SWAT LID Module

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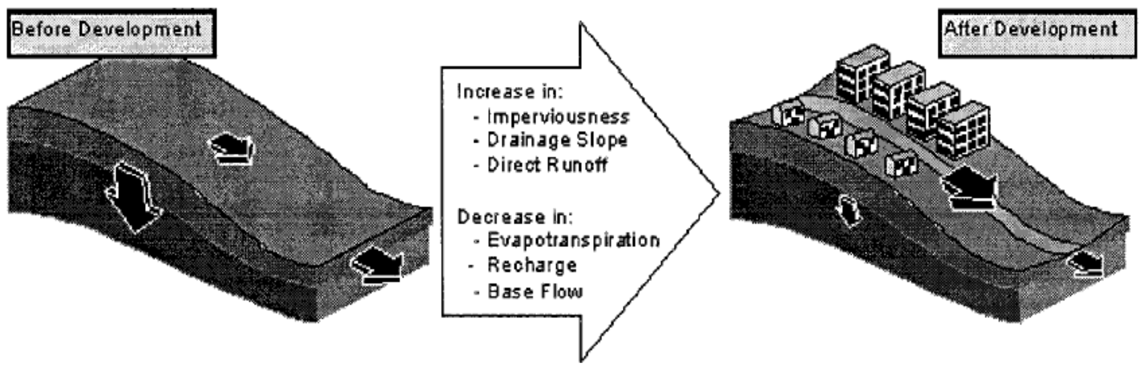
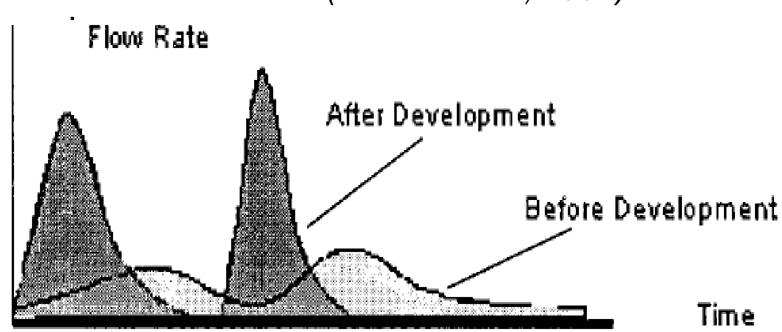
SWAT & Urban Modeling

- Urbanization & Hydrology
  - Increase in impervious cover promotes higher runoff and lower infiltration
  - Stream flow gets flashy
  - Urban Non-Point Sources



(Roesner et al., 2001)



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LID Practices of Interest

- Low Impact Development (LID)
  - Stormwater management practices
  - On-site micro-scale controls
- Types of Lands where LIDs are placed

Land-Use Type	Green Roof	Rain Garden	Cistern	Porous Pavement
Residential	O	O	O	X
Commercial	O	O	O	X
Industrial	O	O	O	X
Civic	O	O	O	X
Parks	X	O	X	X
Transportation	X	O	X	X
Parking Lots	X	X	X	O

  - A cistern is usually connected to a green roof

LID Simulation Strategies

- SWAT subdaily simulation module
- Urban BMPs & LID (Green Infrastructure)

Subdaily model

- ✓ SWAT modules for sub-hourly simulation
- ✓ Overland flow, stream flow, ponds, reservoirs, and point sources
- ✓ Soil erosion and sediment transport

