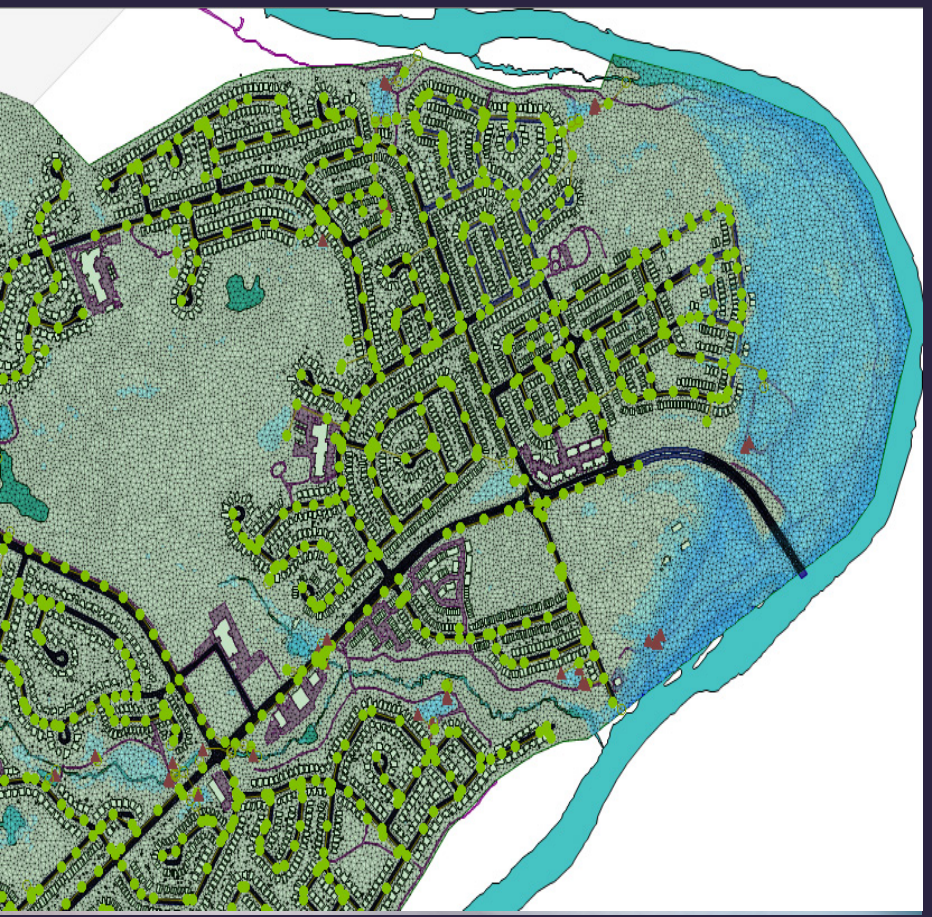

QUANTIFYING THE CUMULATIVE BENEFITS OF LIDS IN A 1D/2D STORMWATER MODEL

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Water Resources Analyst, Sanitary and Stormwater Utilities Division | Infrastructure Services Department | City of Kitchener |

October 18, 2022

KEY TOPICS

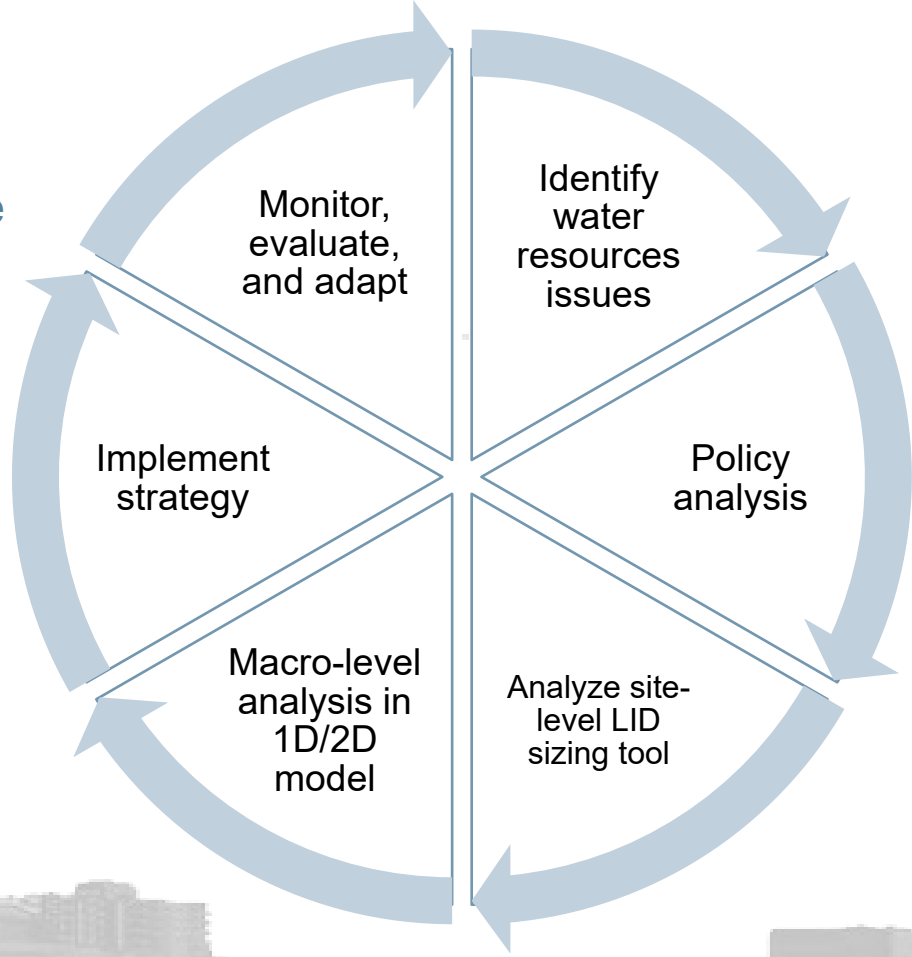
- Current City of Kitchener LID strategy
- Actions to address phosphorous and suspended solids
- City of Kitchener Stormwater Management Policy
- Etobicoke Exfiltration Systems in Capital Roads Program
- Site-level LID sizing tools
- LID integration in a 1D/2D stormwaterm odel

CITY OF KITCHENER LID STATEGY

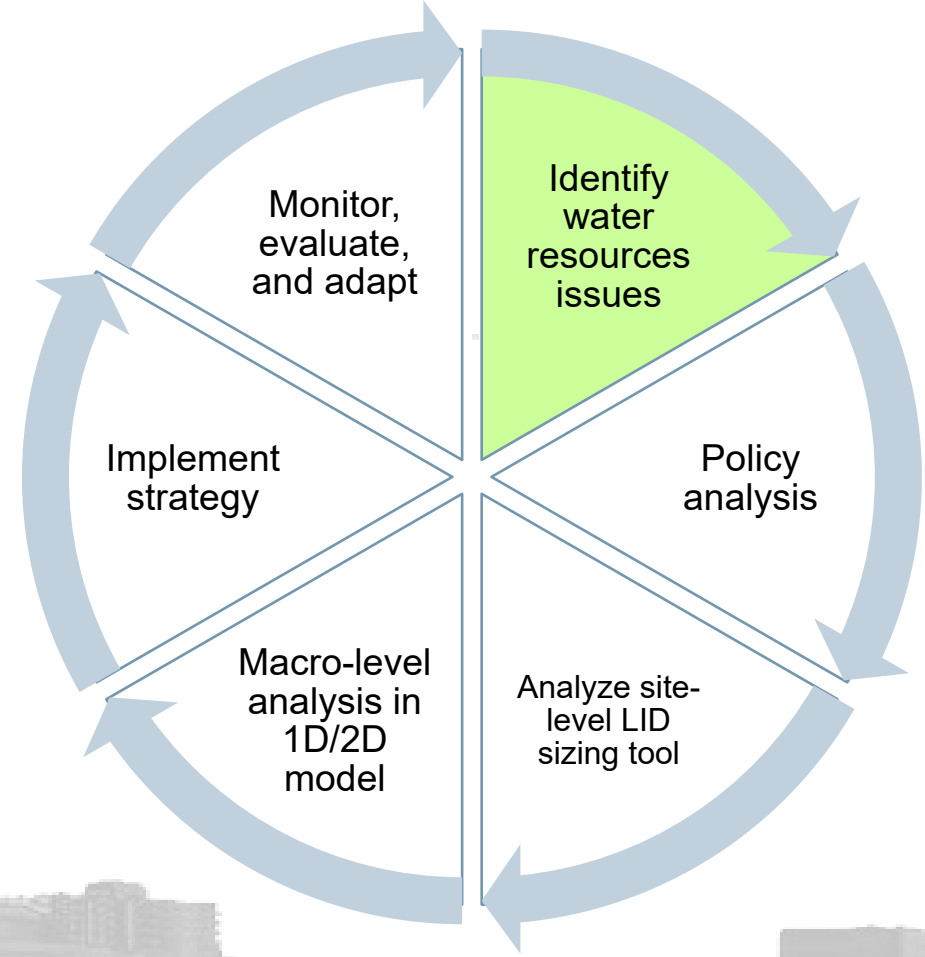
Holistic approach
- Site-level
- Subwatershed scale
- City-wide scale

Continuous, systematic process

Follows principles of Integrated Water Resources Management (IWRM)

