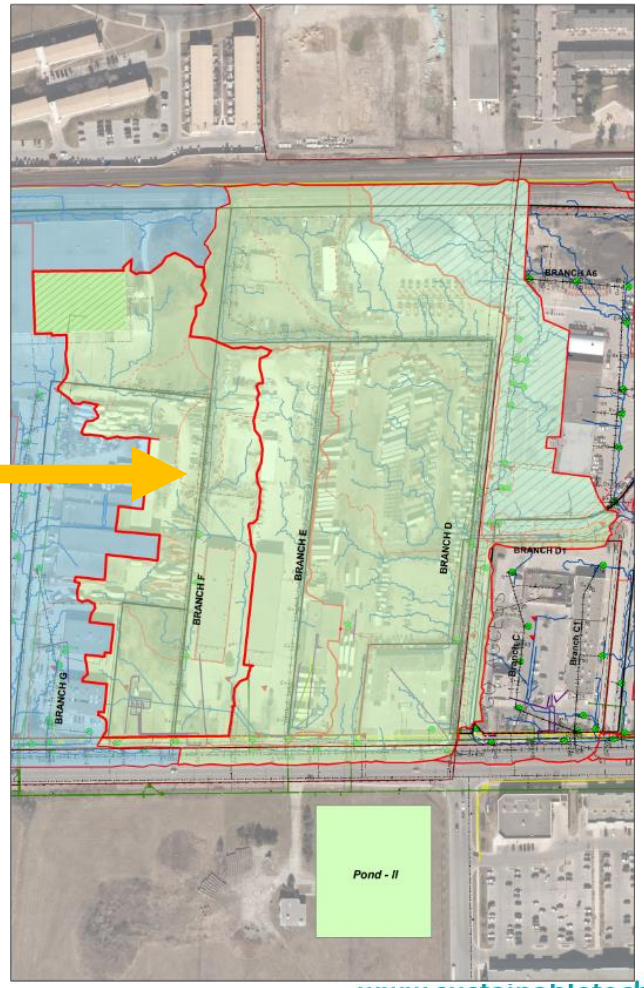
# Communal GSI on Private Property

VS

# Wet Pond on Public Property



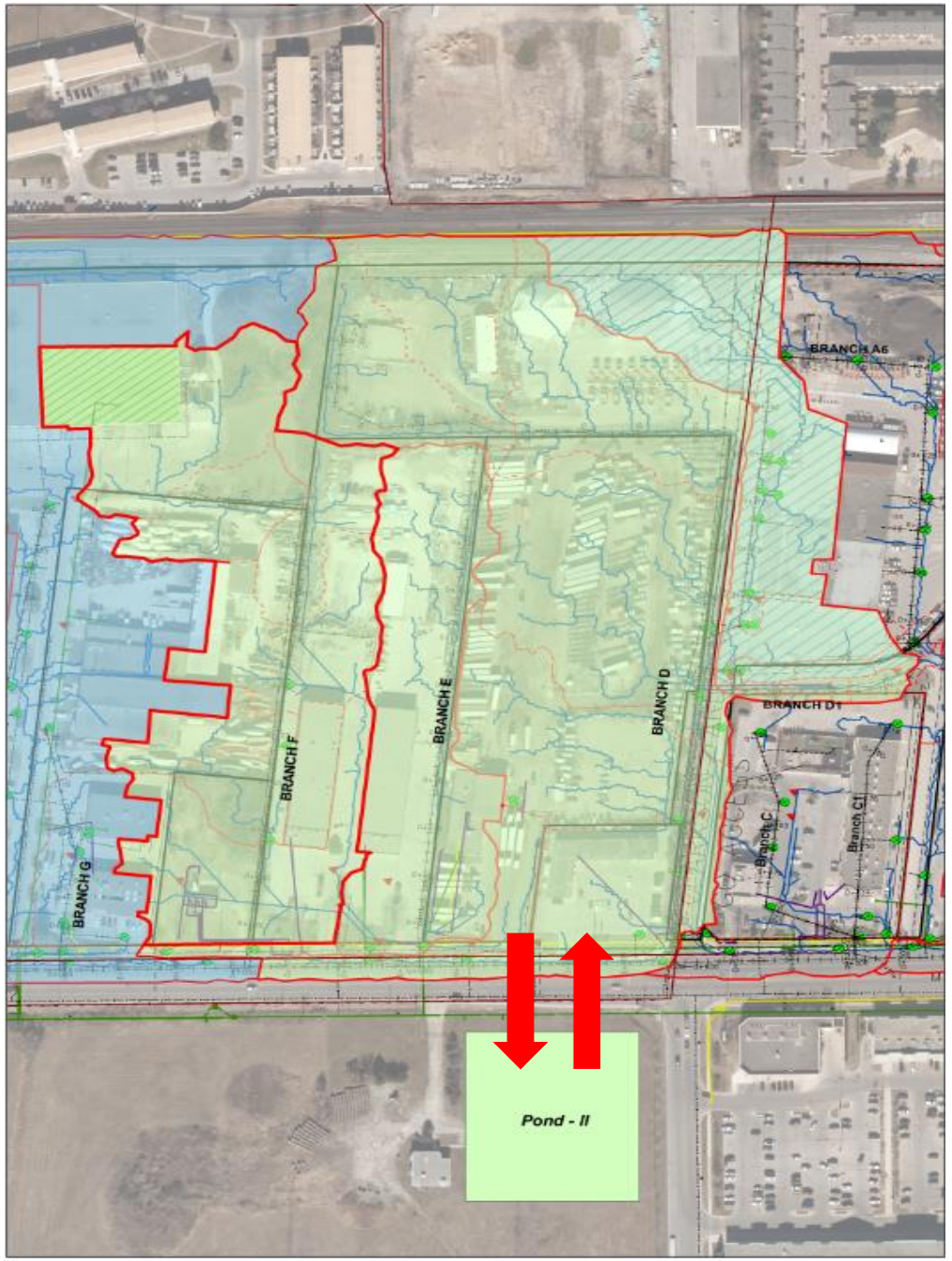

Apples to Apples Comparison



# Wet Pond on Public Property

## Preliminary BRANCH D-F Cost/Hectare = $402,470

- Requires acquisition of other land
- Runoff needs to be conveyed offsite to pond and then to receiver
- *Costs of inlet and outlet structure that cross Royal Windsor Boulevard not yet included in above estimate*
- Capital and maintenance cost goes entirely to the municipality
- Addresses riverine flooding only

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# Communal GSI on Private Property

## BRANCH F Cost/Hectare = $260,000

- Uses land within existing developments
- Runoff is kept on site
