Evaluating Sustainable Stormwater Management in Windsor, Ontario

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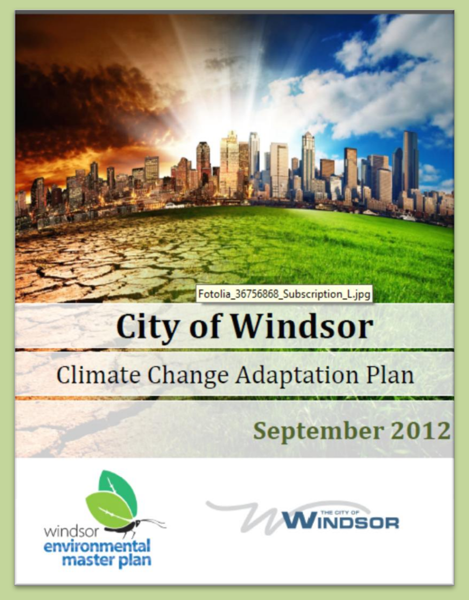
Background

The IPCC Fifth Assessment Report [1] states with very high confidence that "Many climate stresses that carry risk – particularly related to severe heat, heavy precipitation, and declining snowpack – will increase in frequency and/or severity in North America in the next decades."

An intensification of the hydrological cycle [2] is likely to stress water and related infrastructure in Ontario [3].

Urbanization is well known to accelerate runoff and disrupt natural hydrological cycles. Climate change stresses this even further.



In order to deal with these stresses. The City of Windsor, Ontario has published a climate change adaptation plan [4] as well as spent $186 million in recent years upgrading infrastructure in order to reduce combined sewer overflows [5].

Objectives

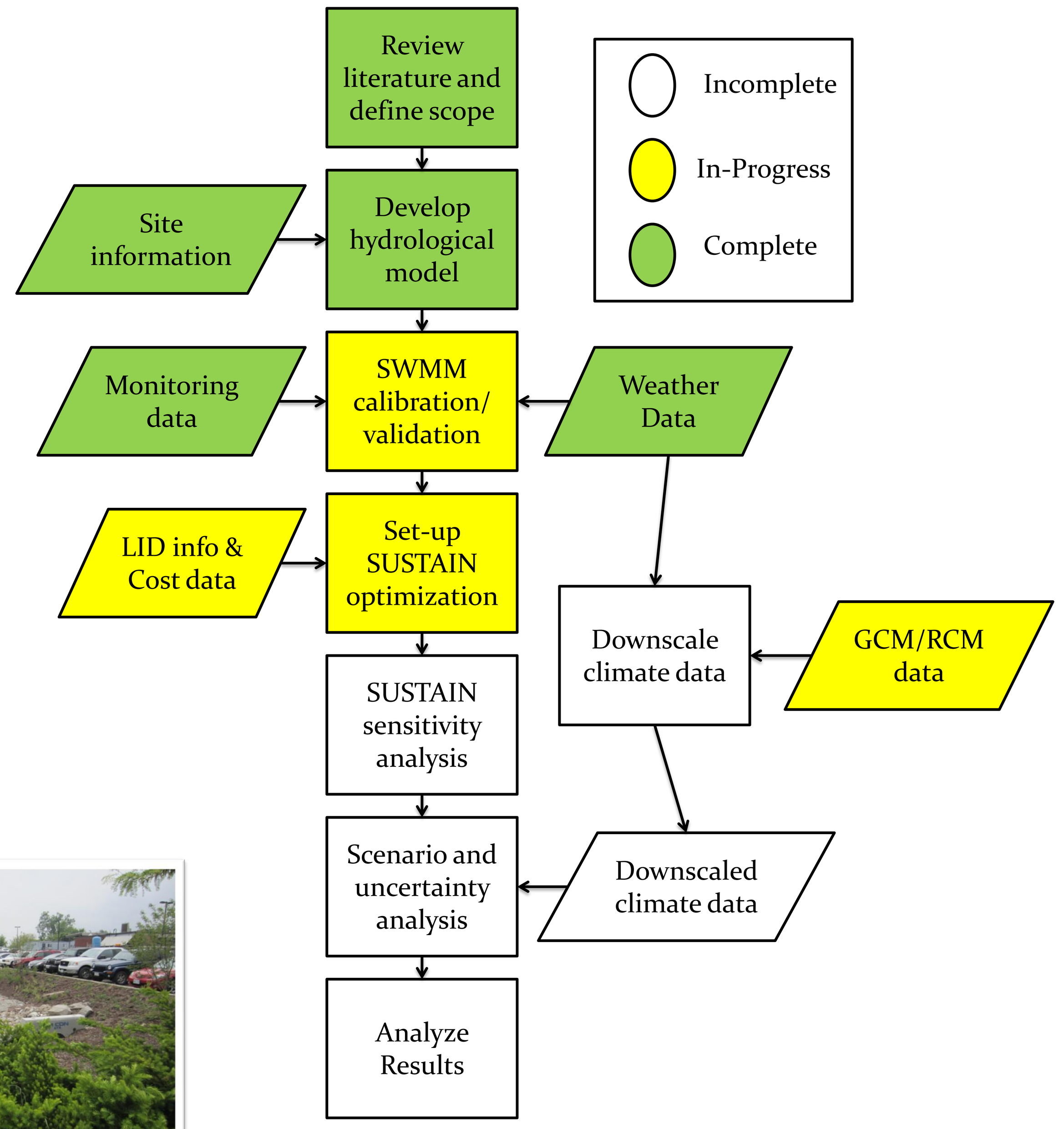
1. Test the utility of low impact development to reduce the burden on stormwater infrastructure in Windsor, Ontario in a cost-effective manner.
2. Test low impact development under climate change conditions to evaluate its utility as a climate change adaptation strategy.
3. Test the usefulness of the SUSTAIN model in carrying out these analyses.