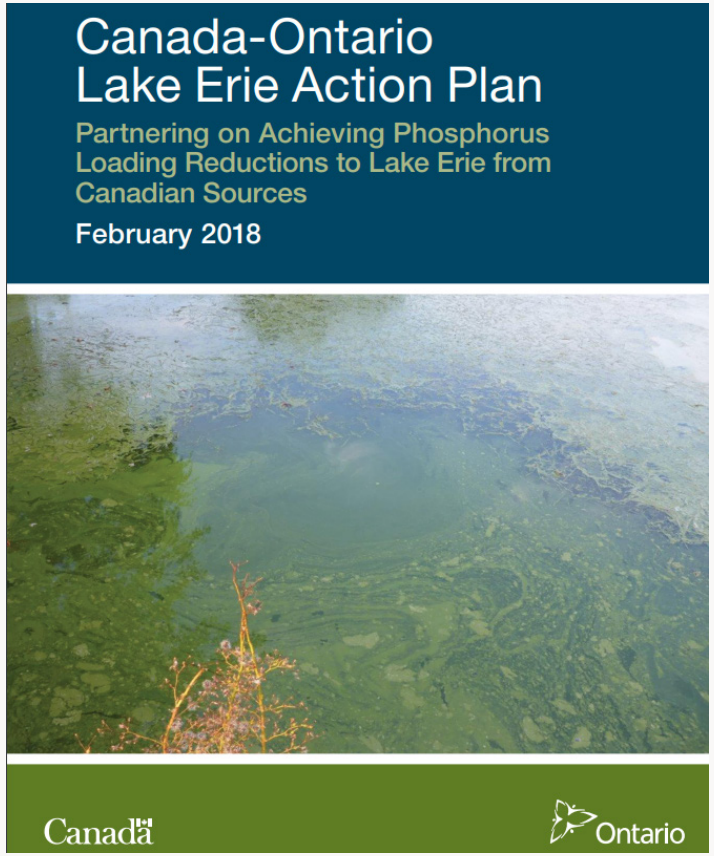


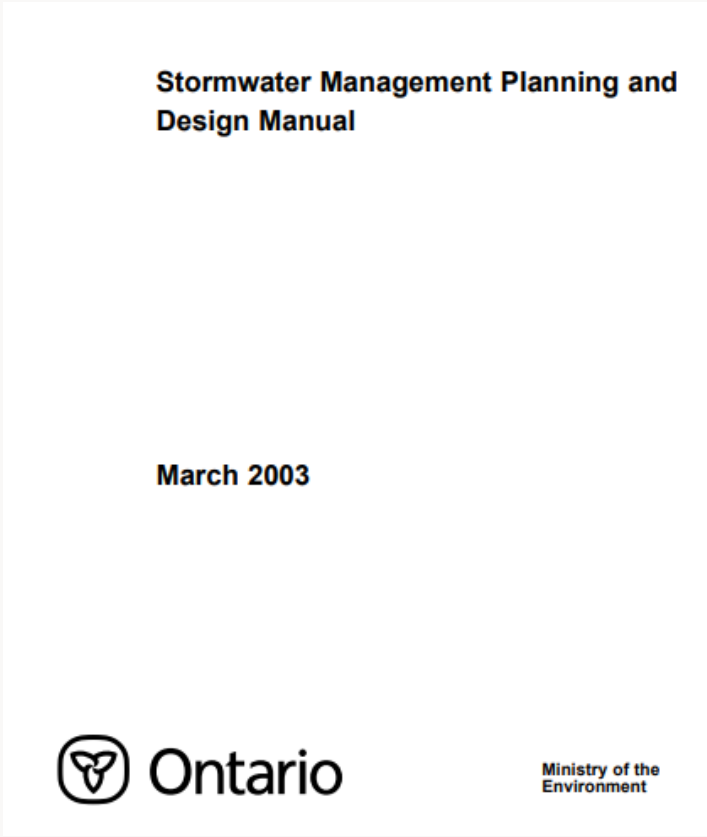
CITY OF KITCHENER LID STRATEGY



IDENTIFY WATER RESOURCES ISSUES

ACTIONS TO REDUCE PHOSPHORUS AND SEDIMENT LOADINGS FROM URBAN AREAS





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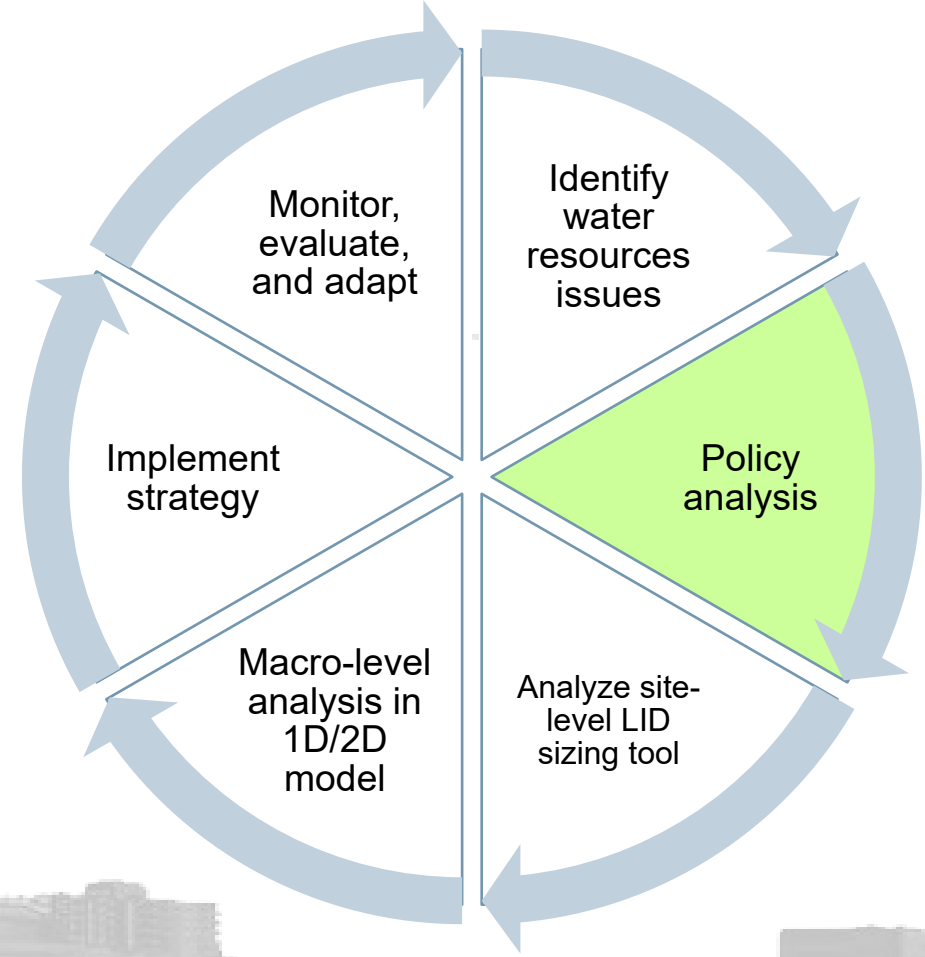
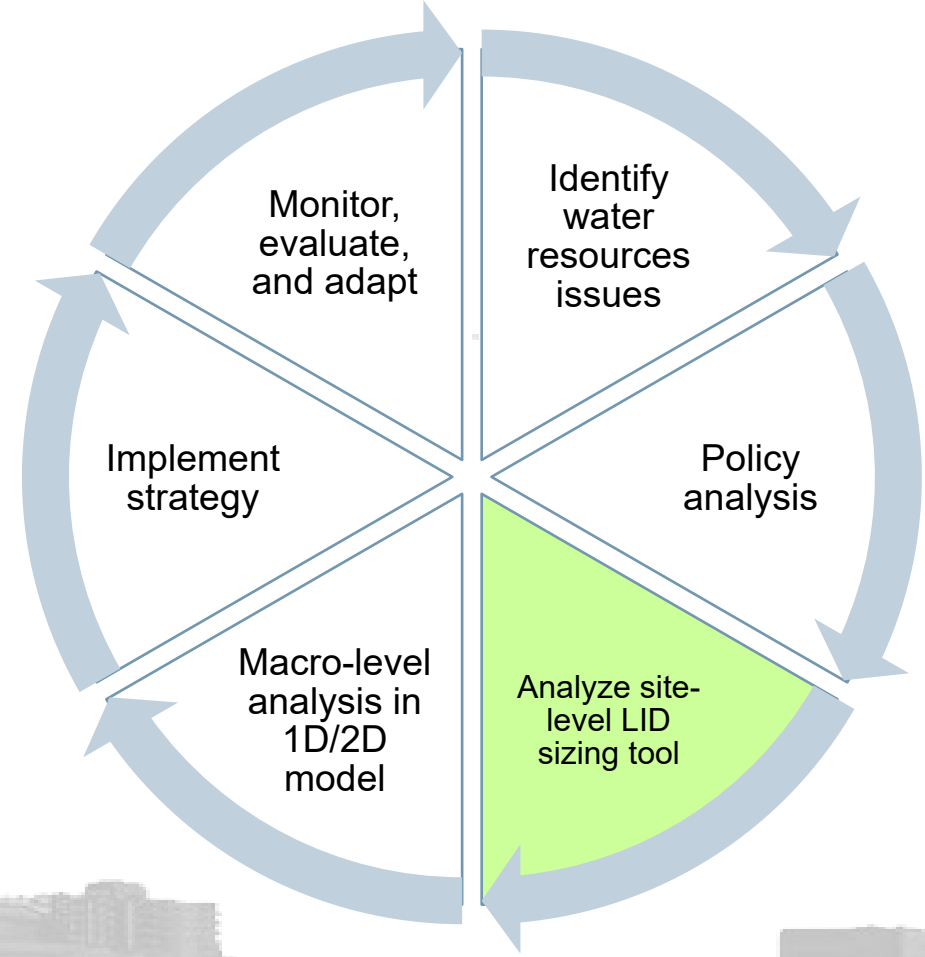


City of Kitchener Stormwater Management Policy (2016)

- Decision support tool as well as a methodology for the prioritization of works outlined in the Integrated Stormwater Management Master Plan (ISWM-MP)
- Supports the implementation of Low Impact Development (LID) to manage rainfall at the source using uniformly distributed decentralized small-scale controls to minimize impact of polluted runoff flowing into watercourses.
- Acknowledges that the use of infiltration practices to reduce runoff and restore natural hydrologic processes is crucial to maintaining and improving the City of Kitchener's natural water systems, maintaining the viability of local stormwater infrastructure, and contributing to climate change adaptation & mitigation strategies.