- Capital and maintenance costs are shared been municipality and landowners
- Addresses Pluvial and Riverine Flooding

# Ongoing Operation & Maintenance of Infrastructure on Private Property

Clearing invasive species

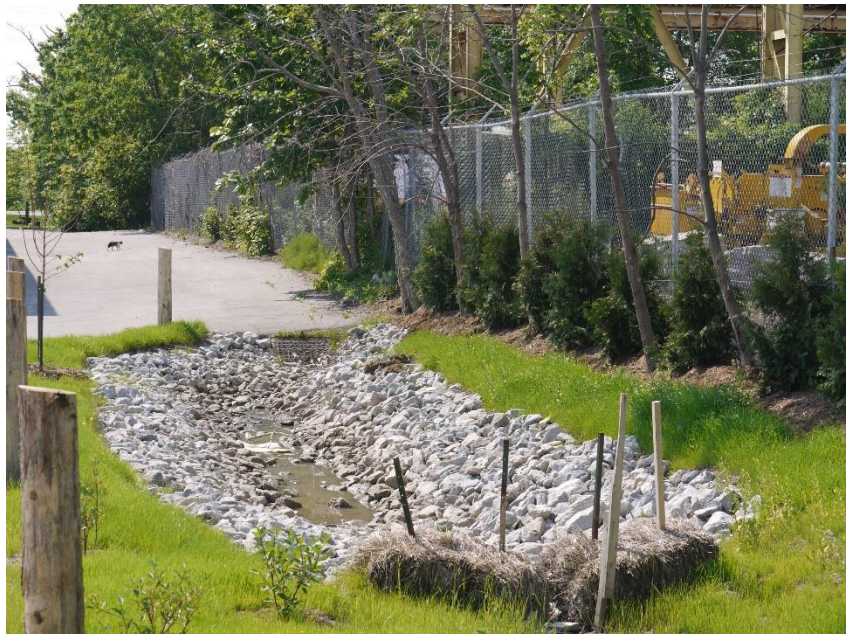
Replacing dead plants

Vacuuming out chambers

- Drainage act process ensures ongoing maintenance is carried out

# Operation & Maintenance Schedules

- The engineer is required to consider how the costs of future maintenance and repair will be addressed
- The cost of future maintenance and repair and minor improvements to a drain may be assessed to properties as defined by the engineer in the report.
- Drainage Superintendent oversees the ongoing O&M of the infrastructure for municipality and private landowners



