Roadside Swales Infiltration Performance Calculator

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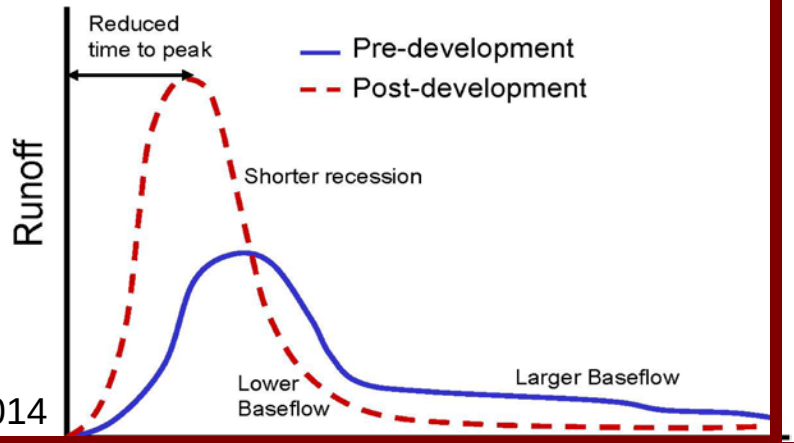
Problem Statement

Stormwater Runoff: non-point source of pollution

Water Quality

Runoff from highways:
TSS, Nutrients, Metals, Organic Compounds

Water Quantity



Liu et al., 2014

Green Infrastructure

"reduces and treats stormwater at its source" US. EPA

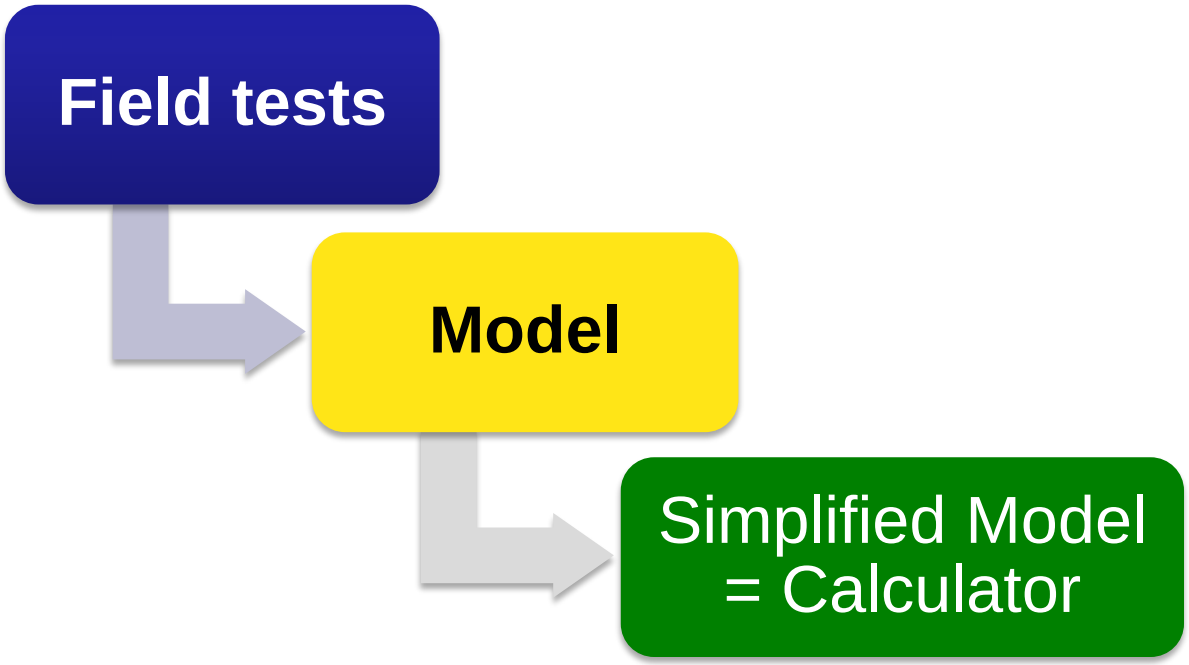
- Ponds
- Infiltration basins
- Rain gardens
- Green roofs

ROADSIDE DRAINAGE DITCHES = FILTER STRIPS / SWALES

Twincities.com

Roadside Drainage Ditches / Swales

Project Steps:

