MIDS Work Group Meeting
December 17, 2010

Performance Goals Evaluation: Stormwater Runoff Rates, Volumes, and Pollutants

BARR

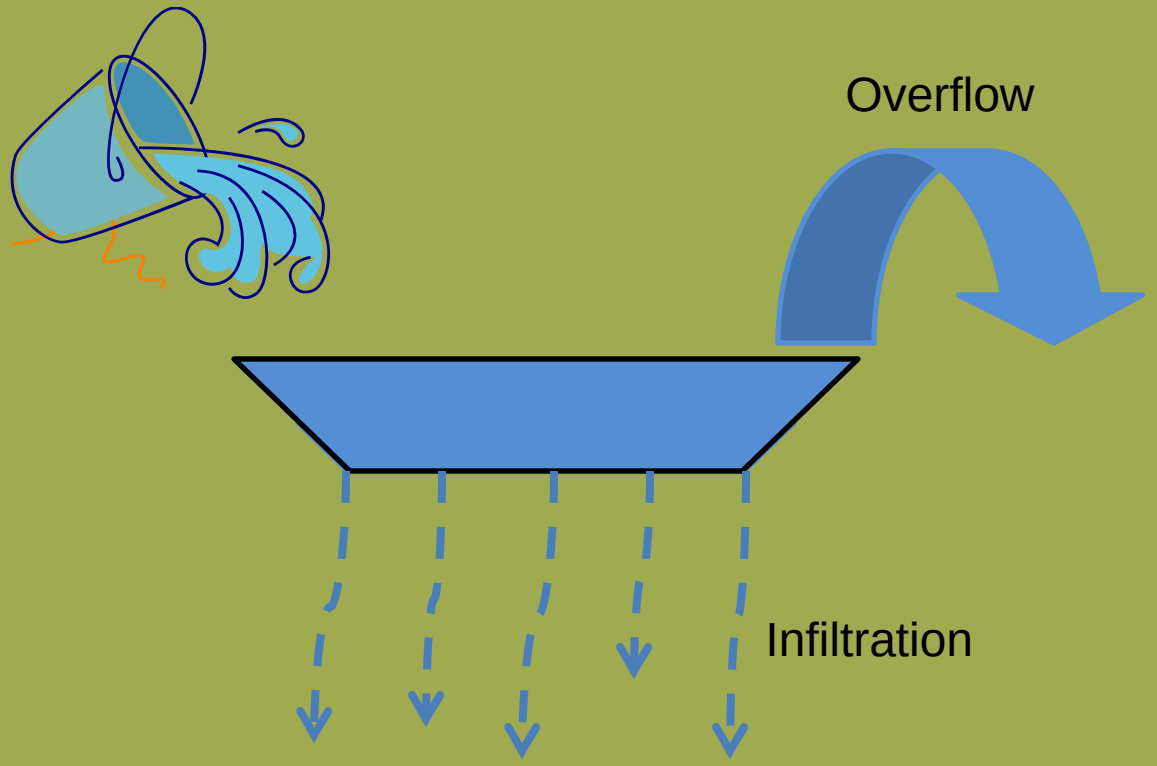
Presentation Outline

- Discuss impacts of runoff rate control
- Continue comparison of runoff volume from common performance goals
- Discuss pollutant removals
- Highlight key factors in selecting performance goal

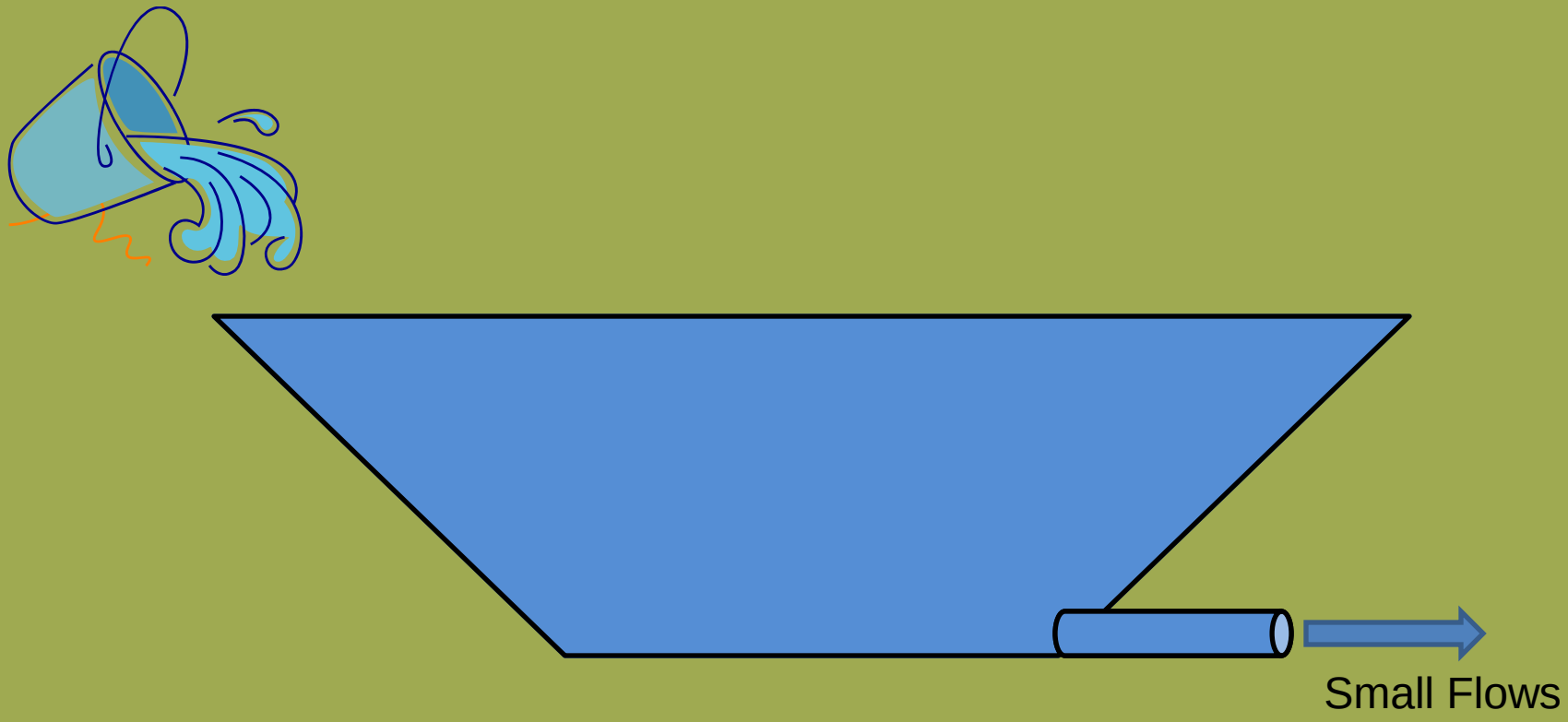
Assess Mimicry of Native Hydrology

- Develop long-term (35 years) continuous simulation model to estimate average annual native runoff
- Use model to evaluate how well rate and volume control standards mimic native runoff

Volume Control BMP



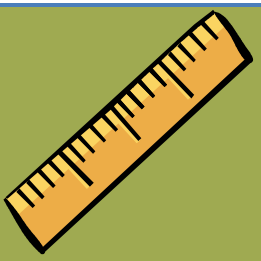
Rate Control BMP



Model 10-Acre Site in Twin Cities Ecoregion

Condition	Hydrologic Soils Group			
	A	B	C	D
Native: 100% Deciduous Forest	X	X	X	X
Native: 100% Meadow	X	X	X	X
Developed: 20% Impervious Surface		X	X	
Developed: 50% Impervious Surface		X	X	
Developed: 80% Impervious Surface		X	X	

Developed Site Volume Control Performance Goals Modeled



1. Retain a runoff volume equal to one inch times the proposed impervious surfaces

2. Retain the post-construction runoff volume on site for the 95th percentile storm

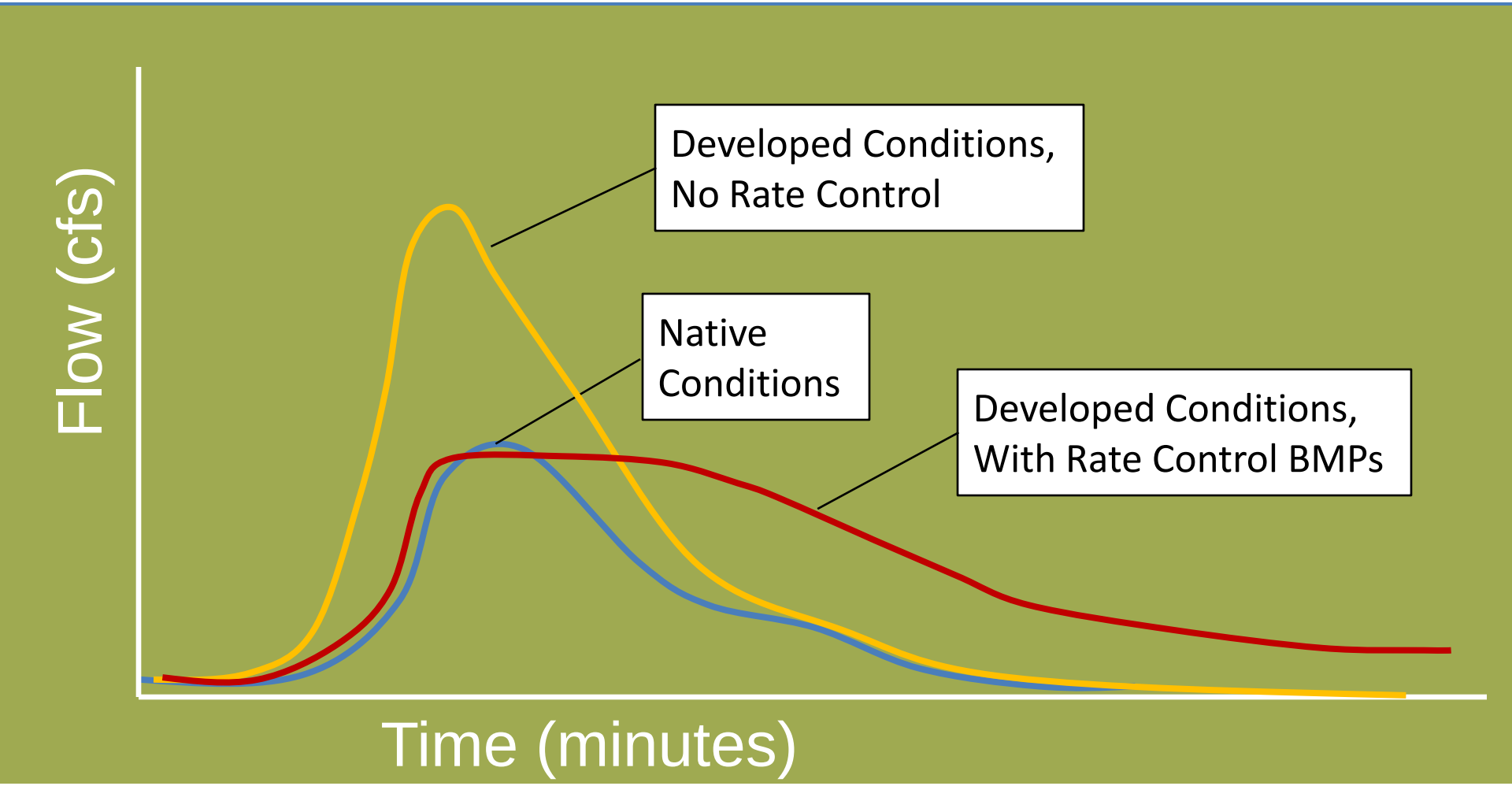
3. Match the native runoff volume for the
   a. 1-year 24-hour design storm
   b. 2-year 24-hour design storm

Developed Site Runoff Rate Control Performance Goals Modeled

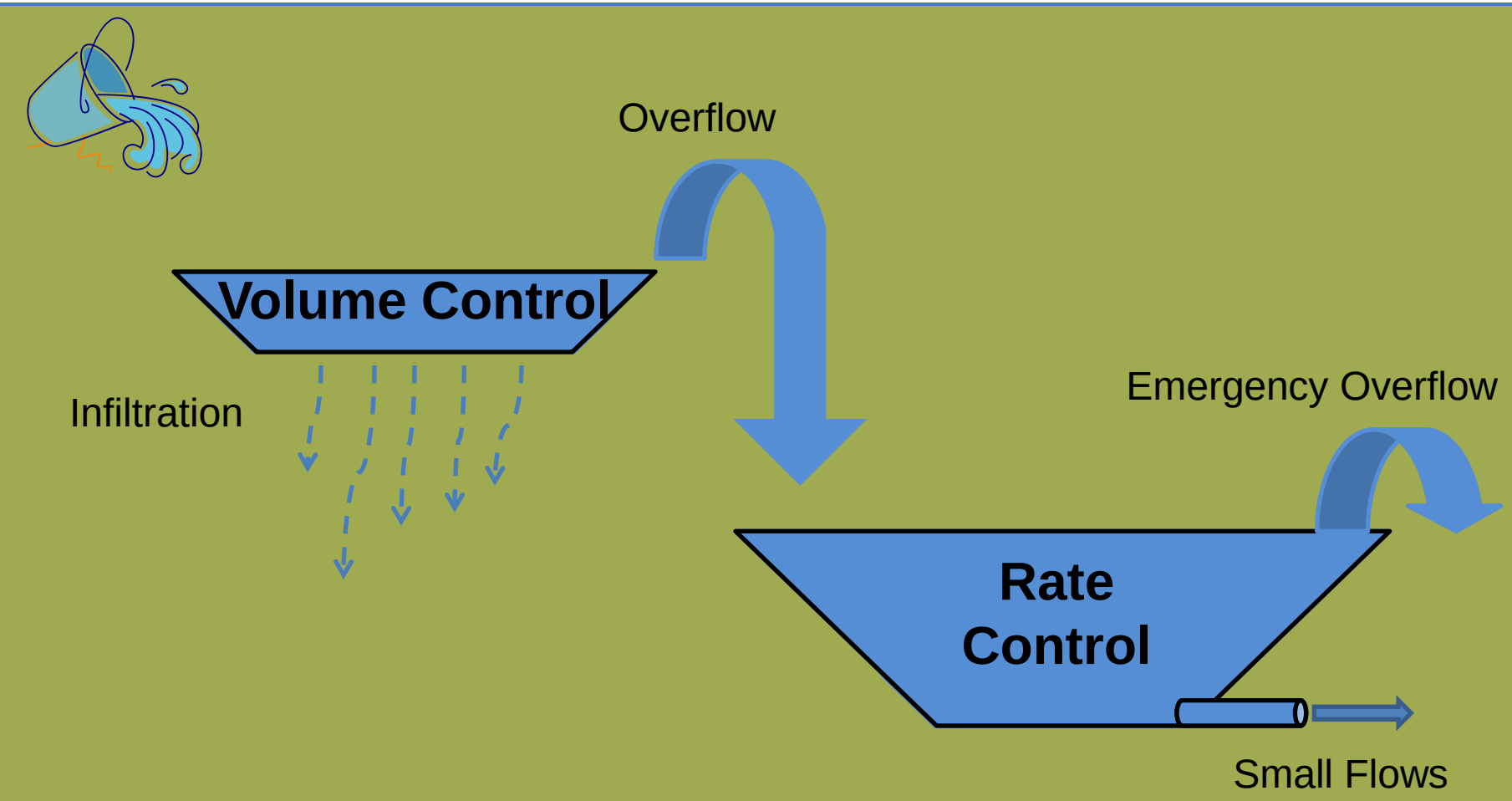
- Peak flow from developed conditions must not exceed peak flow from native meadow site conditions for the 1-, 2-, 10-, and 100-year 24-hour design storm events

- Outlets from rate control BMPs sized to meet standard
  - Involves modeling native conditions and sizing developed sites' BMPs to not exceed