# O&M Schedule

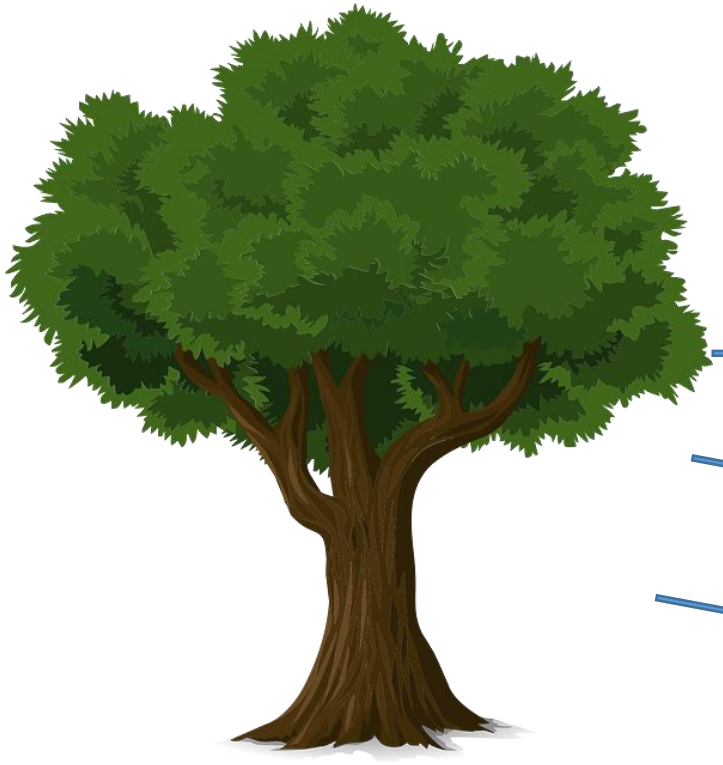
**Schedule B - Schedule of Assessments for Future Maintenance**

| Roll No. | Owner | Interval 5 Chamber & Enhanced Sta 0+149 $ | to 0+181 % | Interval 6 Enhanced Grass Swale Sta 0+181 $ | to 0+244 % | Interval 7 Enhanced Grass Swale Sta 0+244 $ | to 0+307 % | Interval 8 Enhanced Grass Swale Sta 0+307 $ | to 0+343 % |
|---|---|---|---|---|---|---|---|---|---|
| 73-06-020-050-902-10 | Kyle's Green Roof Systems | 1000.00 | 20% | 800.00 | 40% | 1100.00 | 55% | 975.00 | 65% |
| 73-06-020-050-902-11 | R.Hakimi Industries | 1000.00 | 20% | 300.00 | 15% | 300.00 | 15% | 75.00 | 5% |
| 73-06-020-050-902-12 | A.Bhatti Enterprises | 500.00 | 10% | 0.00 | 0% | 0.00 | 0% | | |
| 73-06-020-050-902-13 | S.Malloy Inc. | 1000.00 | 20% | 300.00 | 15% | 0.00 | 0% | | |
| | | | | | | | | | |
| Municipality | | 1500.00 | 30% | 600.00 | 30% | 600.00 | 30% | 450.00 | 30% |
| | | | | | | | | | |
| | | | | | | | | | |
| **TOTAL O&M Costs** | | 5,000.00 | 1.00 | 2,000.00 | 1.00 | 2,000.00 | 1.00 | 1,500.00 | 1.00 |

# Engineer's Report

- Design description and recommendations
- Detailed cost estimate and allowances paid to property owners
- Assessment Schedules for Construction
- Assessment Schedules for Future Maintenance
- Plans, profiles and specifications of drainage system
- Council adopts the report by by-law