Urban BMPs

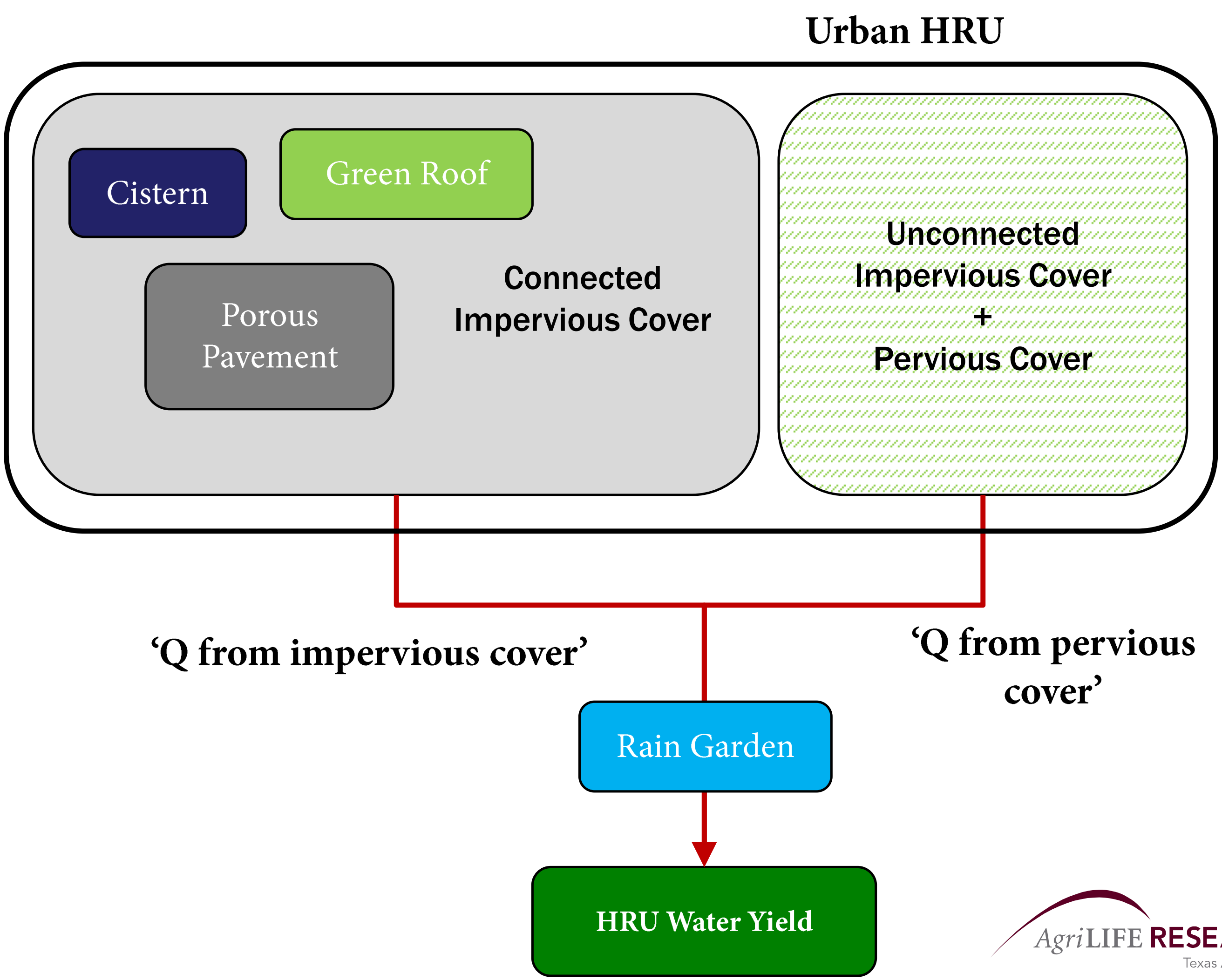
- ✓ Sedimentation-Filtration basin
- ✓ Retention-Irrigation basin
- ✓ Detention pond
- ✓ Wet pond

Green Infrastructure

- ✓ Green roof
- ✓ Rain garden
- ✓ Cistern
- ✓ Porous pavement

LID Simulation Strategies

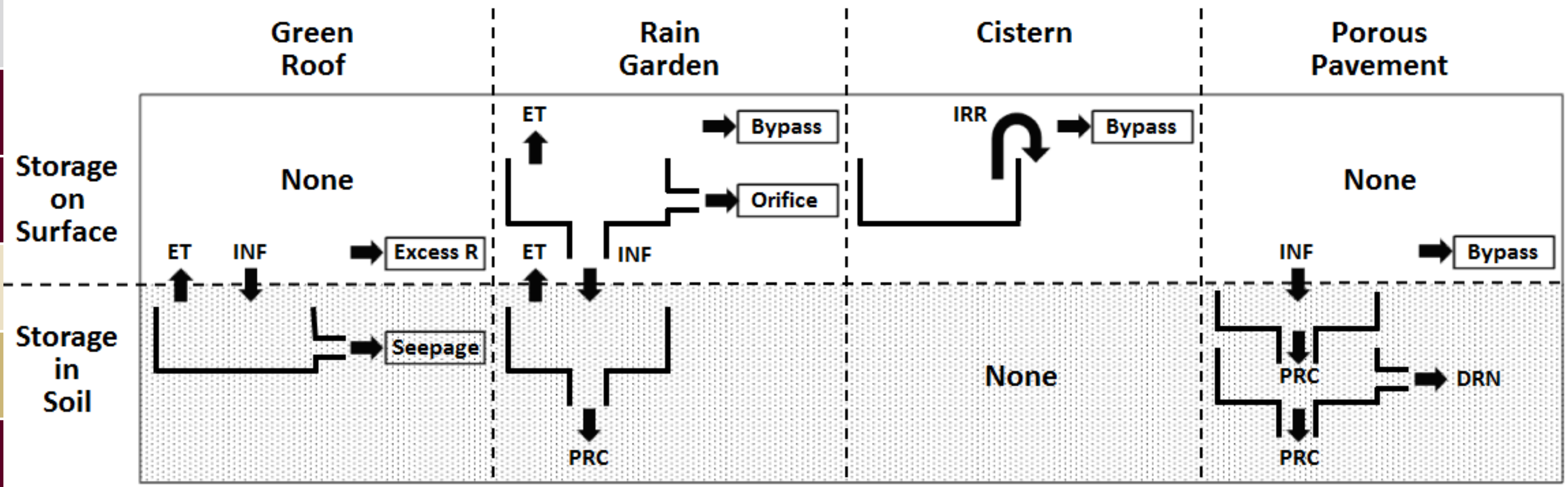
- Direct runoff partitioning



LID Simulation Strategies

- Storages of the LID practices

Storage Type	Green Roof	Rain Garden	Cistern	Porous Pavement
Amended soil layer	O	O	X	O
Surface storage	X	O	O	X
Gravel bed layer	X	X	X	O
No. Storages	1	2	1	2