Runoff Rate Control Summary

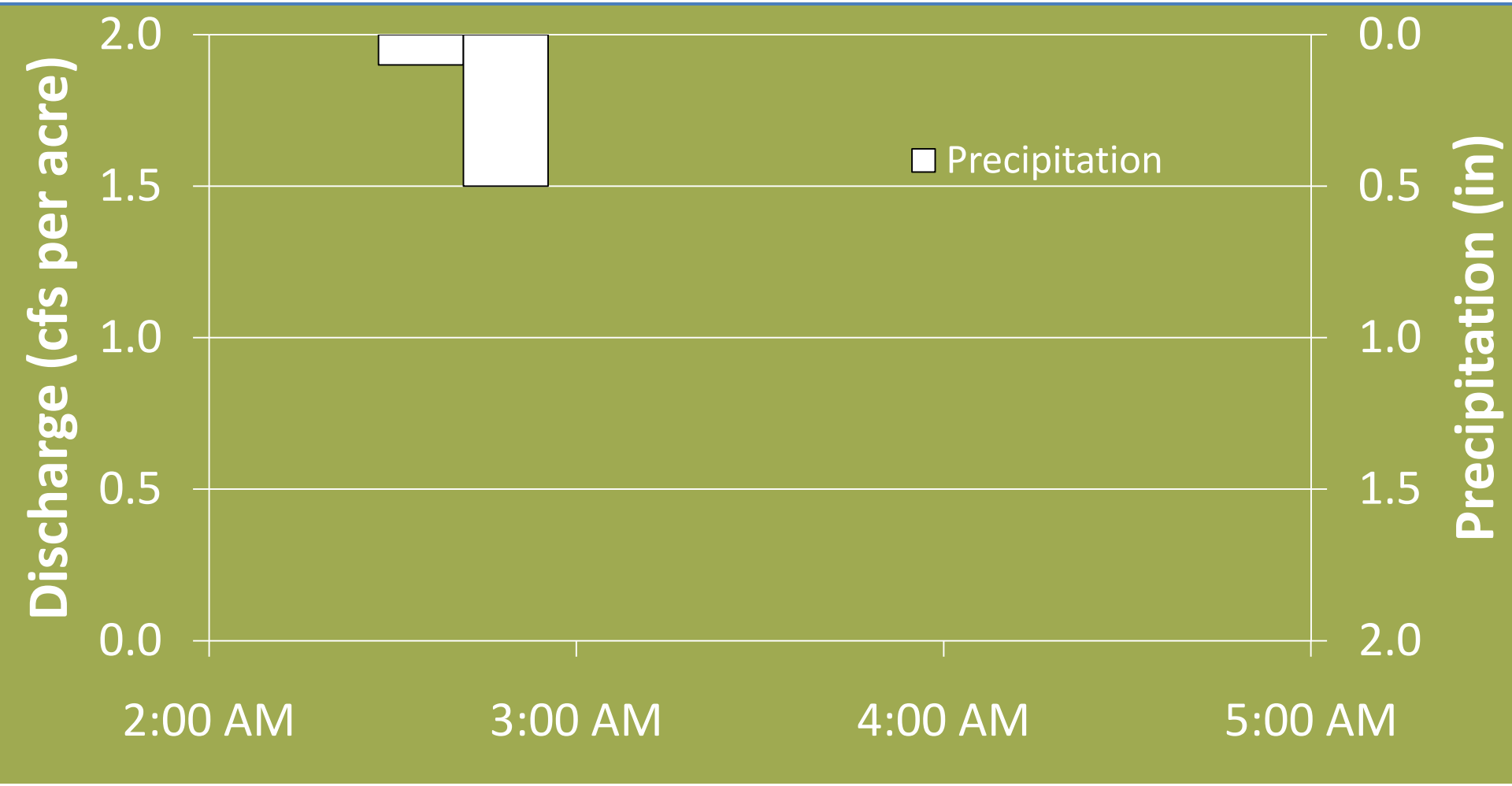


Volume and Rate Control BMPs in Series



Rate Control: 9/12/1978 0.6" Rain Event

Native Forest Conditions, C Soils



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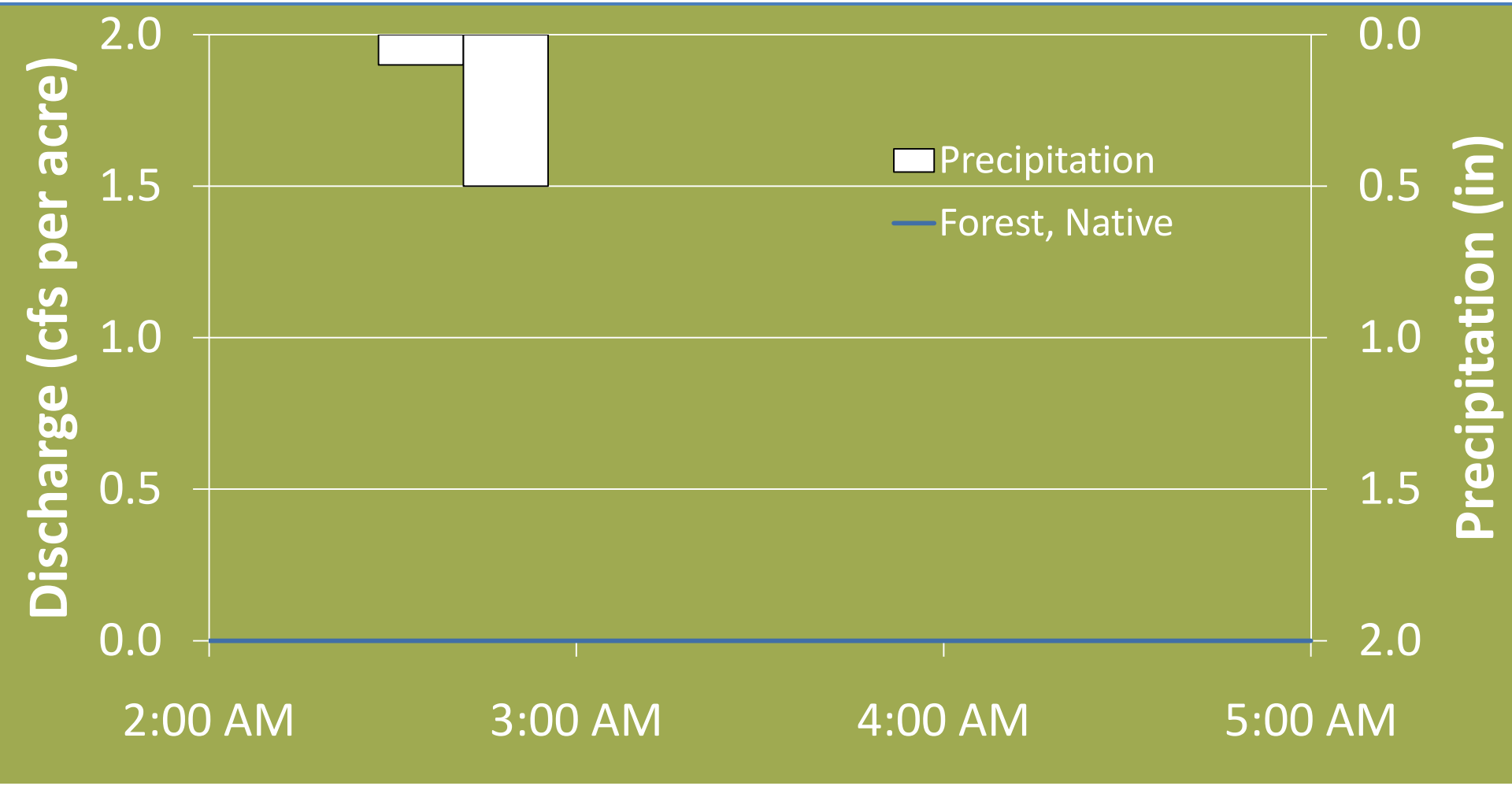

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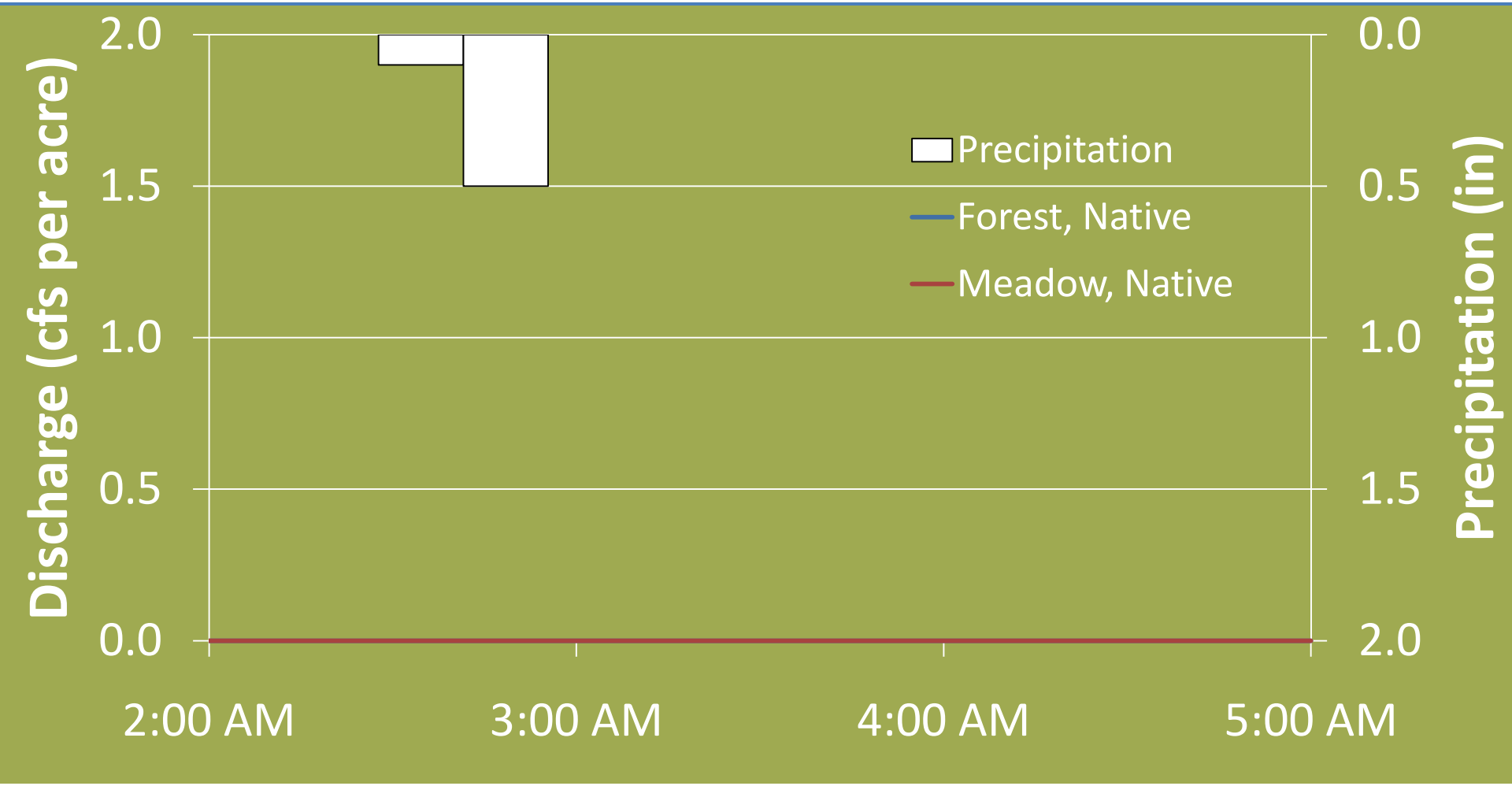
Native Forest and Native Meadow Conditions, C Soils



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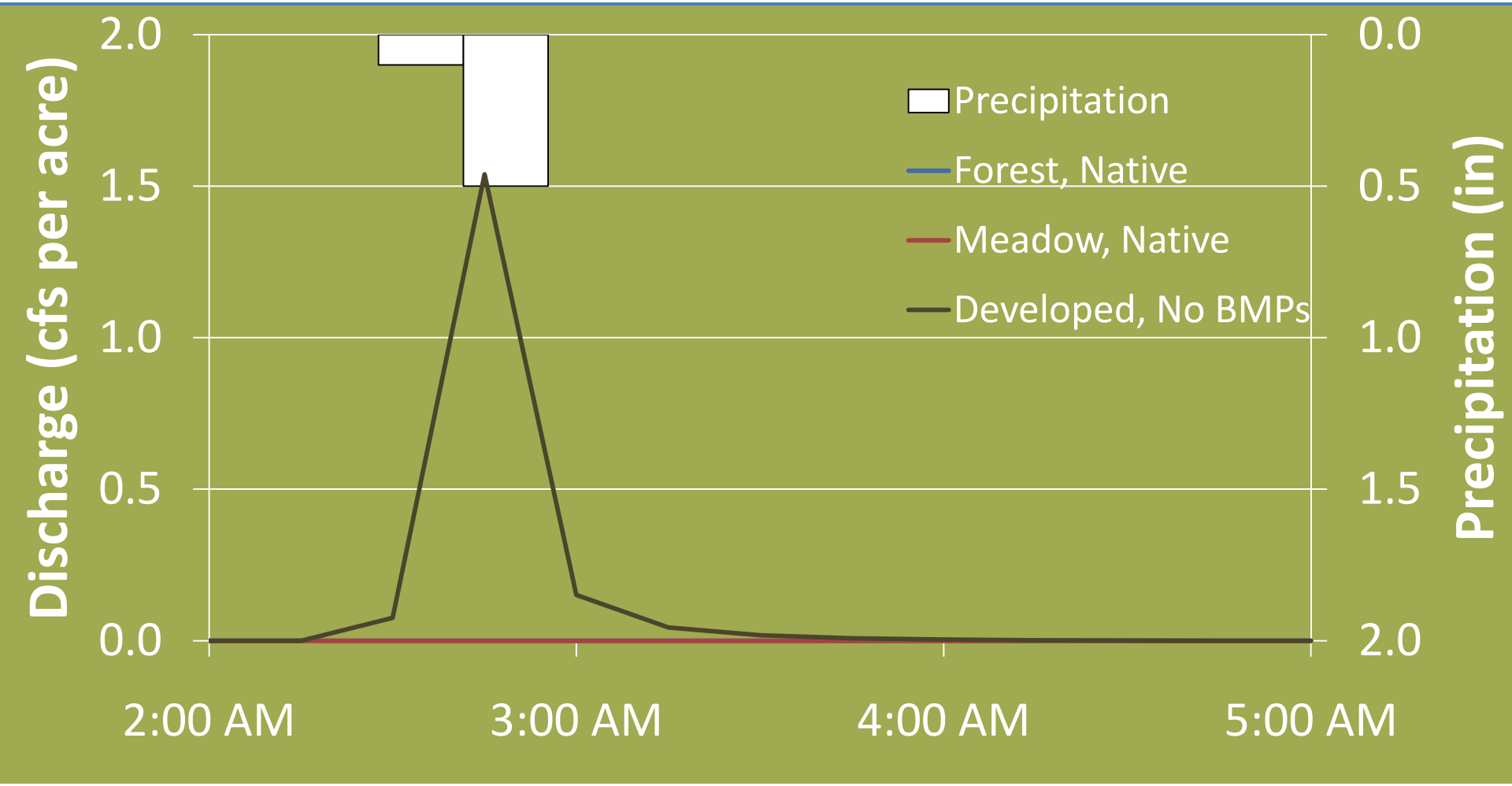
Native and 80% Impervious, C Soils



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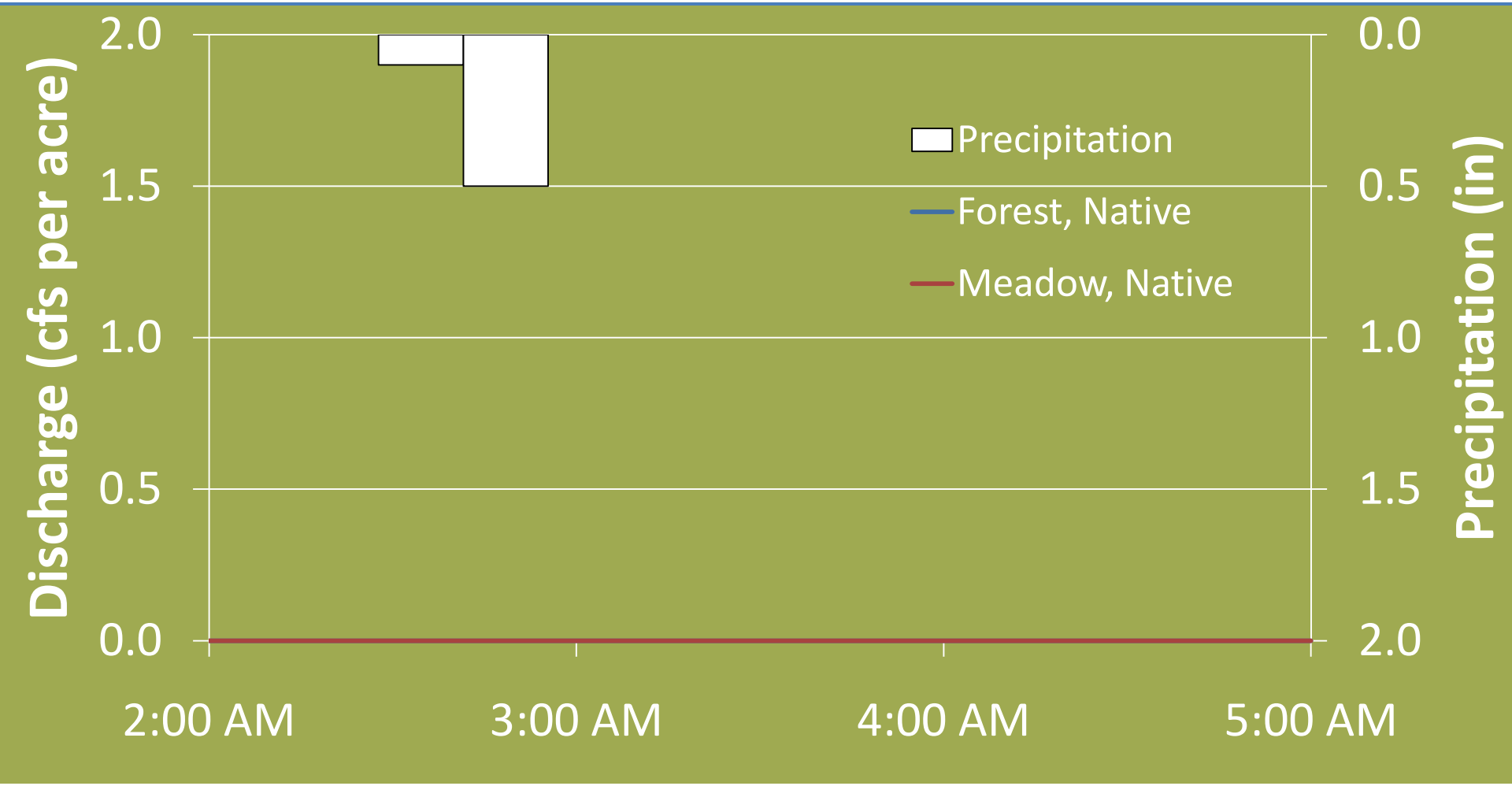
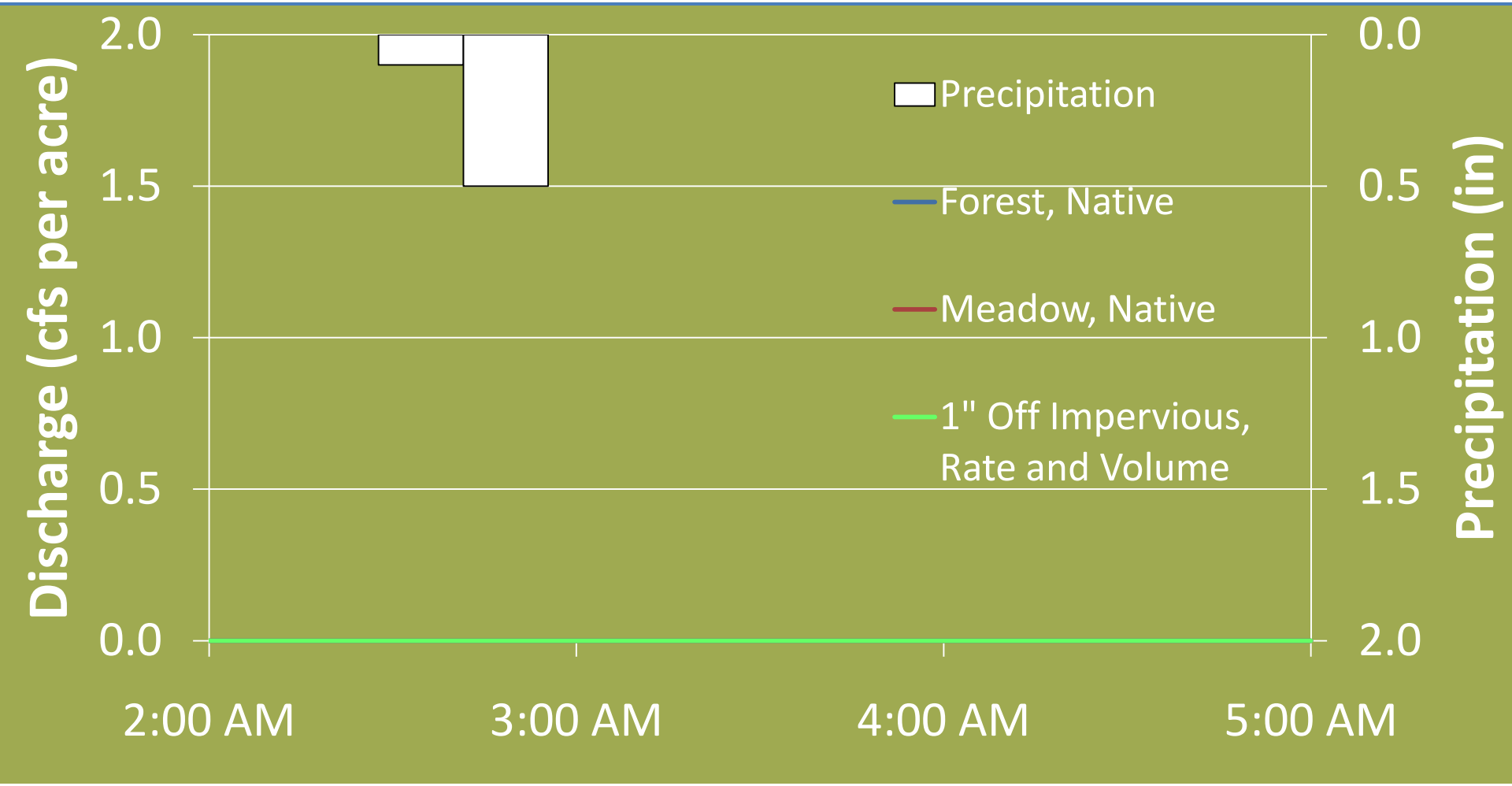
Native Conditions, C Soils