University of Windsor, Green Roof

Bioretention

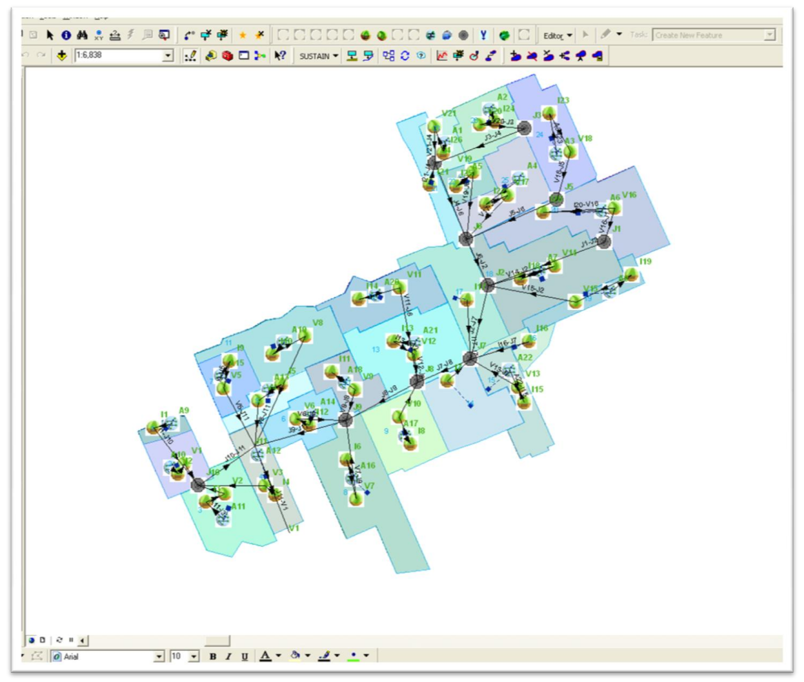
Infiltration Trench

Methodology and Research Progress

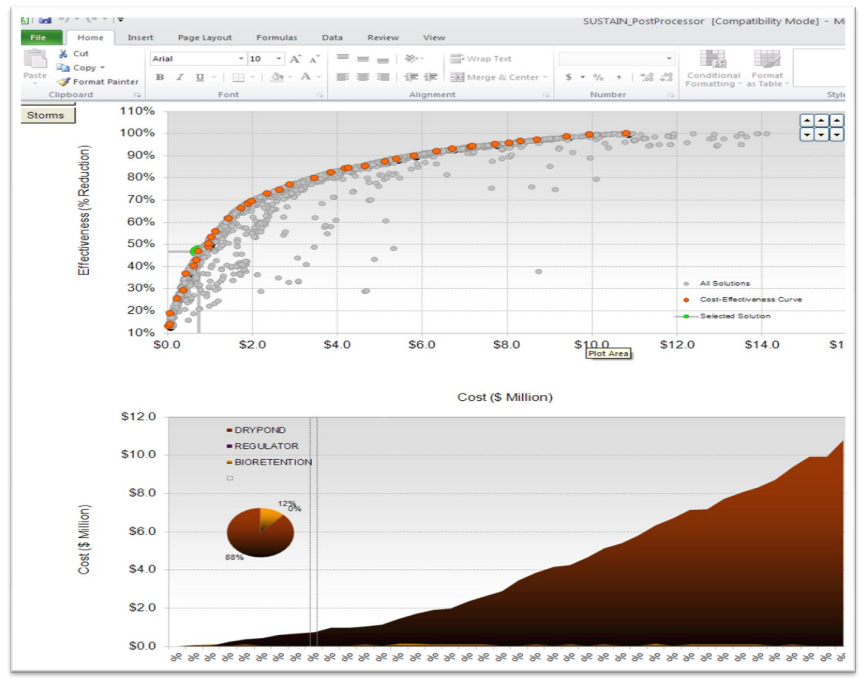


SUSTAIN

- System for **U**rban **S**tormwater **A**nalysis **T**reatment and **IN**tegration (SUSTAIN) [10]
- Developed by Tetra Tech for the U.S. EPA
- Free decision support software for placing BMPs/LID in urban watersheds
- ArcGIS interface
- Compatible with external hydrological models
- Optimization using scatter search of NSGA-II genetic algorithm
- Ability to conduct cost benefit analysis, and create cost-objective curves



SUSTAIN: Sewershed Model With BMPs



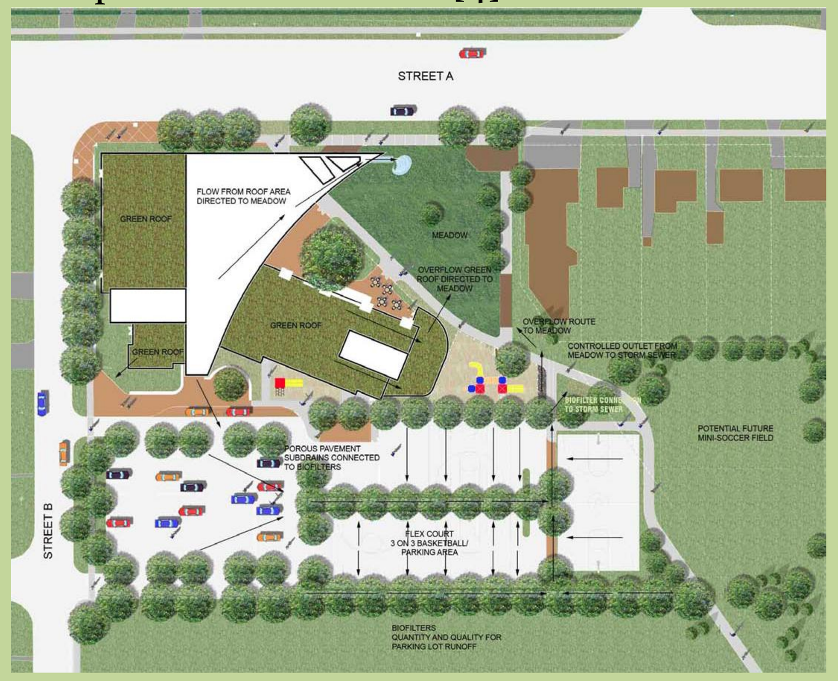
SUSTAIN: Example Cost-benefit Curve and Cost Breakdown

Low Impact Development

The City of Windsor plans to use low impact development practices as a part of their climate change adaptation plan.

Low impact development (LID) is an emerging design philosophy that has been adopted in many places around the world. At its most ambitious, LID seeks to replicate pre-development hydrological conditions and views the human environment as a part of the natural environment rather than the other way around [6, 7]. LID for stormwater focuses on source control methods which utilize infiltration and evapotranspiration.

The LID measures being considered in Windsor include green roofs, rain gardens (bioretention), porous pavement, green-space enhancement, disconnected storage, and mandatory downspout disconnection [4].