LID Simulation Strategies

- Infiltration & percolation rates
  - Infiltration rate: Green-Ampt equation
  - Unsaturated hydraulic conductivity: Van Genuchten equation
  - Percolation rate = Anisotropic coefficient * Sat .Hyd. Cond.

Fig. 1. Comparison of excess rainfall hydrographs calculated using Green-Ampt & CN

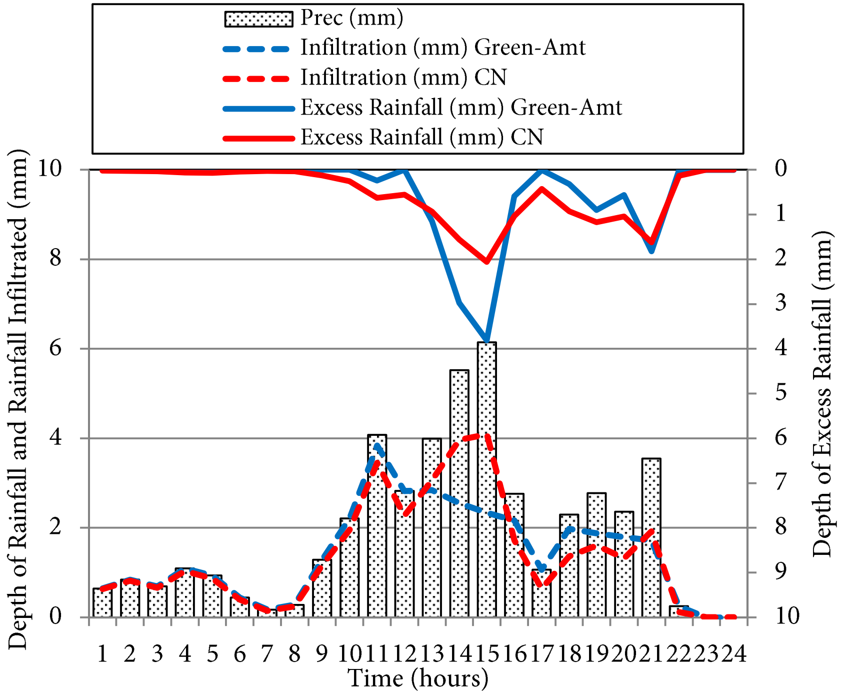
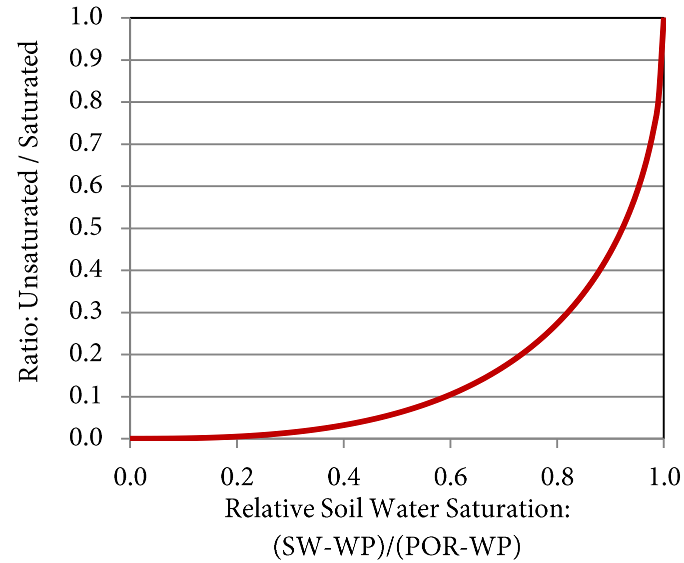


Fig. 2. Response of unsaturated hydraulic conductivity ratio to soil water content