# Scenario 3 – Going beyond Minimum Requirements!



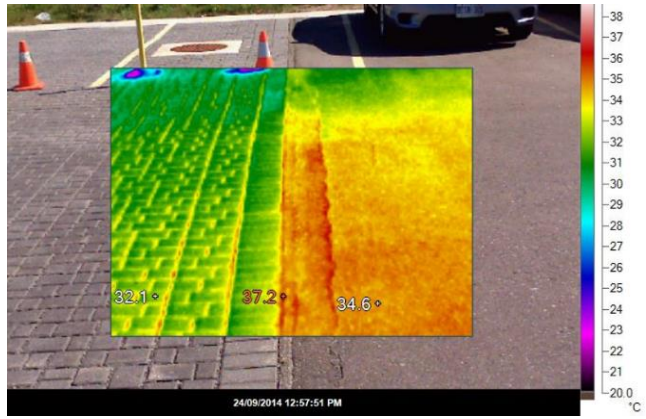
- Air quality improvements $-$$
- Urban heat island reduction $-$$
- Water Conservation $-$$
- Reducing I&I $-$$

Building off work completed to-date, how can additional stakeholders be included in the project and also benefit from economies of scale?

# Scenario 3 – One Water

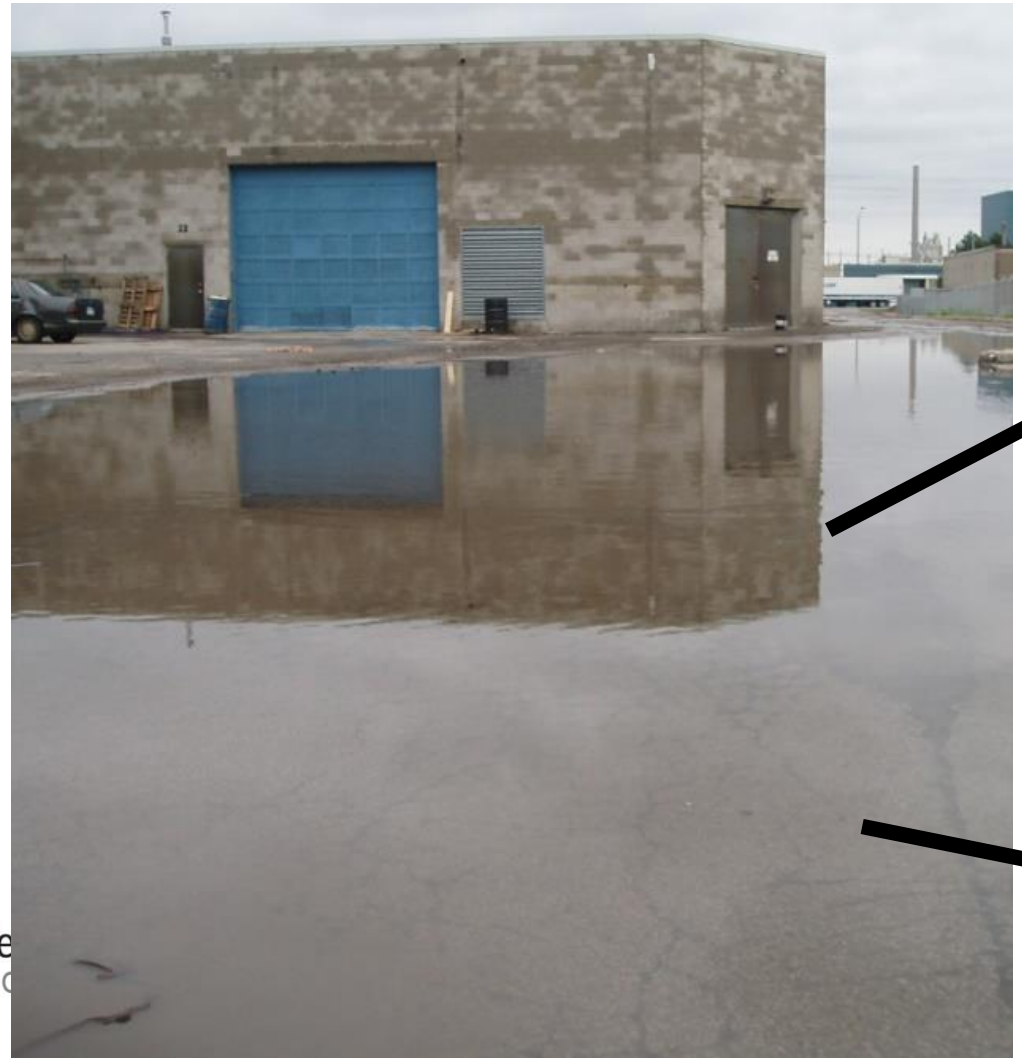
## *Optimize the integration of water and sanitary sewer systems as well as other co-benefits*