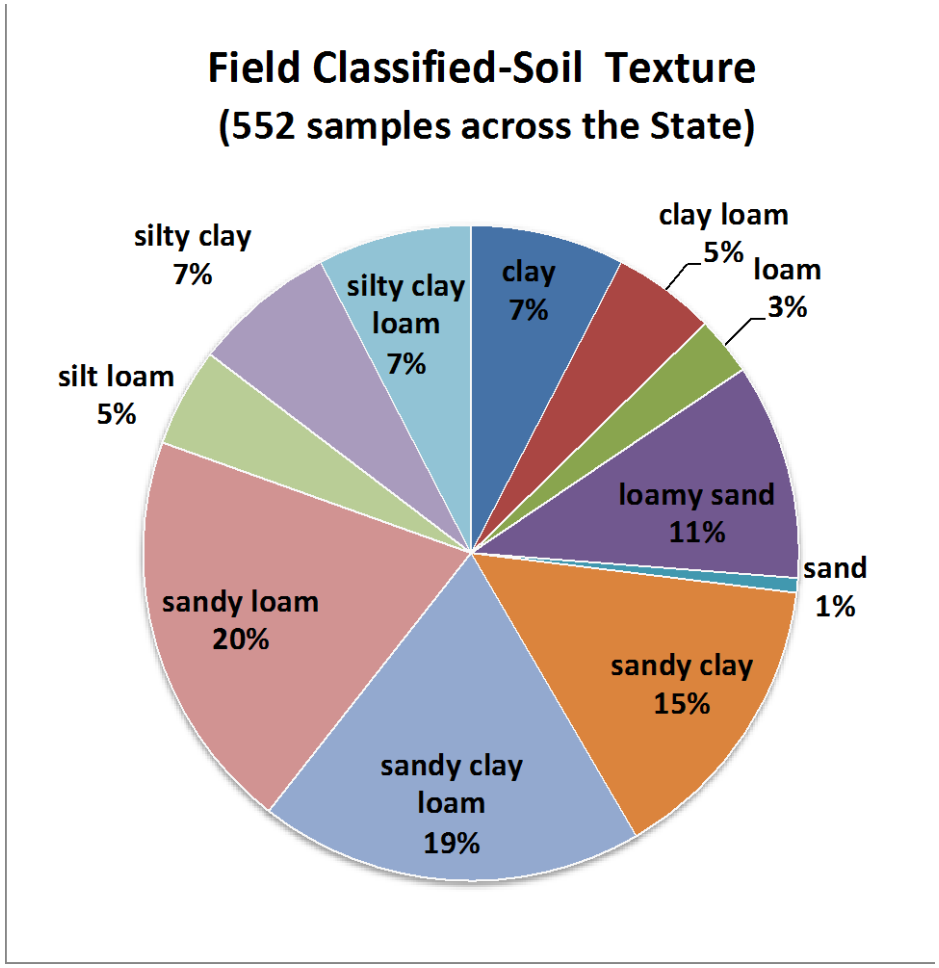


Field Experiments

Field Experiments

- **Simulated Runoff Tests**
  - 4 Highways in TC Metro Area
    - 2 sites/Hwy
  - 3 intensities
    - 1, 2, 10-year storms
  - 3 Seasons
    - Fall, Spring, and Summer

Field Experiments



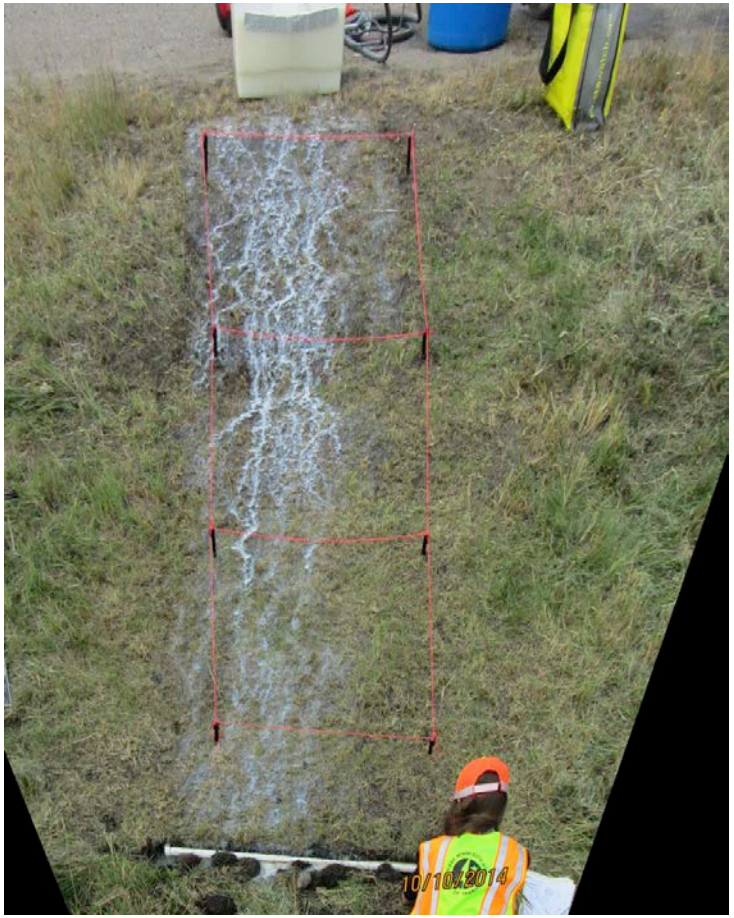
Soil Types

- Loam
- Loamy sand
- Sandy loam
- Sandy clay loam

➢53% soils found in Minnesota road embankments

Field Experiments

Field Experiments



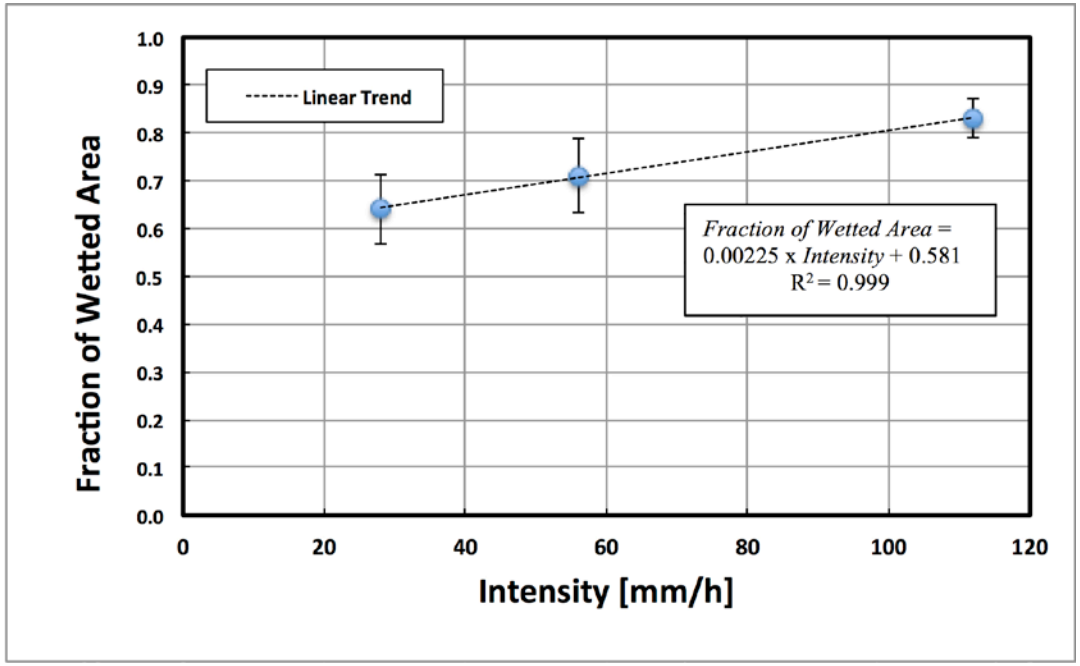
Field Experiments

Saturated Hydraulic Conductivity (K_{sat}) measurements

	Ksat (cm/h)
Hwy 51	3.54 (1.44)*
Hwy 77	5.74 (0.94)*
Hwy 47	3.47 (1.29)*
Hwy 13	4.14 (1.87)*