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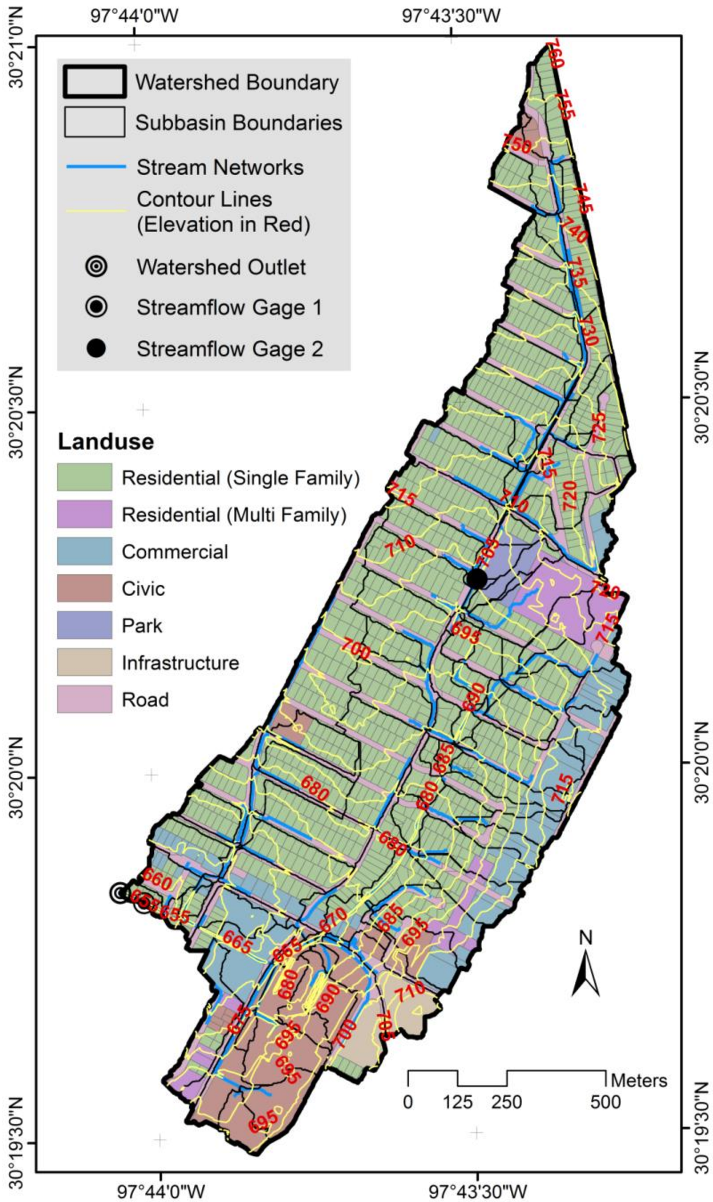
SWAT for Brentwood Watershed

- Brentwood WS
  - Austin, TX
  - 149.8 ha
  - Highly urbanized
  - Monitored by City of Austin
- SWAT
  - Prepared by City of Austin
  - Great details
    - 137 subbasins (1.1 ha/sub)
    - 1212 HRUs (0.12 ha/HRU)
  - Calibrated by BRC



SWAT for Brentwood Watershed

- **Calibrated SWAT**
  - 'Good' performance; overestimated runoff volume

Fig. 1. Comparison of observed & simulated daily runoff

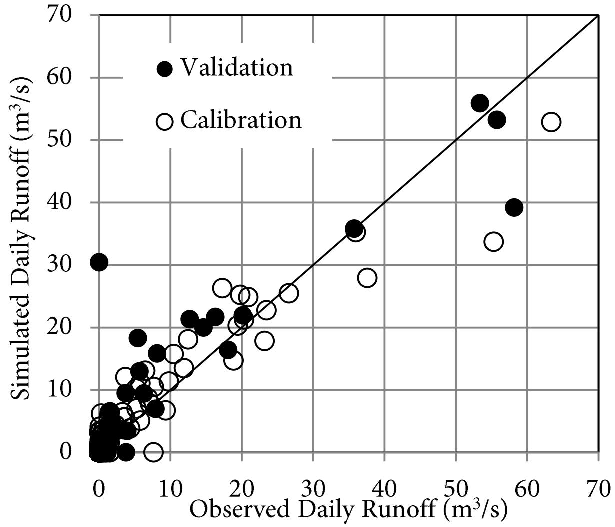


Fig. 2. Comparison of observed & simulated monthly runoff hydrographs

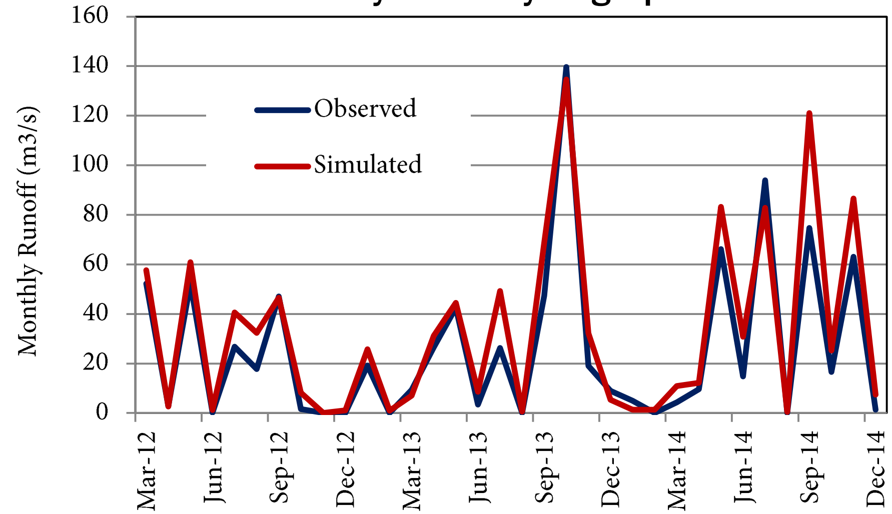


Table. 1. Performance statistics of the calibrated SWAT model

Period	NSE			R^2		
	15-min	Daily	Monthly	15-min	Daily	Monthly
Calibration	0.88	0.91	0.91	0.89	0.91	0.94
Validation	0.71	0.84	0.73	0.71	0.86	0.89