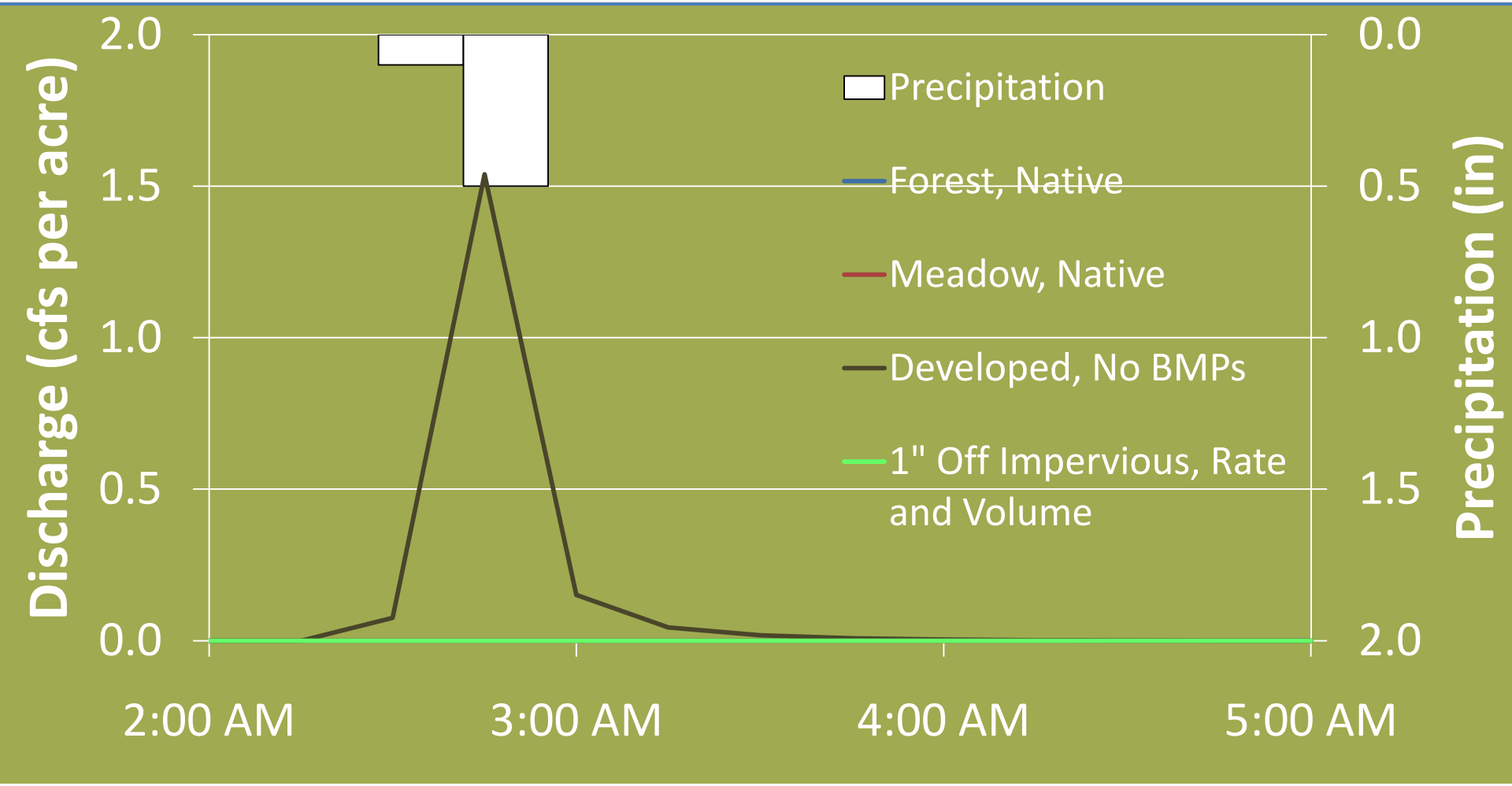
Rate Control: 9/12/1978 0.6” Rain Event

Native and 80% Impervious with , C Soils



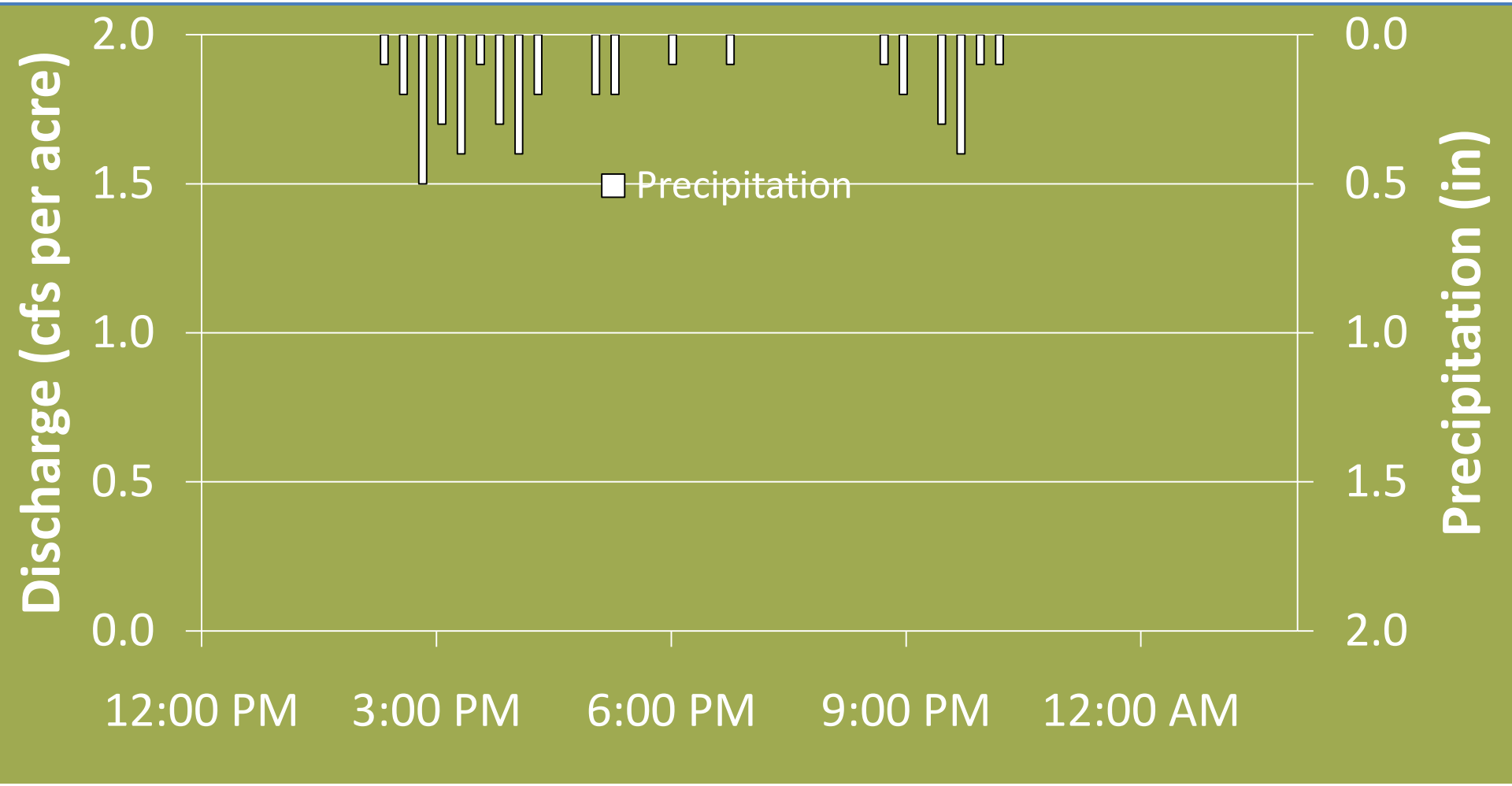
Rate Control: 9/12/1978 0.6" Rain Event

Native, 80% Impervious with no BMPs & , C Soils



Rate Control: 10/4/2005 4.4" Rain Event

Native Forest Conditions, C Soils



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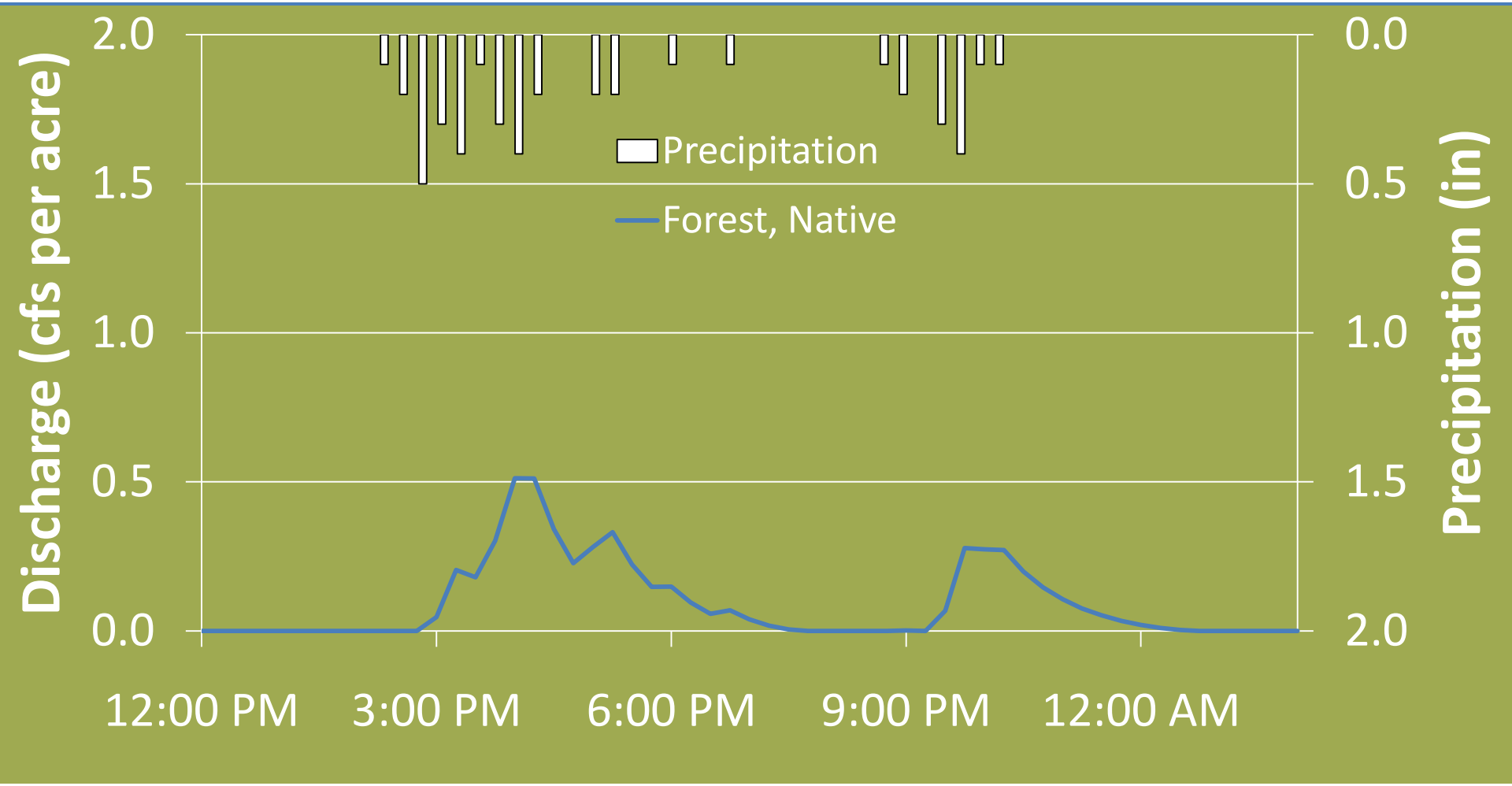
Native Forest Conditions, C Soils



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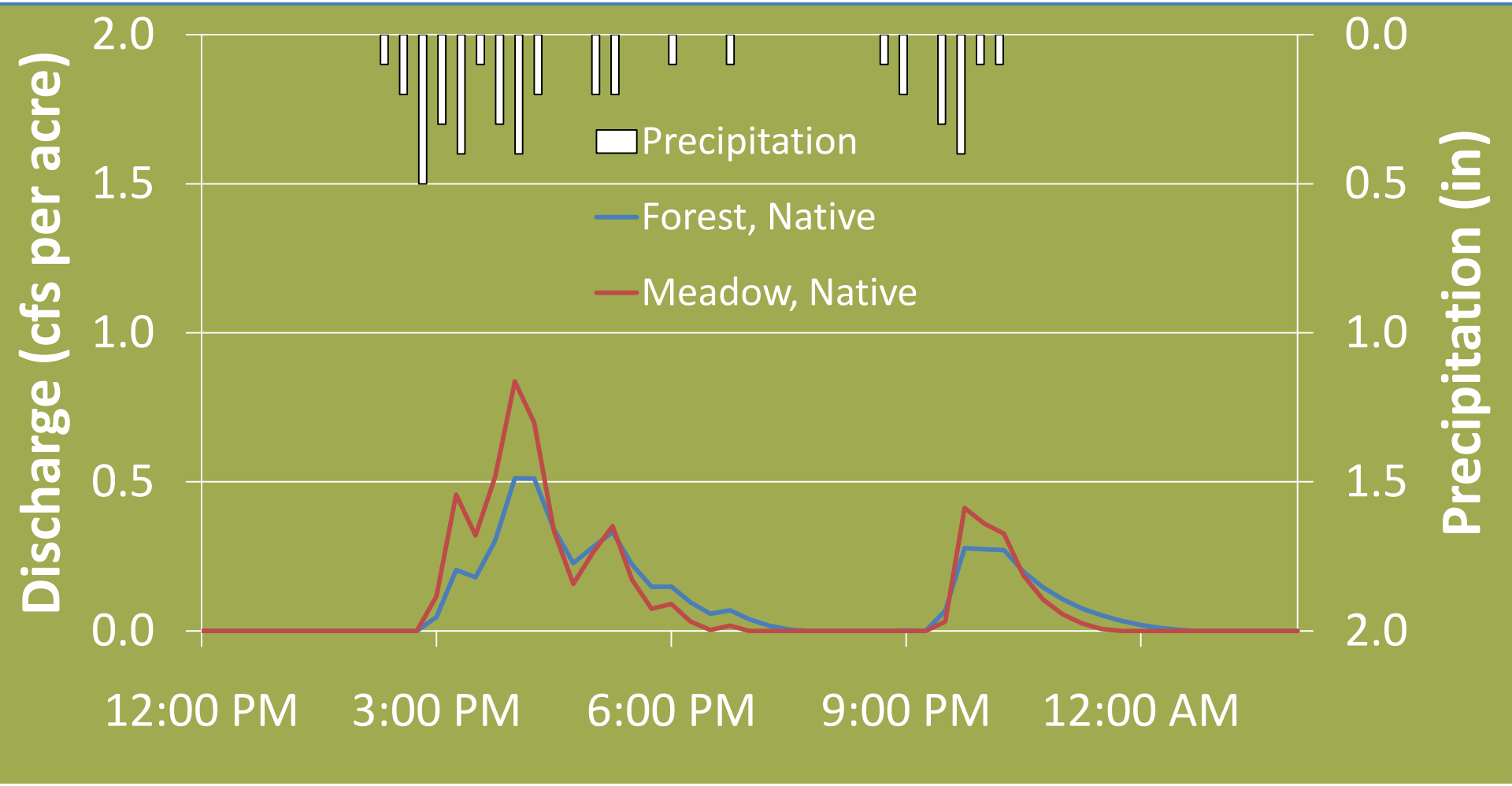
Native Forest and Meadow Conditions, C Soils