CITY OF KITCHENER LID STRATEGY



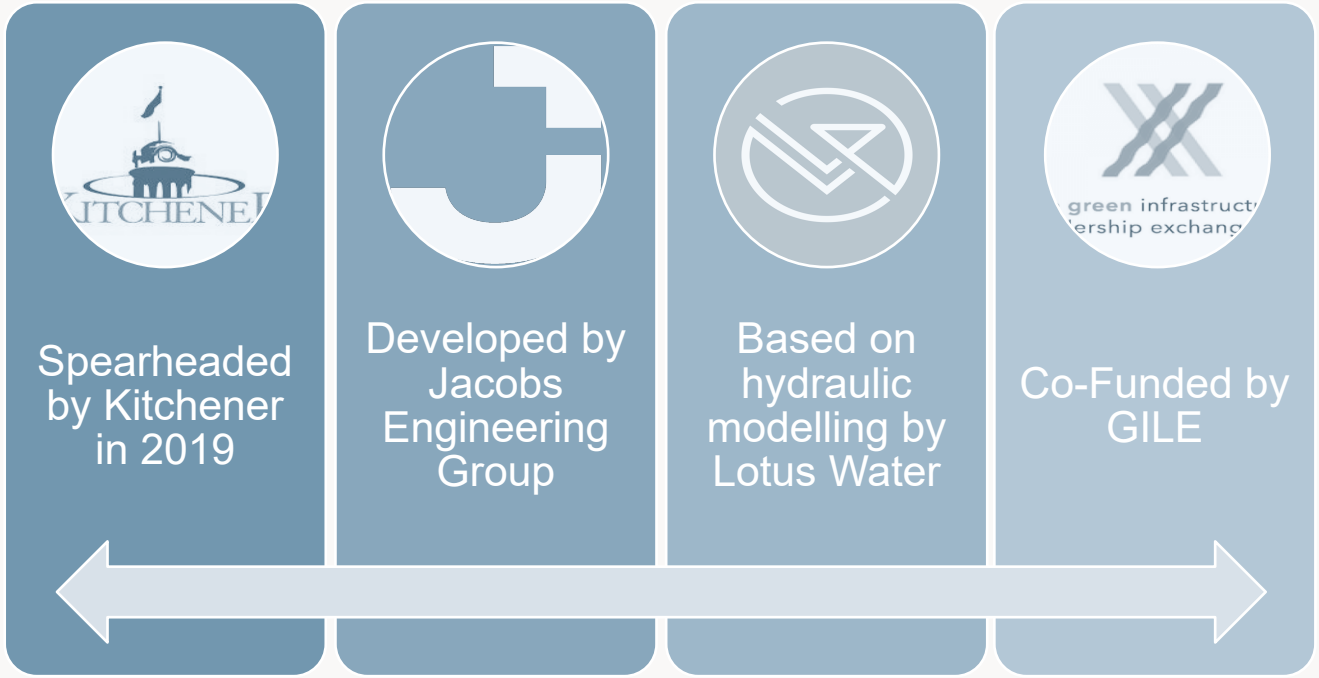
Current LID sizing tool in the City of Kitchener

Benefits

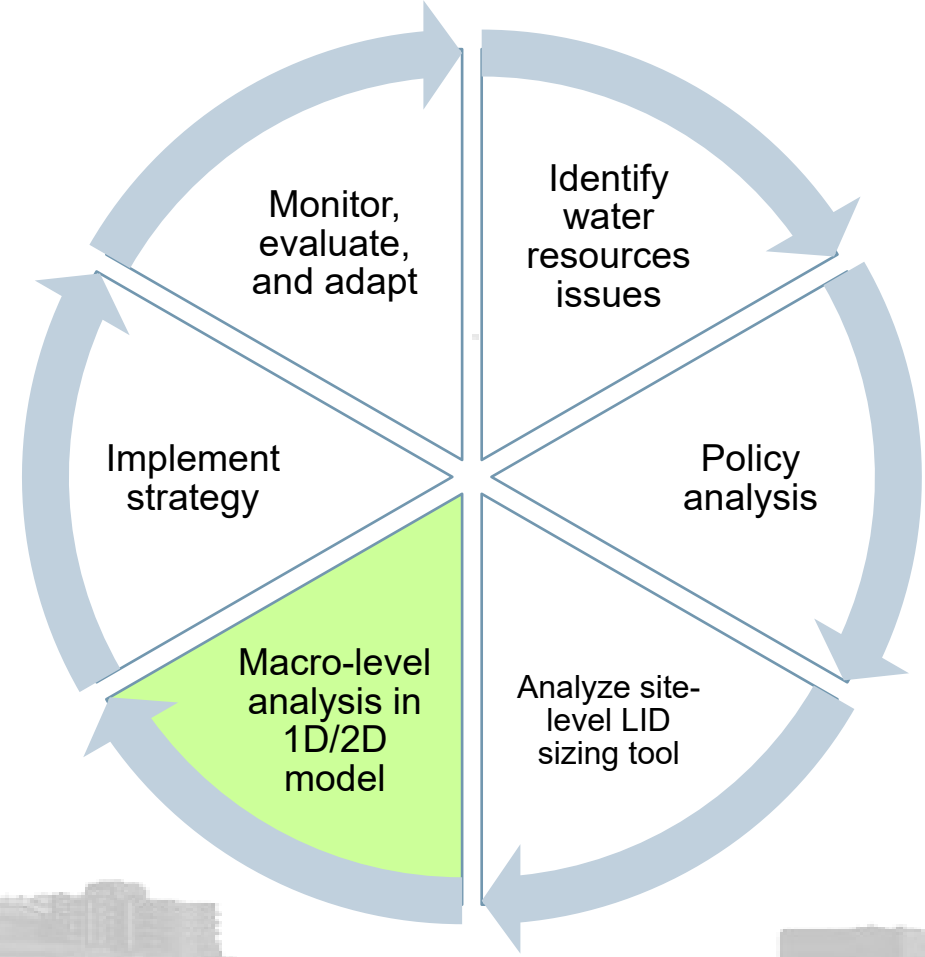
- Excel-based tool based on the output of continuous simulation water balance modelling using PCSWMM (LID toolkit)
- Input parameters: Infiltration rates, pervious and impervious area draining to BMP, BMP footprint.
- Ideal for conceptual design phases of a project
- Applicable for site development, road reconstruction etc.
- Much faster than modelling

Limitations

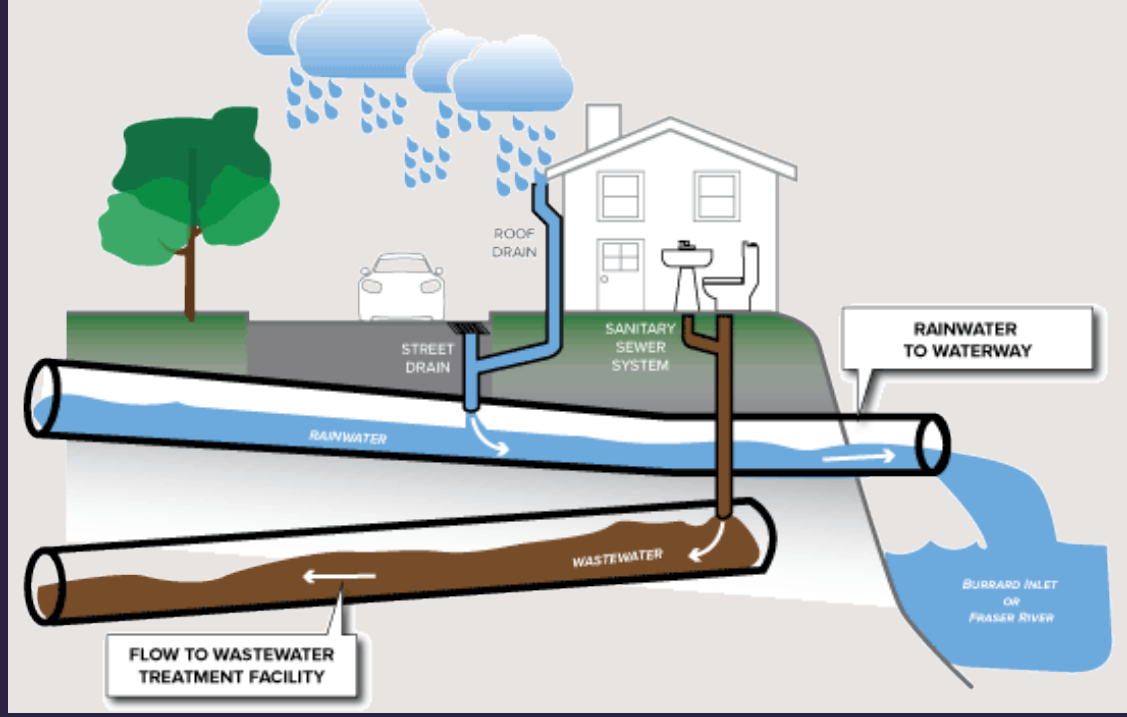
- Not applicable for subwatershed studies, subdivisions etc.
- Less flexible than using a model
- Not applicable for LIDs in series



CITY OF KITCHENER LID STRATEGY



City-wide integrated stormwater modelling using InfoWorks ICM in the City of Kitchener



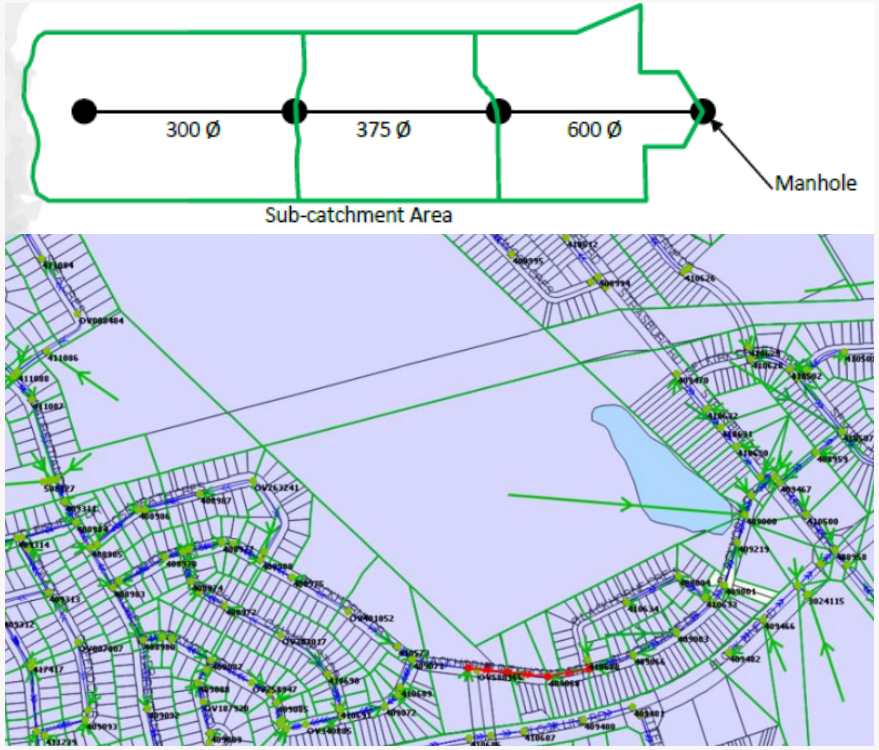
Modeling all sources of flooding in a single, fully-integrated 1D/2D hydrologic and hydraulic model.