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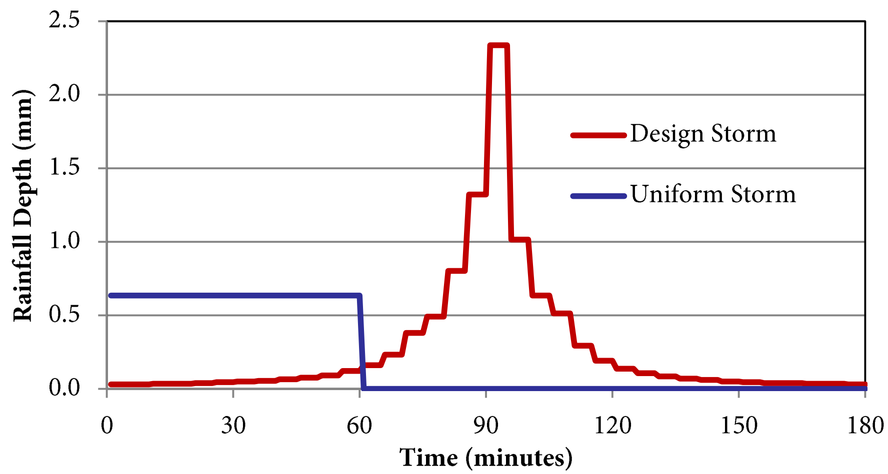
Sensitivity Analysis

- Runoff sensitivity to LID configurations
  - Green roof: porosity
  - Rain garden: hydraulic conductivity
  - Porous pavement: gravel depth & porosity
- Sensitivity is responsive to storm events
  - 38.1-mm, 1-hour uniform storm vs. 1-year, 3-hour design storm (49 mm, City of Austin)
  - Critical storm event

Fig. 1. Comparison of design and uniform storms



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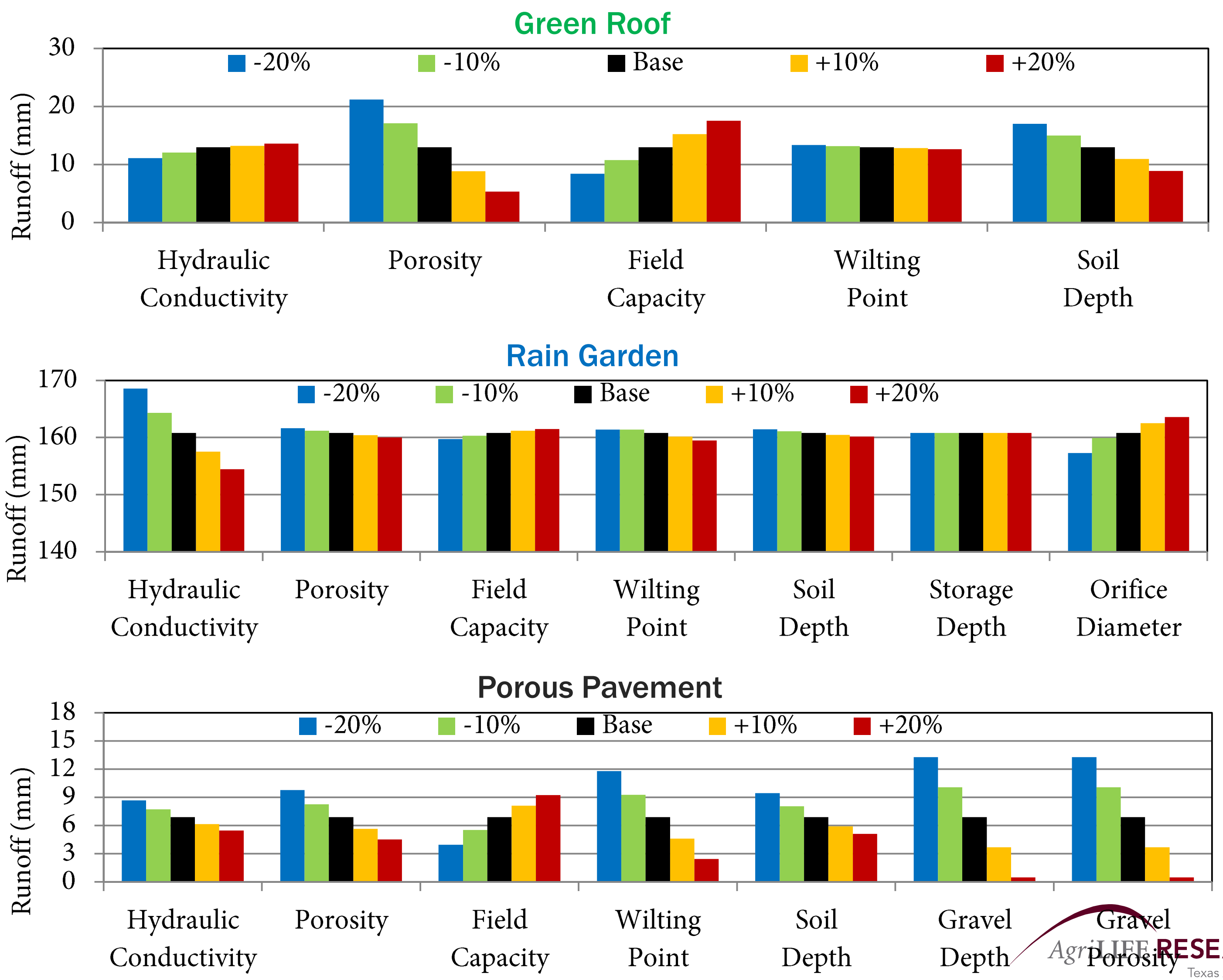
Sensitivity Analysis



