

Stormwater Modeling for Selected Vermont Watersheds

Presented at

**Department of Environmental Conservation
Agency of Natural Resources
Waterbury, VT**

**Tetra Tech, Inc.
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Presentation Outline

- Modeling Objective
- Model Selection and Set up
- Model Calibration
- Model Application



Modeling Objective

- Simulate stream flow using hydrology model to develop flow duration curves (FDC)
- FDC will be used to identify appropriate targets that are necessary to attain applicable water quality standards.



Technical Need for the Model

- Simulate hydrologic response
- Route flow and pollutants
- Model calibration
- Evaluate urban and mixed land uses
- Simulating storm water best management practices (BMPs)



Other Considerations

- Available data
- **Simplicity**
- Budget and time line
- **Modification and Expansion**



Why P8-UCM

- Continuous simulation with hourly output
- Simulates snow melt
- Urban stormwater BMPs and wetland simulation
- Data needs can be filled with available information
- Requires moderate effort to set up, calibrate, and apply
- Widely applied in New England

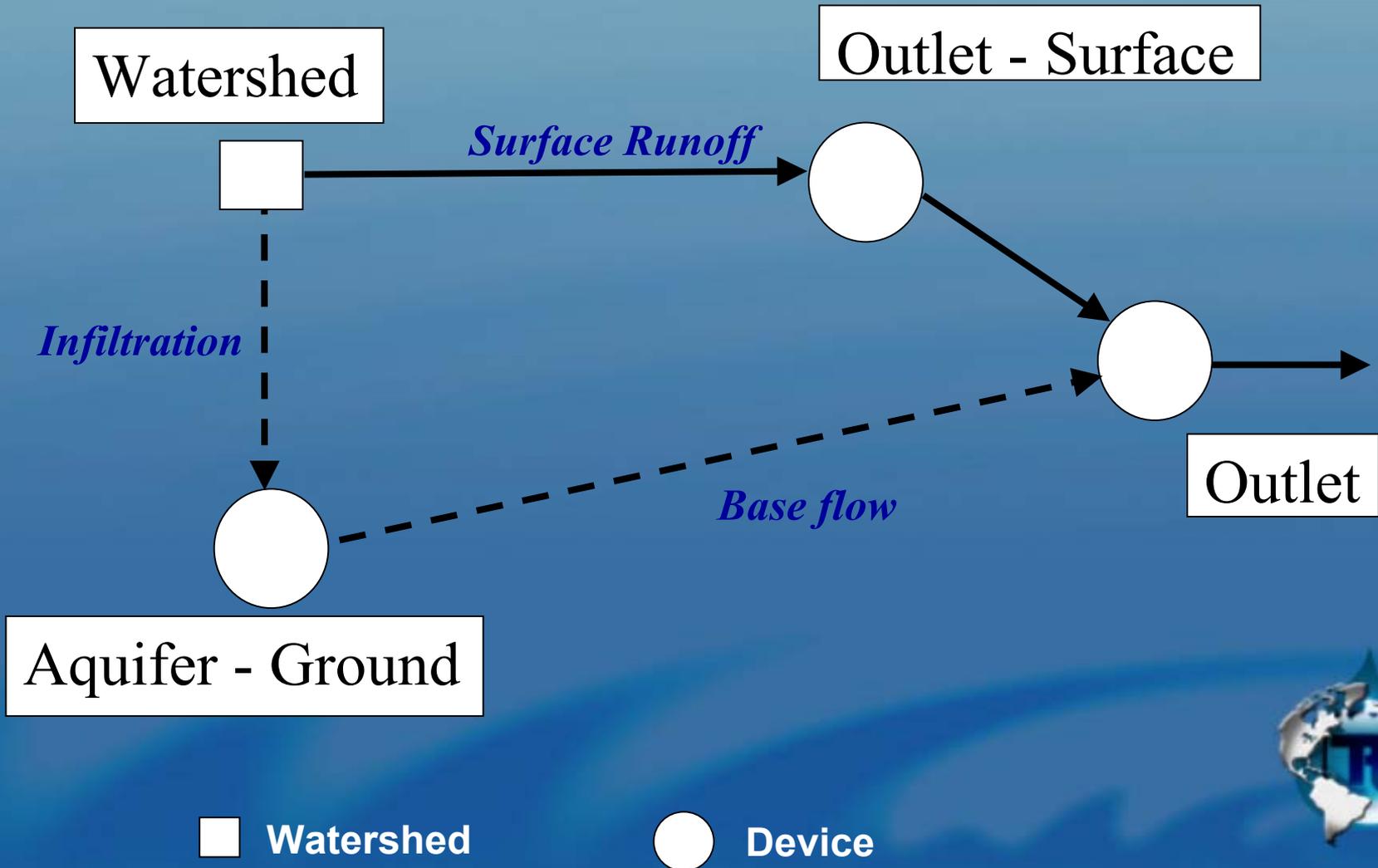


What is P8-UCM

- Predict the generation and transport of storm water and pollutants
- Continuous water balance and mass balance
- Model consists of watersheds, devices, particle classes, and water quality components
- Continuous hourly rainfall and daily air temperature time series data
- Available for free at <http://www.walker.net/p8/>



Simple P8-UCM Set up



Model Inputs

- Watershed
 - Watershed Area
 - Pervious Curve Number (PCN)
 - Percent Imperviousness (PI)
 - Impervious Coefficient (IC)
 - Depression Storage
- Devices
 - Surface – Time of Concentration (TC-SR)
 - Ground – Time of Concentration (TC-BF)
- Climate
 - Hourly Precipitation
 - Daily Temperature



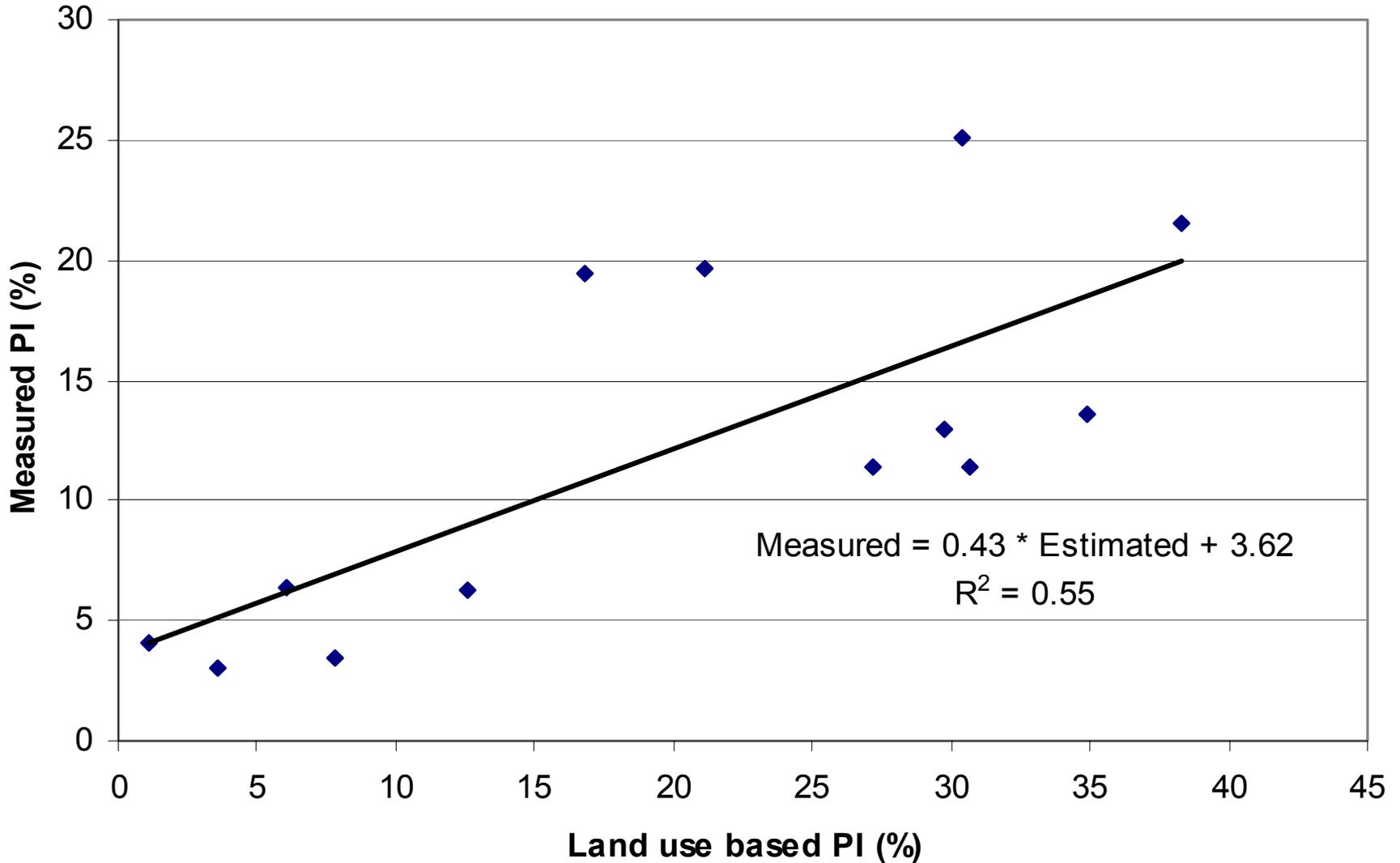
Percent Imperviousness

- Direct Measurements by DEC
- Estimation Using Literature (CWP, 1999)

VCGI Land Use Code	Land Use Name	Percent Impervious Cover
3	Brush/Transitional	0%
11	Residential	14%
12	Commercial	80%
13	Industrial	60%
14	Transportation	41%
17	Other Urban	60%
24	Agriculture/Mixed Open	2%



Percent Imperviousness



Pervious Curve Number

Land Use

CN for hydrology soil group

	A	B	C	D
Pervious portion of urban land uses (Residential, Commercial, Industrial, Transportation, etc.) – Urban Open Space in good condition	39	61	74	80
Brush/Transitional (Assuming Fair Condition)	35	56	70	77
Barren Land (Assuming Natural Desert Landscaping)	63	77	85	88
Agriculture/Mixed Open	30	58	71	78
Forest (All types in Fair Condition)	36	60	73	79
Non Forested Wetland (as per MA NRCS)	78	78	78	78
Row Crops (Assuming Contoured + Crop residue Cover in Good Condition)	64	74	81	85
Hay/Pasture (Assuming Fair Condition)	49	69	79	84

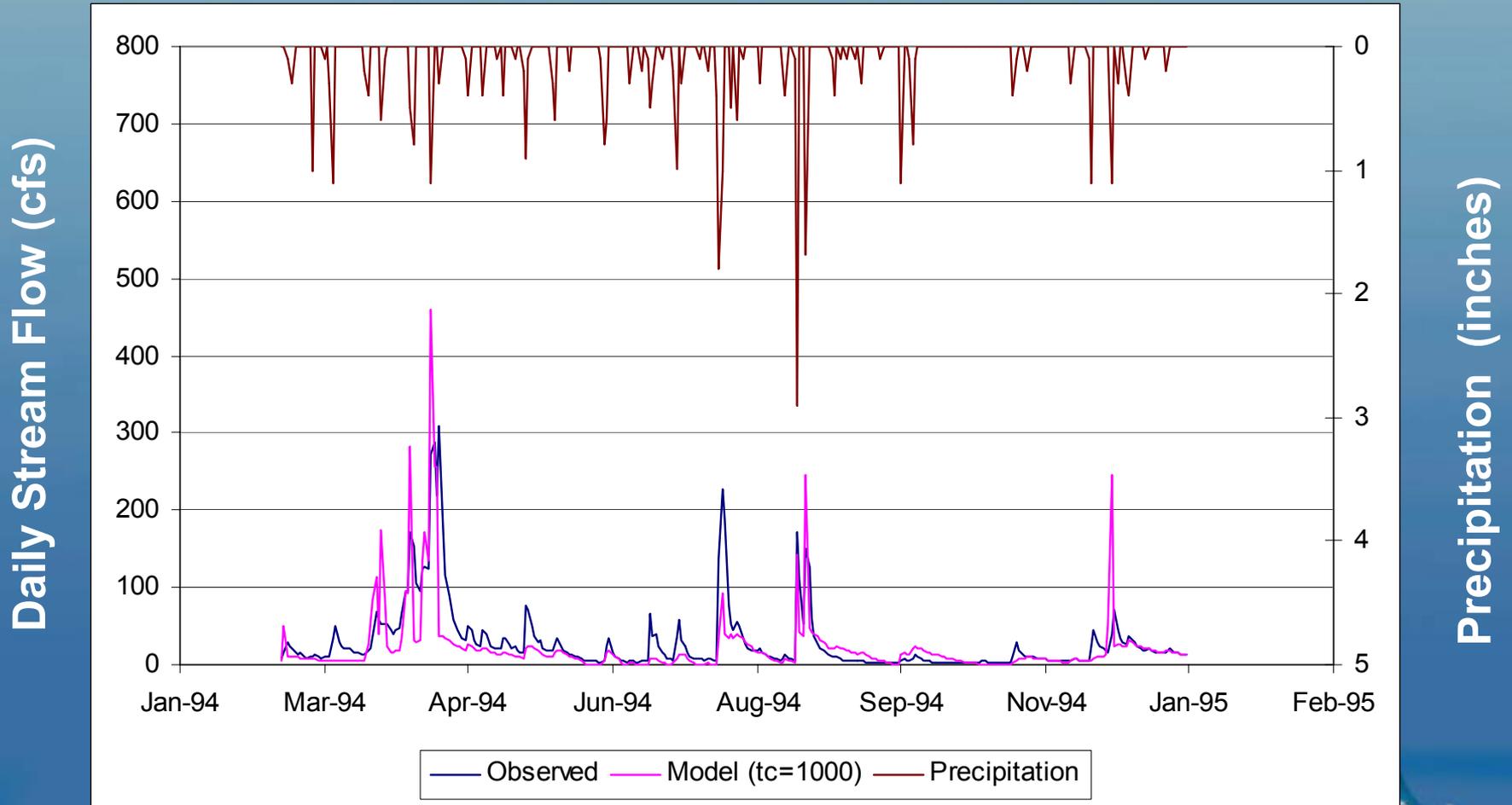


Model Calibration

- Initial Calibration Using USGS Daily Data
- Detailed Calibration Using UVM Hourly Data