- Considering greater range of green infrastructure benefits
- One Water Investigations
  - Sanitary sewer inflow investigations
  - Water conservation investigations



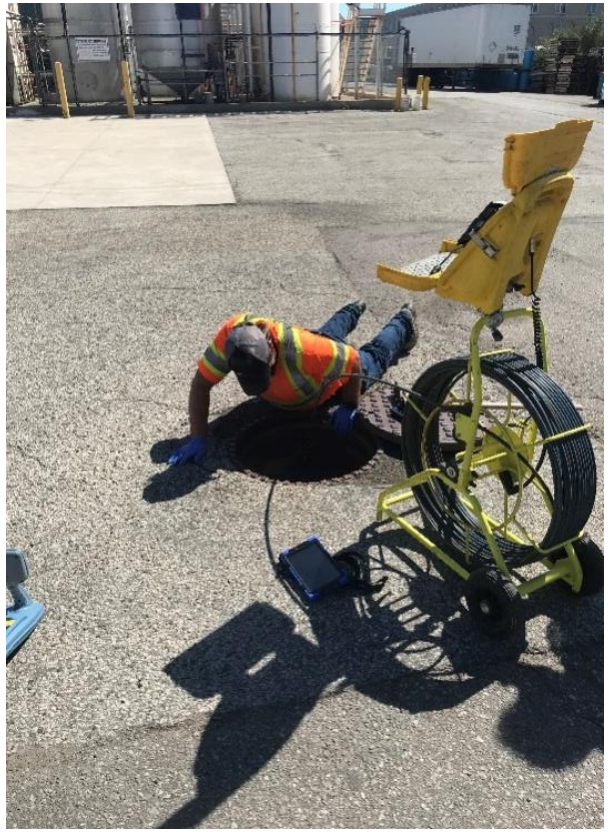
# Sanitary Maintenance Hole Inflow Investigations