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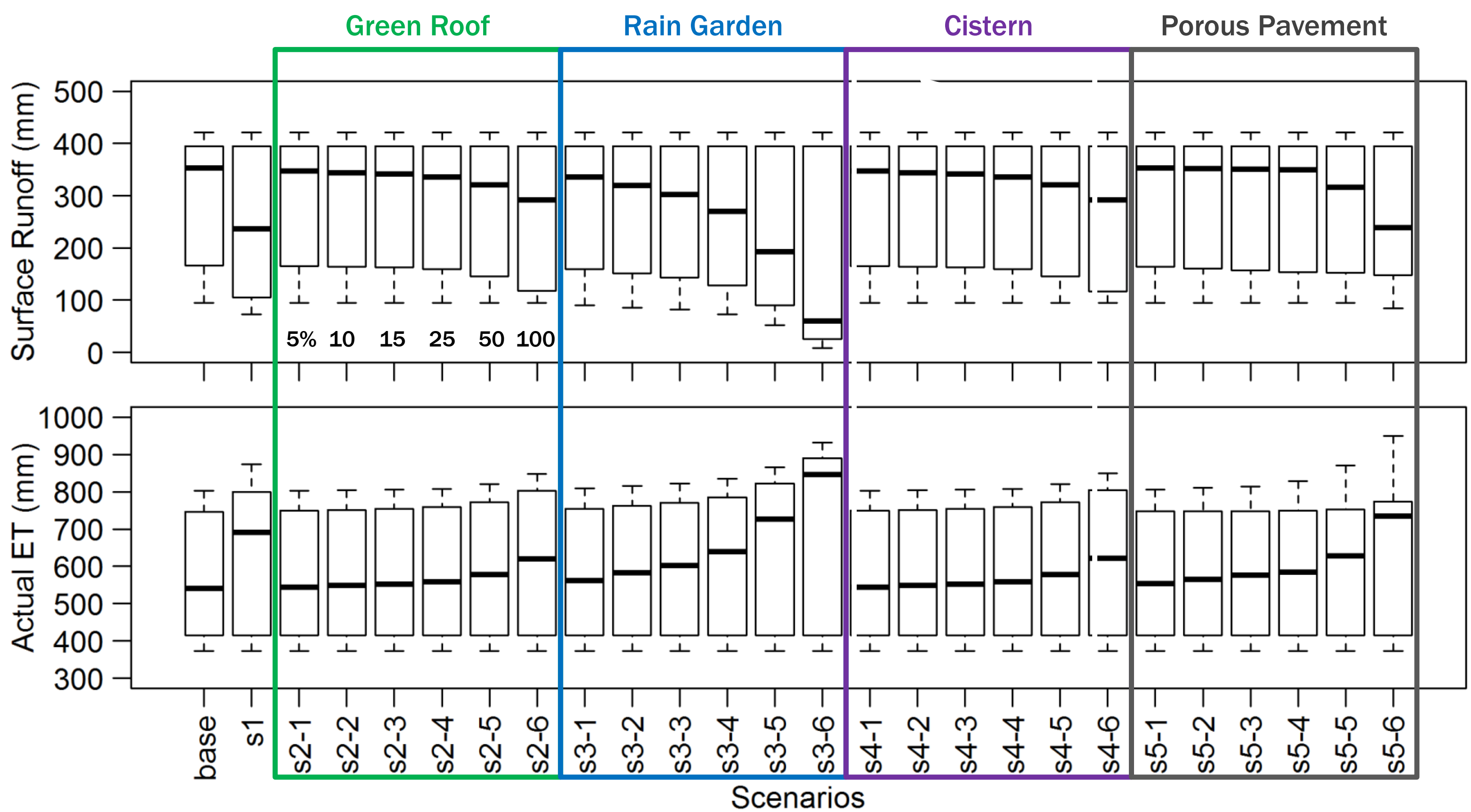