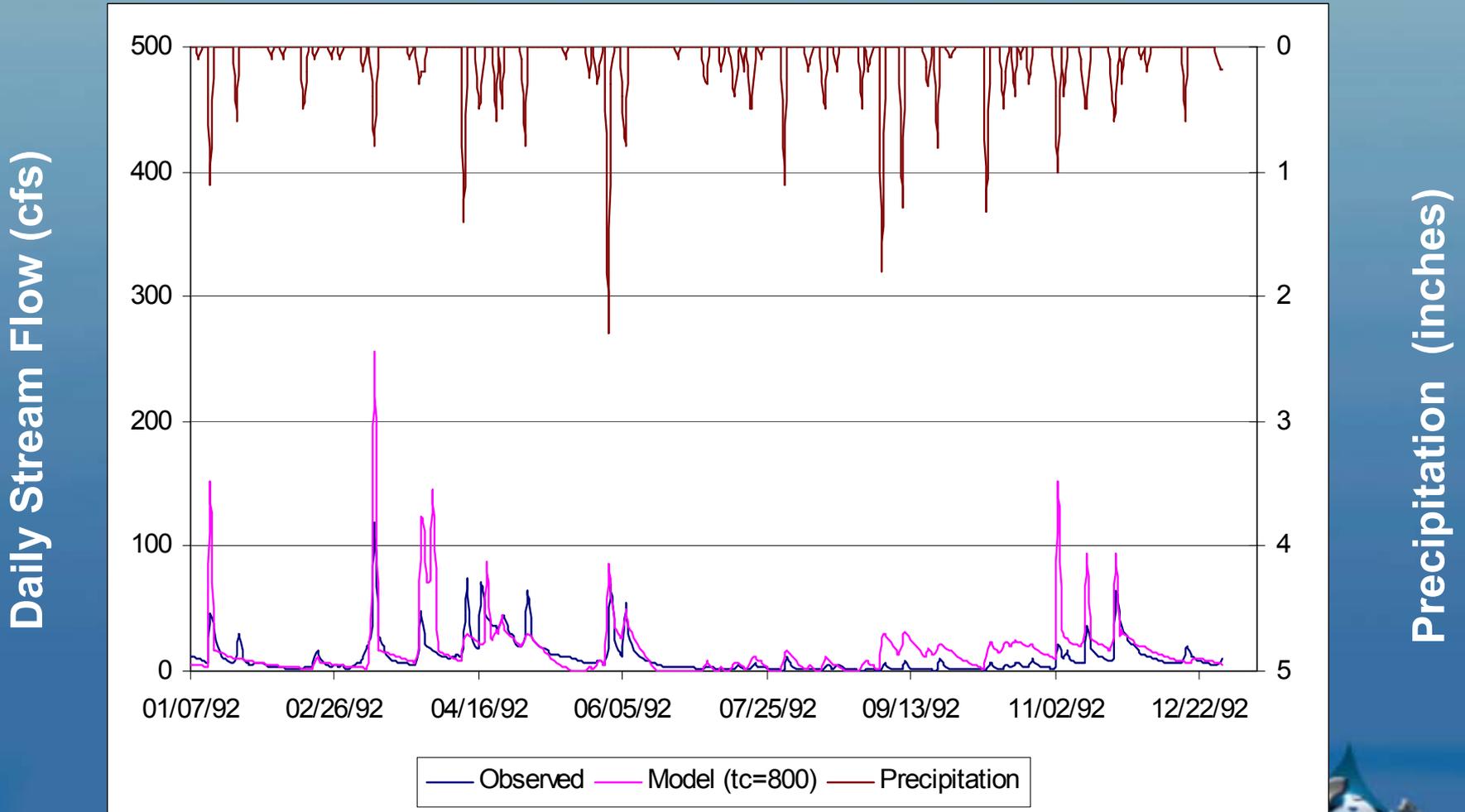
Initial Calibration



Daily Flow at MOUNT HOPE BROOK, SOUTHBAY NEAR WHITEHALL, NY
(USGS 04279125)



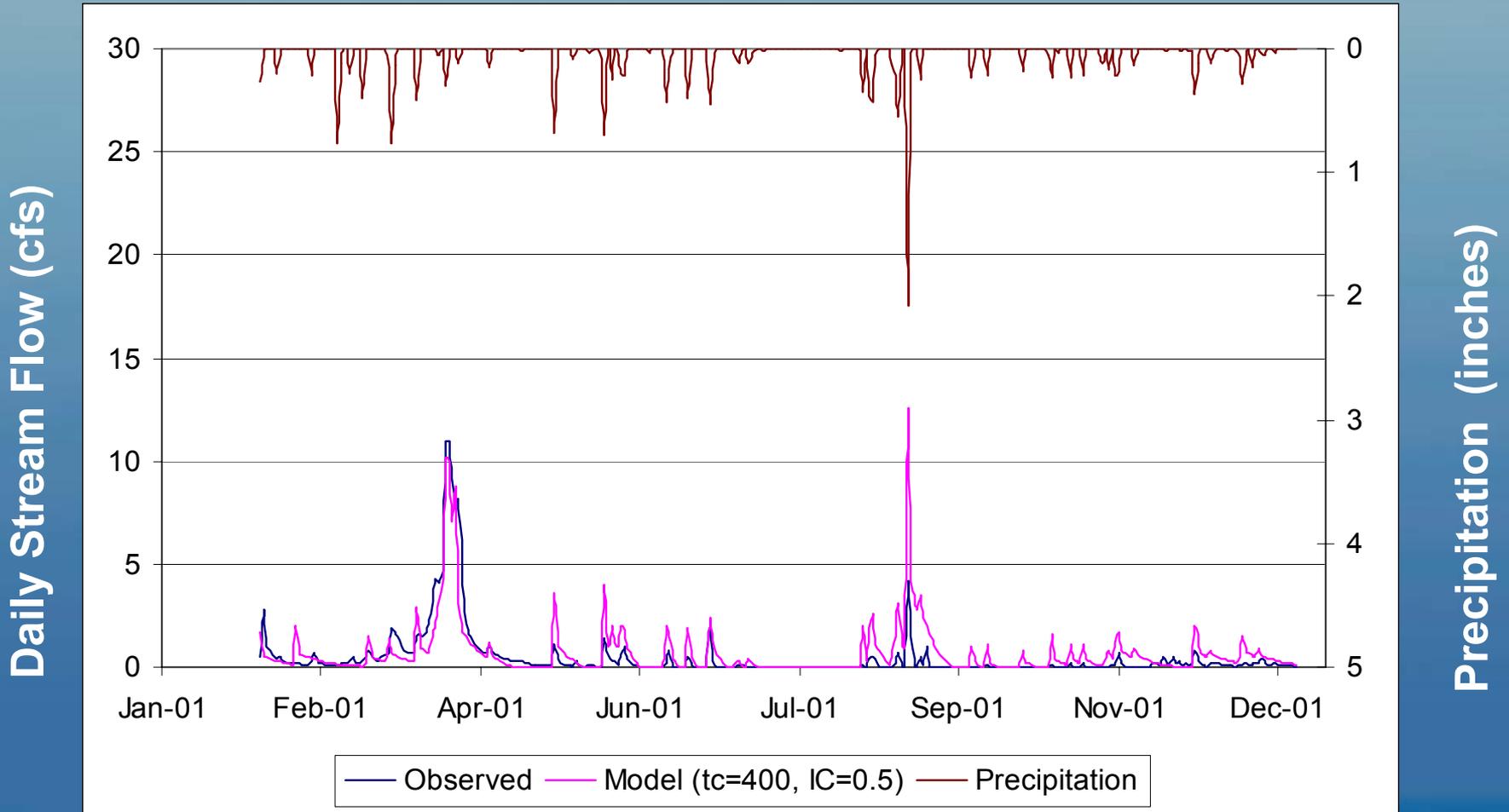
Initial Calibration



Daily Flow at MILL BROOK, PUTNAM, NY
(USGS 04279040)



Initial Calibration



Daily Flow at ENGLSBY BROOK, BURLINGTON, VT
(USGS 04282815)

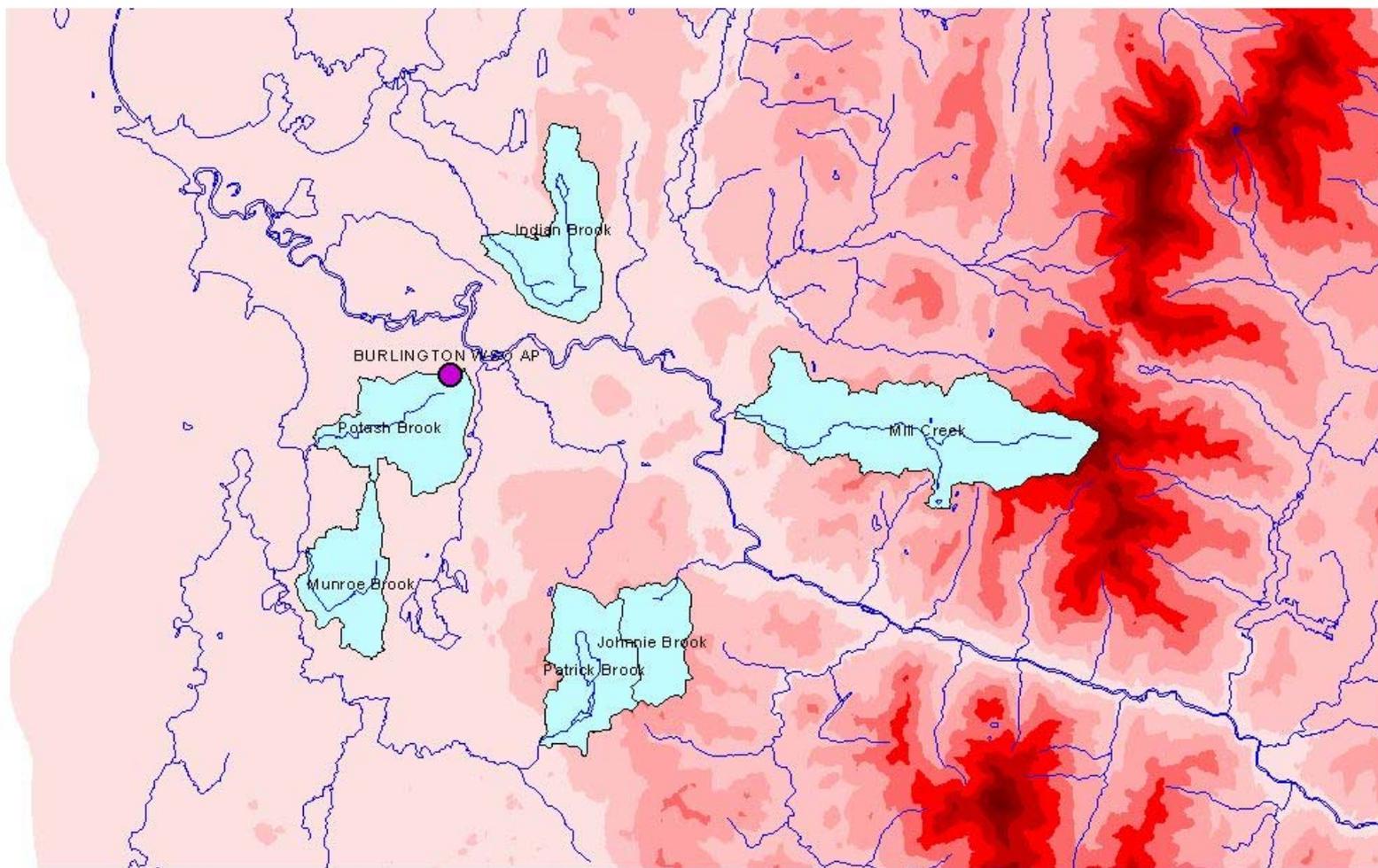


UVM Calibration: Focus on Stormwater

- Calibrate Model Parameters
 - Percent Imperviousness (PI)
 - Impervious Coefficient (IC)
 - Pervious Curve Number (PCN)
 - Surface Runoff Time of Concentration (TC-SR)
- Estimating Model Parameters for Un-gauged Watersheds