Ponding Water – Potential inflow through maintenance hole cover

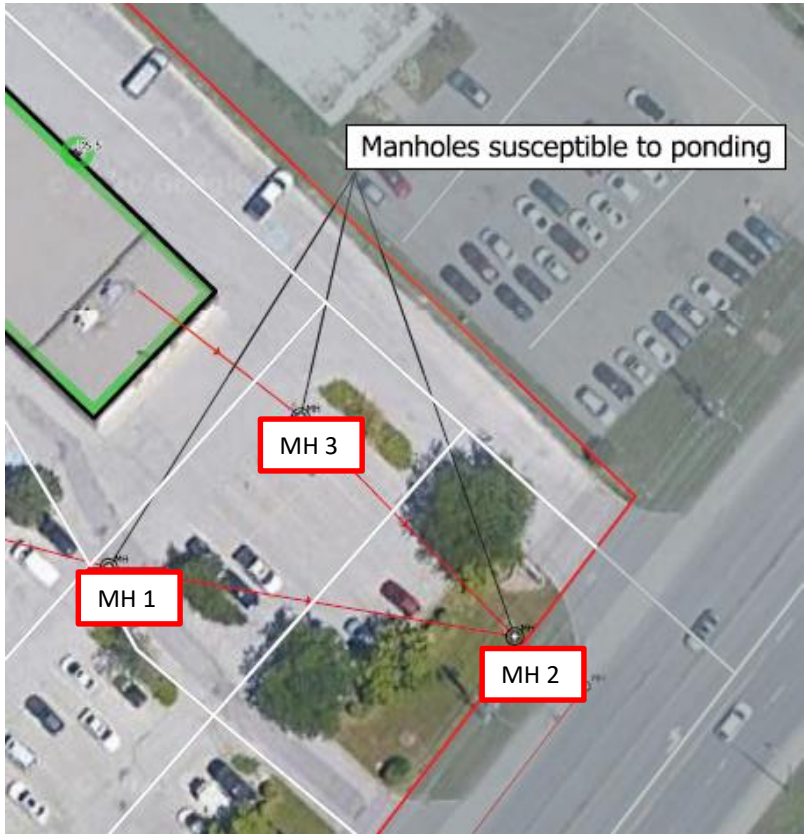


Inflow Evidence

# Sanitary Sewer Connectivity Inflow Investigations– line of sight, CCTV and dye testing



# Sanitary Inflow Investigations – It's Complicated!




# Inflow Estimates from PCSWMM Model

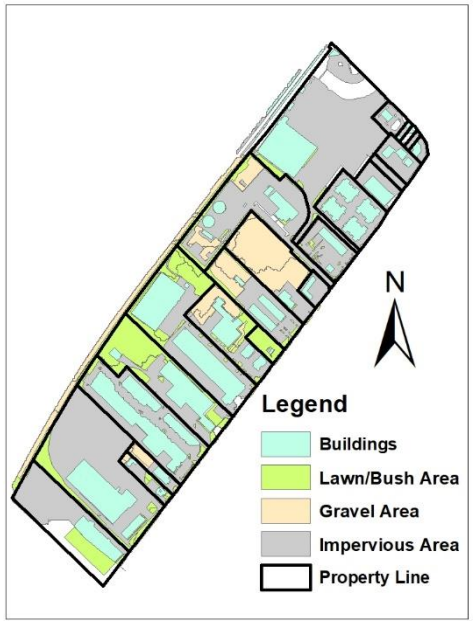
Inflow to the sanitary sewer system through manhole covers

| Drainage Area | 25mm | 2 year | 5 year | 10 year | 25 year | 50 year | 100 year | 2006-07 |
|---|---|---|---|---|---|---|---|---|
| Drainage Section AA-7 (Branch E/F) | 3.38 | 3.61 | 3.93 | 4.33 | 4.54 | 5.02 | 5.15 | 97.5 |
| Entire Site | 97.4 | 120.7 | 160.2 | 196.9 | 227.0 | 254.6 | 283.9 | 2617.9 |

# Water Conservation Investigations

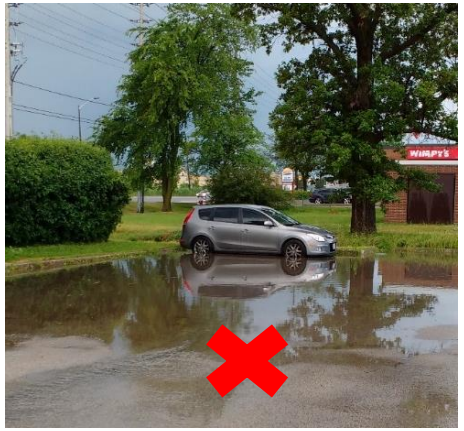
## Demand

## Supply




- **Buildings represent 23% of the study area**
- **28,000m$^3$ of rain land on the roofs each year**
- **There is demand for more than 15,000m$^3$ of non-potable water each year**