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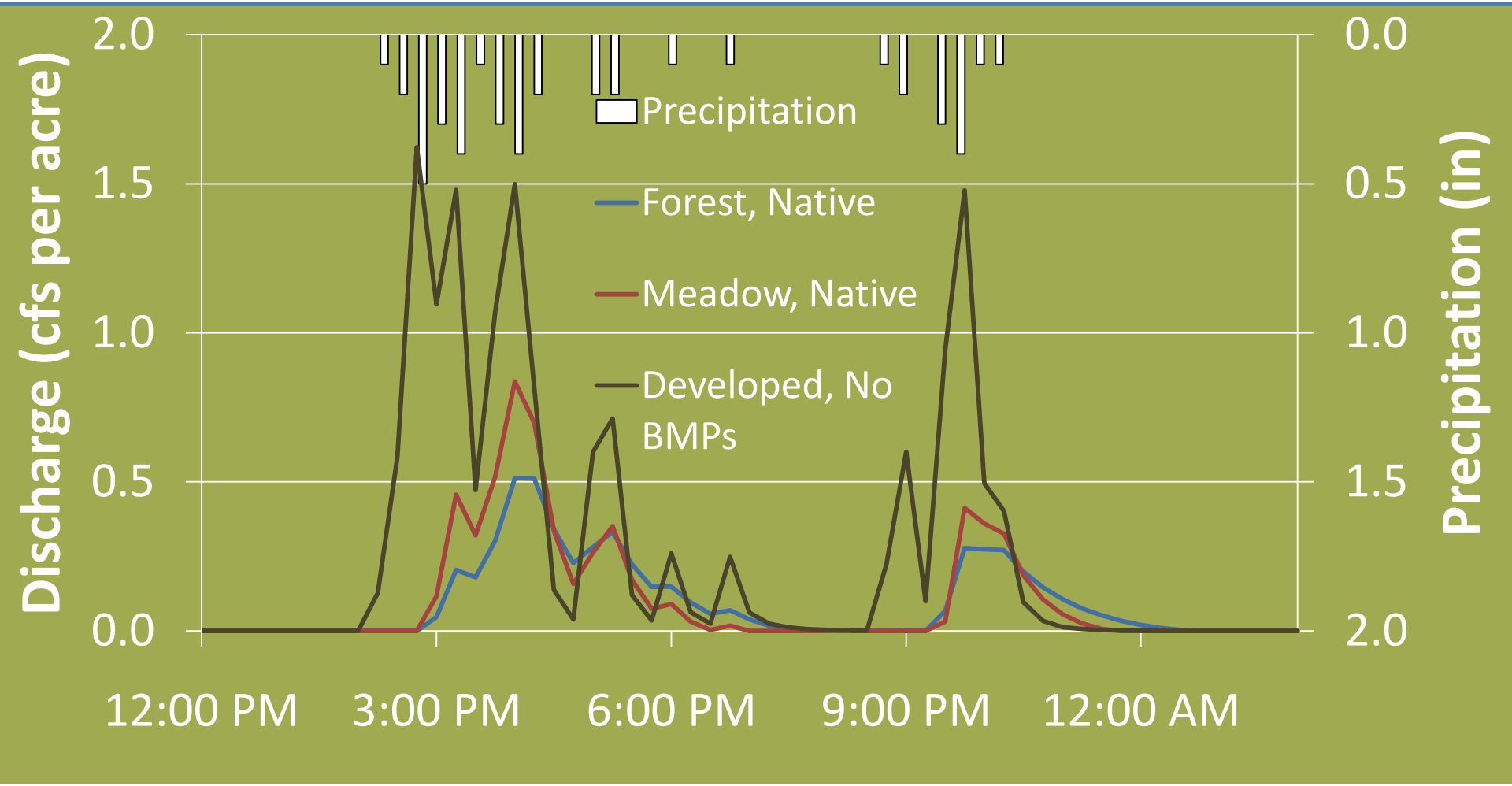
Native Conditions and 80% Impervious, C Soils



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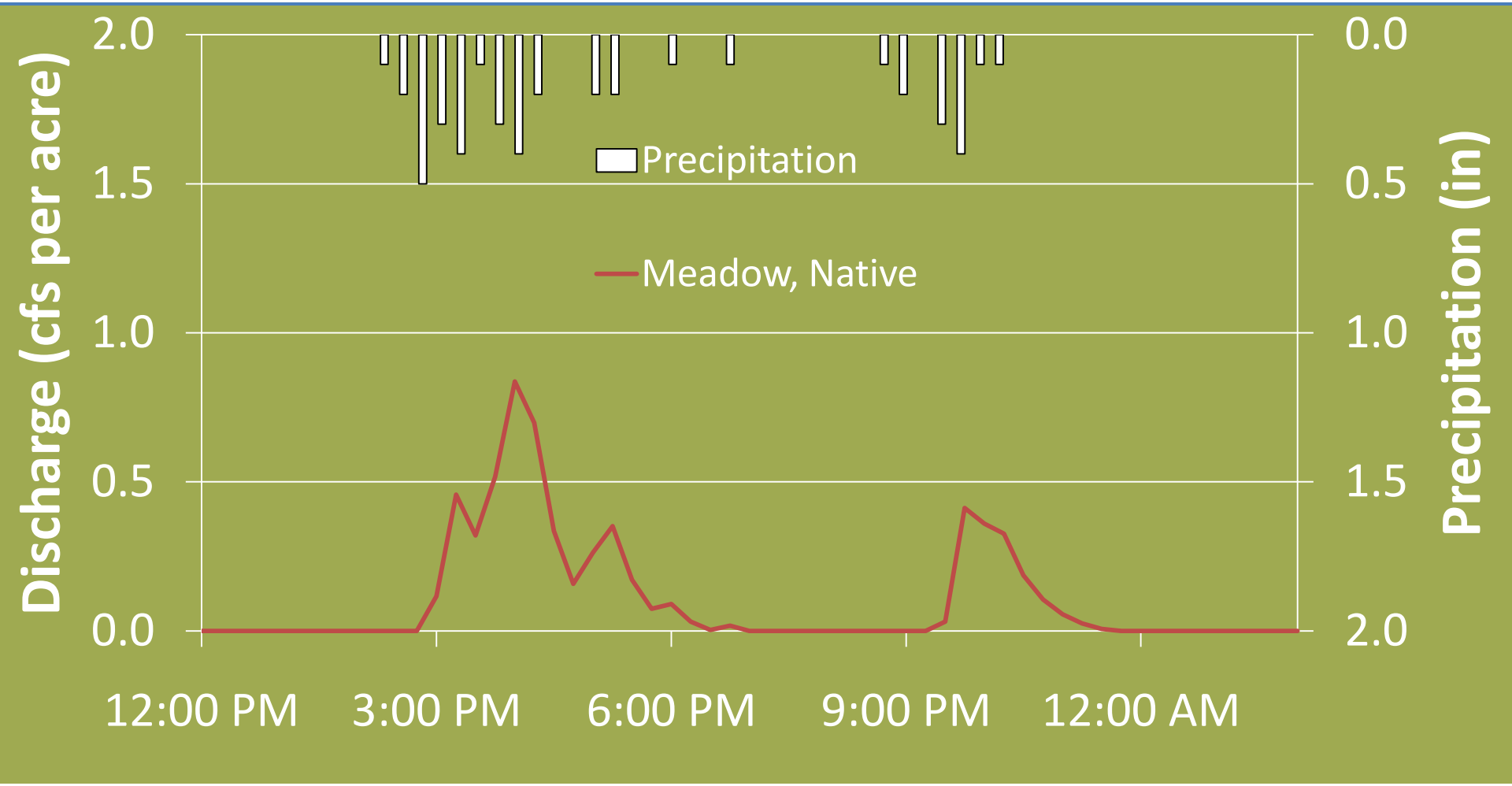
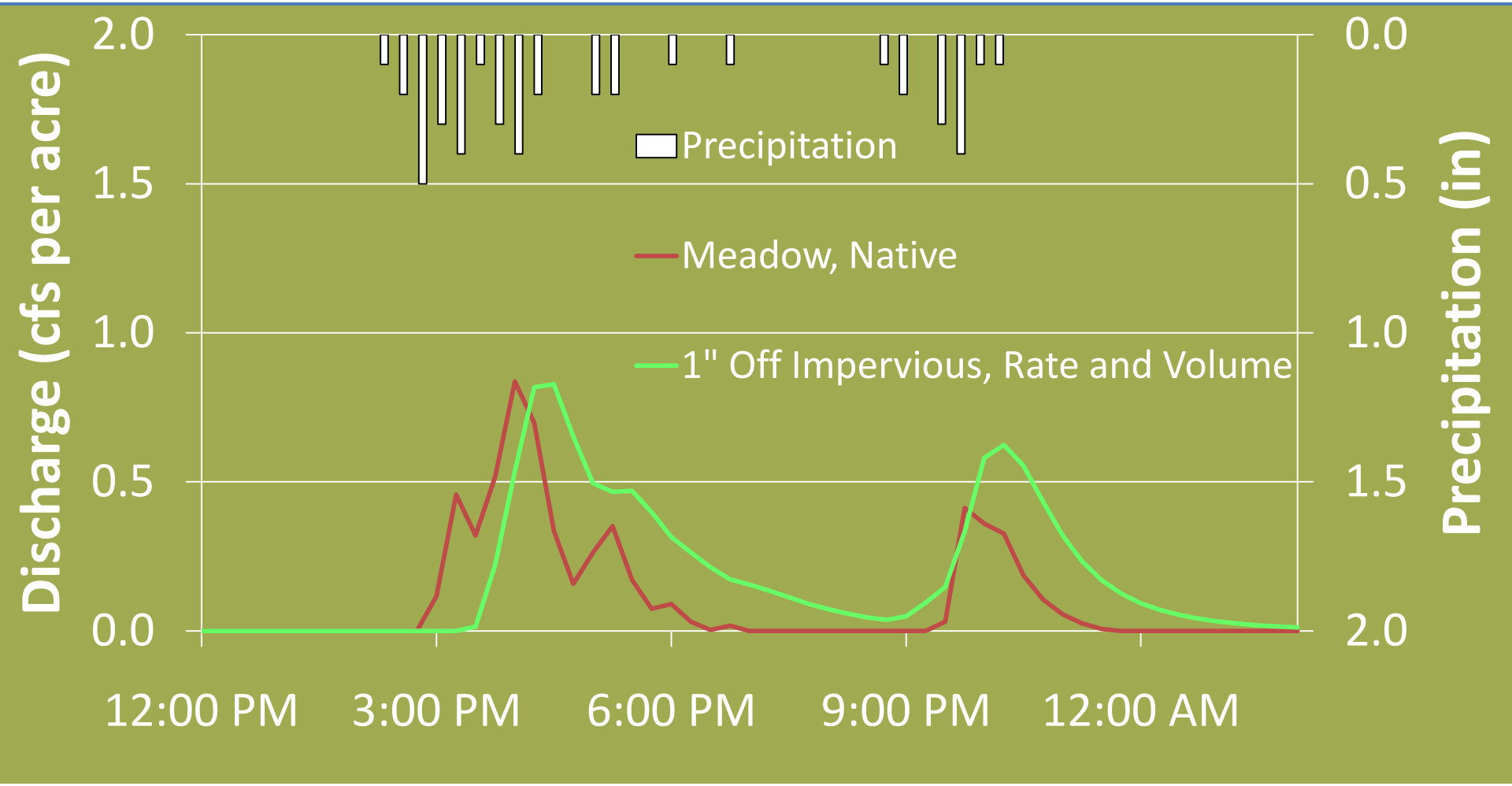
Native Conditions, C Soils