Includes watercourses, storm sewer systems, bridges, culverts, etc.

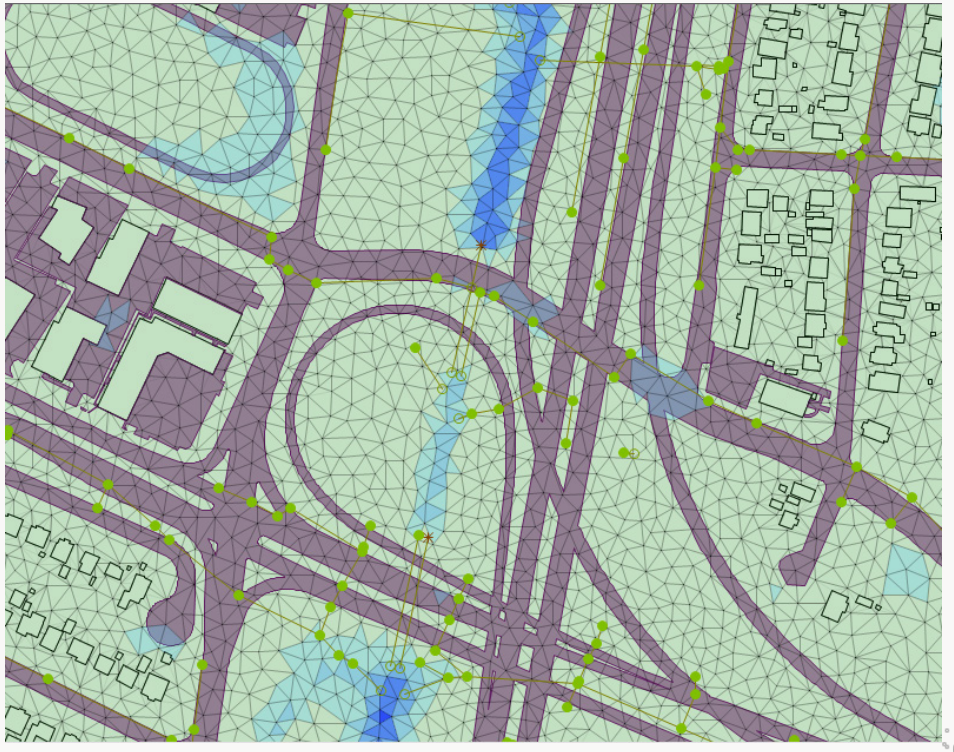
Ideal for storm sewer capacity assessments

Approach to city-wide climate resiliency planning, LID modeling, and emergency preparedness.