UVM Calibration



6 0 6 12 Miles

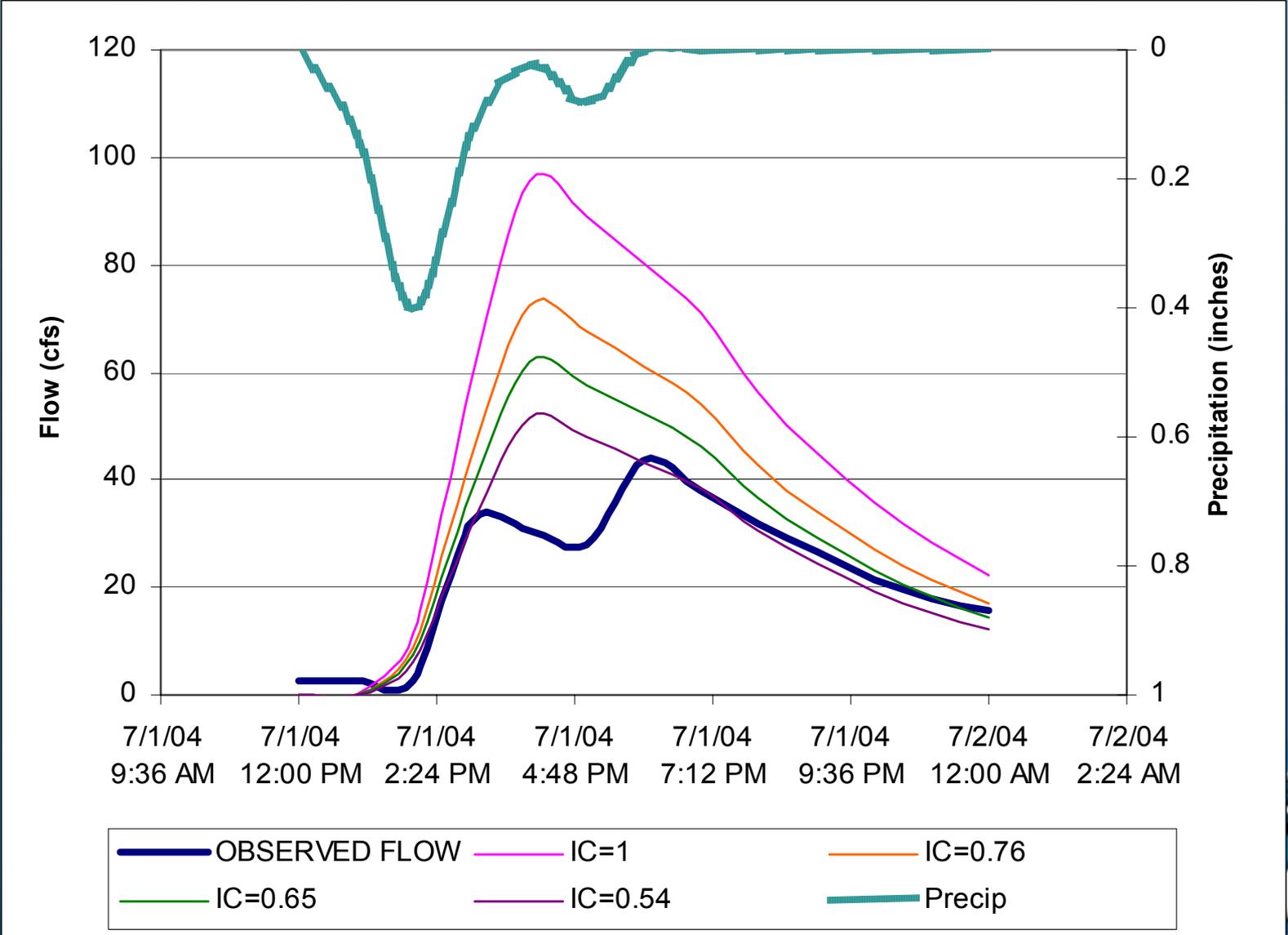


UVM Calibration: Potash Brook

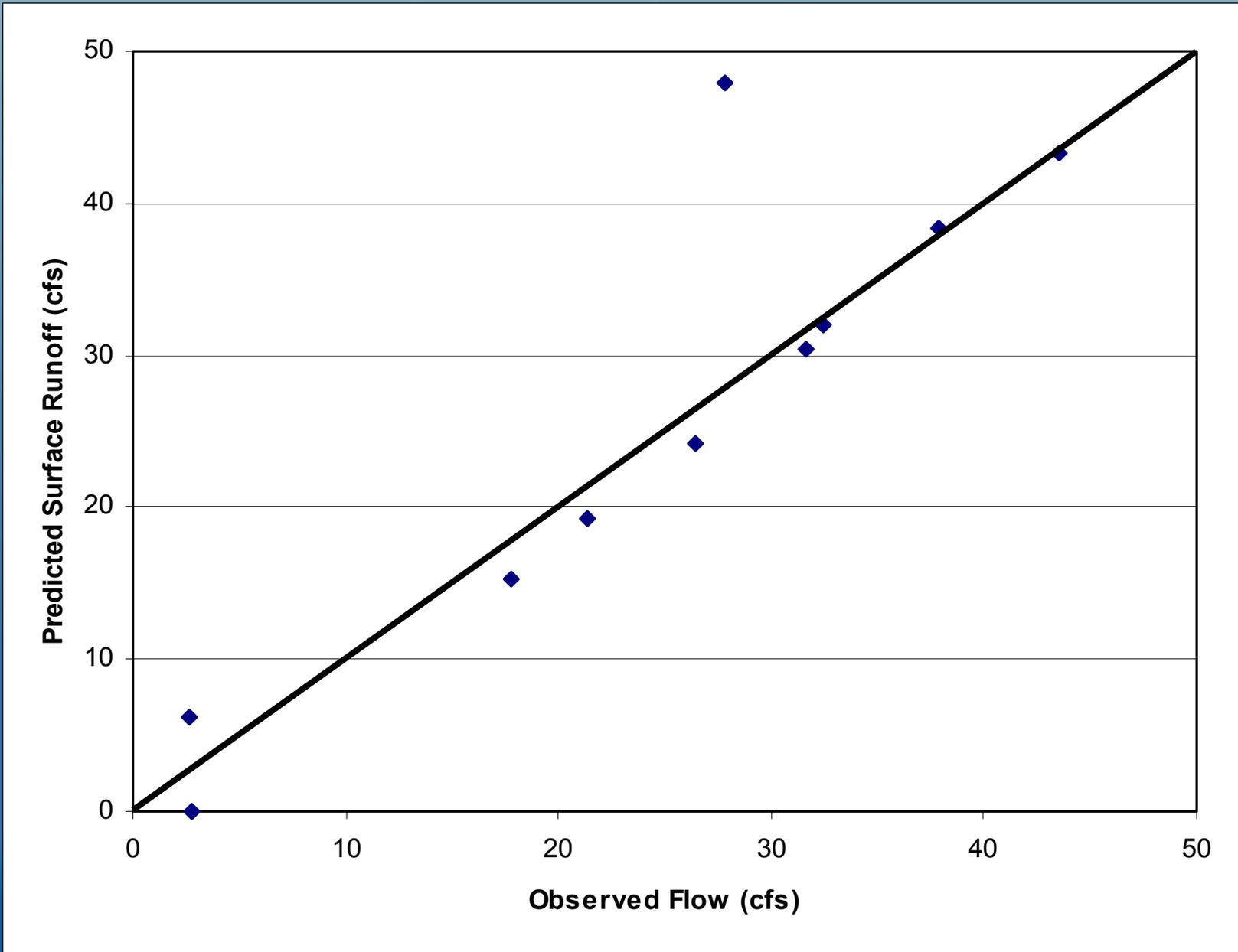
- Calibrate PI & IC
 - Measured PI = 20%
 - Tested ICs of 1, 0.76, 0.65, & 0.54
 - Selected Storm of 0.75 inches on 01/07/2004



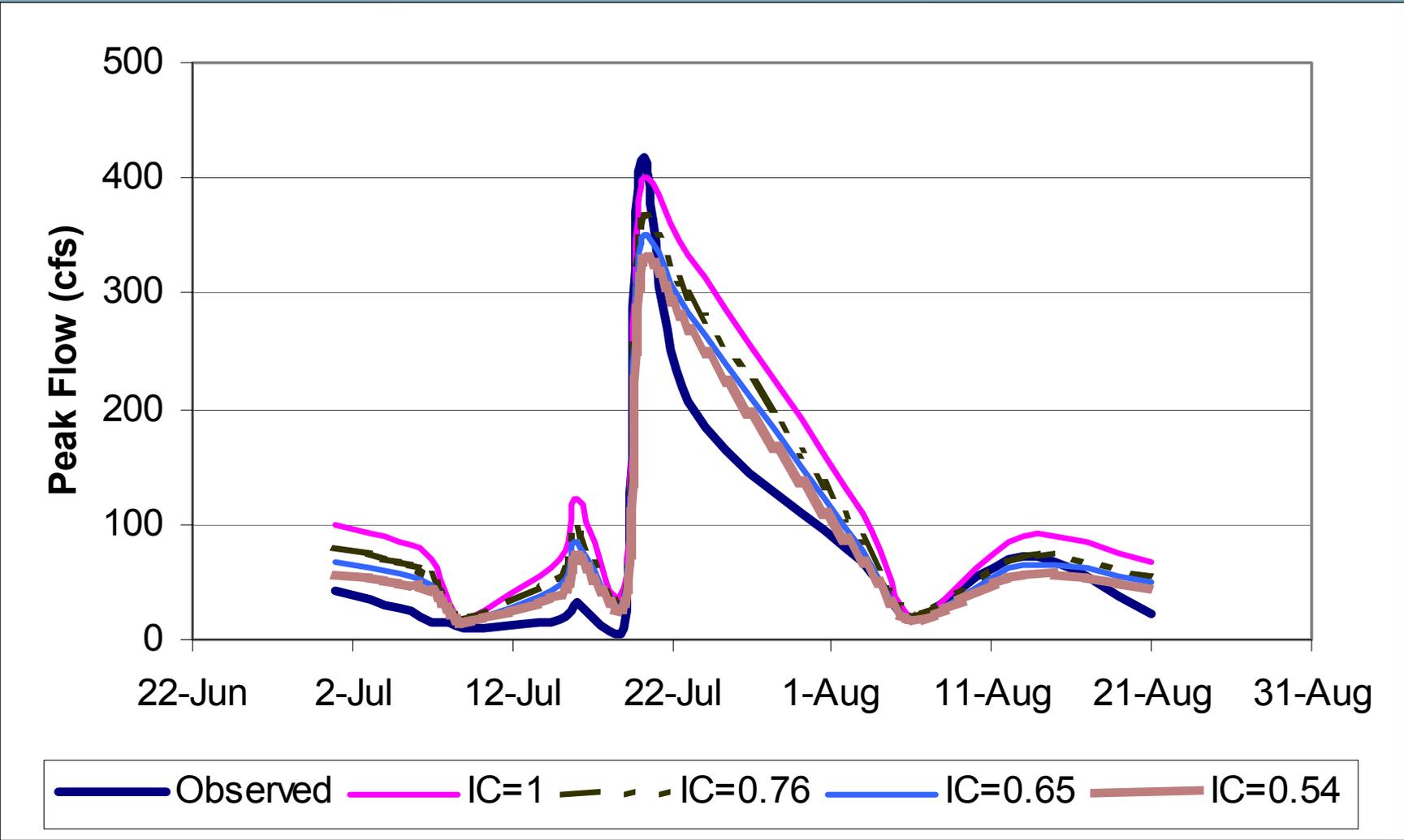
UVM Calibration: Potash Brook



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UVM Calibration: Potash Brook