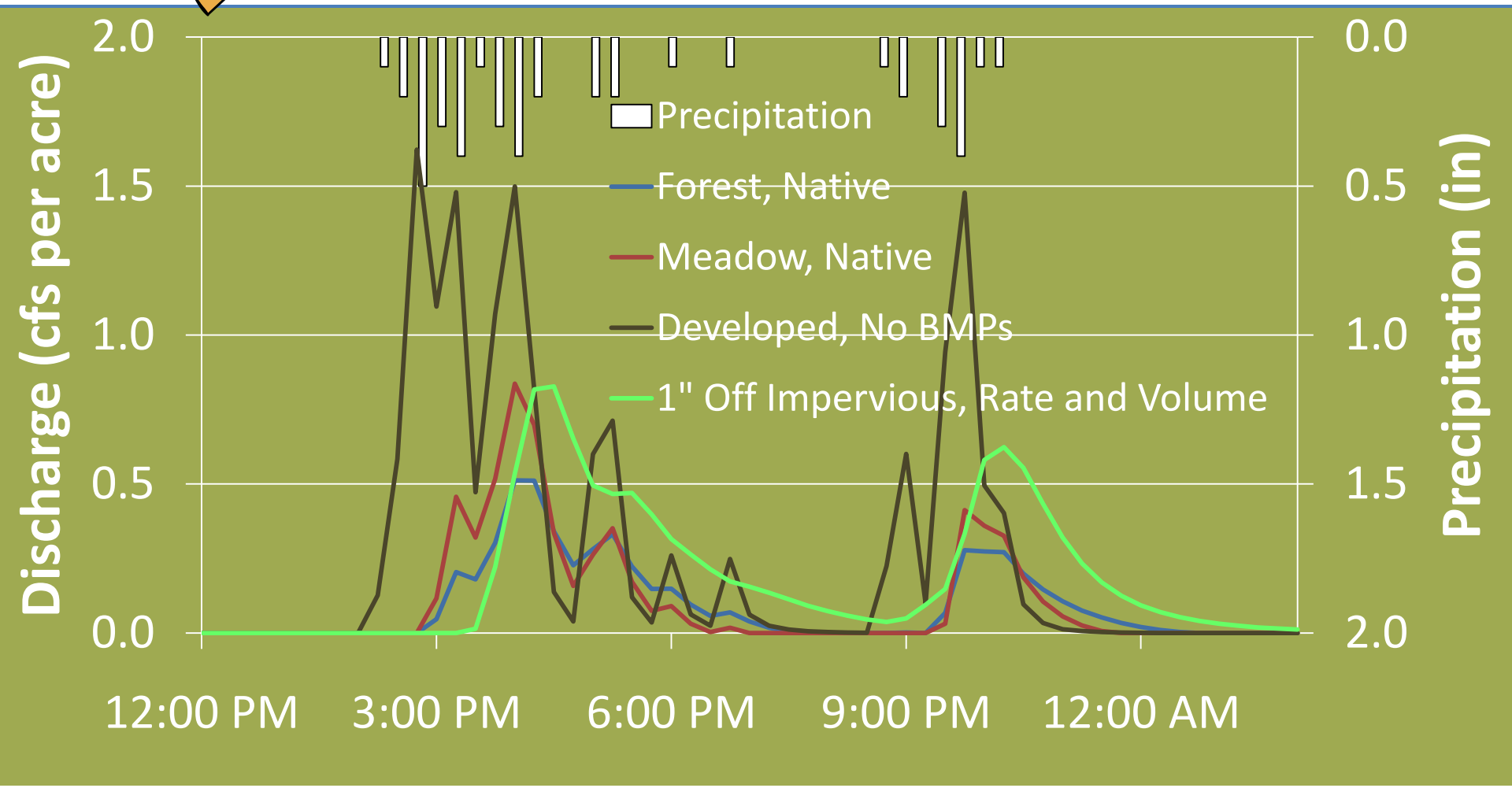
Rate Control: 10/4/2005 4.4" Rain Event

Native Conditions & 80% Impervious with , C Soils

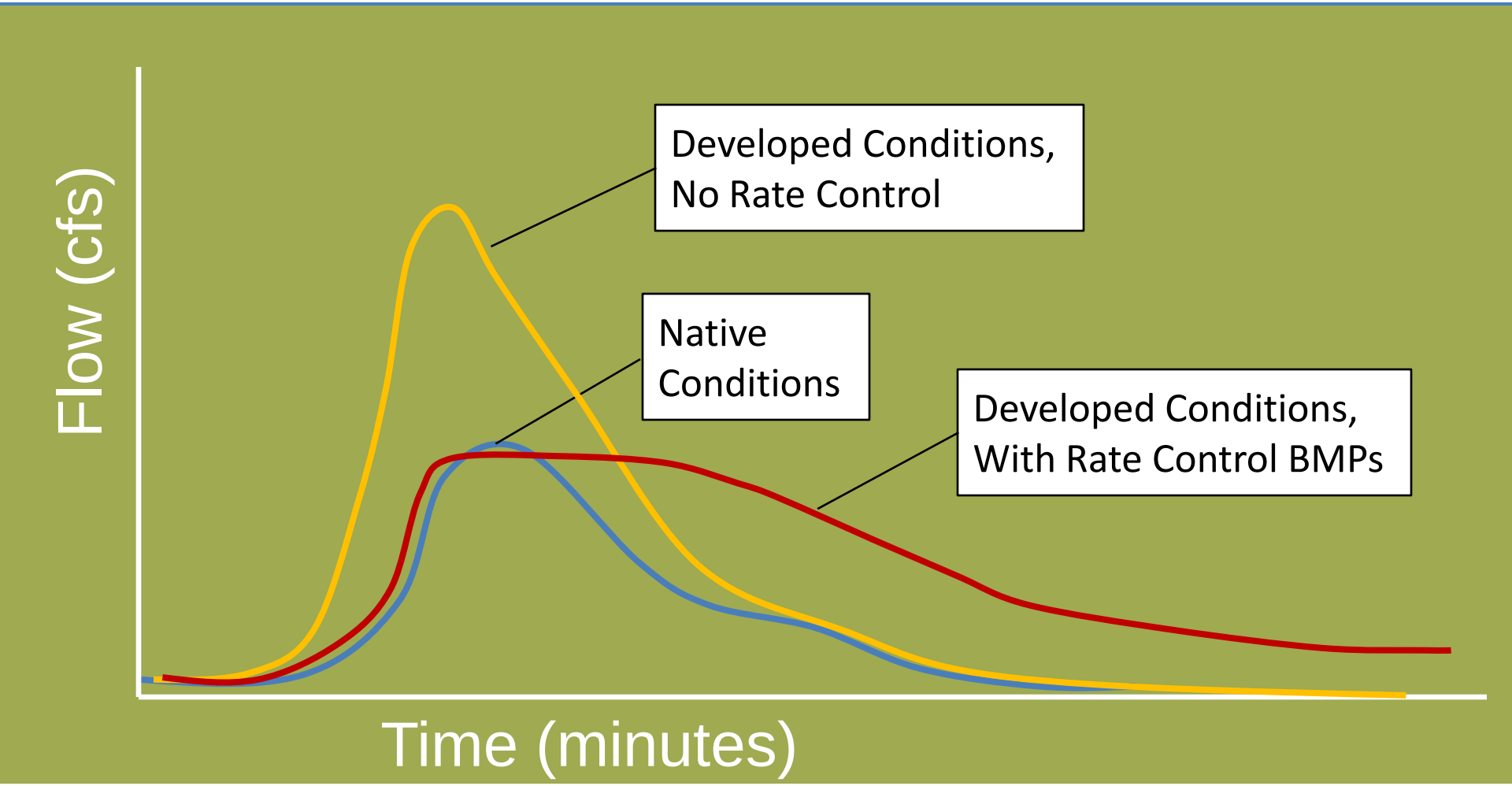


Rate Control: 10/4/2005 4.4" Rain Event

Native Conditions & 80% Impervious with no BMPs and with , C Soils



Runoff Rate Control Summary



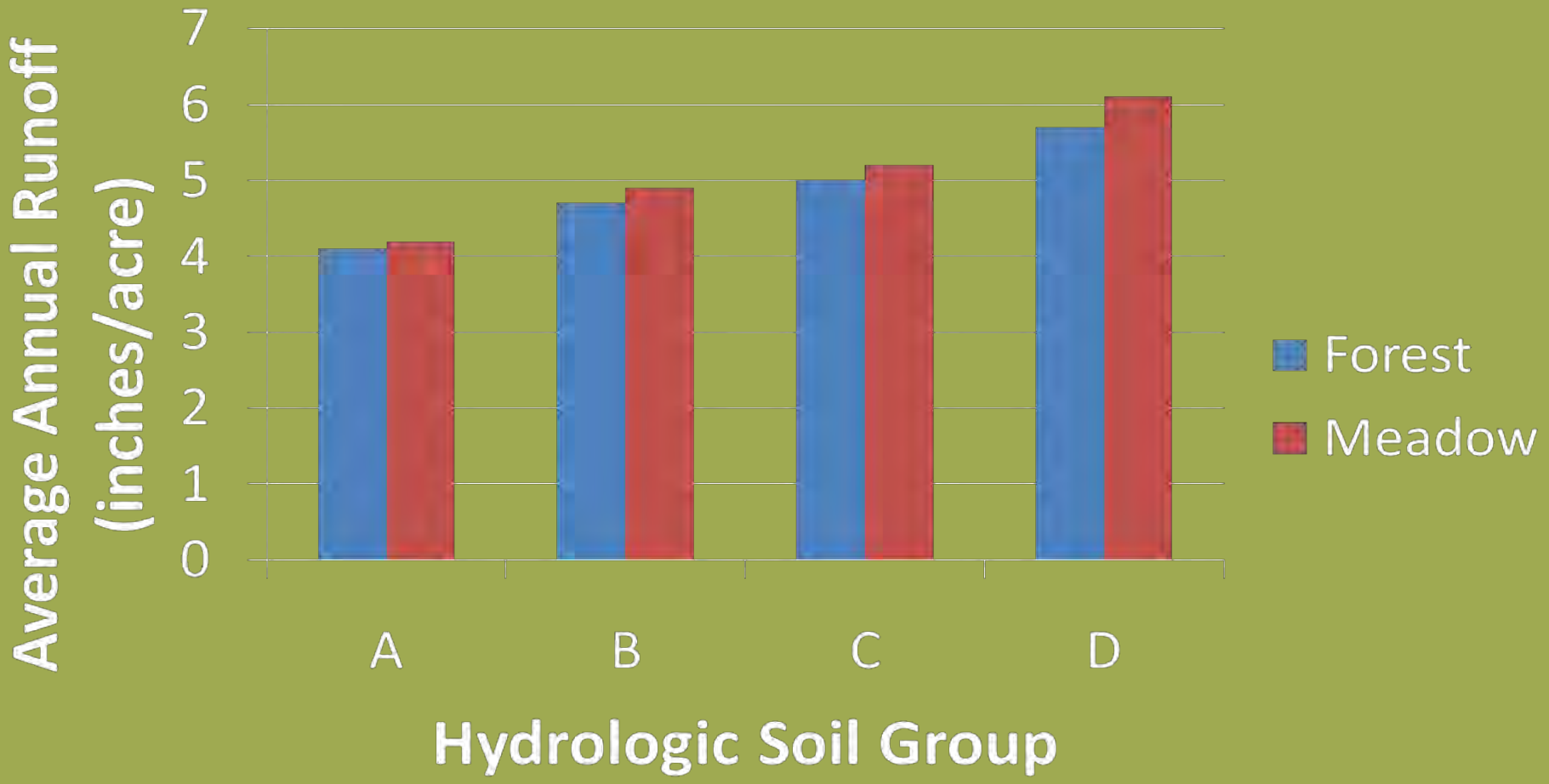
Conclusions from Rate Control Analysis

- Volume control BMPs controlled the 1-year 24-hour (sometimes the 2-year) event peak rates for most scenarios
- Rate control BMPs are needed to mimic native hydrology

Continuation of Runoff Volume Comparisons

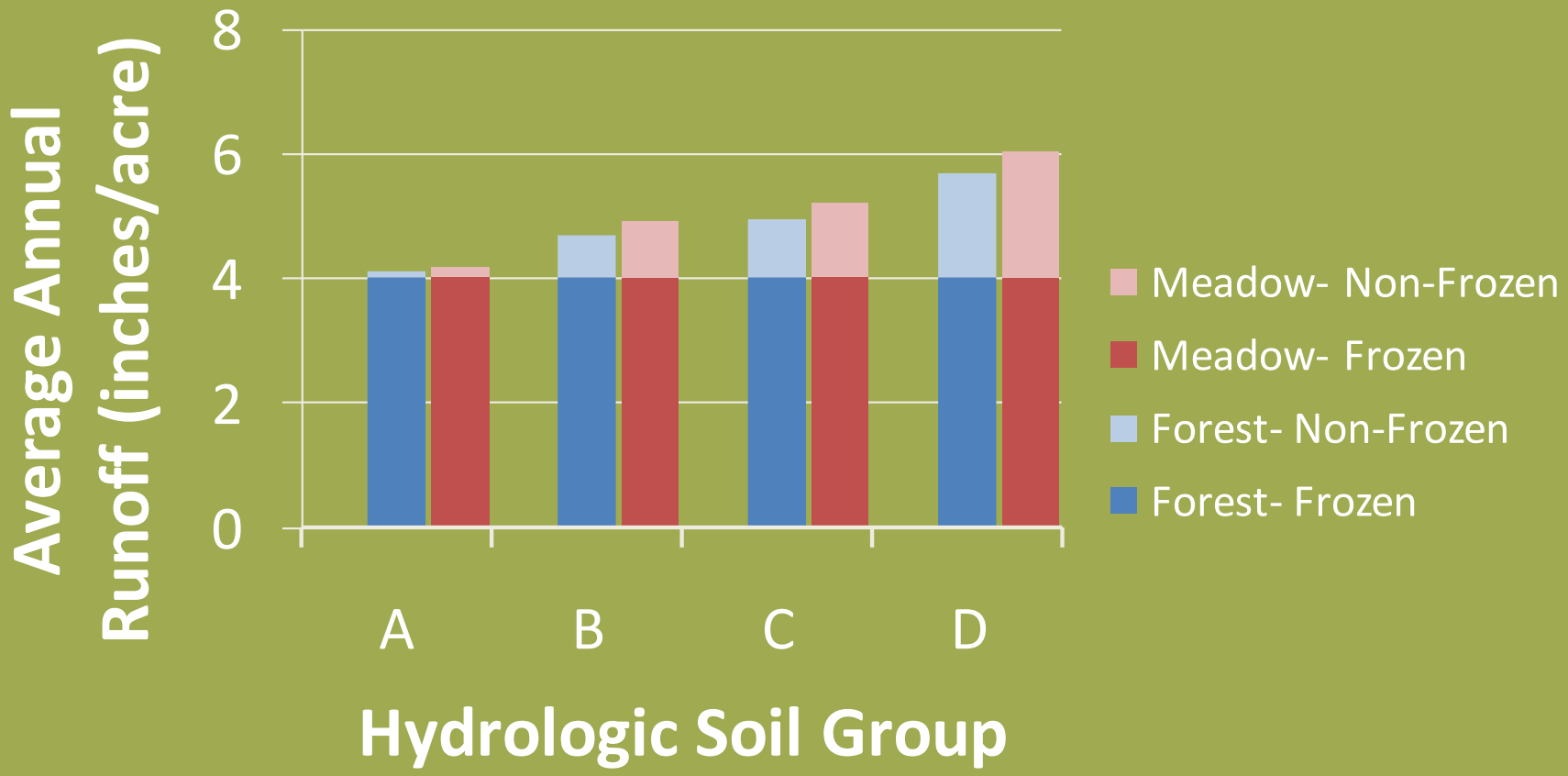
- Review annual runoff volume comparison
- Compare runoff from frozen and non-frozen conditions
- Evaluate frequency of exceeding native runoff volume

Native Conditions:
Stormwater Runoff Volume Leaving 10-Acre Site



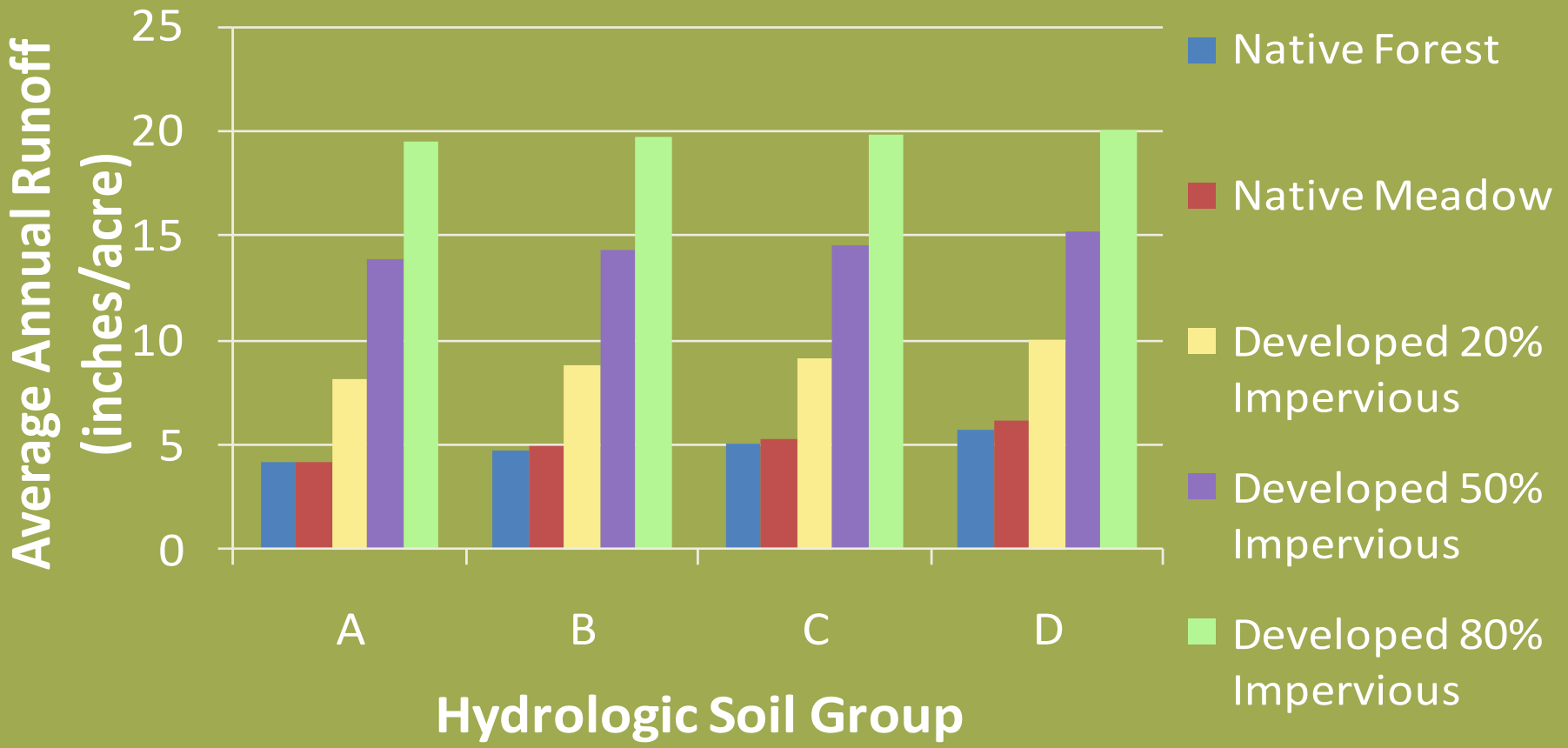
Native Conditions:

Stormwater Runoff Volume from Frozen versus Non-Frozen Ground



Runoff Volume from 10-Acre Site

Native Conditions and Developed with No BMPs



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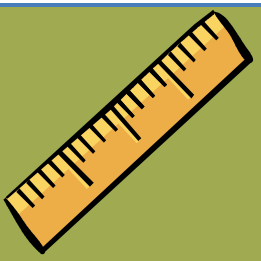
Developed Site Volume Control Performance Goals Modeled



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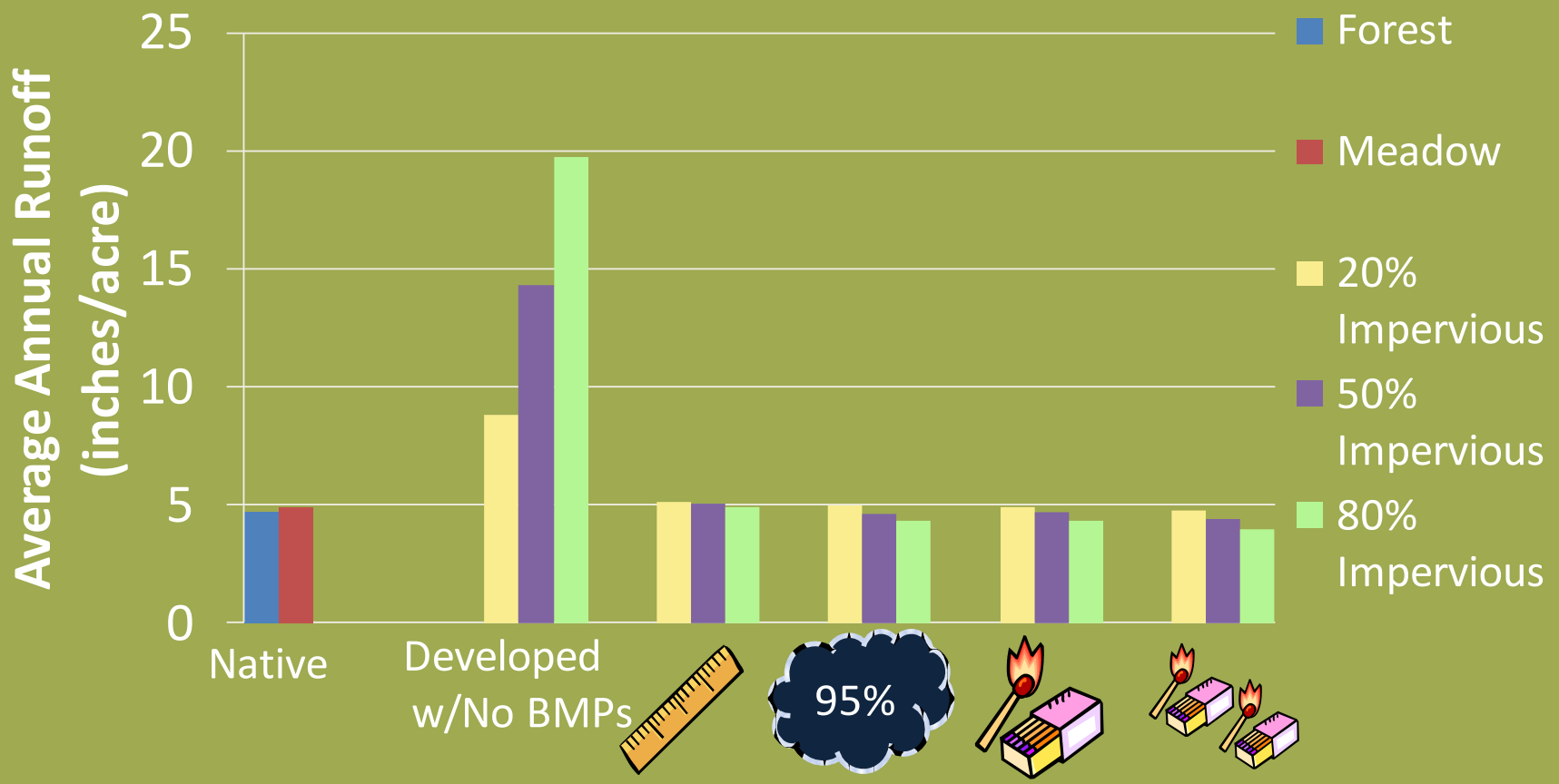
Comparison of Volume Controls:
Stormwater Runoff Volume Leaving 10-Acre Site with B Soils