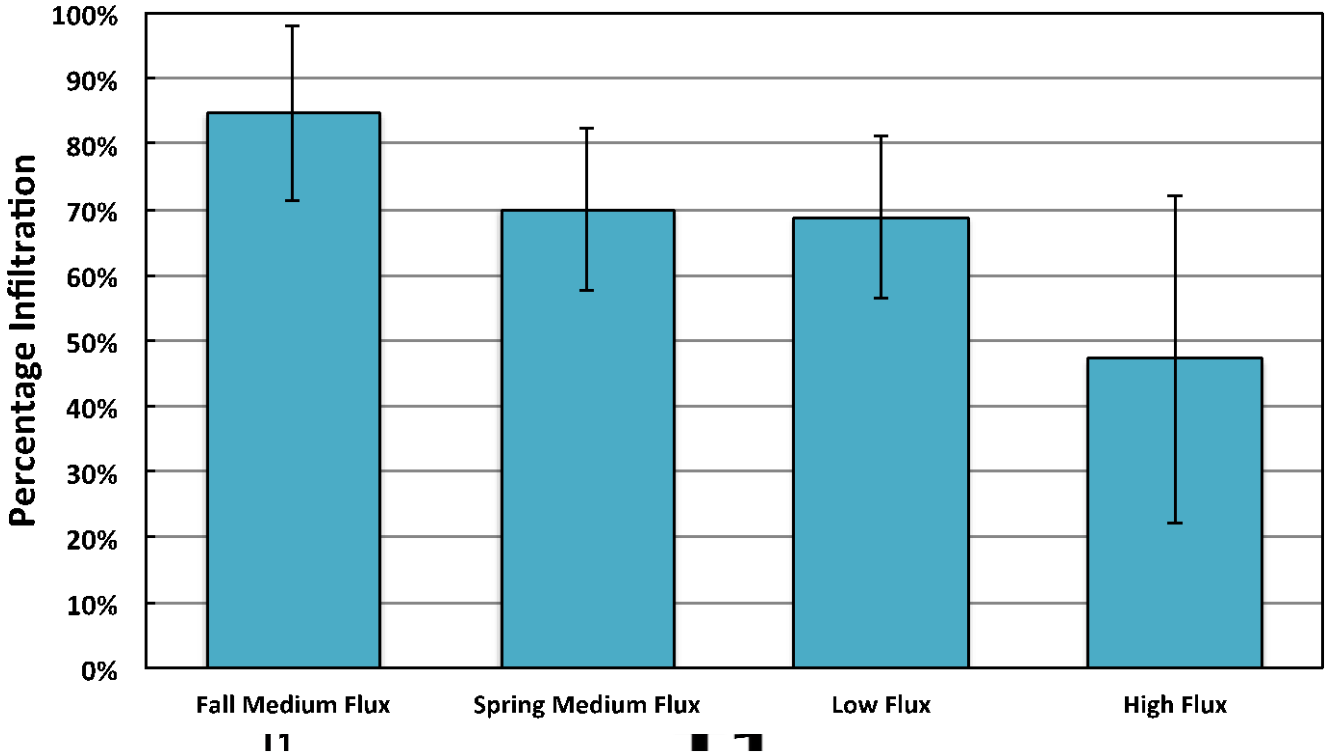
Field Experiments

Results



Field Experiments

Results

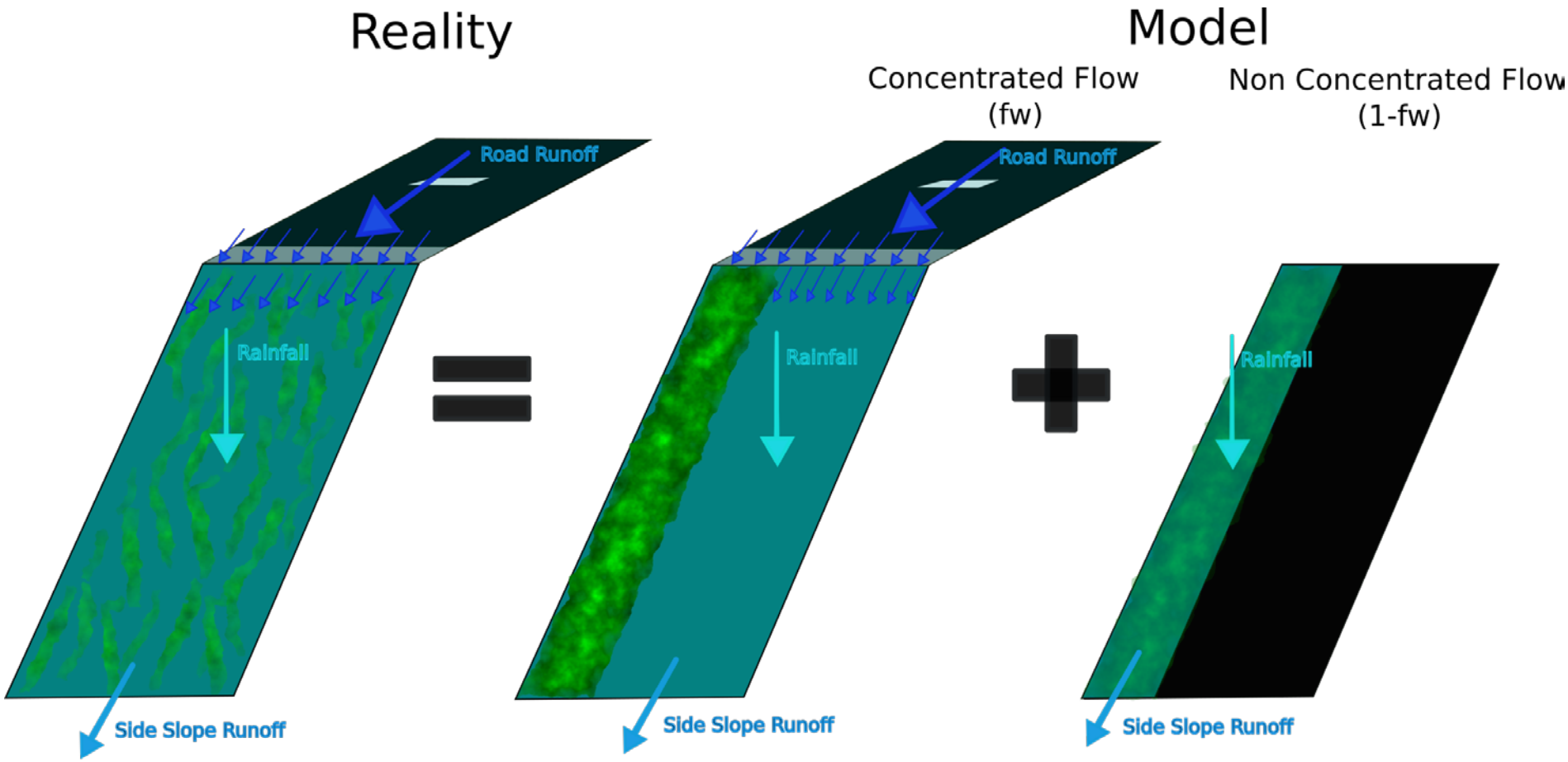


Fall
2-year

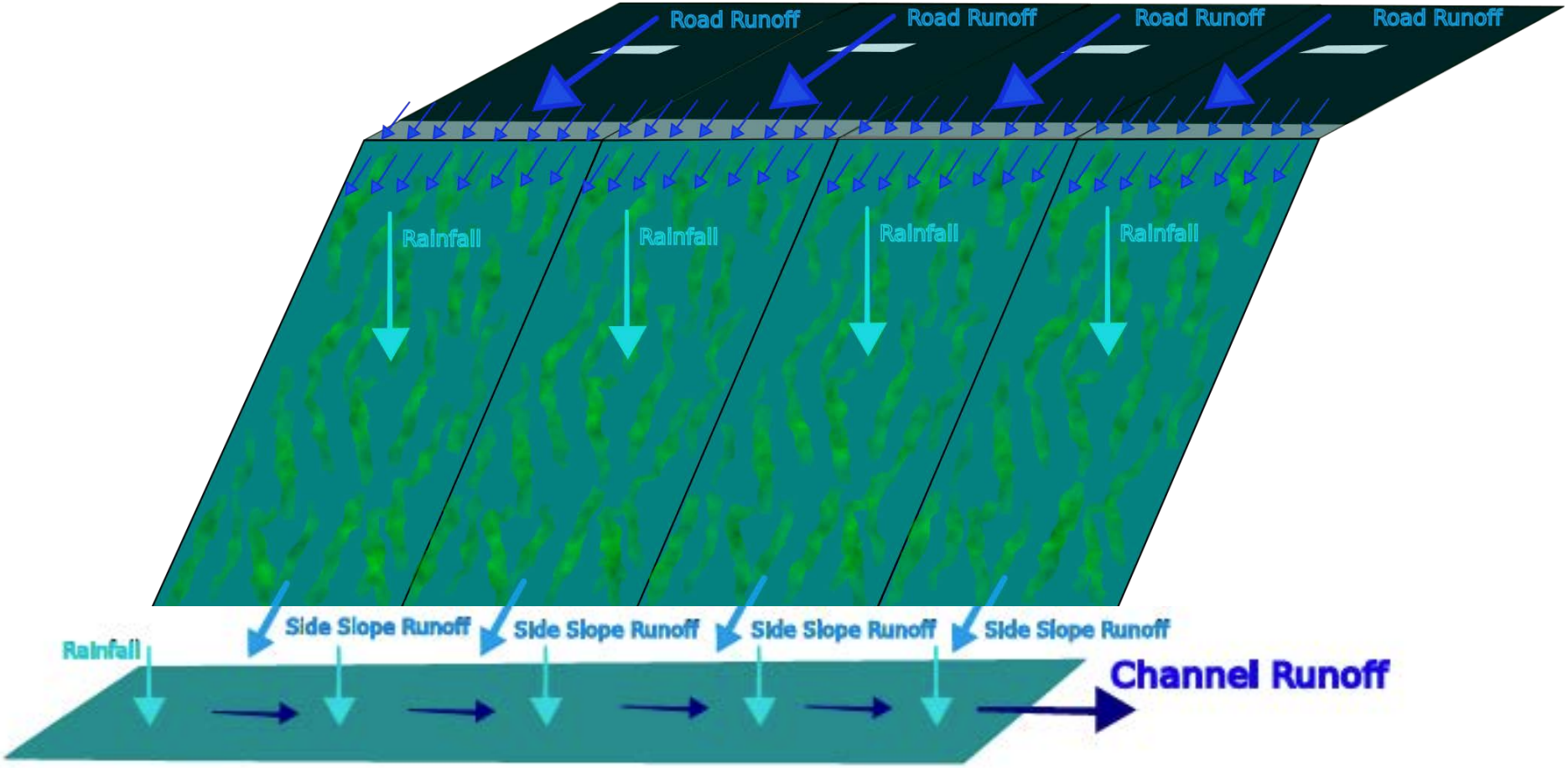
Fall
2-year

Infiltration-Overland Flow Model

Infiltration-Overland Flow Model

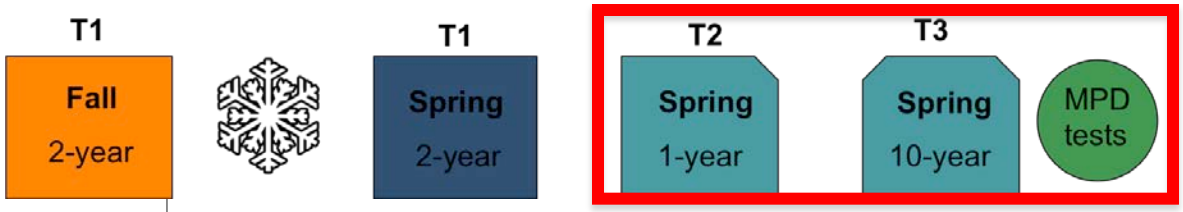