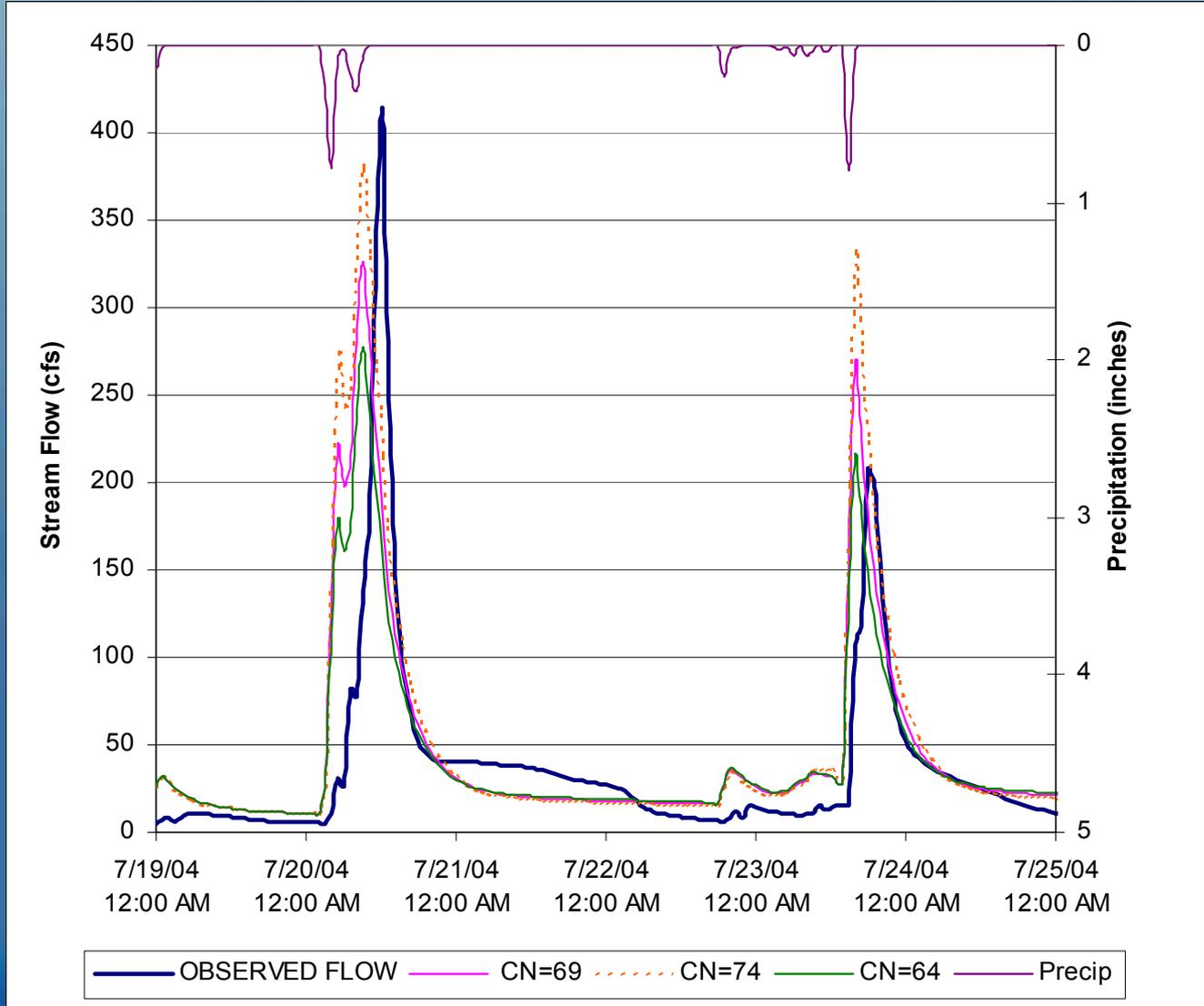


UVM Calibration: Potash Brook

- Calibrate PCN
 - Estimated PCN from Soil & Land use = 69
 - Tested ICs of 64, 69, & 74
 - Selected Storms of 1.65 inches on 07/20 & 1.25 inches on 07/22 - 23



UVM Calibration: Potash Brook

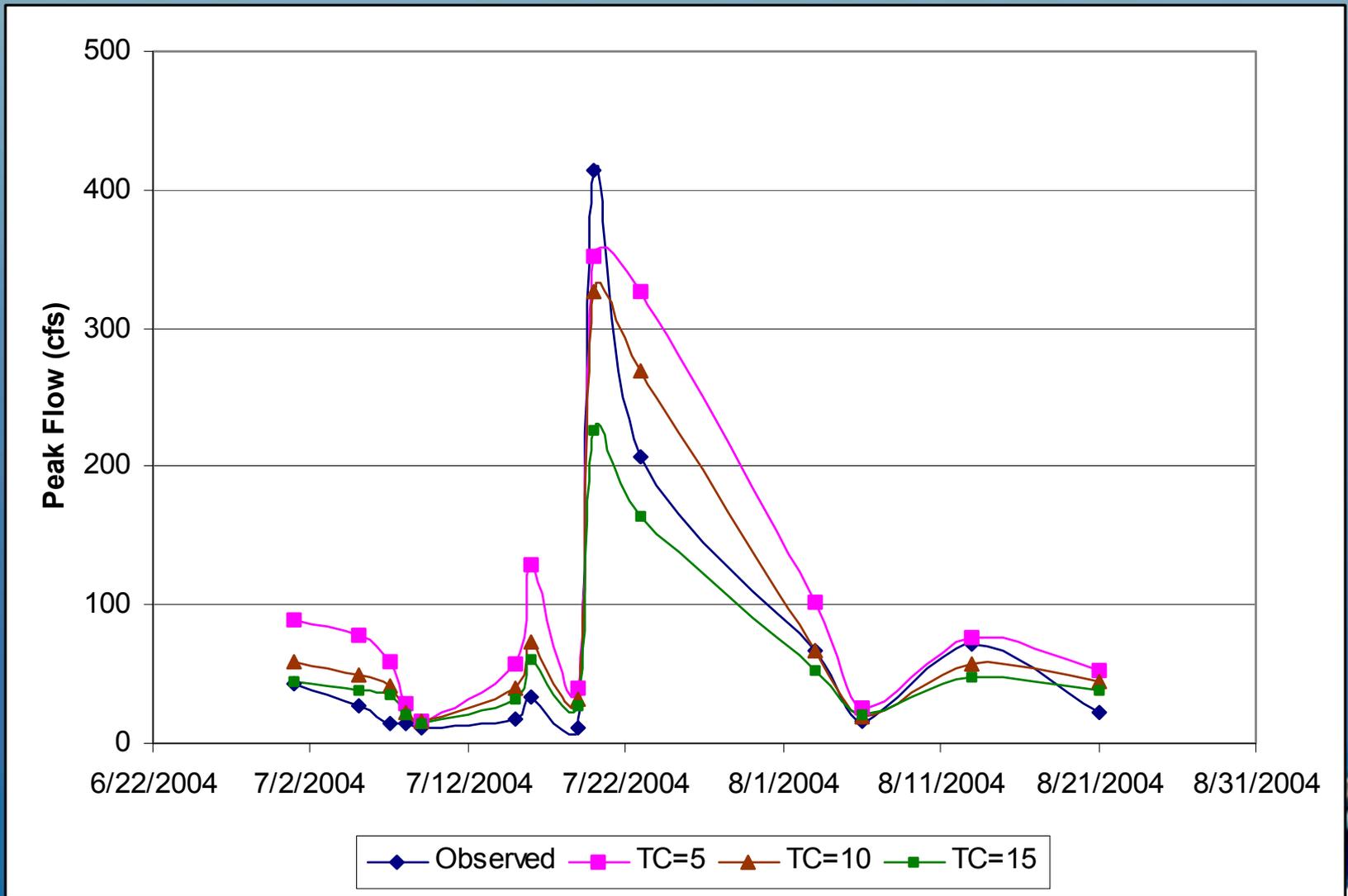


UVM Calibration: Potash Brook

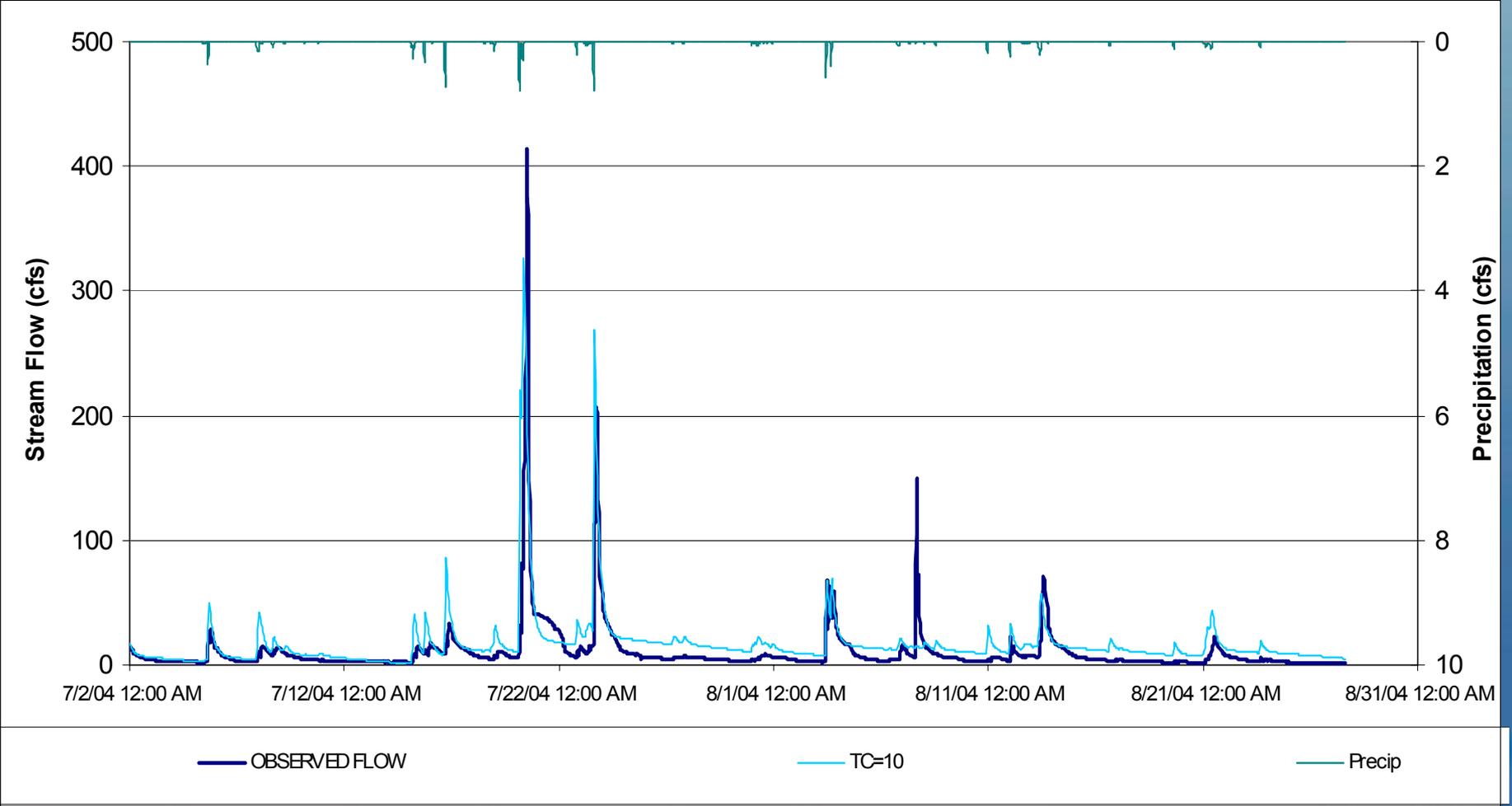
- Surface Runoff Time of Concentration
 - Tested TC-SRs of 5, 10, & 15 hours