Hydrology: Traditional catchment delineation vs Rain-on-Mesh approach

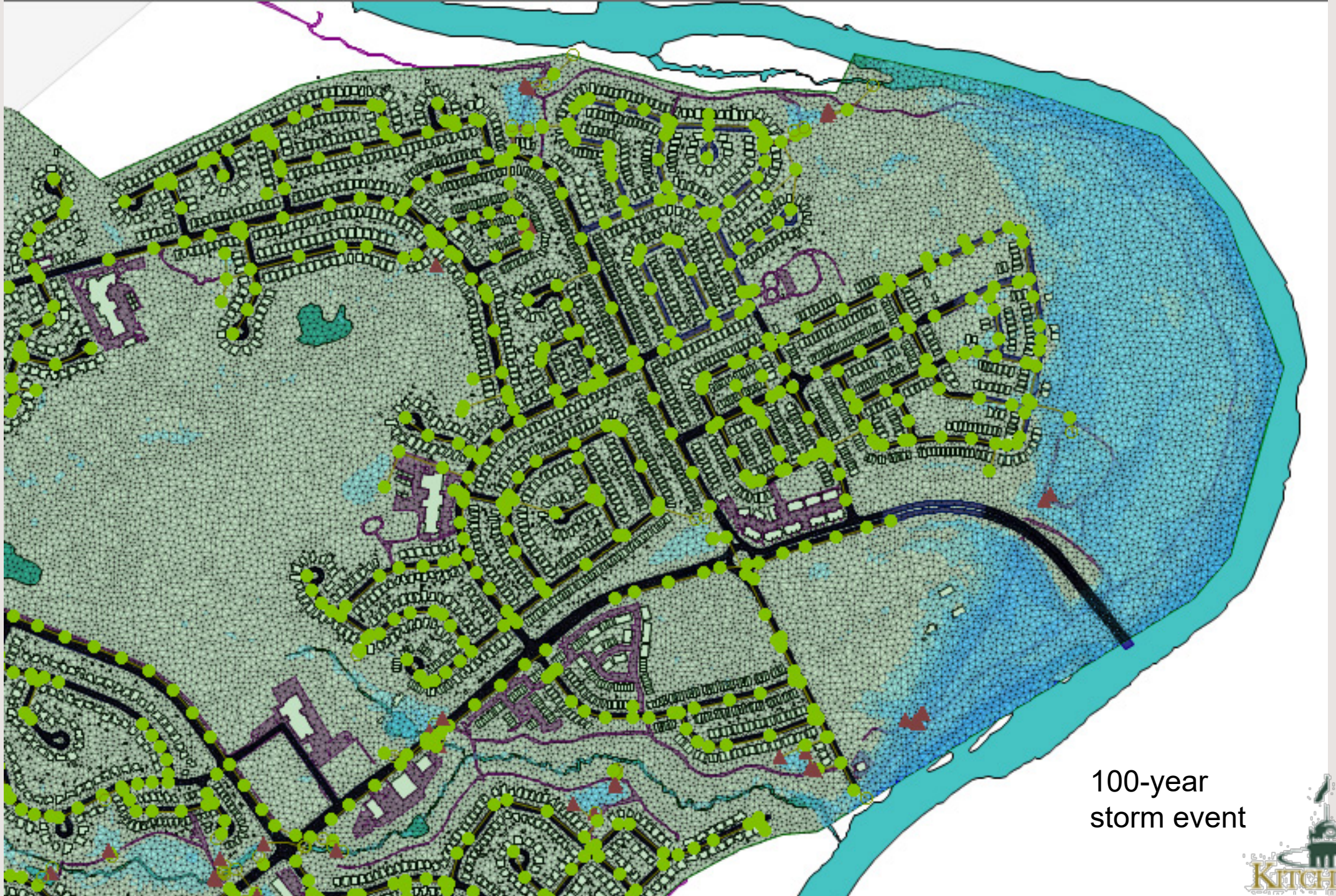


Traditional catchment delineation



Rain-on-mesh approach

Existing conditions

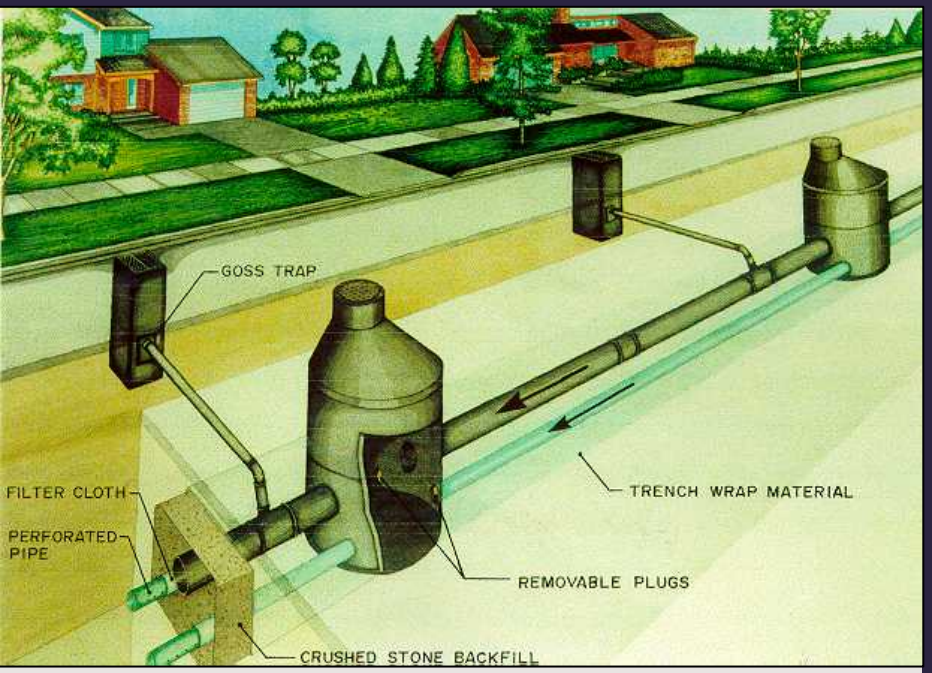


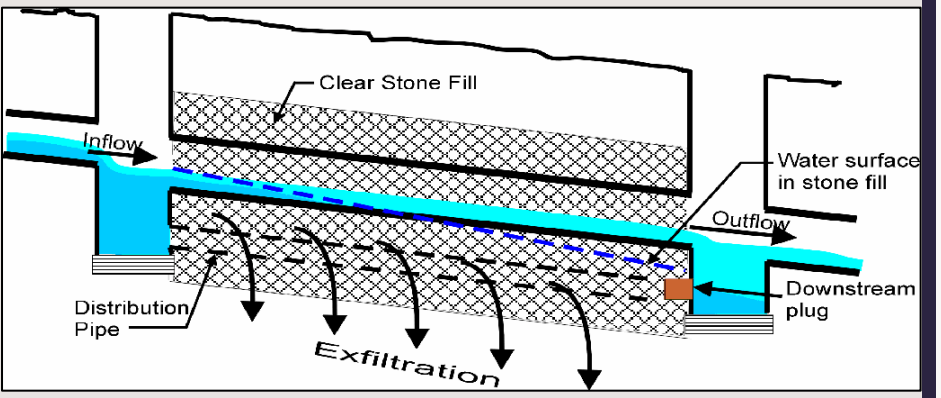
100-year
storm event

Modeling LIDs in InfoWorks ICM: Etobicoke Exfiltration Systems

Quantifying the cumulative benefits of LIDS
in a 1D/2D hydraulic model

KITCHENER

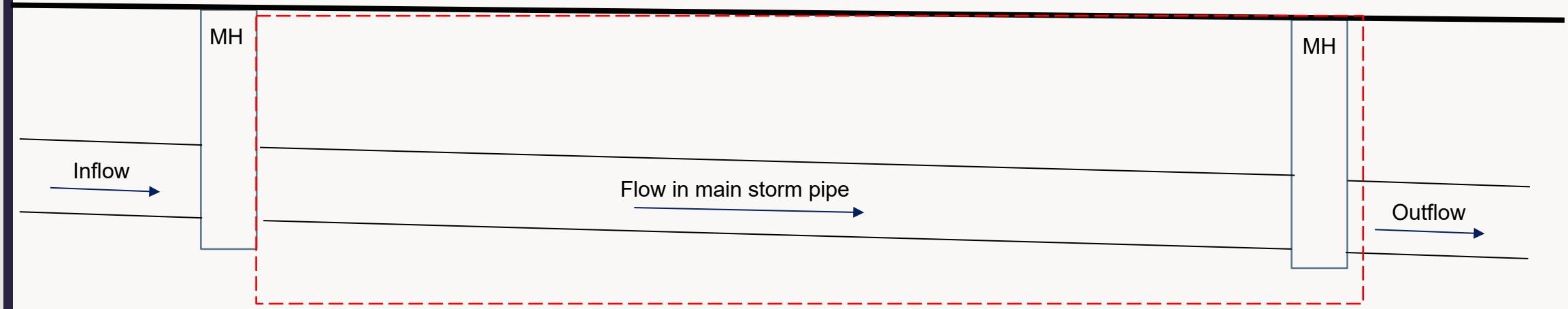




LID integration in Capital Roads Program using Etobicoke Exfiltration System (EES)

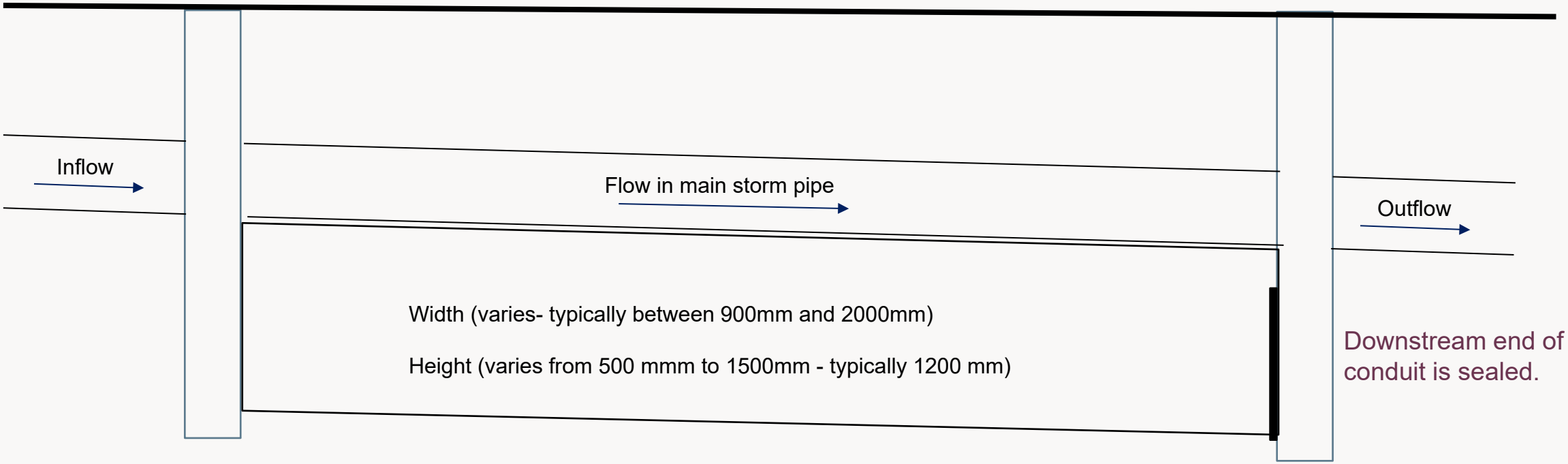
- The City of Kitchener incorporates LIDS in road right-of-way (ROW) reconstruction (resurfacing) and full reconstruction projects.
- LID practices must provide storage for at least 27mm of runoff (over the contributing drainage area to the facility) in order to achieve an enhanced level of water quality control.
- Treatment of the runoff from all storms smaller than the 90th percentile rainfall event will provide a high level of pollutant load reduction, roughly equivalent to a 90% reduction in the long-term annual load of suspended sediment.

Methodology for modeling EES in InfoWorks ICM



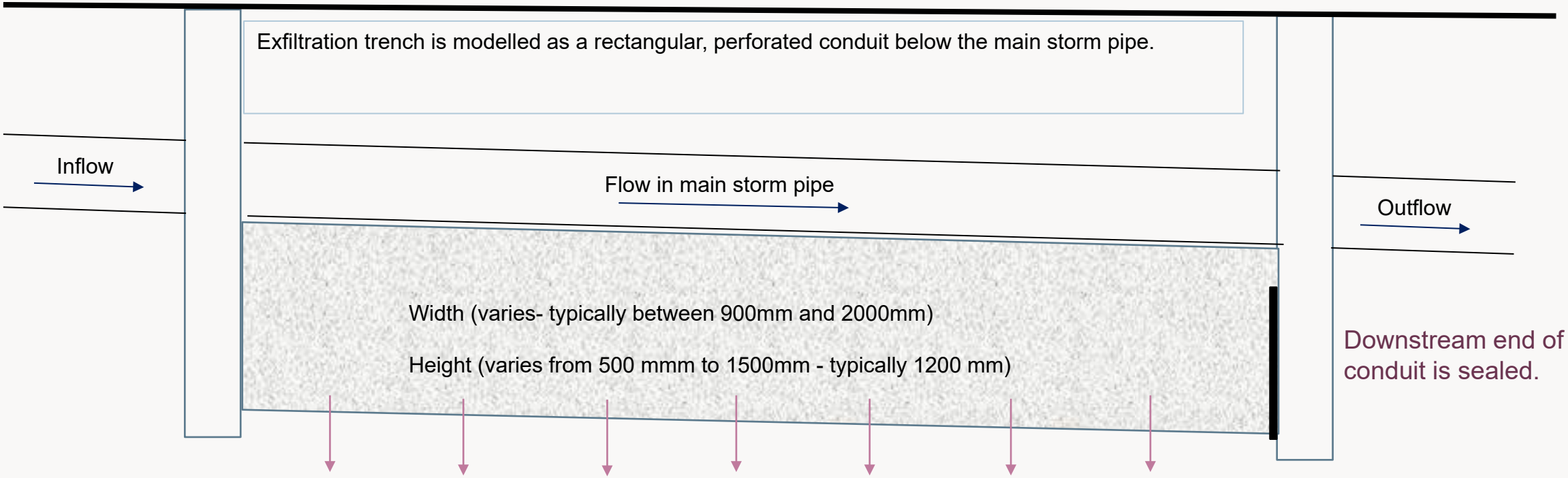
1. Select existing storm pipe and downstream MH

Methodology for modeling EES in InfoWorks ICM



2. Duplicate storm pipe and downstream MH
3. Change size to match proposed exfiltration trench
4. Modify inverts to place trench below main storm pipe

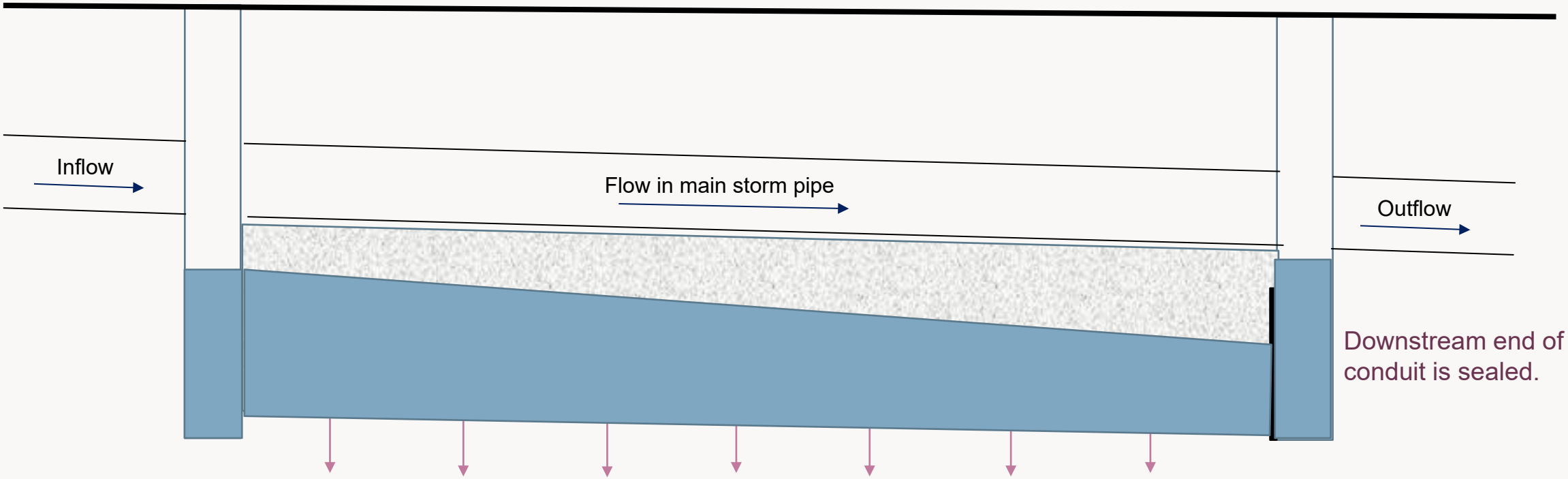
Methodology for modeling EES in InfoWorks ICM



Base infiltration loss coefficient (mm/h) depends on soil type from 0.5 – 127 mm/h.