*Poor Stormwater Drainage*



*Manhole Inflow*

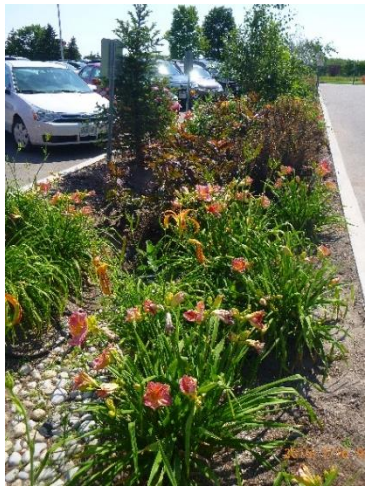
*Direct Connection Inflow*

*Potable Water Consumption*

# One Water Solution

*Peak Flow and Volume Control*

*Water Quality Control*



*Rainwater Harvesting*

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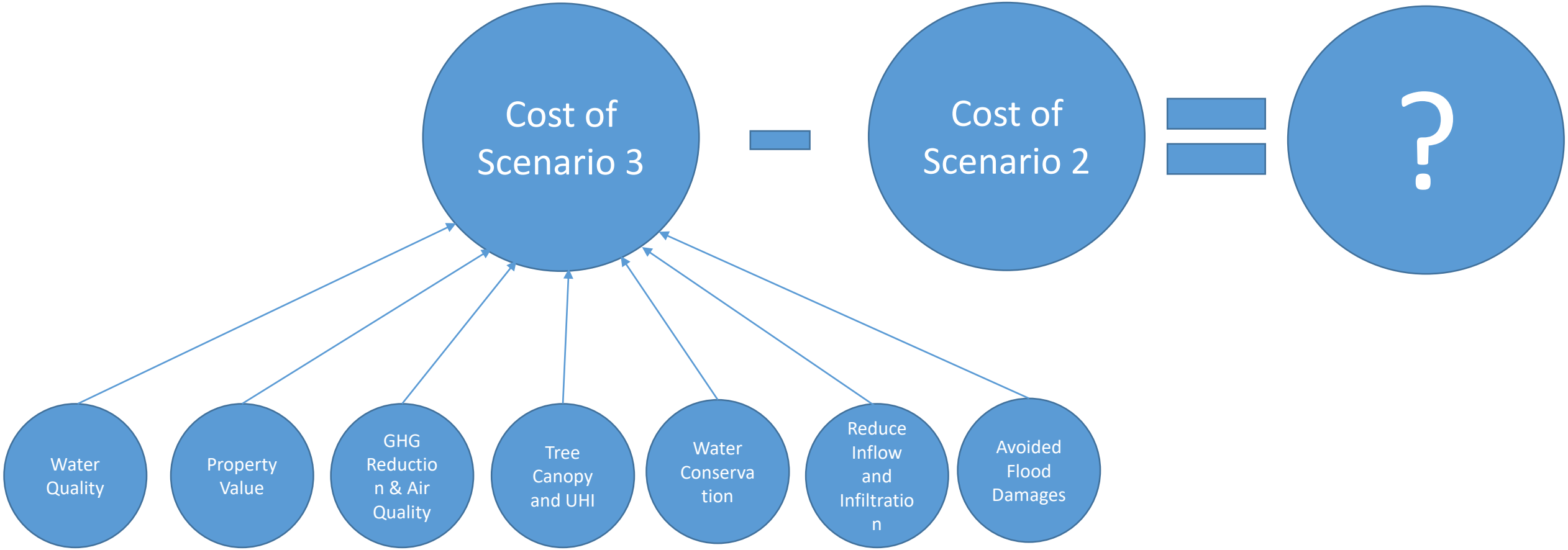
# Branch F


Cost of Scenario 3
–
Cost of Scenario 2
=
?
Water Quality
Property Value
GHG Reduction & Air Quality
Tree Canopy and UHI
Water Conservation
Reduce Inflow and Infiltration
Avoided Flood Damages