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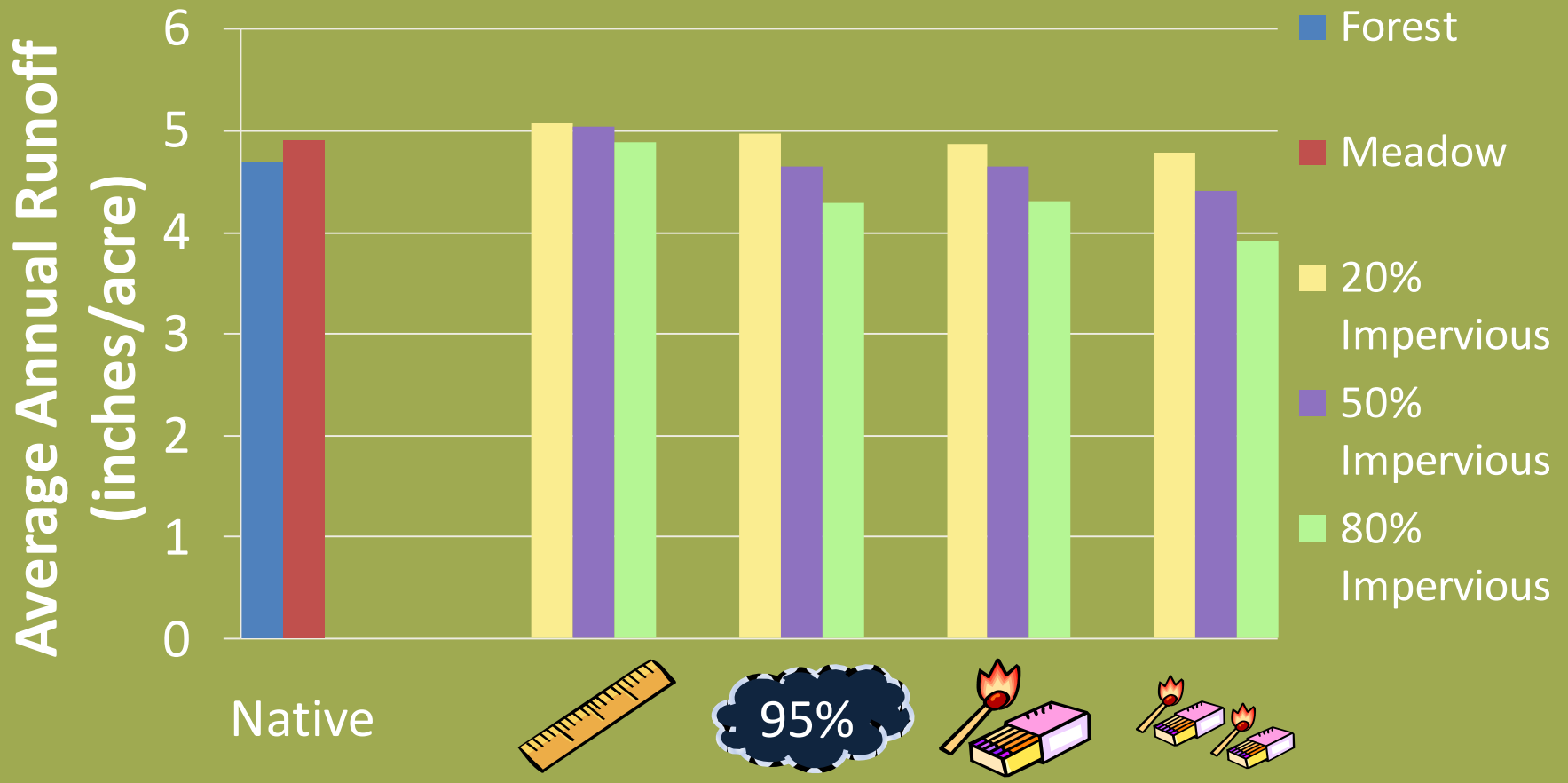
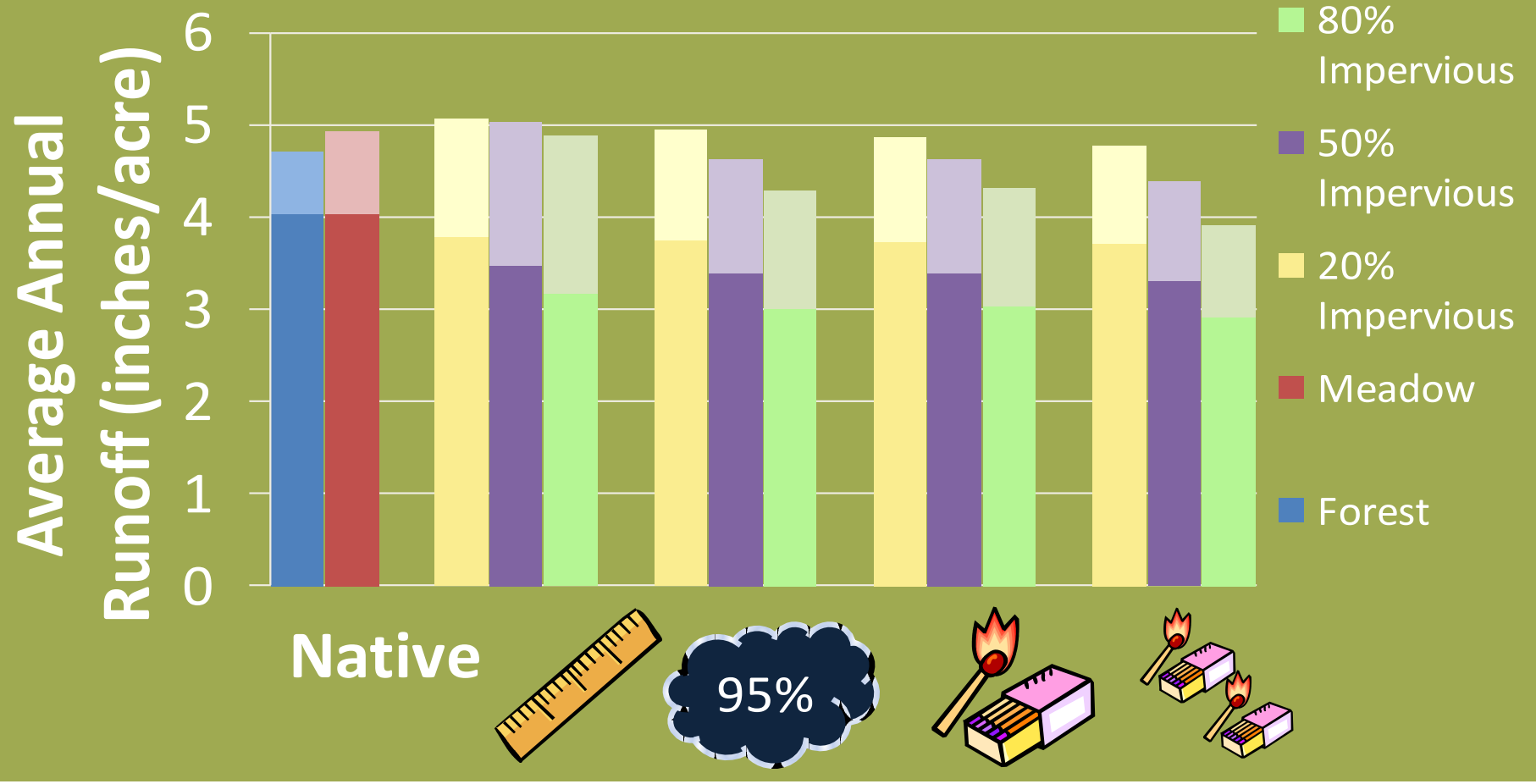
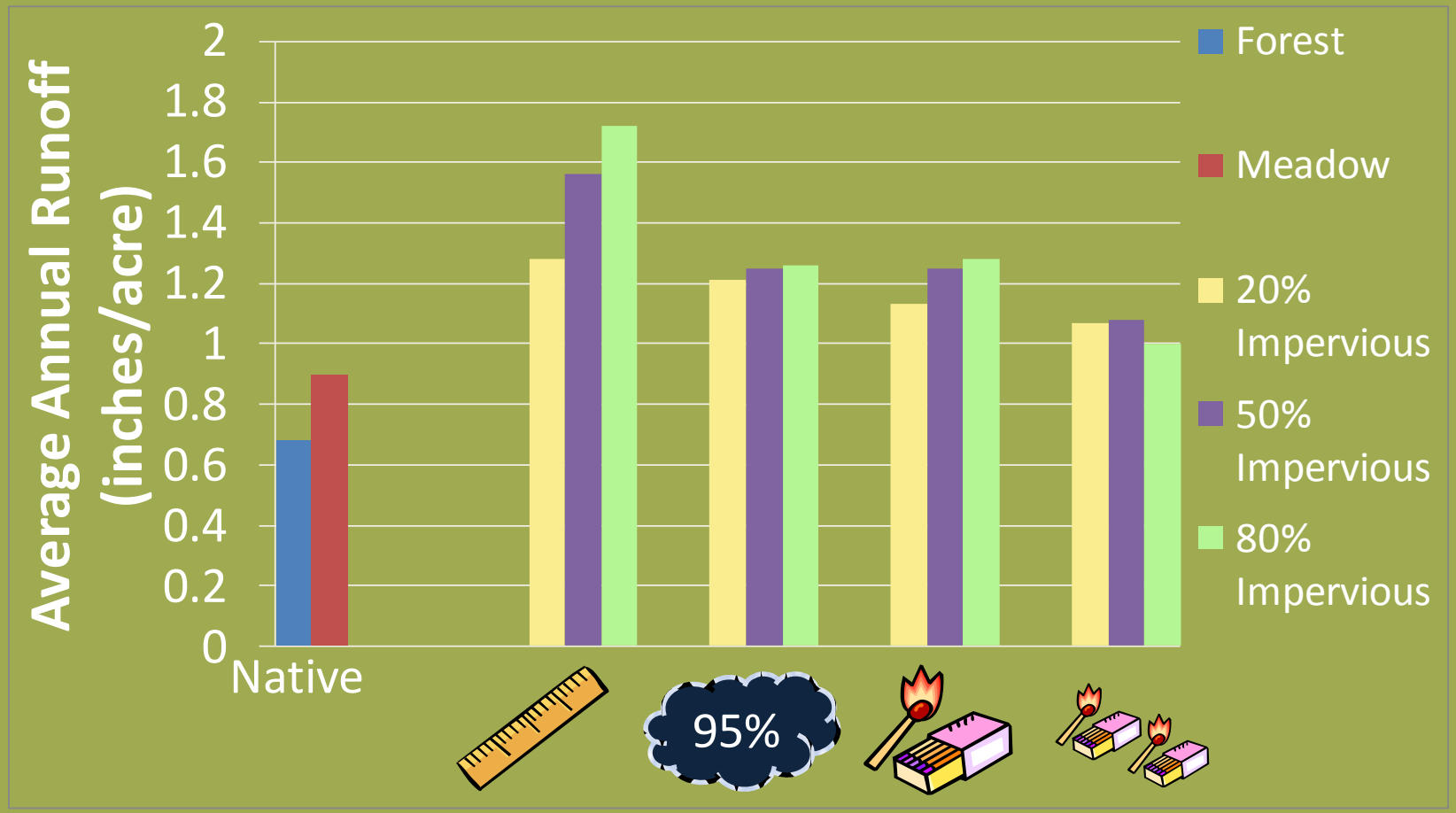


Comparison of Volume Controls:
Stormwater Runoff Volume from Frozen versus Non-Frozen Ground, B Soils

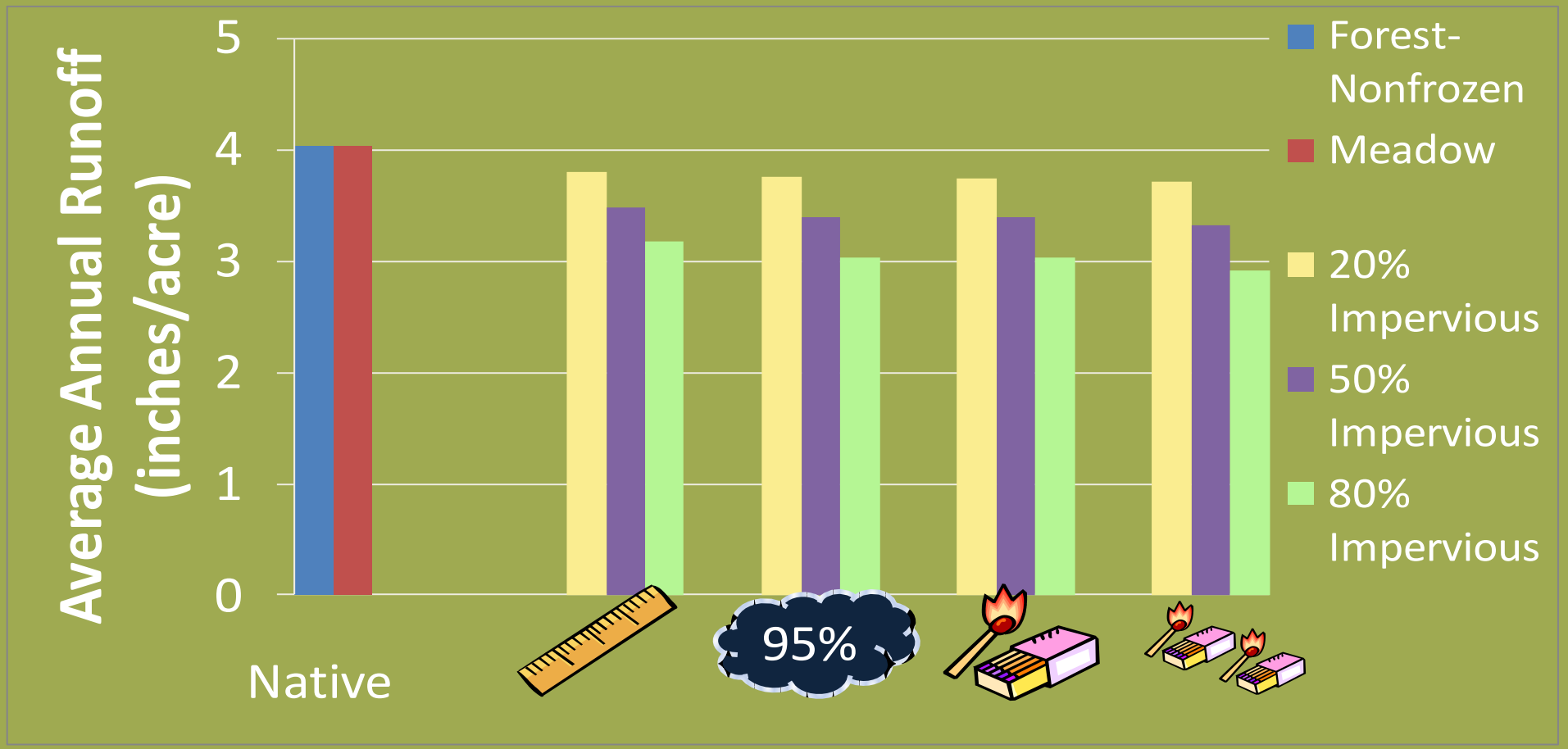


Comparison of Volume Controls: B Soils Non-Frozen Ground Period

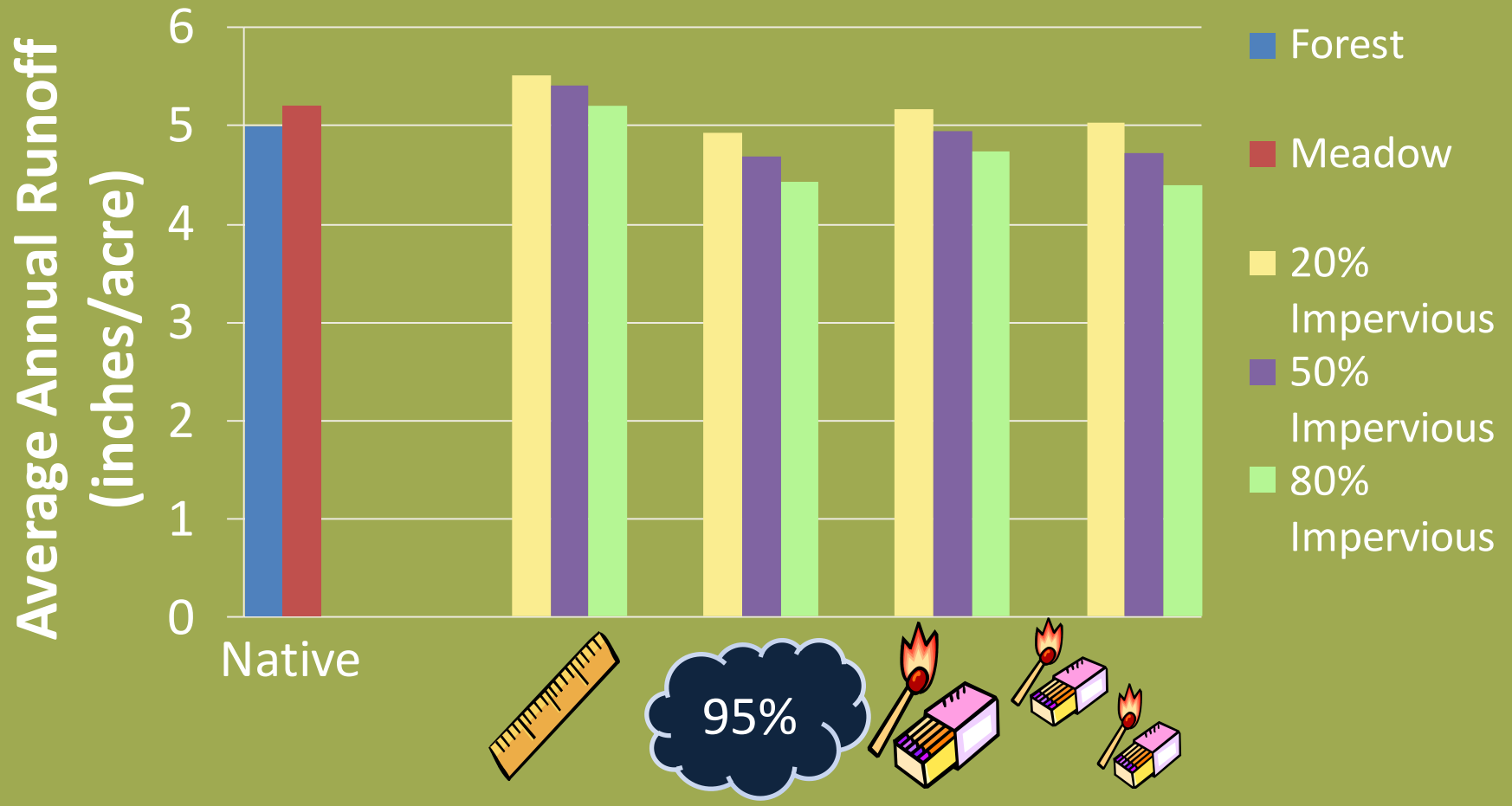
(April 8 – Dec. 5)



Comparison of Volume Controls: B Soils Frozen Ground Period
(Dec. 6 – April 7)



Comparison of Volume Controls:
Stormwater Runoff Volume Leaving 10-Acre Site with C Soils