Example LID Design [8]

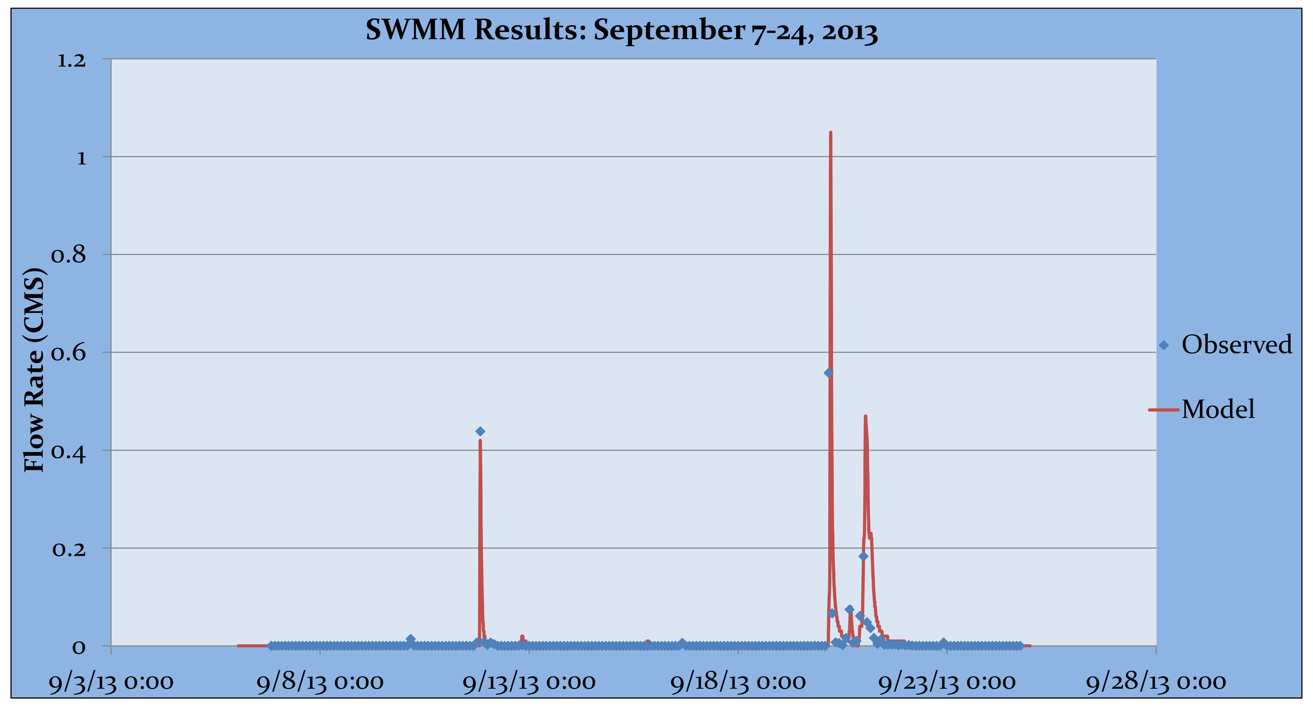
LID can also be used in series, and in combination with more traditional best management practices (BMP) such as detention ponds [6, 9]. This includes using LID to retrofit existing stormwater systems.