Infiltration-Overland Flow Model



Infiltration-Overland Flow Model

Validation

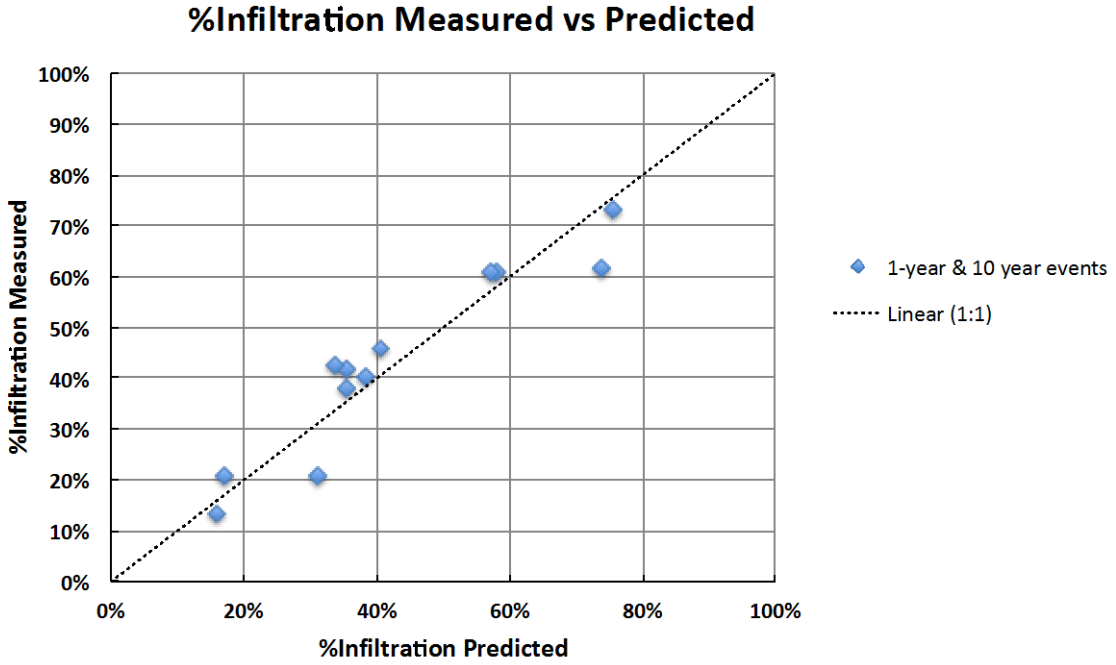


K_{sat} input: estimated in the field

N=12

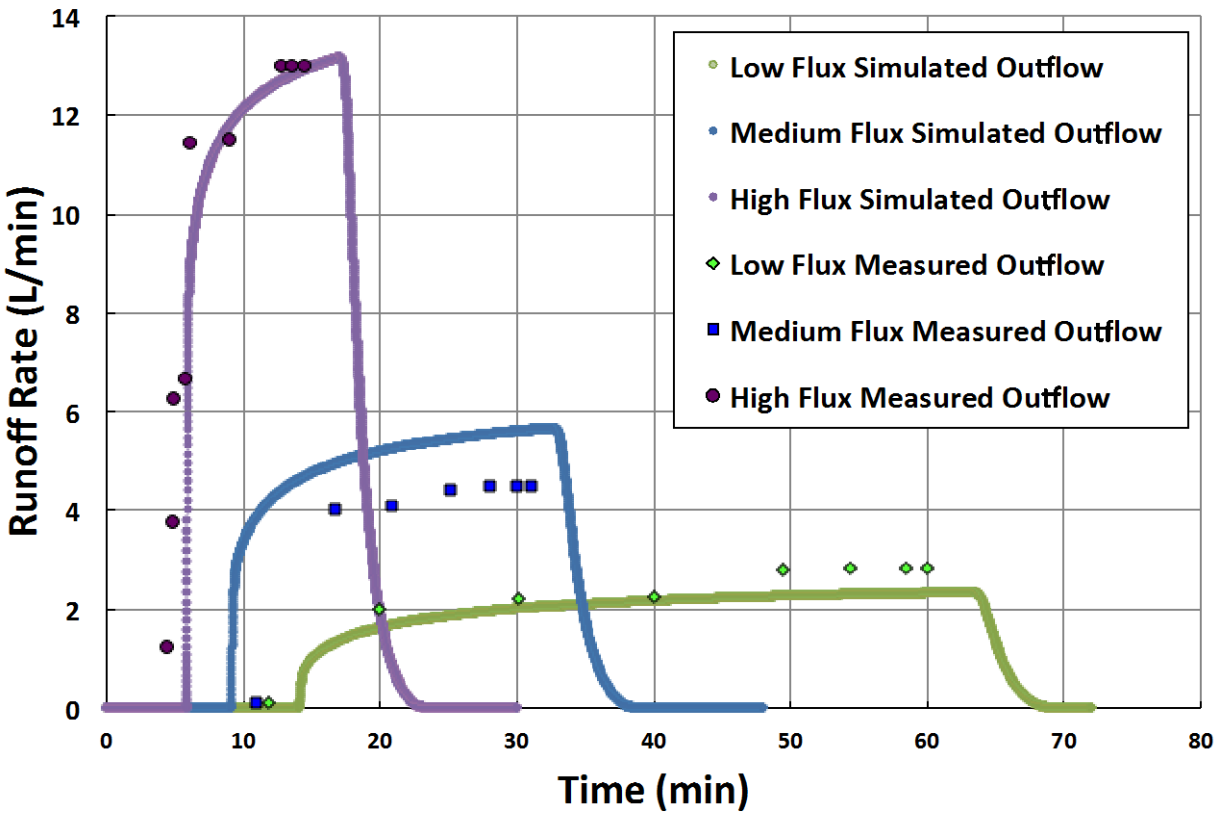
RMSE= 6%

Normalized MSE= 12%



Infiltration-Overland Flow Model

Validation



Infiltration-Overland Flow Model