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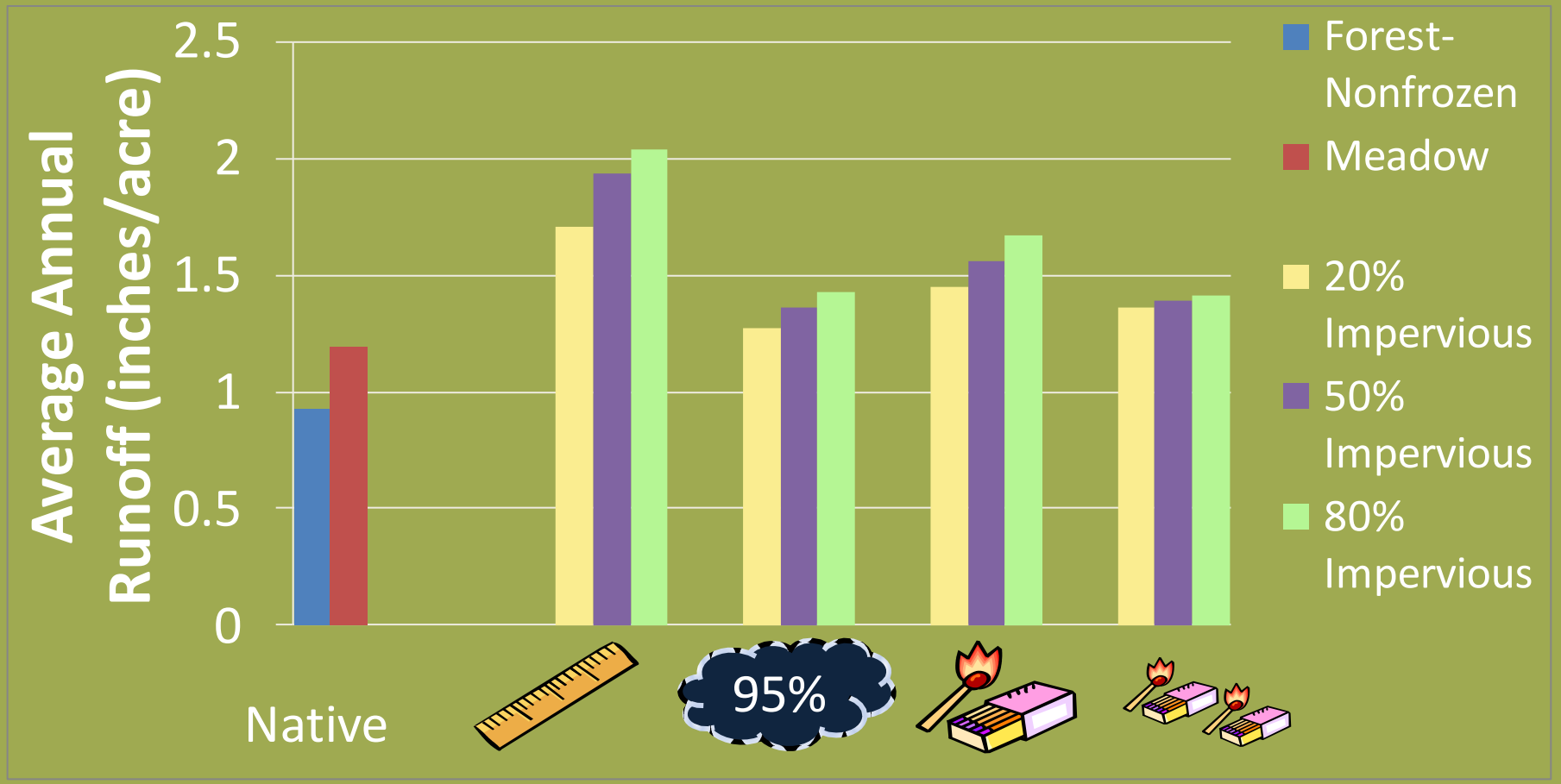
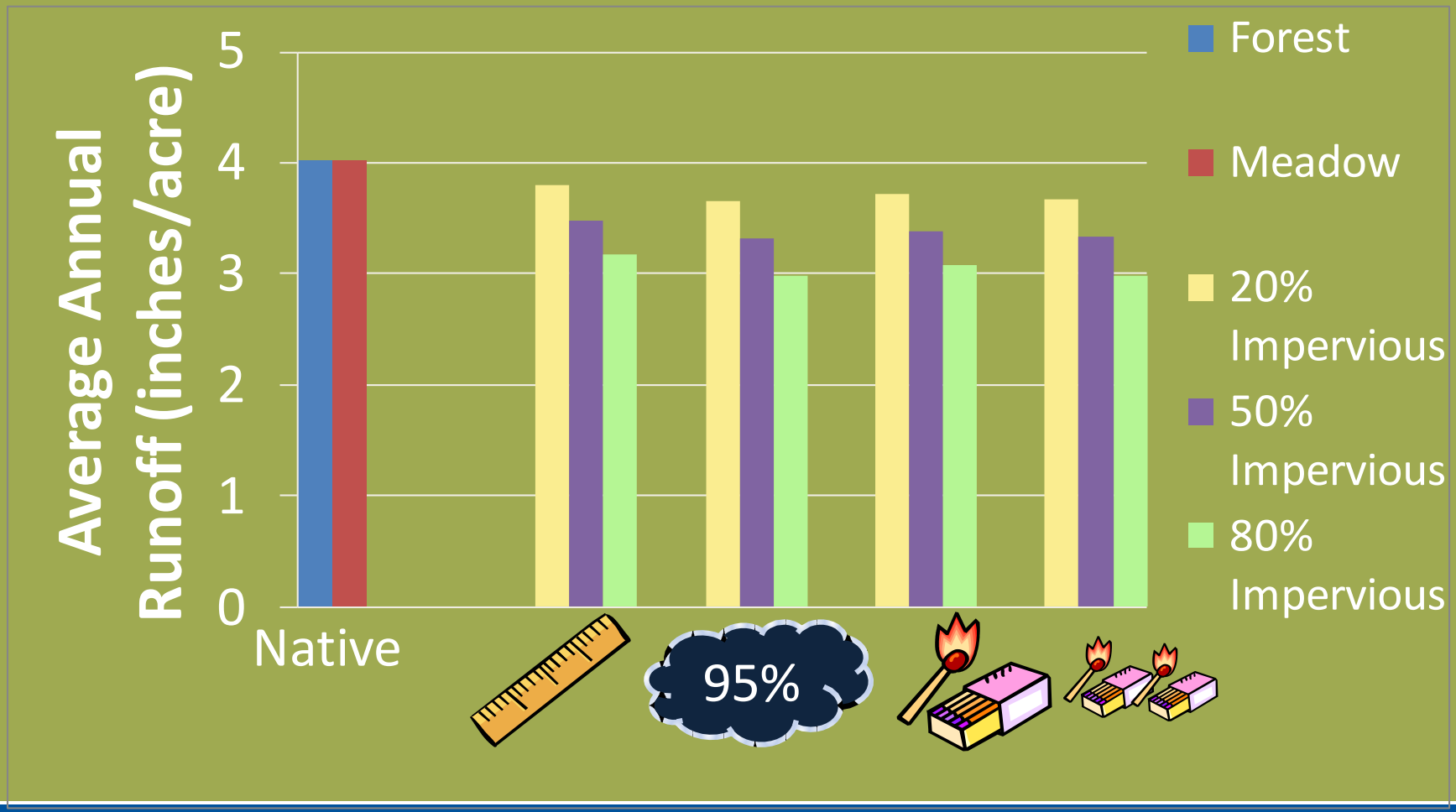
Comparison of Runoff Volumes: C Soils Non-Frozen Ground Period
(April 8 – Dec. 5)



Comparison of Runoff Volume: C Soils Frozen Ground Period

(Dec. 7 – April 6)



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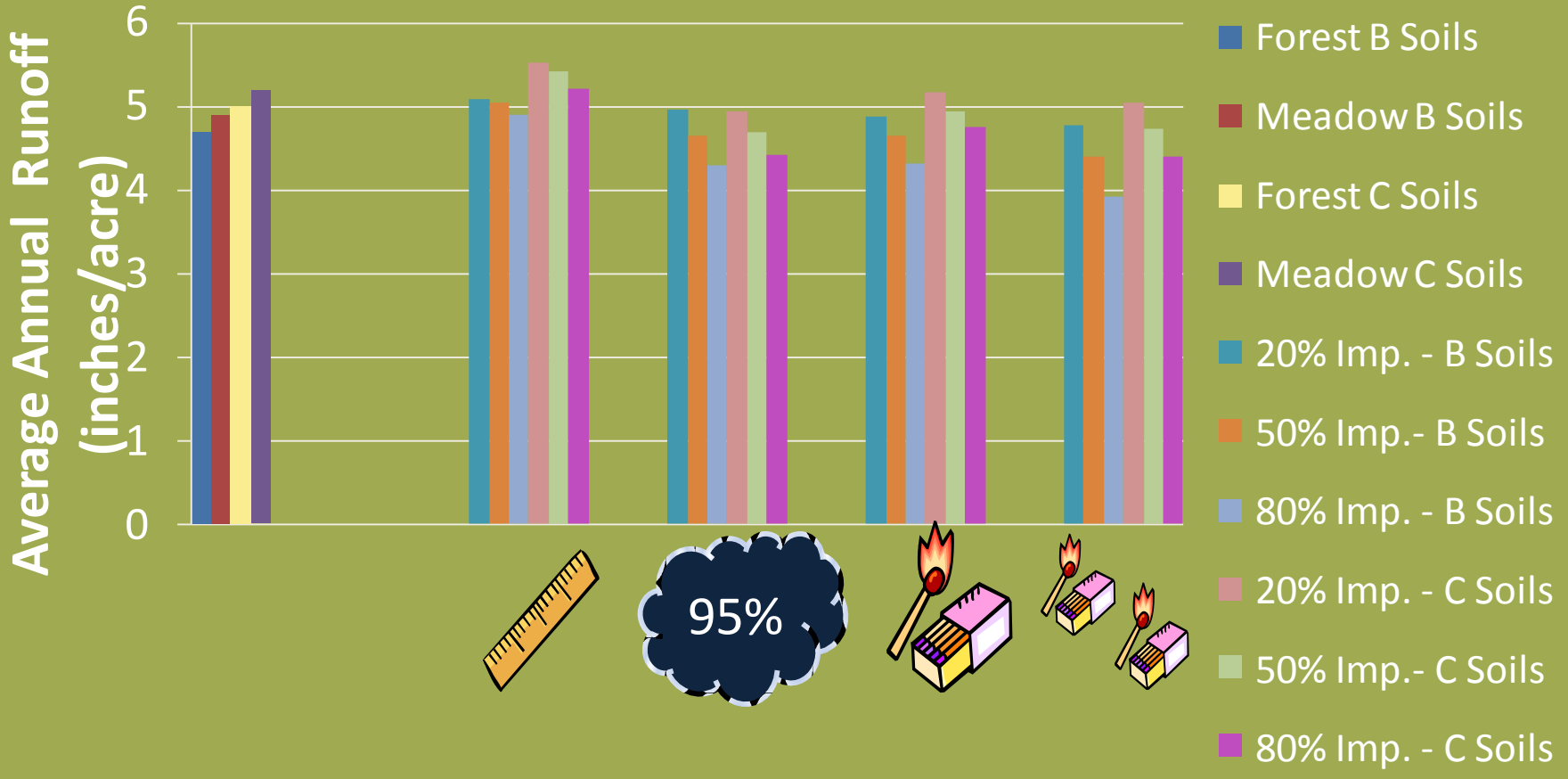
Comparison of All Volume Controls:
Stormwater Runoff Volume Leaving 10-Acre Site



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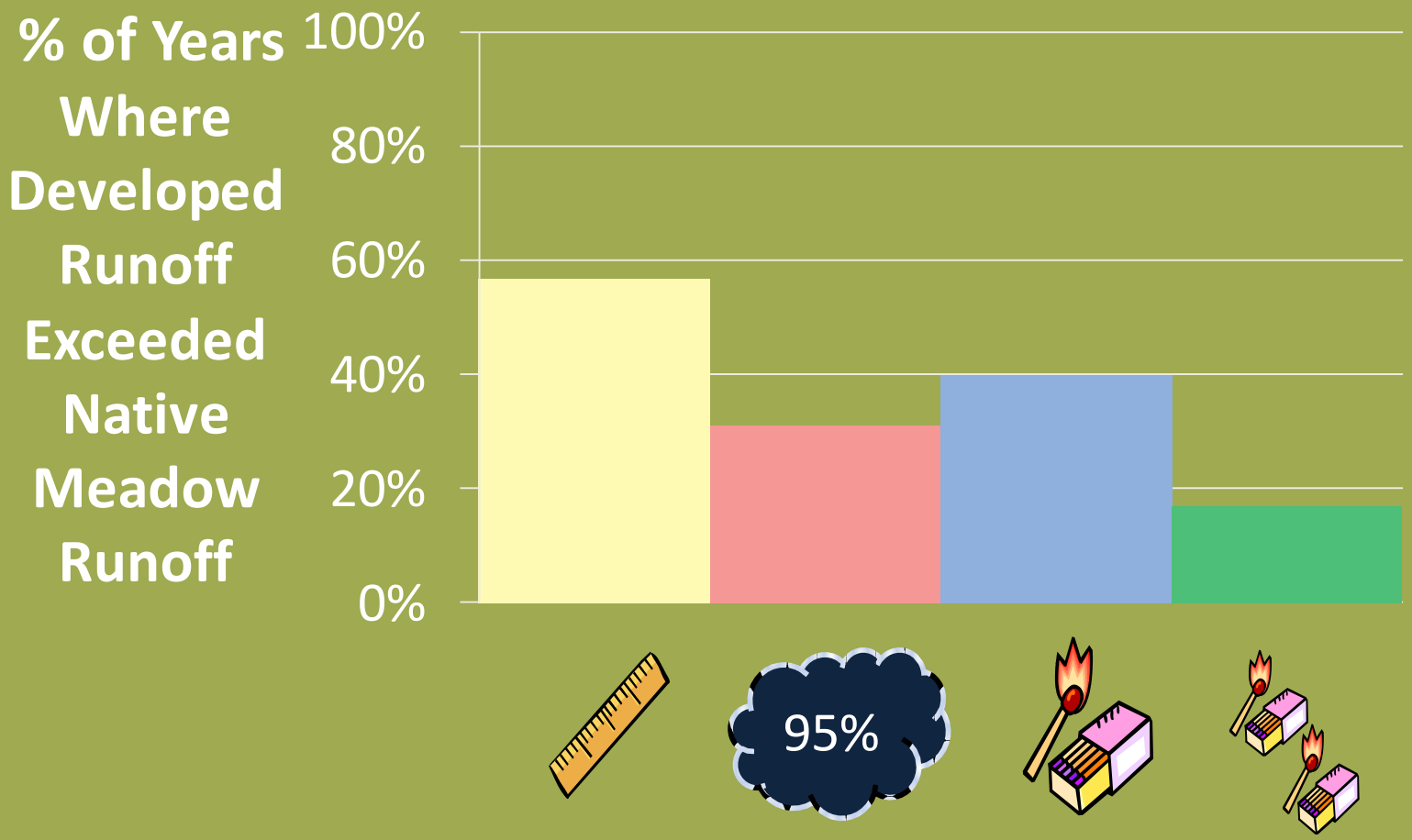
Annual Variability of Performance Goals

B soils, 50% Impervious



Conclusions from Volume Control Analysis

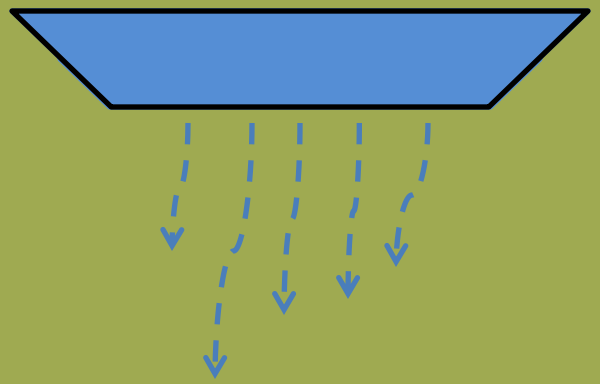
- Developed sites without BMPs produce ~2-4 times the average annual runoff volume of native conditions
- Volume control BMPs controlled the 1-year 24-hour peak rates for most scenarios

Conclusions from Volume Control Analysis

- All performance goals do well at matching native conditions on an average annual basis
- All do worse at matching native conditions during non-frozen ground conditions (some yield up to 2 times more runoff)
  - If goal is to match or not exceed native conditions, values could be adjusted (e.g., use 1.3” vs. 1”, use 97% vs. 95%, use 5-year vs. 2-year)

Comparison of Pollutant Removals

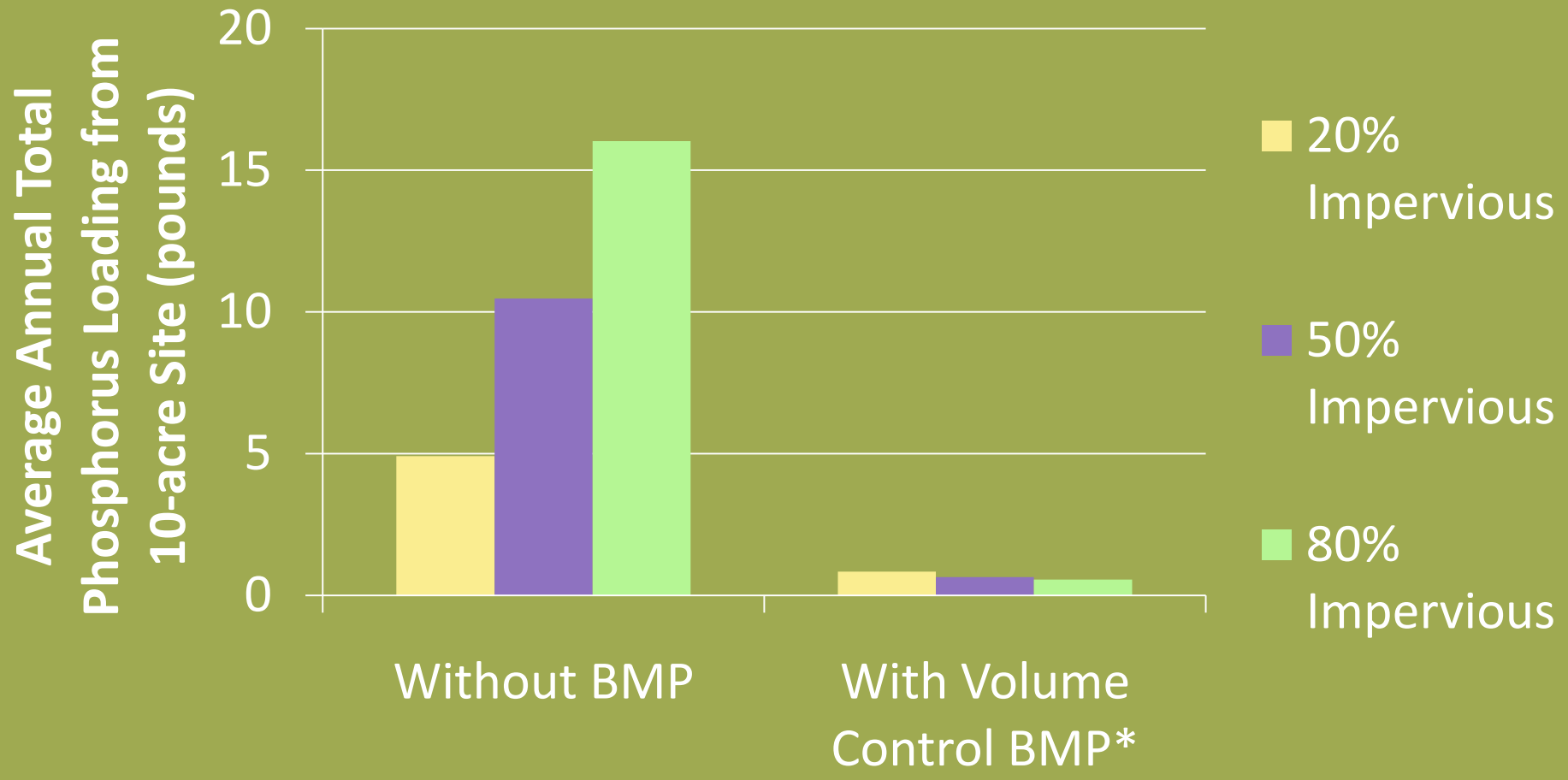
Comparison of Pollutant Removals



Results of Pollutant Removal Analysis

- Volume reduction performance goals result in significant pollutant loading reduction from a site