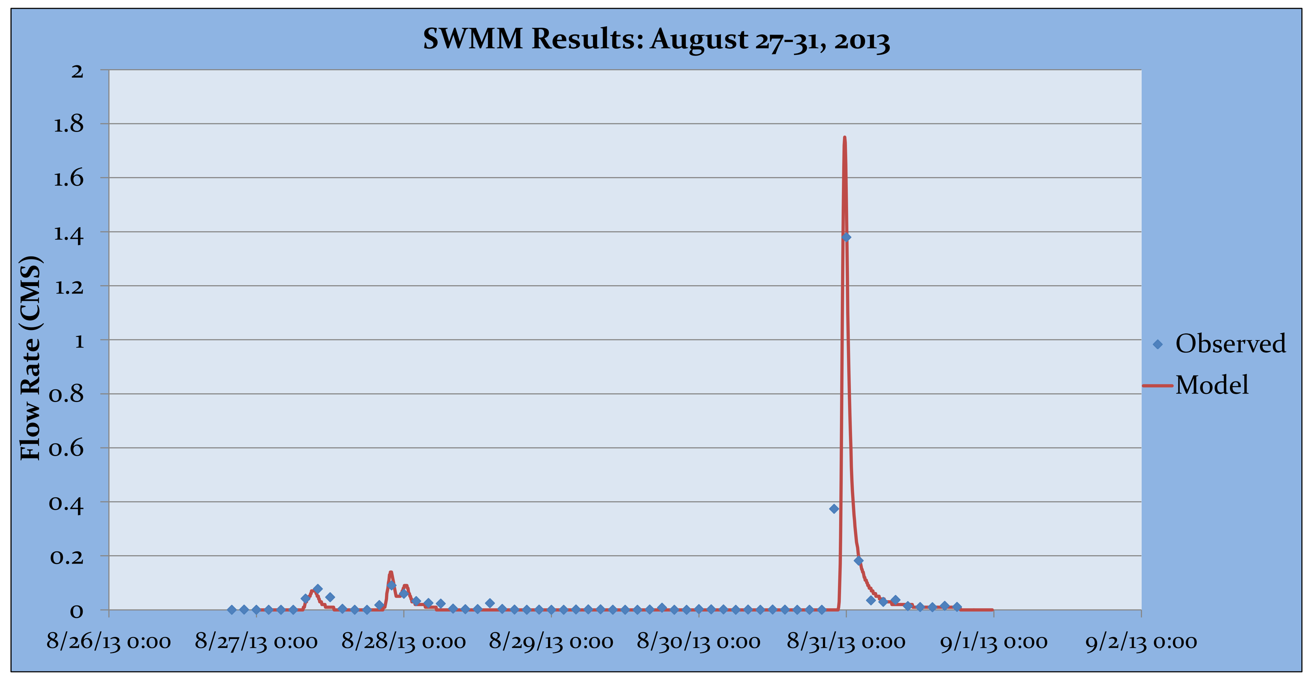
Potential Benefits:
- **Stormwater runoff reduction and attenuation**
- Protect grey infrastructure to avoid costly and disruptive expansions.
- Improvements in runoff water quality.
- Improved air quality.
- Increased green space (aesthetic benefits).
- Reduced urban heat island effect.
- Creation of natural ecosystems in urban environments.
- Forces communities to become more connected to their water systems.

Potential Challenges:
- Often requires widespread community participation.
- Lack of relevant knowledge and skills available when compared to traditional infrastructure.
- Lack of performance data, and poor long-term monitoring of existing projects.
- Performance is highly dependent on local environmental factors.

Modeling Approach

The sewershed will first be modeled using the EPA's Stormwater Management Model (SWMM 5). This model will be developed and calibrated using sewer maps, rain gauge data, and flow monitoring data provided by The City of Windsor. Soil, elevation, and land use data will also be considered. Once the SWMM model is calibrated, the output rainfall-runoff timeseries can be used as inputs for the SUSTAIN model, which will be used for optimization and scenario analysis.





SUSTAIN Example LID Definition

Green Roof

Property	Optimization?
Length (ft)	Y
# Units	Y
Width (ft)	N
Design Drainage Area (ac)	N
Exit Type	N
Orifice Diameter (in)	N
Orifice Height (Ho, ft)	N
Wier Crest Width (B, ft)	N
Depth of Soild, Ds (ft)	Y
Depth of Soild, Ds (ft)	Y
Soil Porosity (0-1)	N
Soil Field Capacity	N
Soil Wilting Point	N
Initial Survace Water Depth (ft)	N
Initial Moisture Content (0-1)	N
Saturated Soil Infiltration (in/hr)	N
ET Multiplier	N
Storage Depth (Du, ft)	N
Media Void Fraction (0-1)	N
Background Infiltration (in/hr)	N

Grassed Swale

Property	Optimization?
Manning's N	N
Width (ft)	N
Lenth (ft)	Y
Max. Depth (ft)	Y
Slope 1	N
Slope 2	N
Slope 3	N
# of units	Y
Design Drainage Area (ac)	N
Depth of Soil, Ds (ft)	Y
Soil Porosity (0-1)	N
Soil Field Capacity	N
Soil Wilting Point	N
Initial Survace Water Depth (ft)	N
Initial Moisture Content (0-1)	N
Saturated Soil Infiltration (in/hr)	N
ET Multiplier	N
Storage Depth (Du, ft)	N
Media Void Fraction (0-1)	N
Background Infiltration (in/hr)	N

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