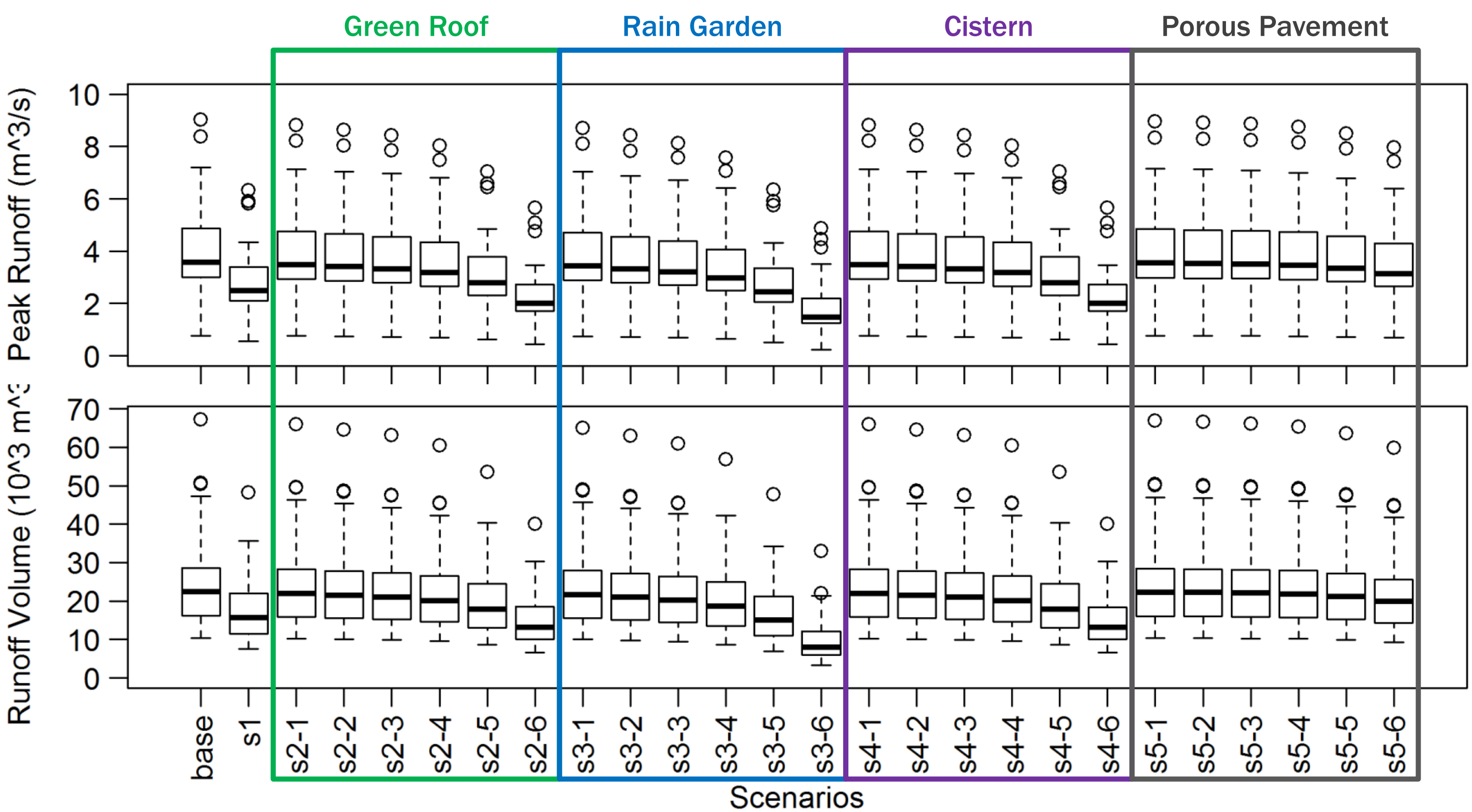
Scenario Analysis