Phosphorus Loading Reduction from Volume Control BMPs



* Based on average loading from the four performance goal scenarios

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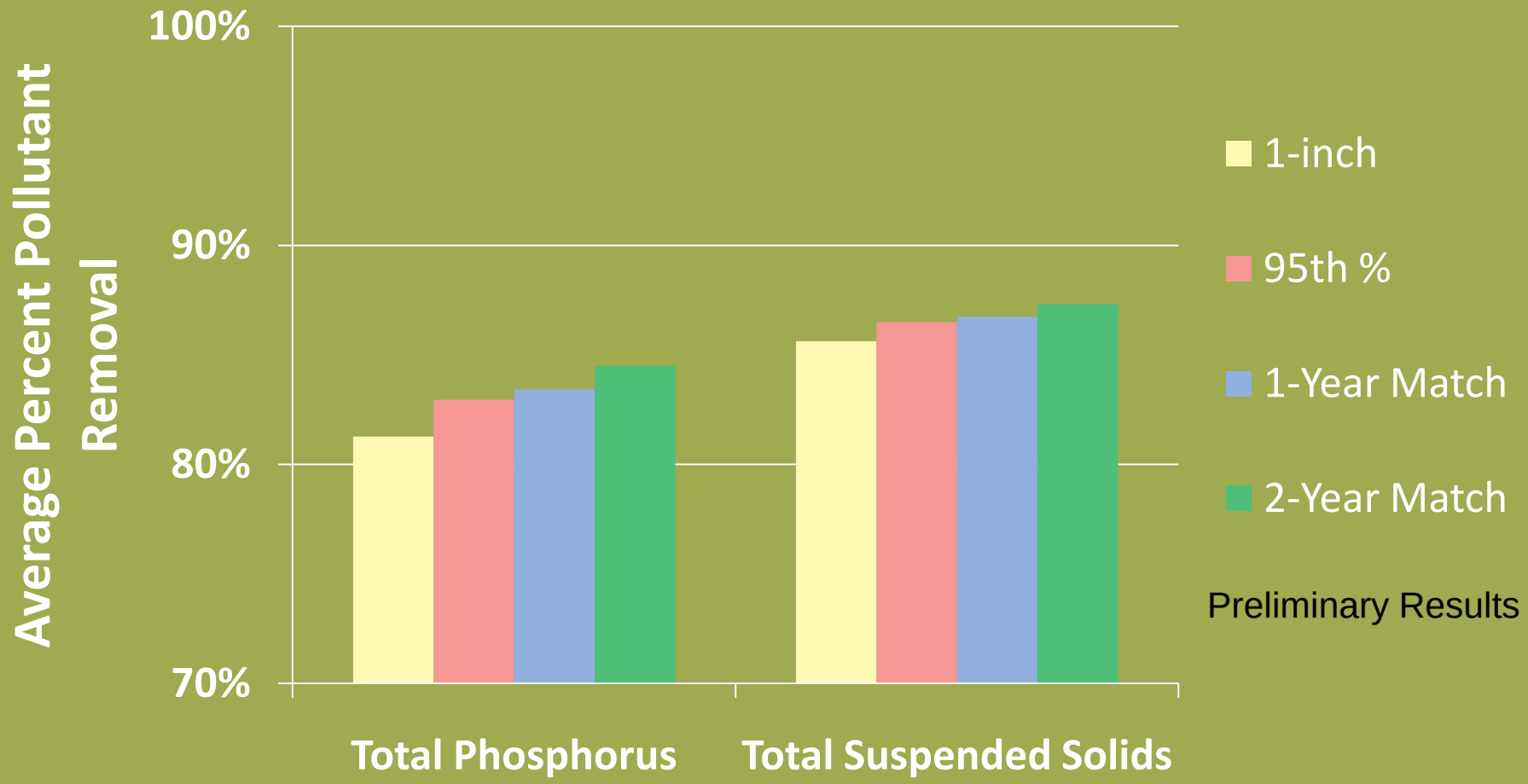
Results of Pollutant Removal Analysis

- All performance goals evaluated have similar removal efficiencies for TP and TSS

Comparison of Removal Efficiency of Four Performance Goals

20% Impervious, B Soils



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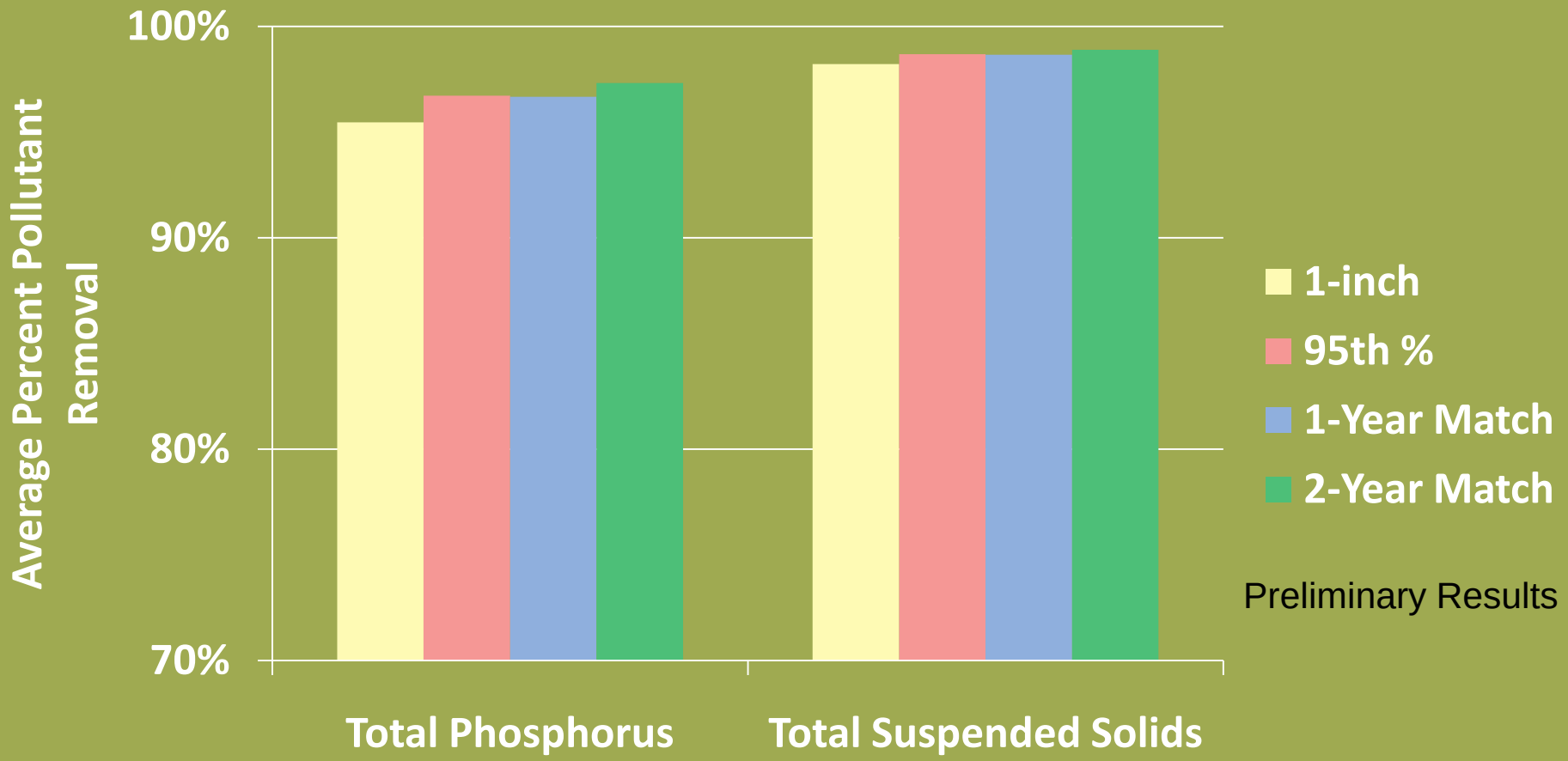
Comparison of Removal Efficiency of Four Performance Goals

80% Impervious, B Soils



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Conclusions of Pollutant Removal Analysis

- Volume reduction performance goals result in significant pollutant loading reduction from a site
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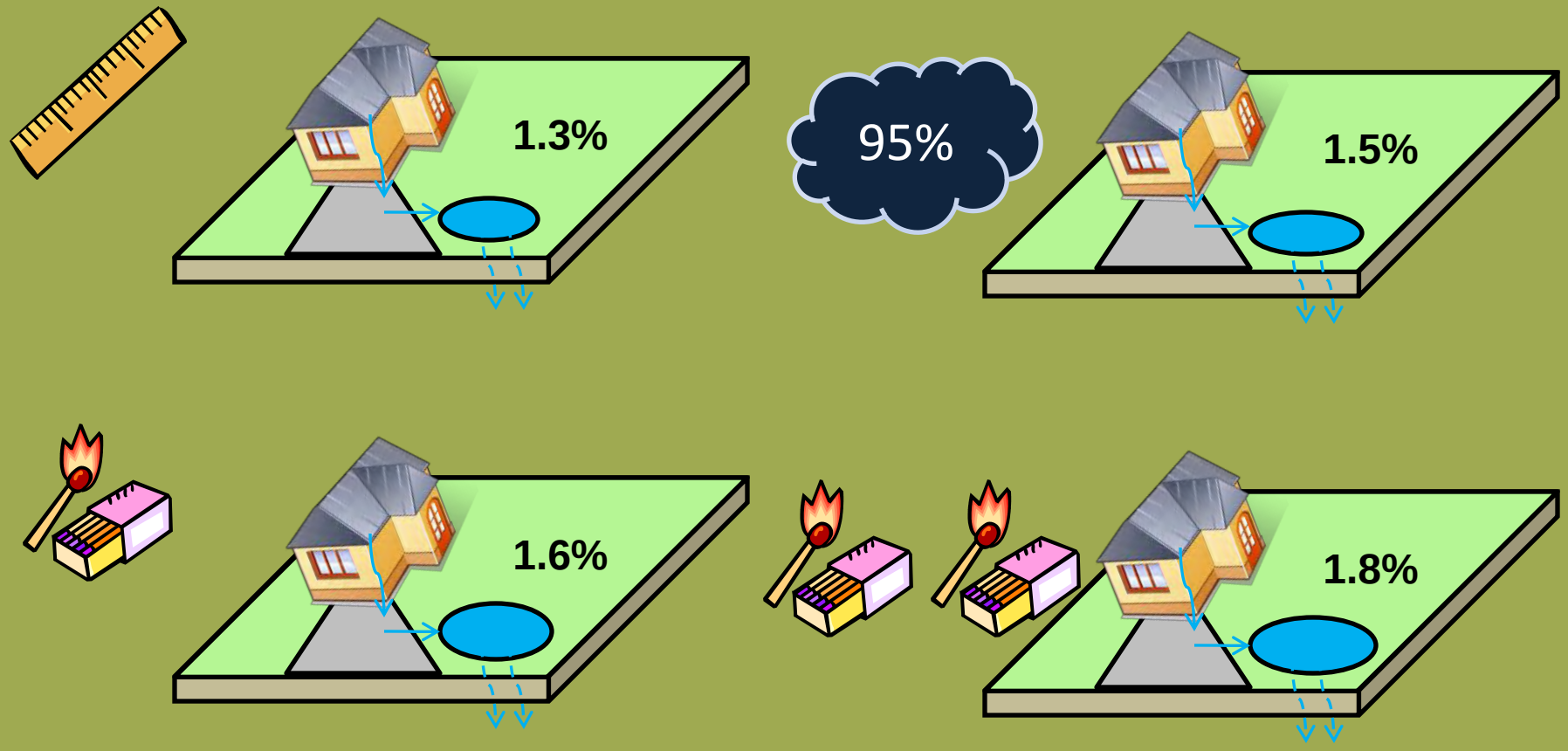
Comparison of BMP Footprints (land area)

Sizing the Volume Control BMPs

- Volume control BMP was modeled as a bioretention basin (rainwater garden)
  - Most common volume control BMP
  - Aesthetically pleasing
  - Above ground: Easy maintenance, inexpensive
- Depth of basin based on soil infiltration rate
  - 48 hour drawn-down of basin
  - C Soils infiltrate at 0.2 inches/hour = 9.6” deep basin
  - B Soils infiltrate at 0.6 inches/hour = ~~28.8” deep basin~~
  - Max depth of basin = 18” to protect plantings

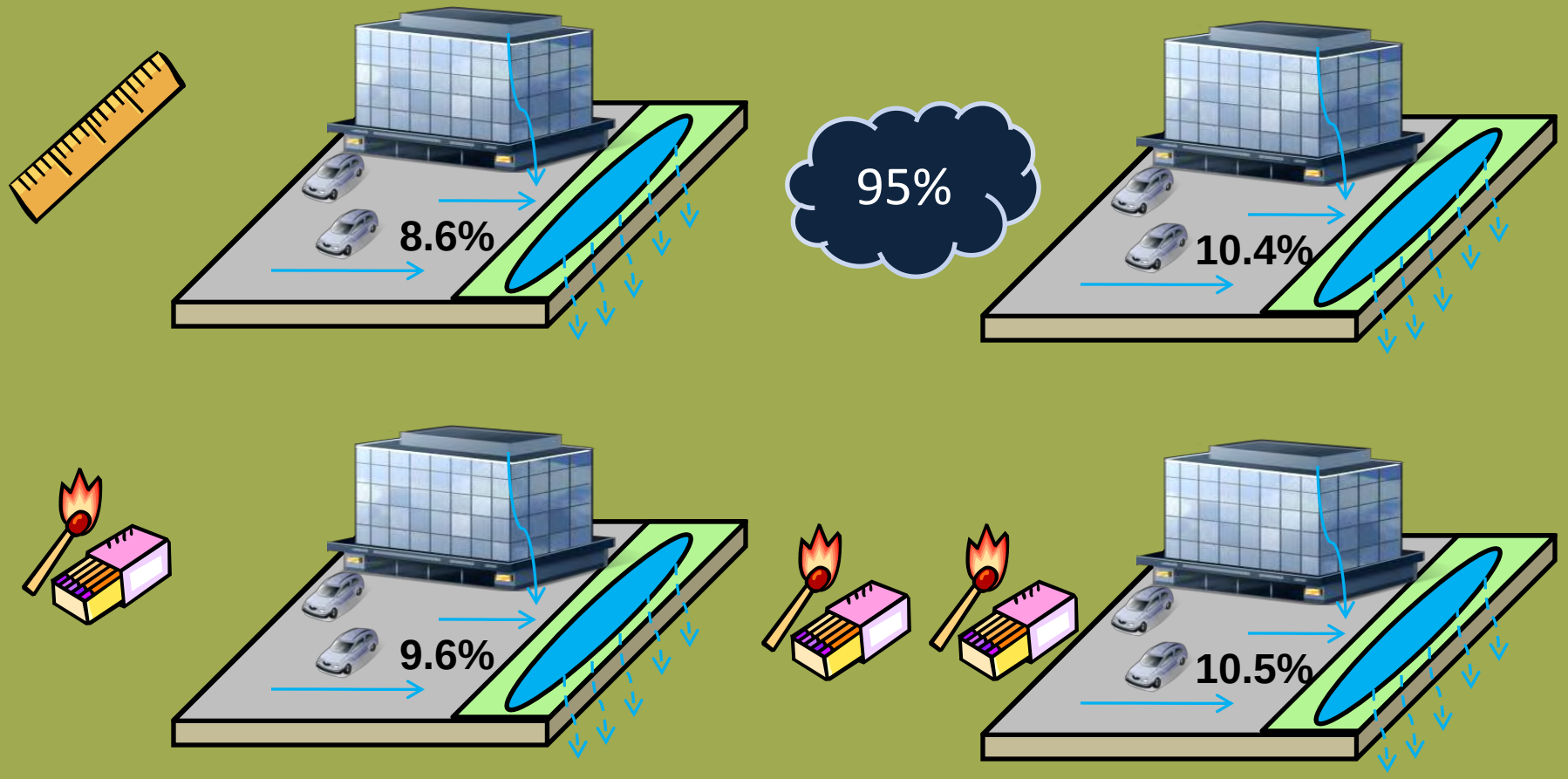
BMP Sizes as Percentage of Site Area

20% Impervious Scenario, B Soils



BMP Sizes as Percentage of Site Area

80% Impervious, C Soils



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Conclusions of BMP Sizing Analysis

- BMP sizes between volume control performance goals differ by less than 2% of site area
  - Larger BMPs more closely match native runoff volumes
- If bioretention BMPs are used for conformance, all performance goals require use of a significant portion (all?) of green space for high-density development

Decisions for Work Group on Volume Control Performance Goals

- What methodology should be used to calculate the required retention volume? (See Side A of handout)
  - Use simplest (e.g., 1-inch off impervious surface)
  - Use method that accounts for pervious and impervious
  - Use matching scenario

- What should be the volume control goal? (See Side B of handout)
  - Does mimic native hydrology mean not exceed native annual runoff volumes? Non-frozen ground average runoff volumes?
  - What's close enough?

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