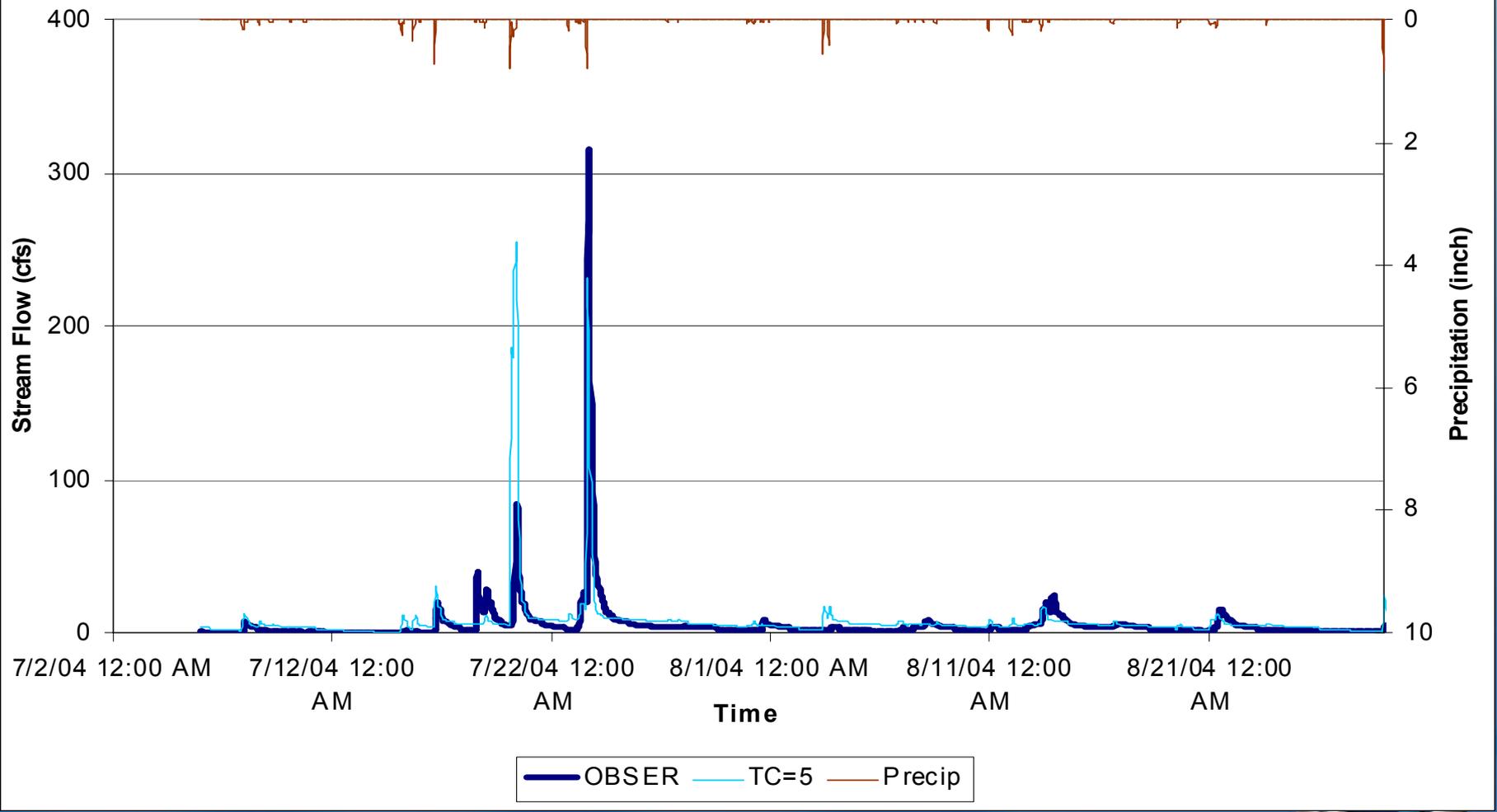
UVM Calibration: Potash Brook



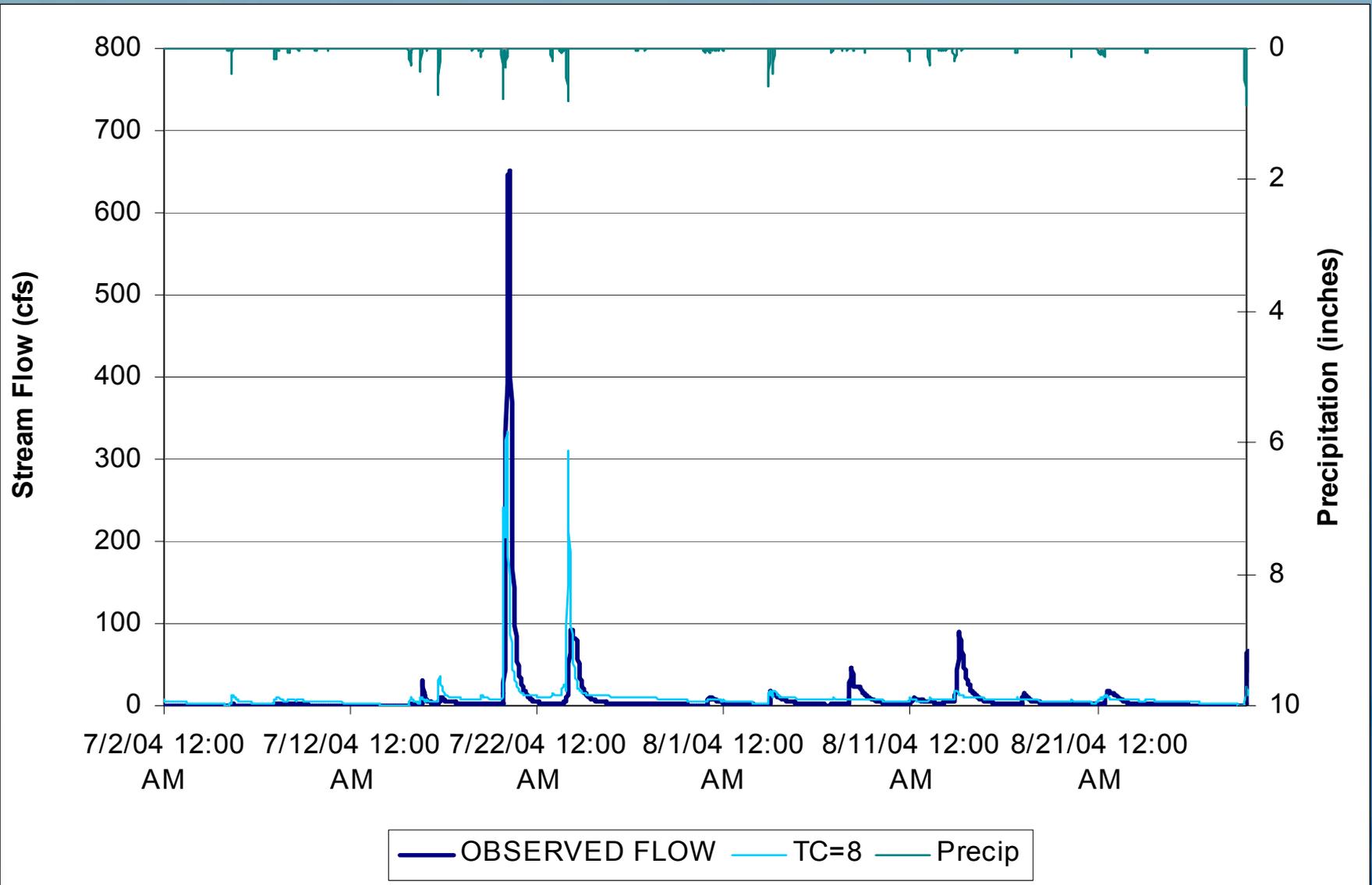
UVM Calibration: Potash Brook



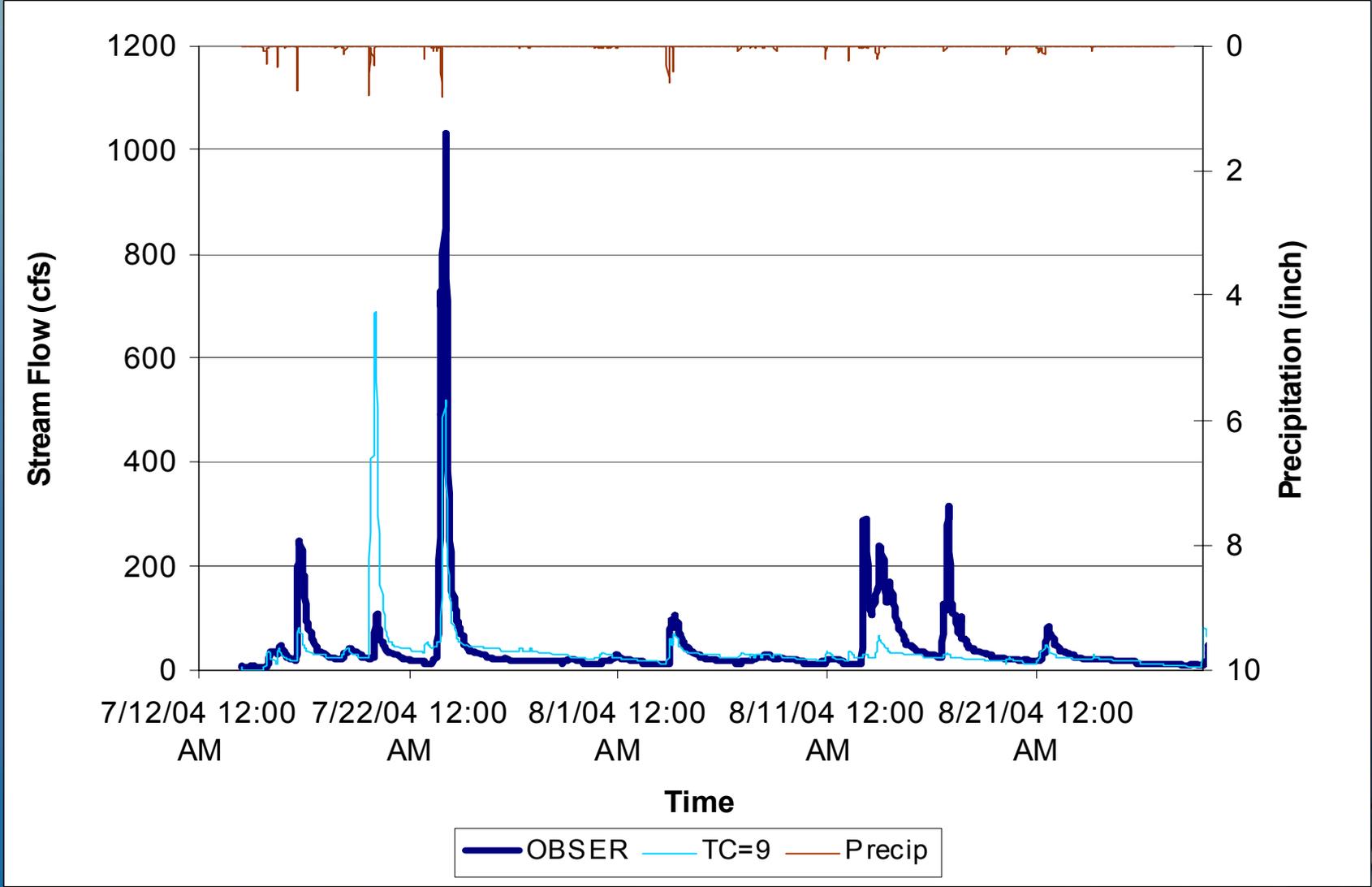
UVM Calibration: Johnnie Brook



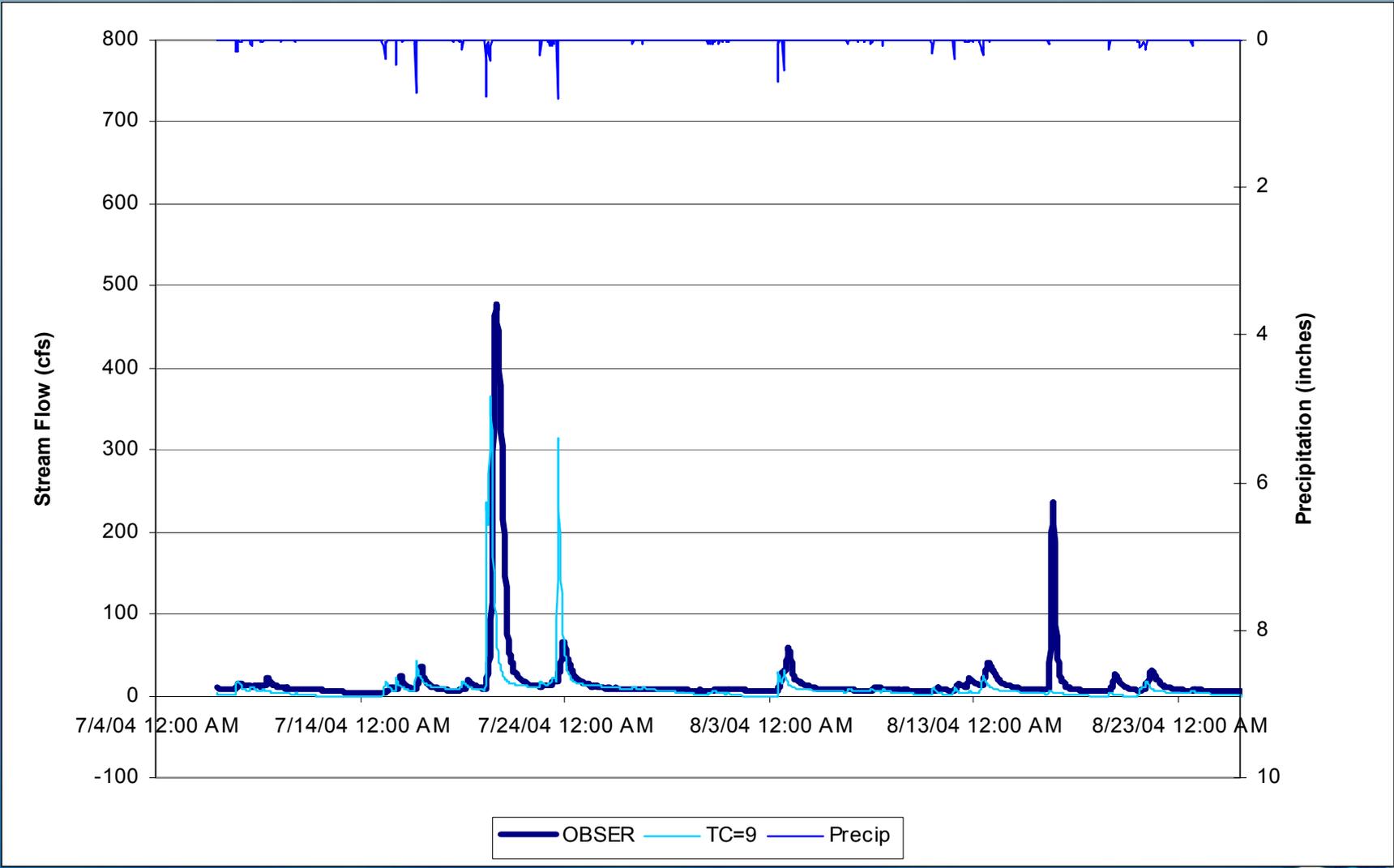
UVM Calibration: Munroe Brook



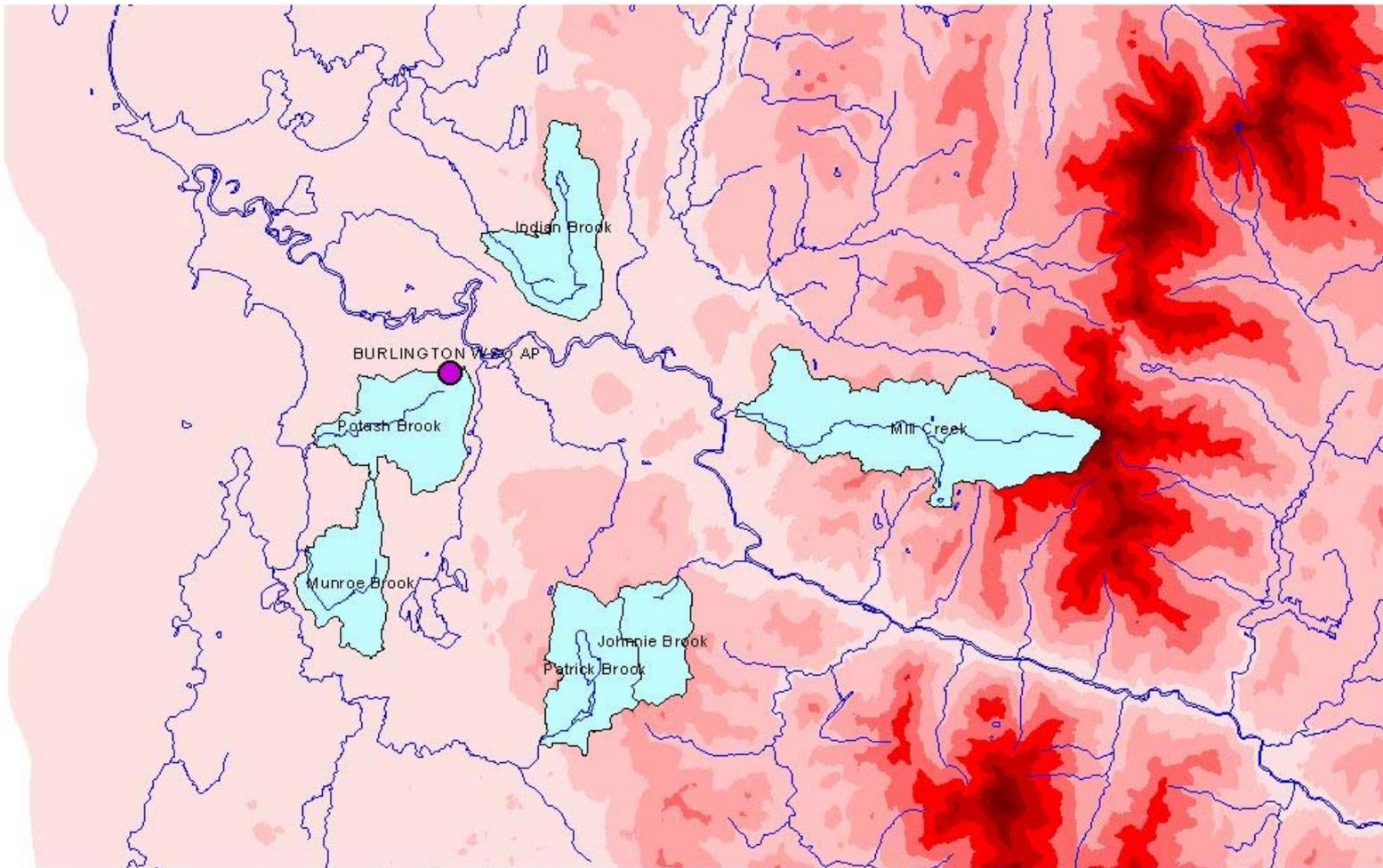
UVM Calibration: Mill Brook



UVM Calibration: Indian Brook



UVM Calibration: Limitations



UVM Calibration: Limitations

■ Spatial Variation of Precipitation

Date	Precipitation at Gauge (inches)			