Matlab Model

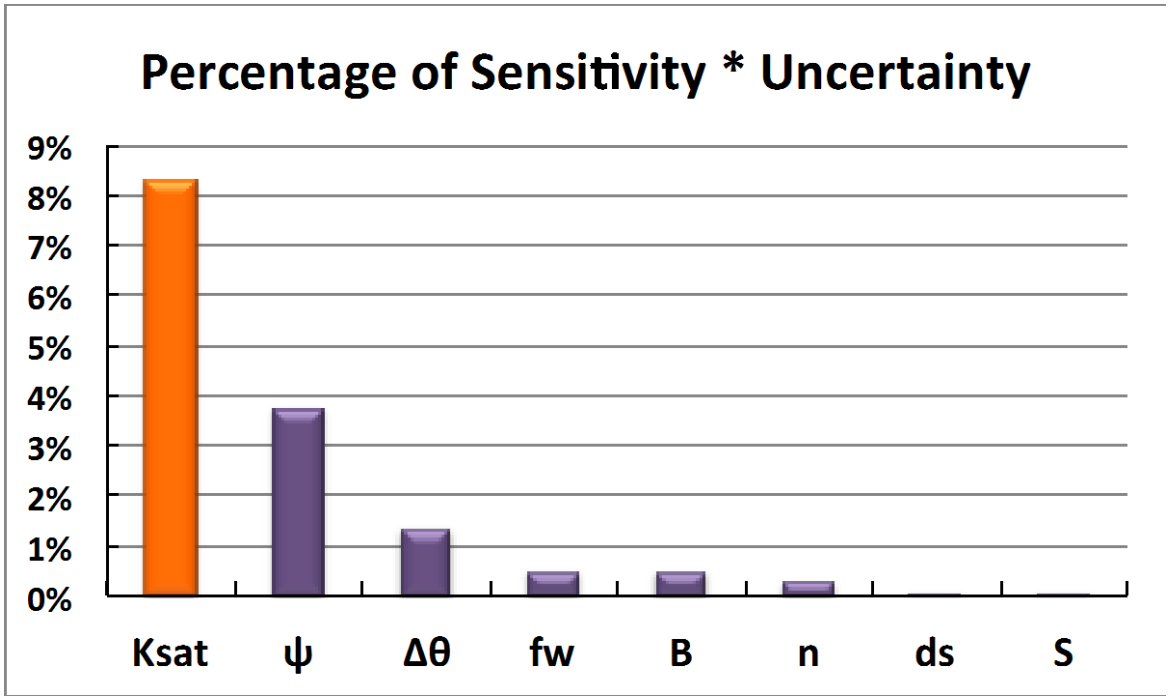
Inputs:

- Rainfall intensity (i)
- Duration of storm event (t)
- Length of side slope (L)
- Soil suction head (ψ)
- Soil water deficit (Δθ)
- Saturated Hydraulic Conductivity (K_s)
- Width of swale and channel (w) (B)
- Fraction wetted (f_w)
- Side slope (S)