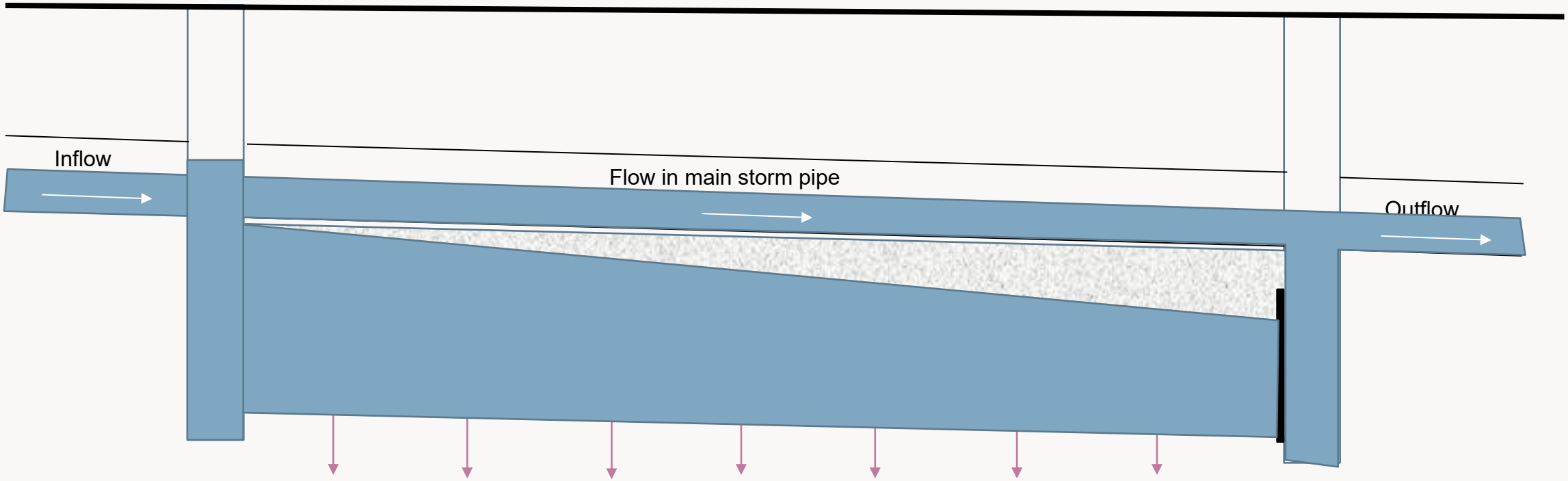
5. Apply SUDS (LID) parameters to trench

Methodology for modeling EES in InfoWorks ICM

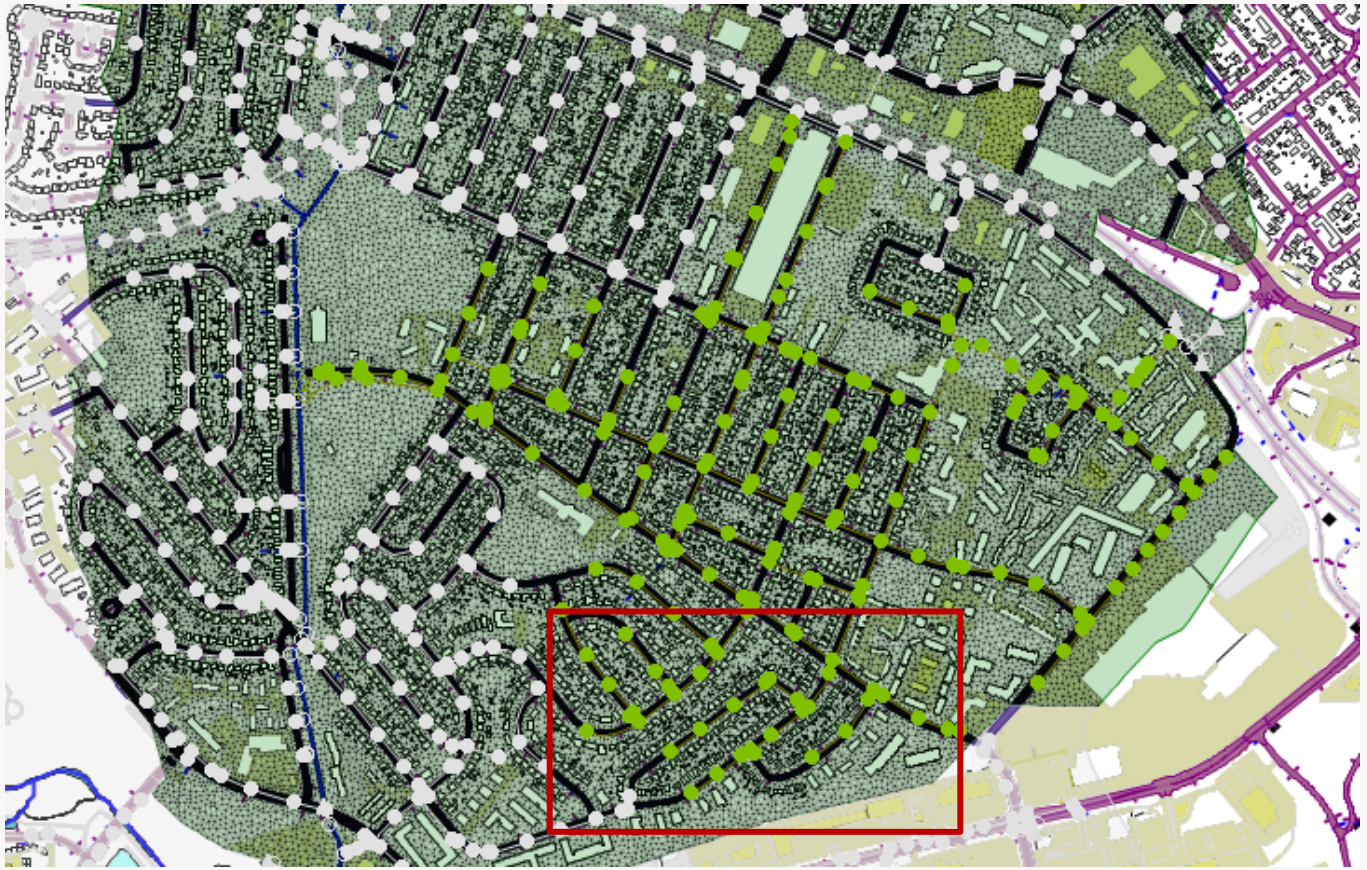


Base infiltration loss coefficient (mm/h) depends on soil type. From 0.5 – 127 mm/h.

Methodology for modelling EES in InfoWorks ICM



Applying modeling methodology to selected storm pipes where EES are feasible



Rainfall scenarios for modeling EES

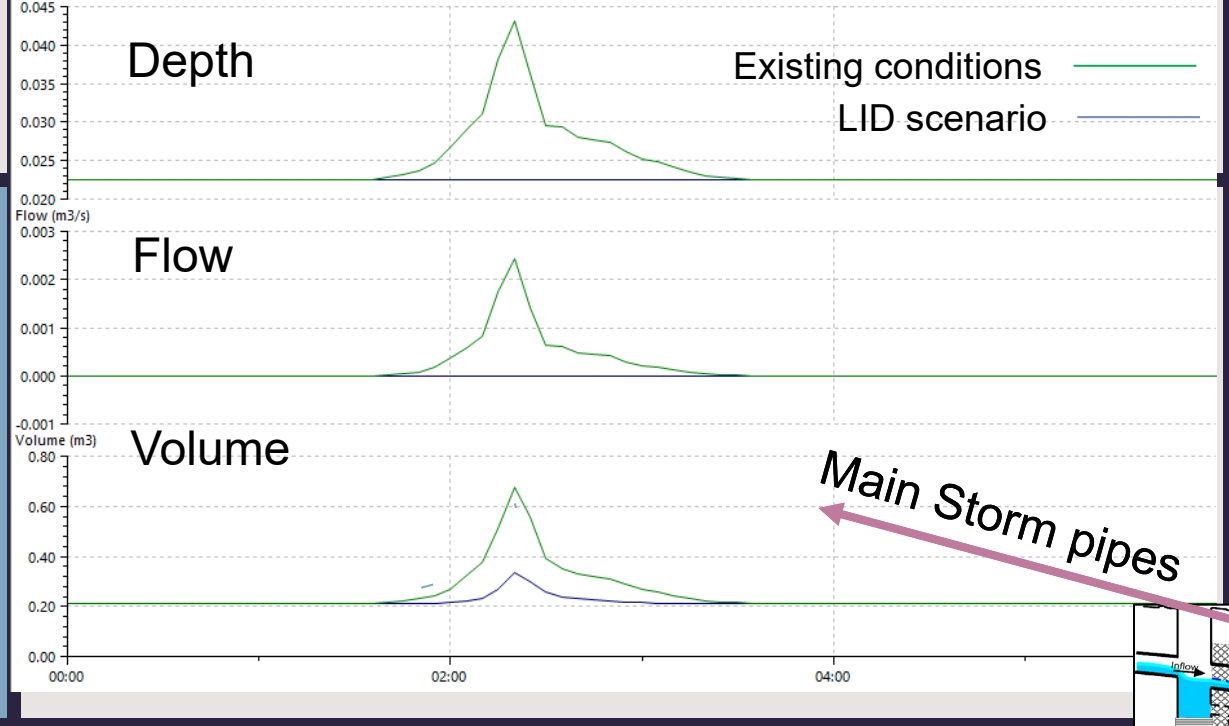
- Rain gauge data with single rainfall events
- 12.5mm is the current retention requirement established by the City of Kitchener
- 25mm is a typical rainfall depth requirement for water quality controls in absence of site-specific studies
- 27mm is the 90th percentile rain event for the City. Retaining the 90th percentile event is considered level of water quality protection and for restoring the natural hydrologic cycle effective for achieving Enhanced Quality control
- Continuous rainfall data