	Burlington Airport	Potash Brook	Mill Brook	Patrick Brook
July 20, 2004	1.68	NR	2.08	NR
July 23, 2004	1.09	NR	2.71	1.05
July 31, 2004	0.28	NR	1.43	0.31
August 7, 2004	0.10	NR	2.12	0.43
August 13, 2004	0.63	0.74	0.90	0.63
August 21, 2004	0.66	0.84	1.56	0.67

NR –No record available

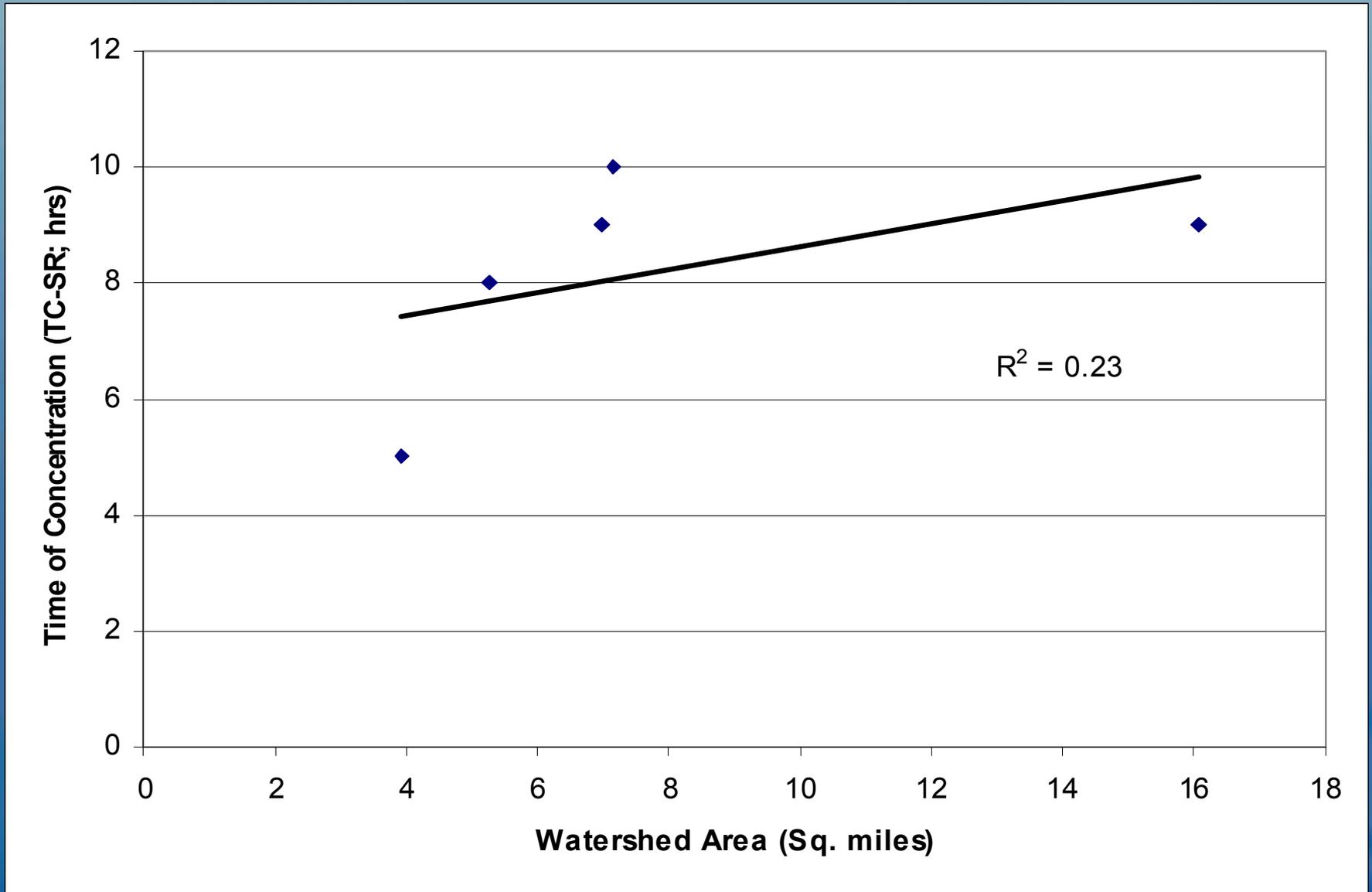


Time of Concentration (TC-SR) for Un-gauged Watersheds

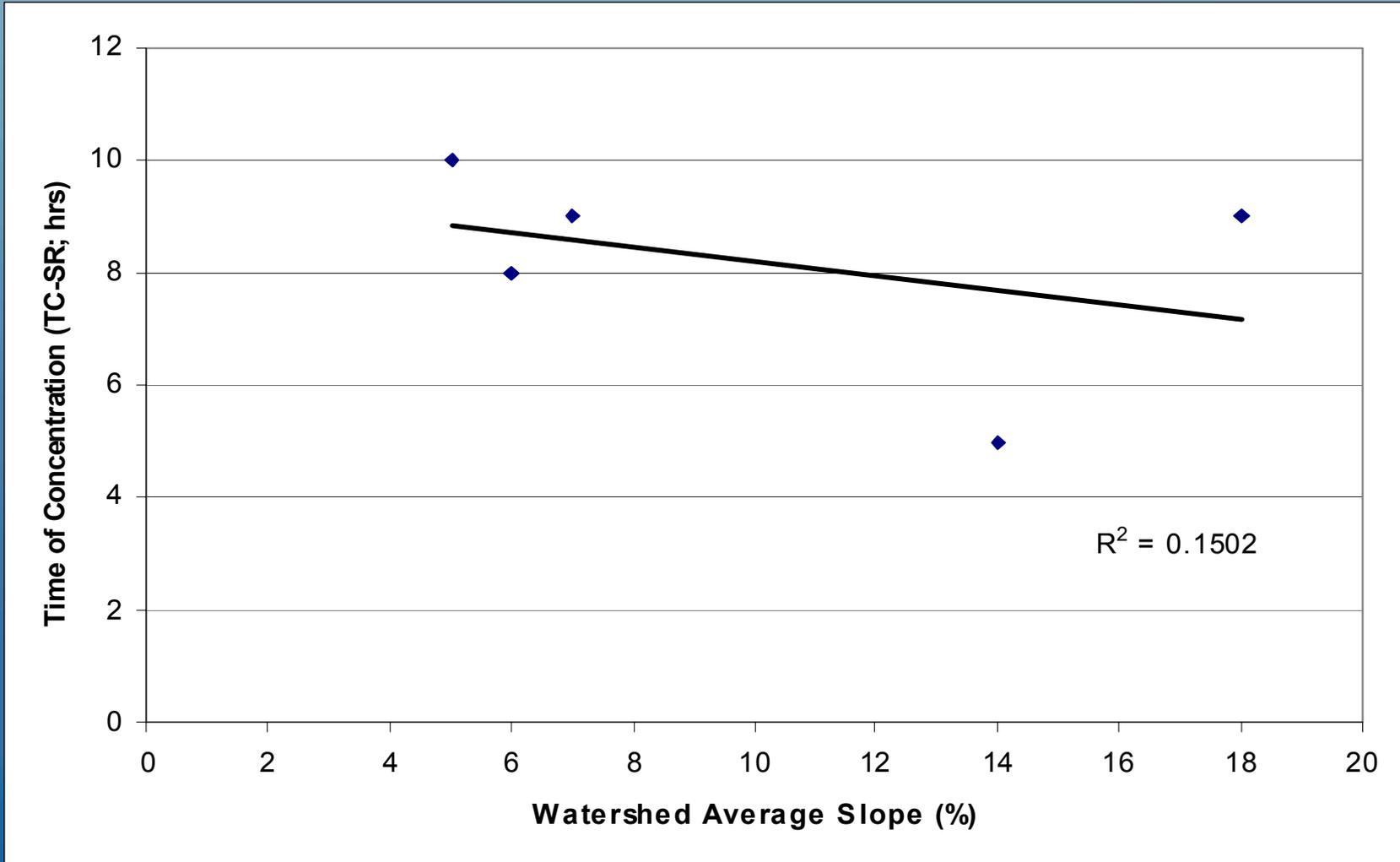
- Examine the rations between TC-SR and watershed characteristics
- Develop relationship/tool to estimate TC-SR