- Manning's n (n)
- Depression storage (ds)

Simplification of the Model
=
Swale Calculator

Simplification of the Model

Sensitivity and Uncertainty Analyses

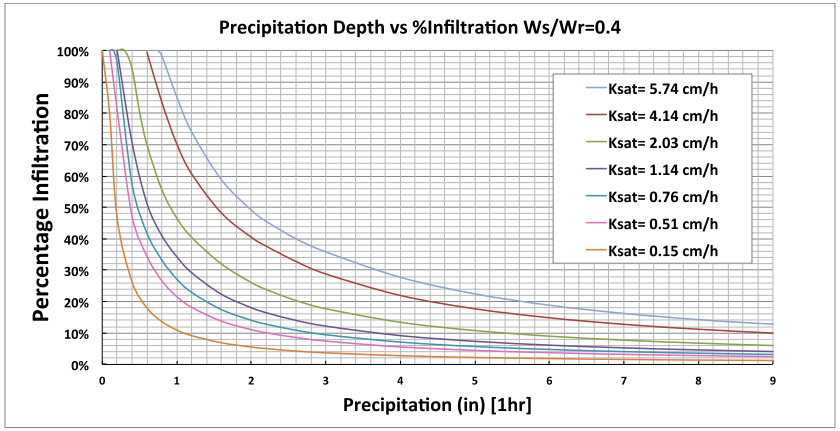


Swale Calculator

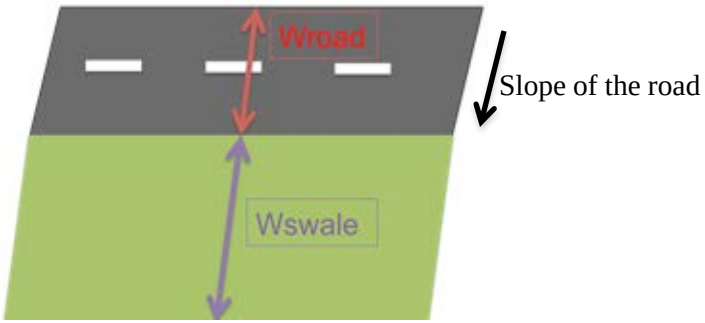
1- Saturated Hydraulic Conductivity (K_{sat})

Ahmed et al. (2015)