Model simulation results

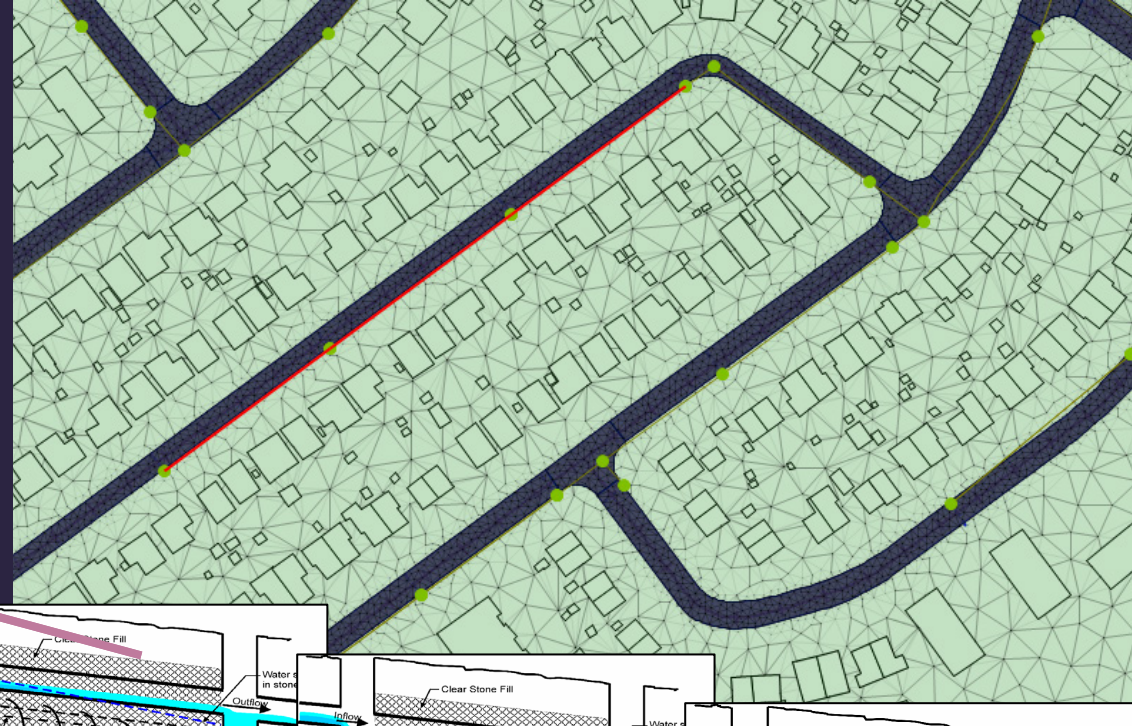
Quantifying the cumulative benefits of LIDS
in a 1D/2D hydraulic model

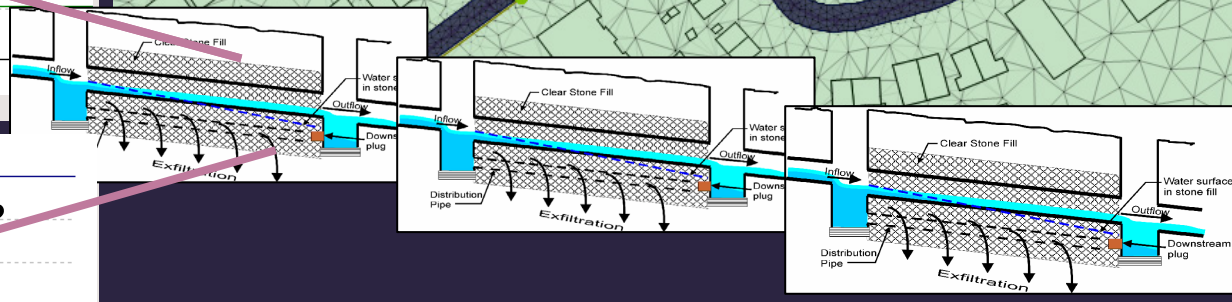
1. Depth, infiltration loss, and volume within trenches for various rainfall events.