# Calculating a New Net Assessment

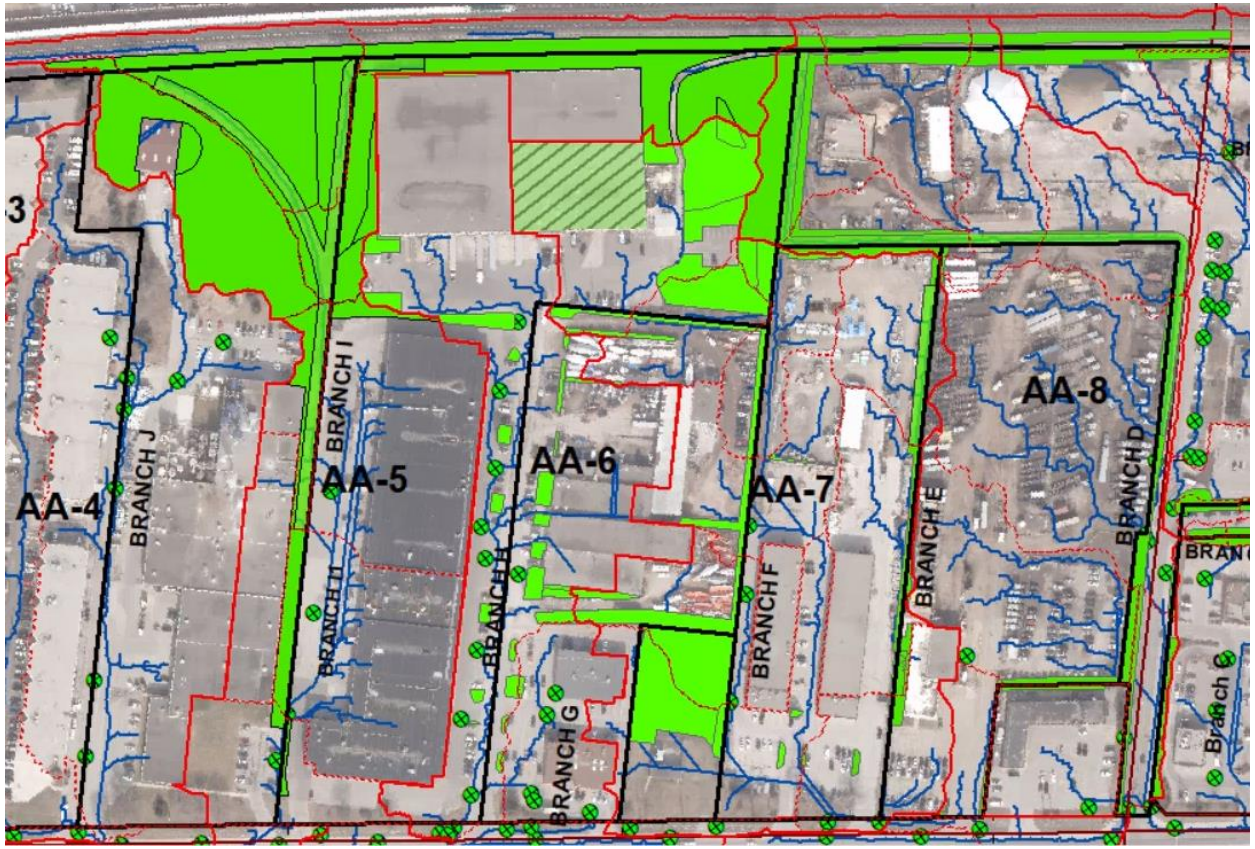
- What is the marginal increase in cost to add additional features to meet multiple objectives?(one contract, one restoration, etc.)
- Who is willing to pay for the additional cost to achieve the additional co-benefits?
- Leverage partnerships to stack benefits in the most cost-effective way.

# Allocating benefits

| Description | Beneficiary |
|---|---|
| Flood risk reduction | Landowners, Municipality |
| Water quality improvements | Conservation Authority, Municipality , Province |
| Air quality improvements | Municipality |
| Heat island reduction | Municipality |
| GHG reduction | Municipality , Province, federal gov't |
| Property value increase | Landowners, Municipality |
| Inflow and infiltration reduction | Municipality, landowners |
| Water efficiency | Municipality, landowners |

# Next Steps

- Complete modeling for Scenario 3
- Complete Feasibility Study in 2021
- Secure funding for proof of concept



# Aggregated, Communal Approaches to Green Infrastructure Implementation

The STEP Water partners have developed and monitored many successful projects that demonstrate the benefits of green infrastructure (GI) and low impact development (LID) for stormwater management. Despite the proven success and benefits of GI, there are still barriers preventing wide-scale implementation, particularly on private property in existing developments. This is largely due to the associated capital costs. The aim of this project is to find ways to overcome this hurdle through aggregation, where private and public properties are grouped together to facilitate the communal and cost-efficient management of stormwater. As part of this project, the potential of the provincial Drainage Act (R.S.O., 1990) to assist in the aggregation process is being considered, since applying the mechanisms available within the Act will result in cost savings as well as the optimization of feature selection, sizing and overall performance.

Website - https://sustainabletechnologies.ca/home/urban-runoff-green-infrastructure/aggregated-communal-approaches-to-gi-implementation/

# Thank You

For more information:

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# Branch F Benefit table: current status

| Description and value | | Source | Status |
|---|---|---|---|
| Flood risk reduction | $ 259,877 | Autocase | Refining with RROIT |
| Water quality improvements | $ 16,157 | Autocase | Working to refine estimates with CVC staff |
| Air quality improvements | $ 24,795 | Autocase | Looking at Clarkson Airshed Study, evaluating Autocase methodology |
| Heat island reduction | $ 28,545 | Autocase | Evaluating Autocase methodology |
| GHG reduction | $ 10,522 | Autocase | Evaluating method |
| Property value increase | $ 713,620 | Autocase | Values are not likely accurate – working with Autocase economists |
| Inflow and infiltration reduction | $1.1367 per m3 (4,817 m3) = $5,475 / year | Region of Peel | Verifying |
| Water efficiency savings | $1.4725 per m3 | Region of Peel | Verifying |