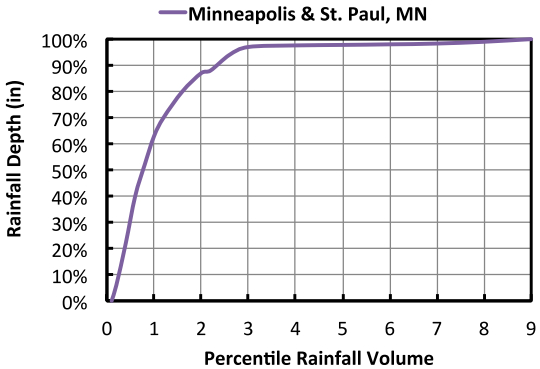
3- K_{sat} + W_{swale} / W_{road} = % Infiltration



2-Width of the road and side slope



4-Location (Percentile Rainfall Volume)

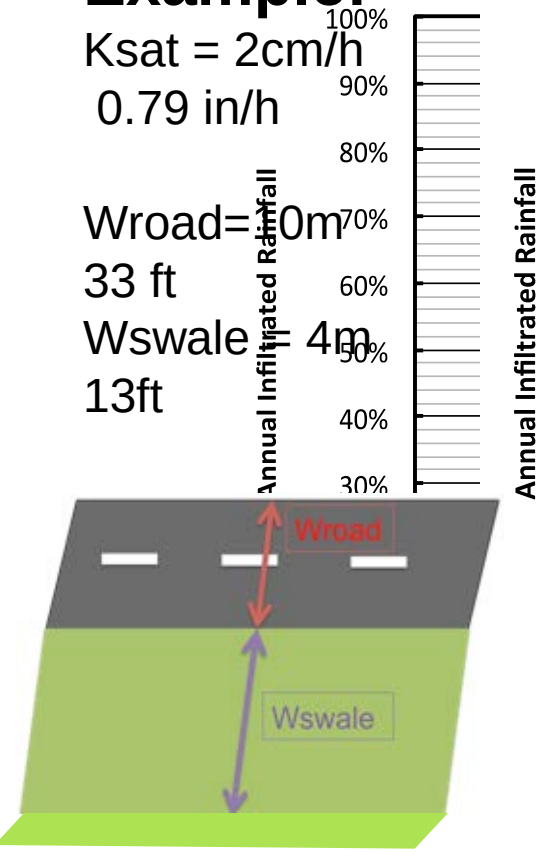


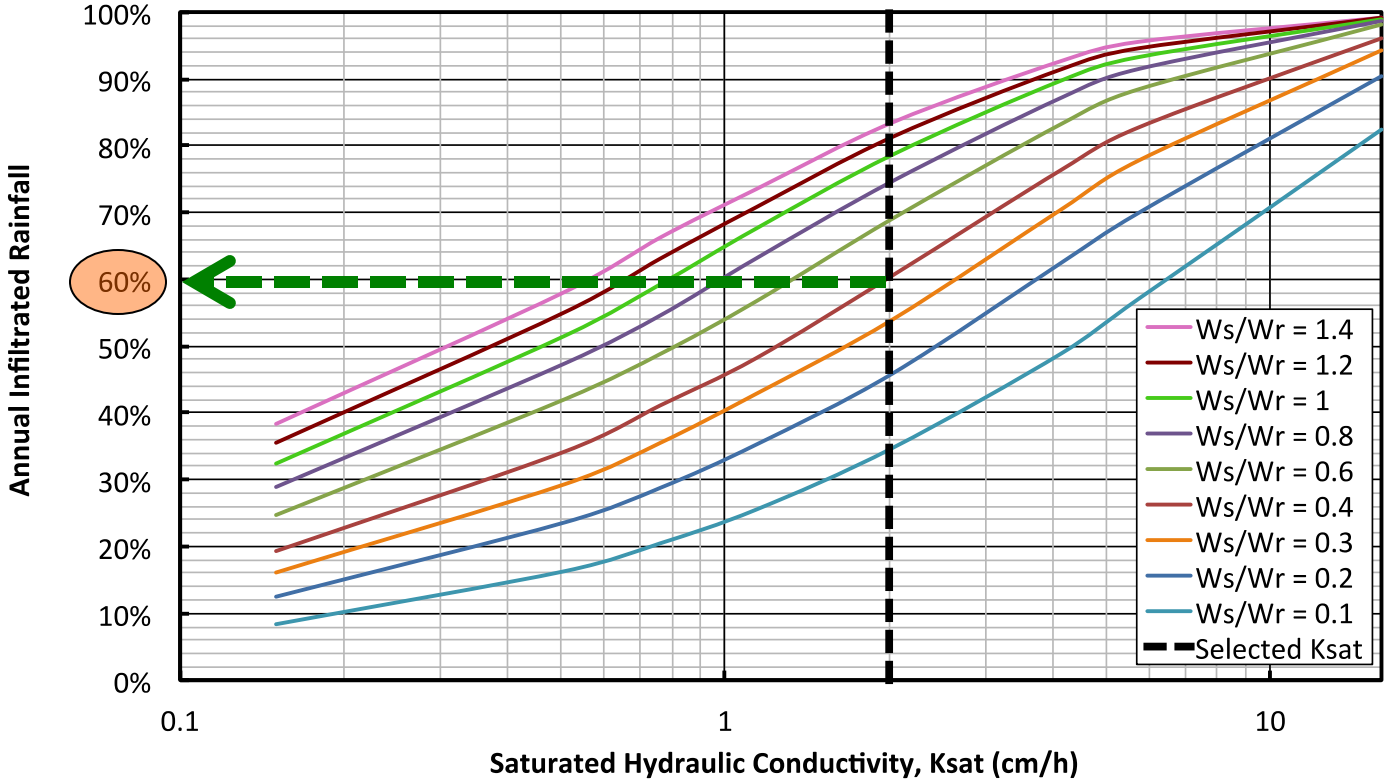
Swale Calculator

Example:

Ksat = 2cm/h
0.79 in/h

Wroad=10m
33 ft
Wswale = 4m
13ft



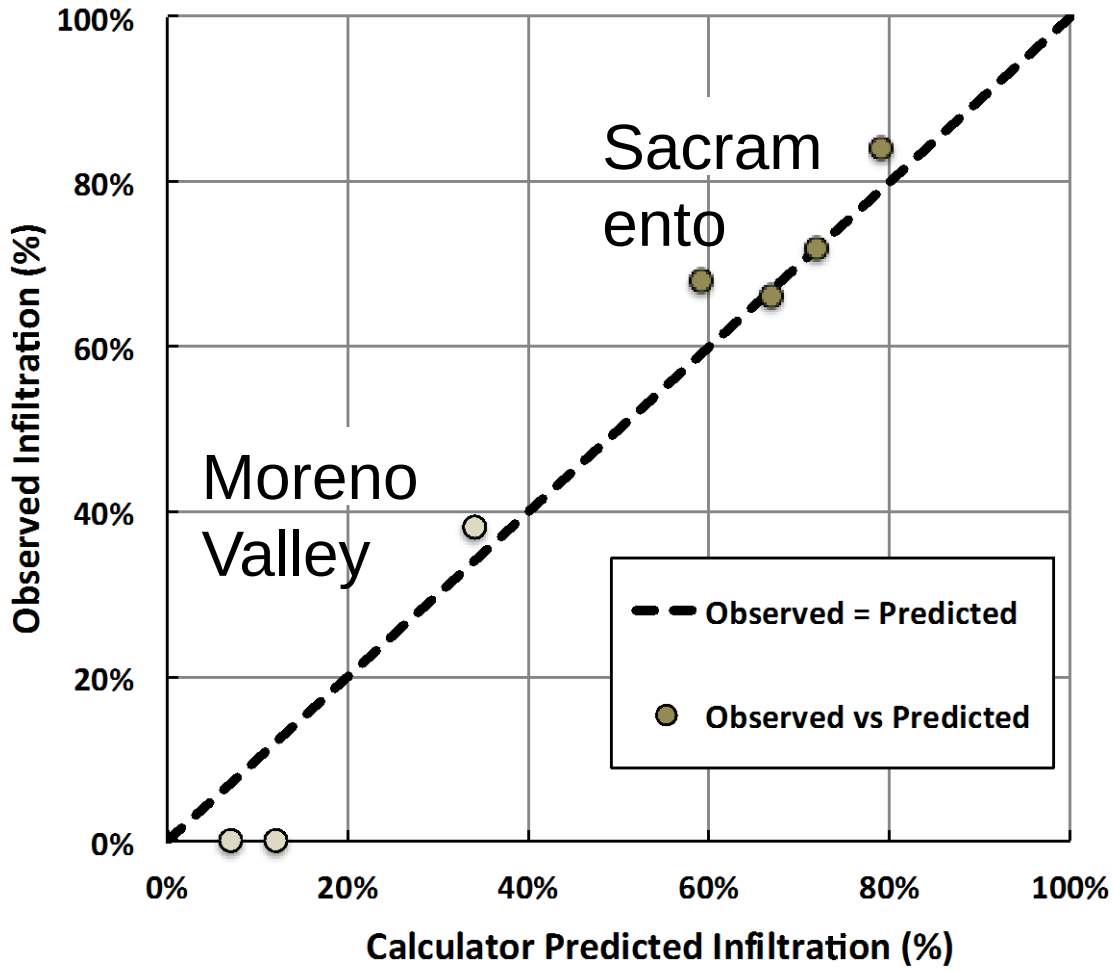


Swale Calculator – Case Study

California

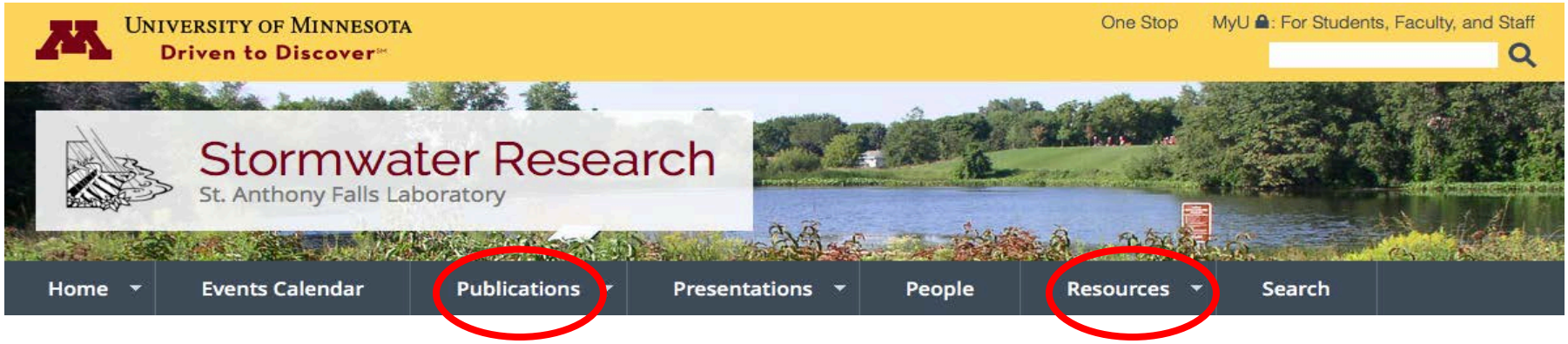
Caltrans (2003)

Location	Filter Width [m]	K_{sat} [cm/h]
Sacramento	1.1	4.08
	4.6	2.41
	6.6	2.17
	8.4	2.39
Moreno Valley	2.6	0.22
	4.9	0.3
	9.9	1.03



Download Calculator

- http://stormwater.safl.umn.edu



- ***RESOURCES/ROADSIDE SWALE CALCULATOR***
- ***PUBLICATIONS/REPORTS***

Acknowledgements

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- Minnesota Department of Transportation (MnDOT)
  - Barbara Loida, Technical Liaison
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- Student researchers David Liddell, Raphael Martins, Tyler Olsen, and Anthony Vecchi.

➢ **http://stormwater.safl.umn.edu**

Roadside Drainage Ditches/Swales
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Stormwater Management Practice

SMPs are closer than they appear

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