- 12mm
- 25mm
- 27mm

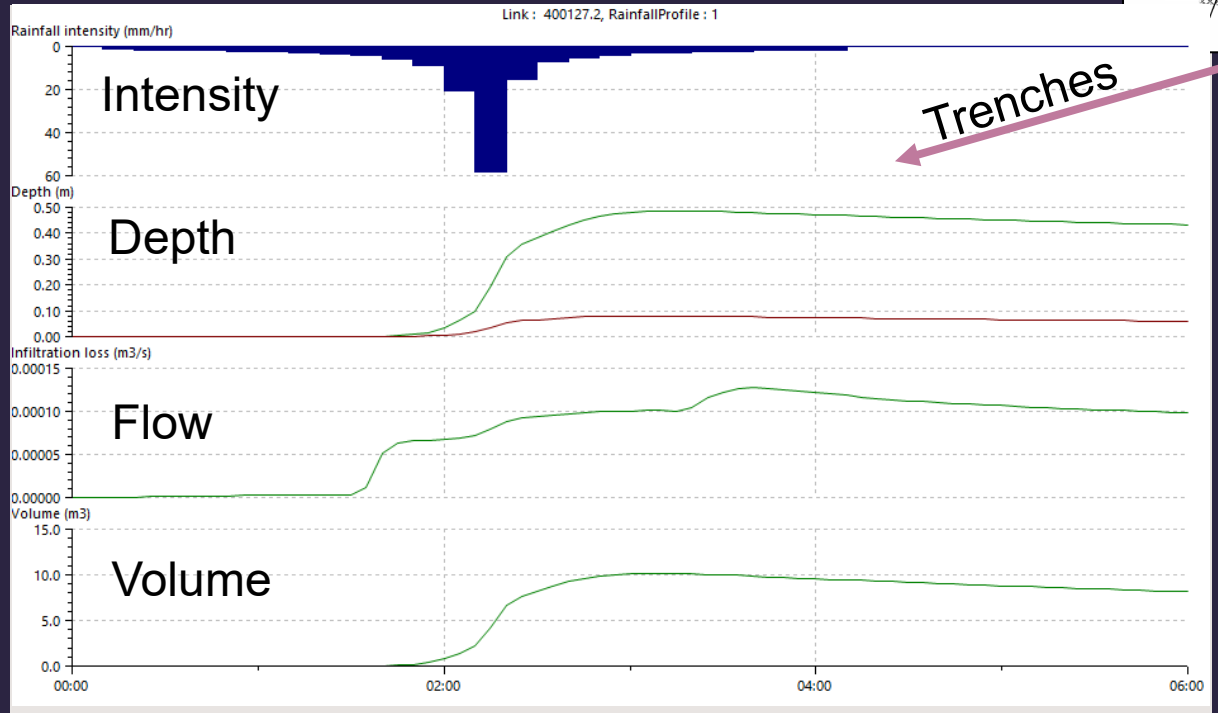


Main Storm pipes

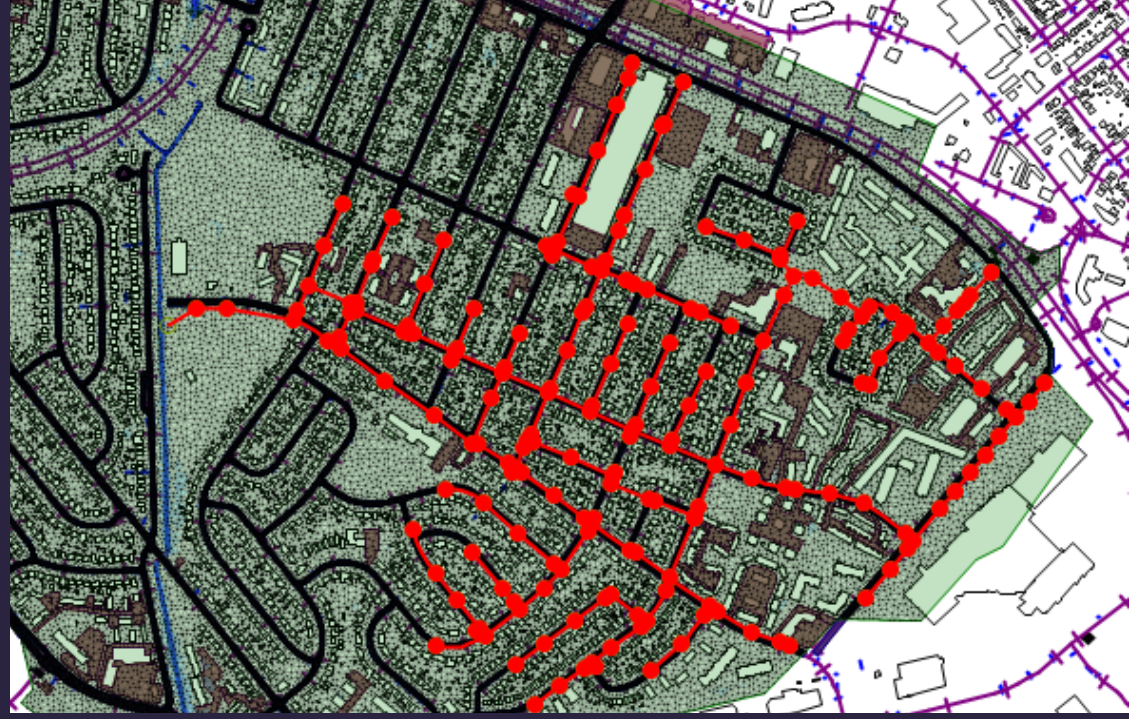


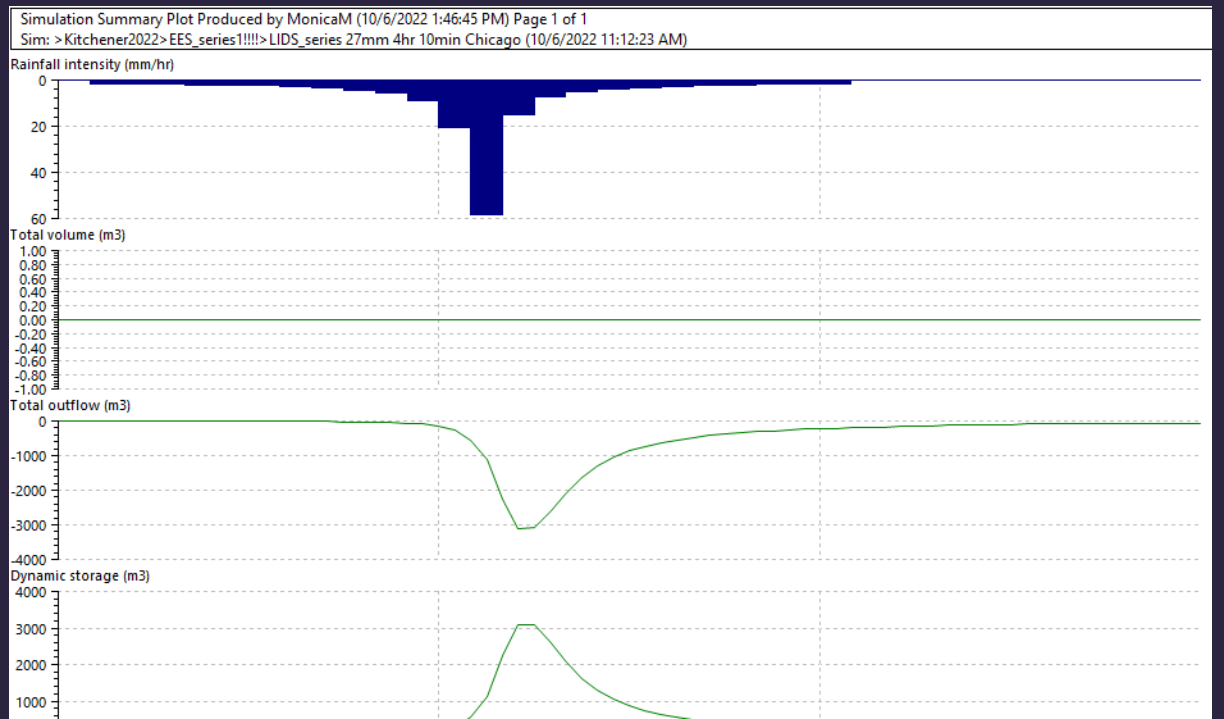


Trenches



2. Depth, flow, volume, and infiltration for multiple Etobicoke Exfiltration Systems in series.



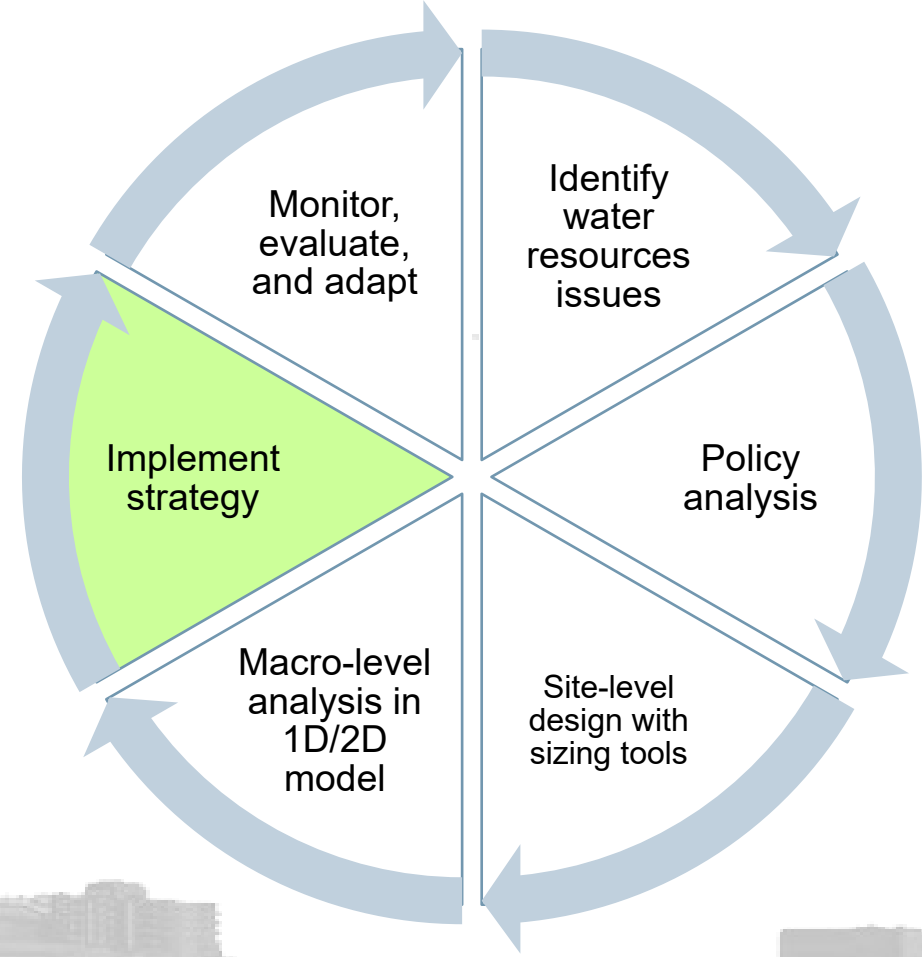


3. A simulation summary report for the entire system or any point within the system.

Overview of modeling EES in InfoWorks ICM

- Includes inflows from upstream storm sewer network and sewershed
- Ideal for optimizing EES performance when implemented in series
- Applicable for site development, road reconstruction, subwatershed studies, subdivisions etc.
- Simulation summary reports can be created to compare existing conditions to proposed LID scenario
- Ideal for detailed design phases of a project
- Ideal for macro-level system-wide analysis

CITY OF KITCHENER LID STRATEGY



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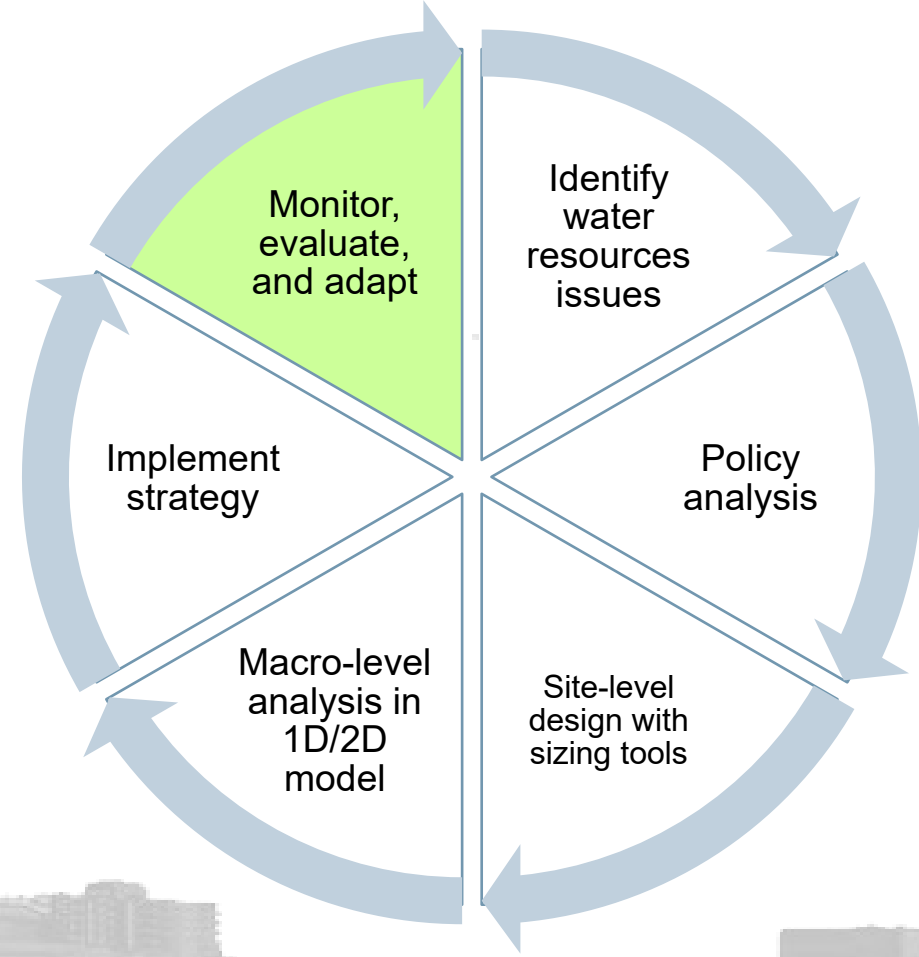

Future opportunities

Growth management scenarios New developments	Quantify the cumulative benefits of other LIDS in the treatment train (i.e. bioswales, permeable pavement, rain gardens).	Prioritize LID implementation where most effective	Evaluate existing stormwater volume criteria and targets
Climate change- how future precipitation and temperatures can impact LID performance	Develop City of Kitchener LID modeling standards and guidelines	Optimization and maintenance	Inform asset management Define scope of work for road infrastructure projects

Thank you!