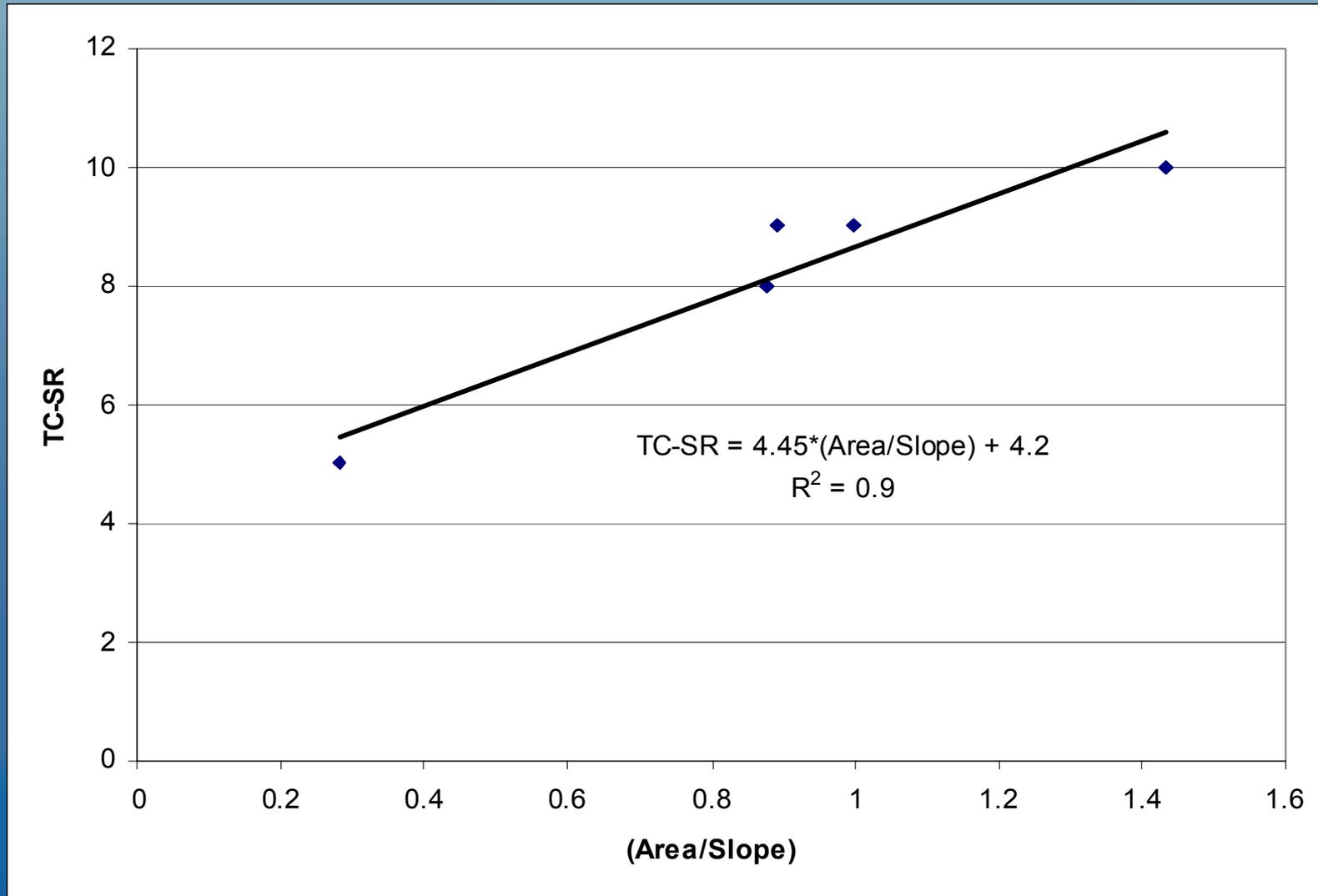
Time of Concentration & Area



Time of Concentration & Slope



TC-SR & (Area/Slope)



Model Application: Estimate Model Parameters

- **Watershed Percent Imperviousness (PI)**
 - Use Measured PI, if available
 - Estimate PI using VCGI land use data and CWP coefficient
 - Adjust the estimation using regression equation to get “Equivalent Measured PI”
 - Set the Impervious Coefficient (IC) as 0.54



Model Application: Estimate Model Parameters

- **Pervious Curve Number**
 - Estimate PCN using VCGI Land use data & VCGI SURRGO soil data
- **Surface Runoff Time of Concentration (TC-SR)**
 - Estimate Slope using VCGI Slope24 Data
- **Set Groundwater Time of Concentration as 1000 hrs**
- **Set Depression storage as 0.014**



Selecting Attainment Watershed

- **Initial Phase (Using watershed characteristics from available GIS Data)**
 - Eco-region (high/moderate gradient and precipitation zone)
 - Topography (Slope)
 - Land use, soils, impervious cover
 - Drainage Area
- **Second Phase (maps/orthophotos)**
 - Wetlands/Dams
 - Watershed Shape

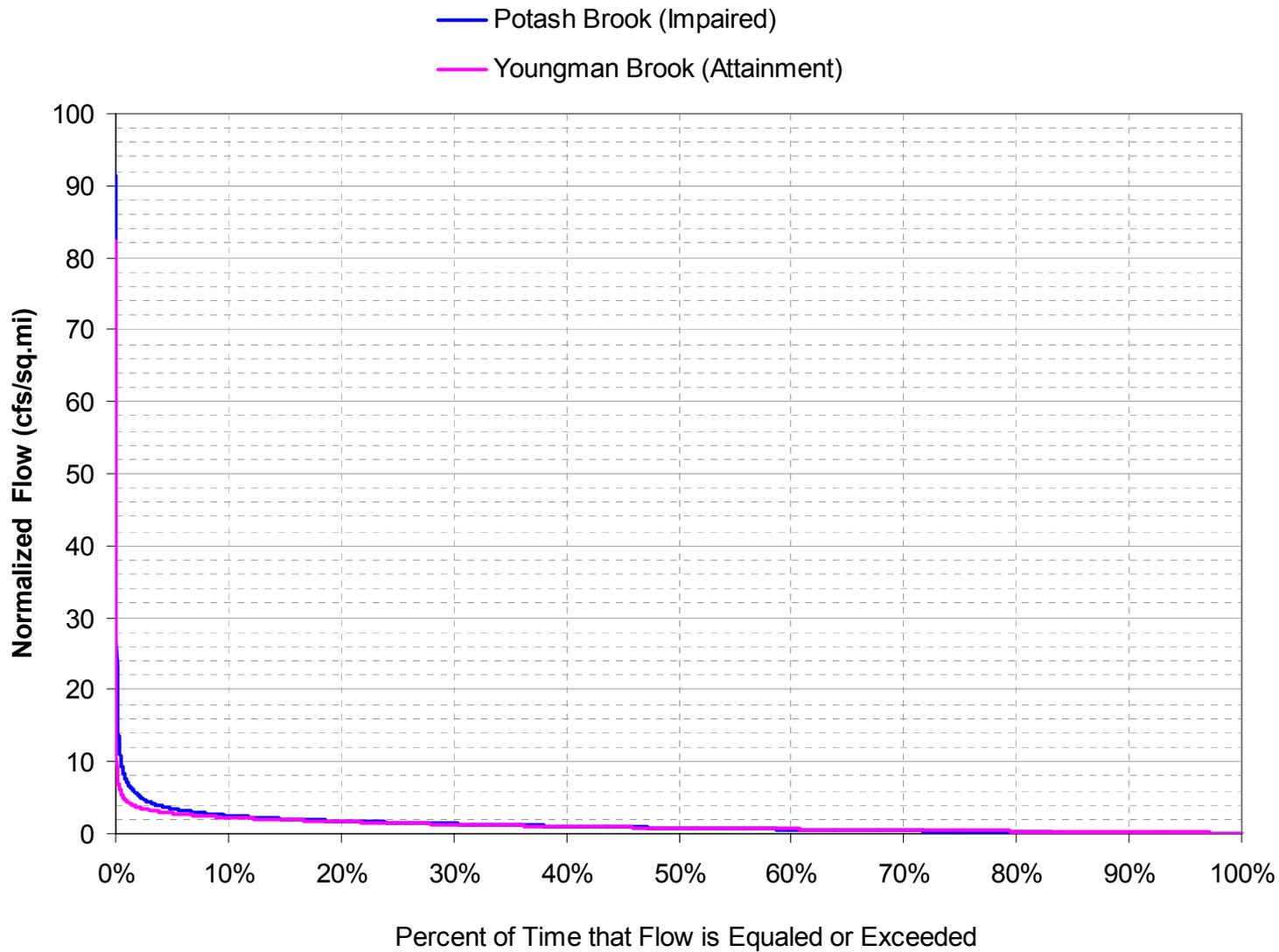


Model Application: Flow Duration Curve

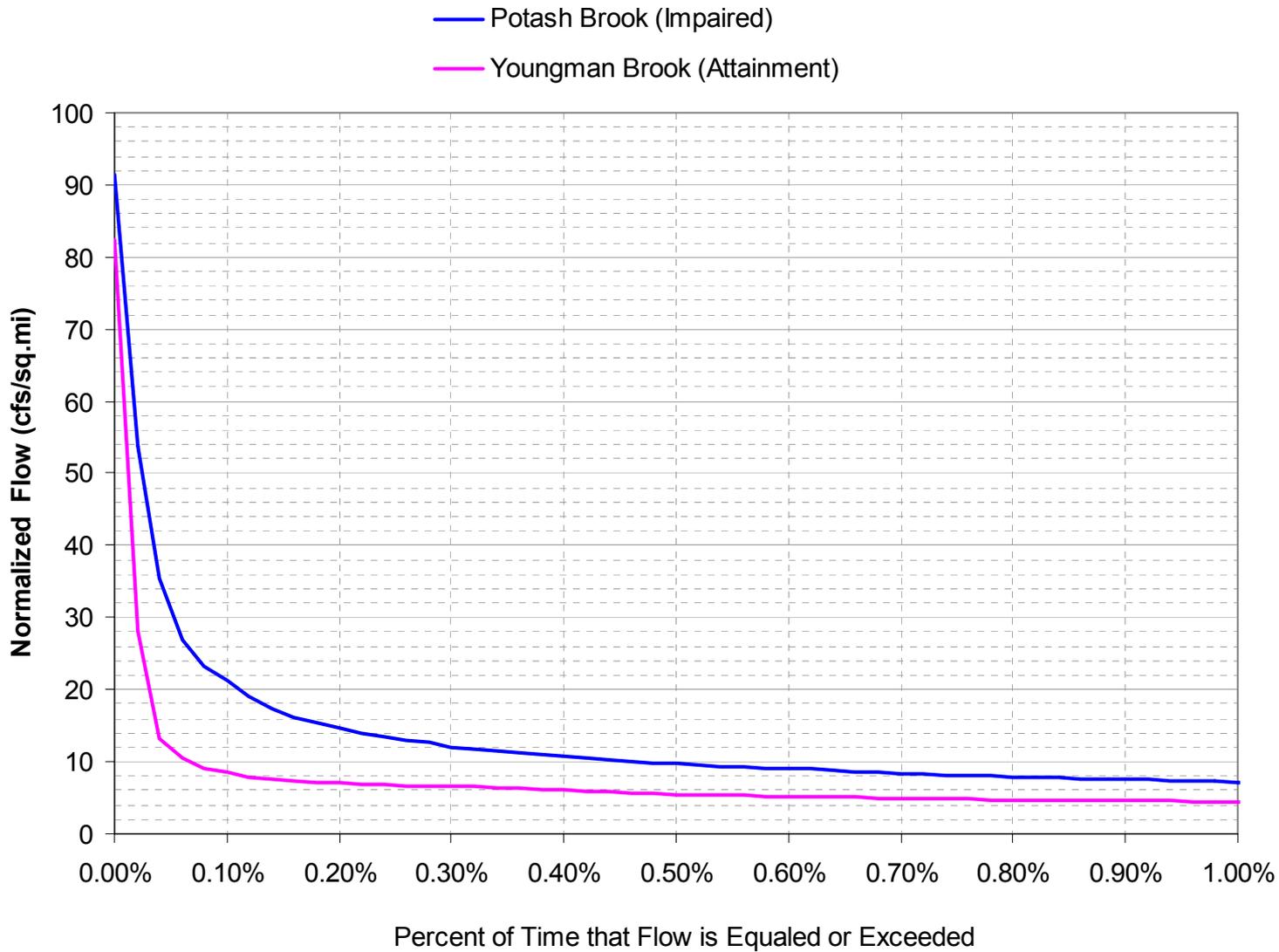
■ Watershed Characteristics

Watershed Characteristics	Potash Brook	Youngman Brook	Moon Brook	Mallets Creek
Area (acres)	4556	672	5546	9318
Average Slope (%)	5	5	13	10
Percent Imperviousness (%)	20	3	13	4
Pervious Curve Number	70	57	68	74
Surface Runoff – Time of Concentration (Hour)	10.5	5.1	7.2	10.7