- As LID adaptation rate increases:
  - Surface runoff decreases
  - ET increases



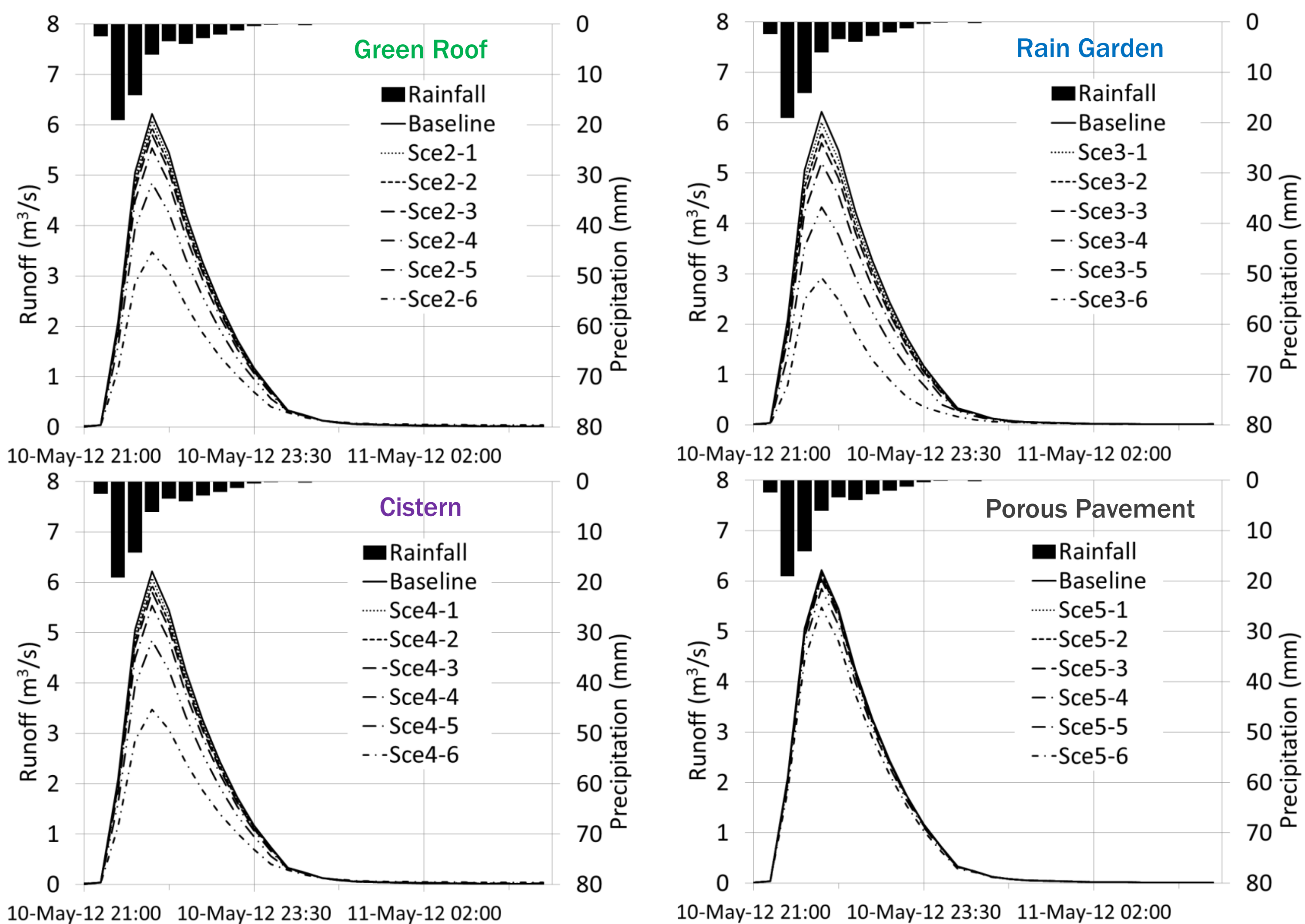
Scenario Analysis

- As LID adaptation rate increases:
  - Peak runoff & runoff volume decreases



Scenario Analysis

- Hydrographs at the watershed outlet



Field Scale Validation

- Green Roof

Lady Bird Johnson Wildflower Center (U of Texas, Austin) & City of Austin

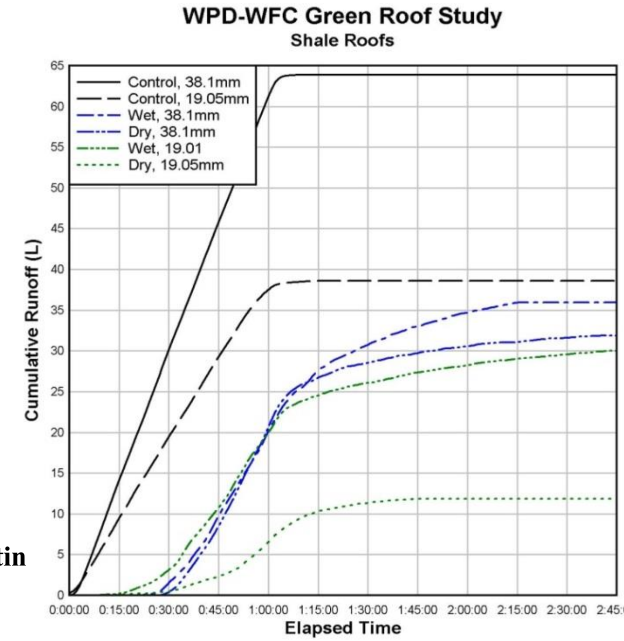


Fig. 1. Simulated runoff of a green roof