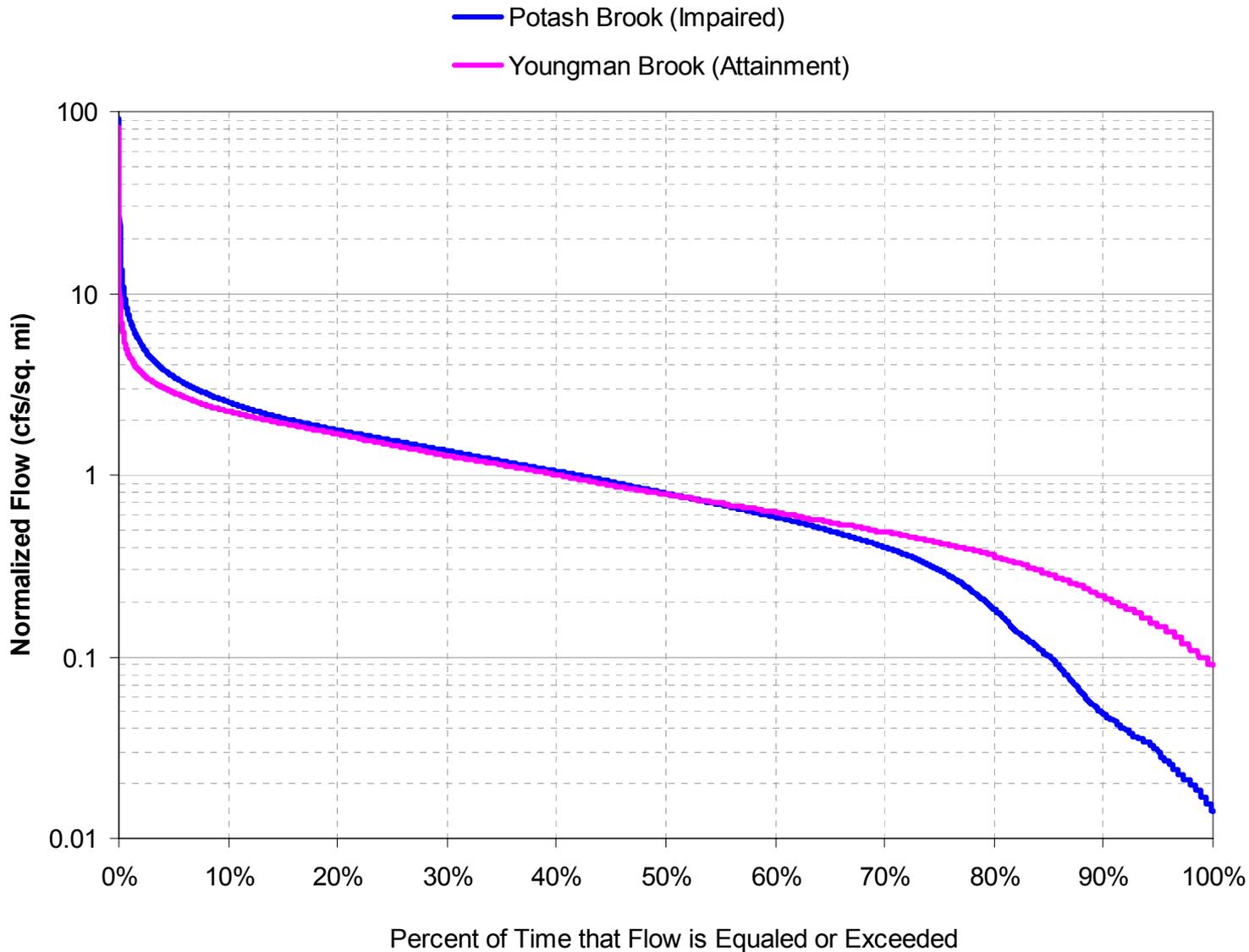
FDC: Potash & Youngman



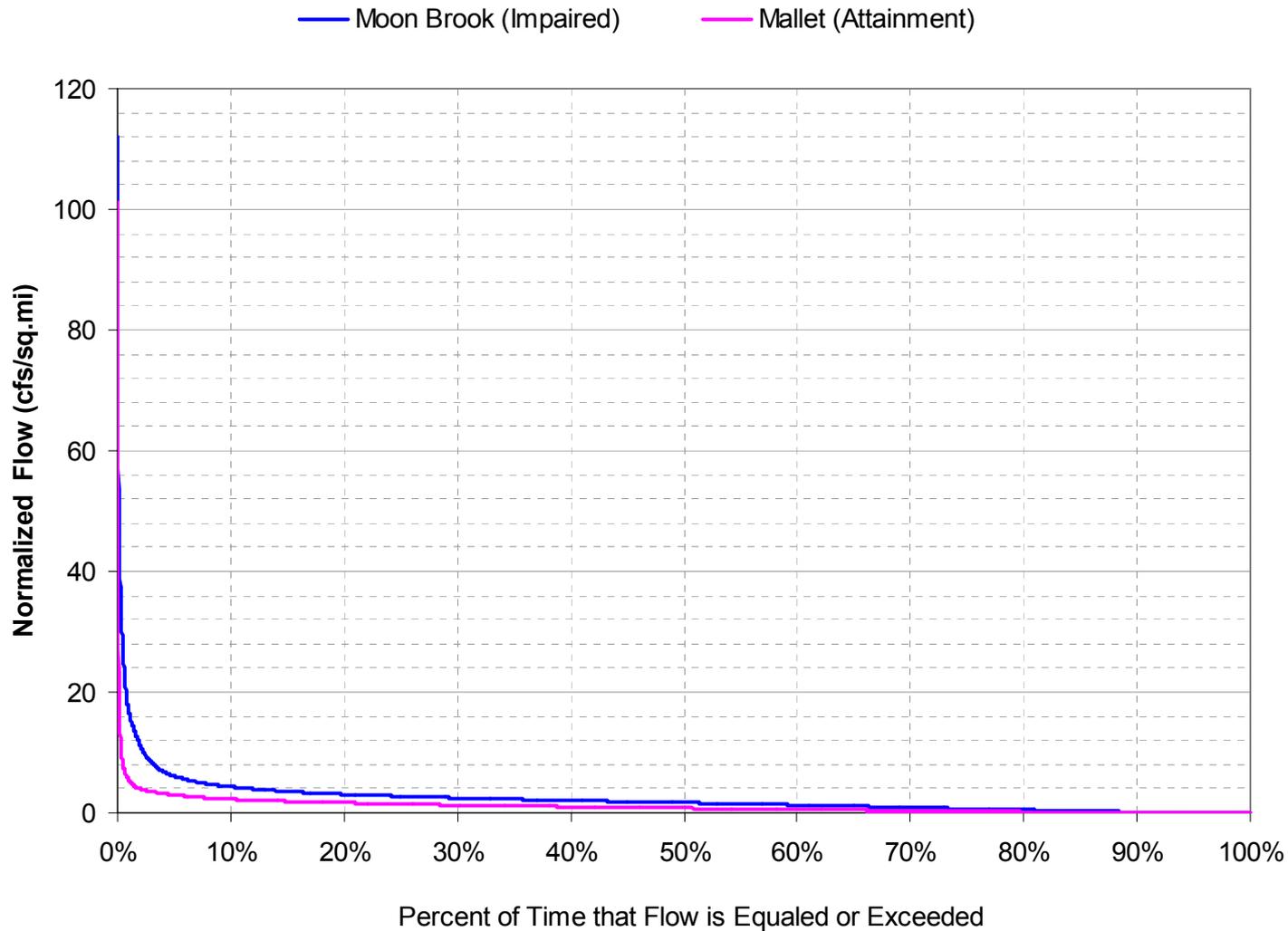
FDC: Potash & Youngman



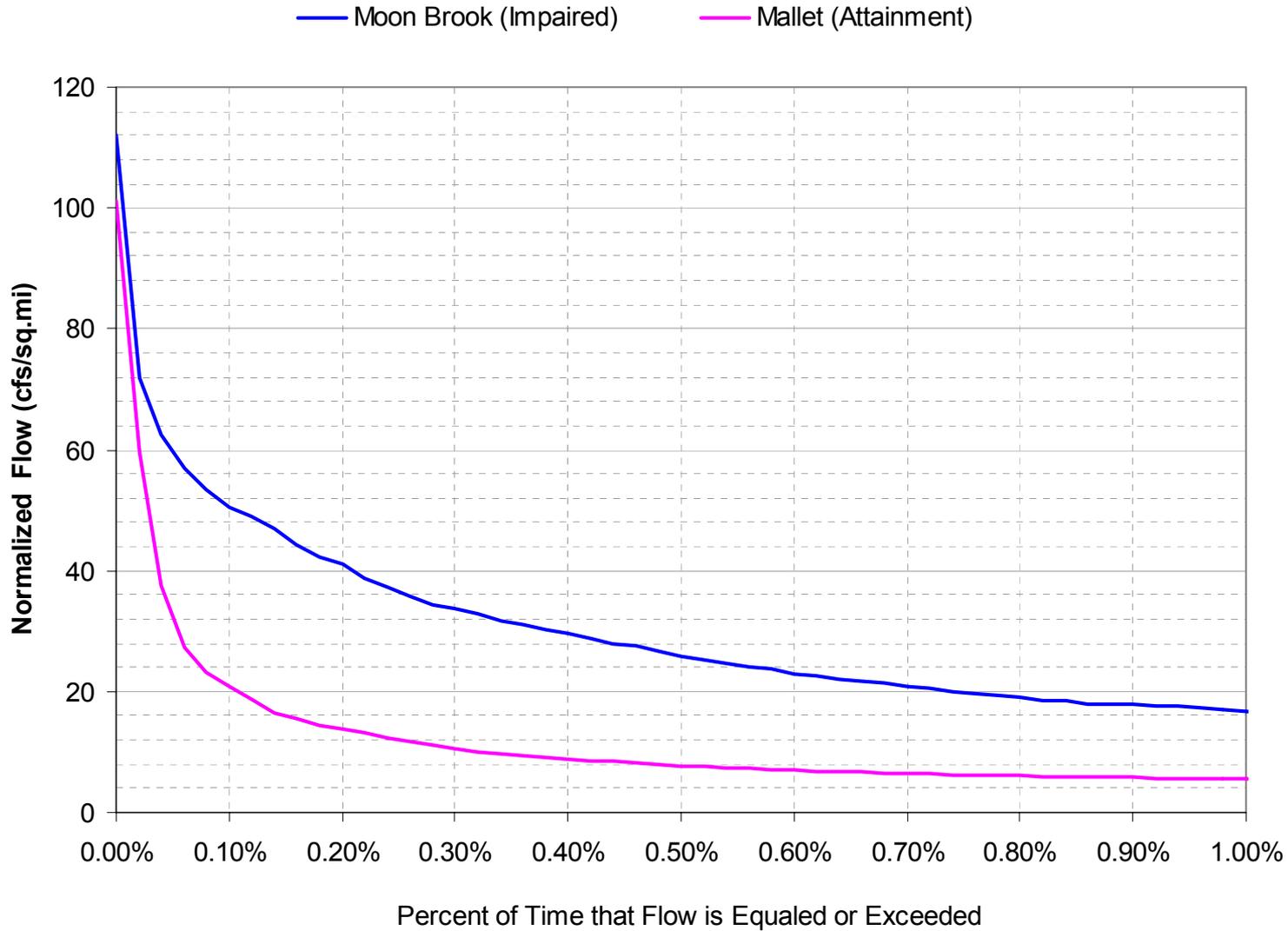
FDC: Potash & Youngman



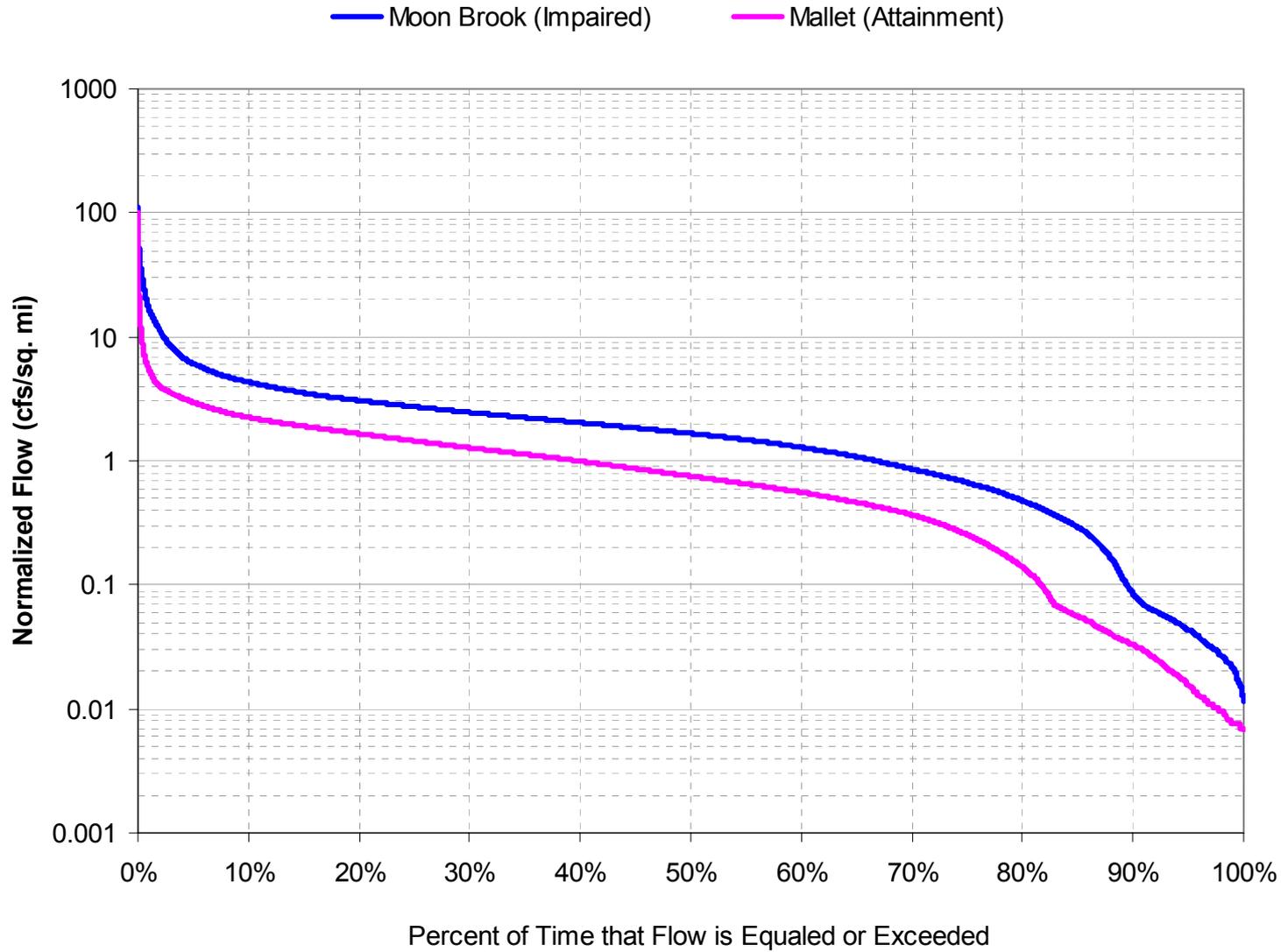
FDC: Moon & Mallets



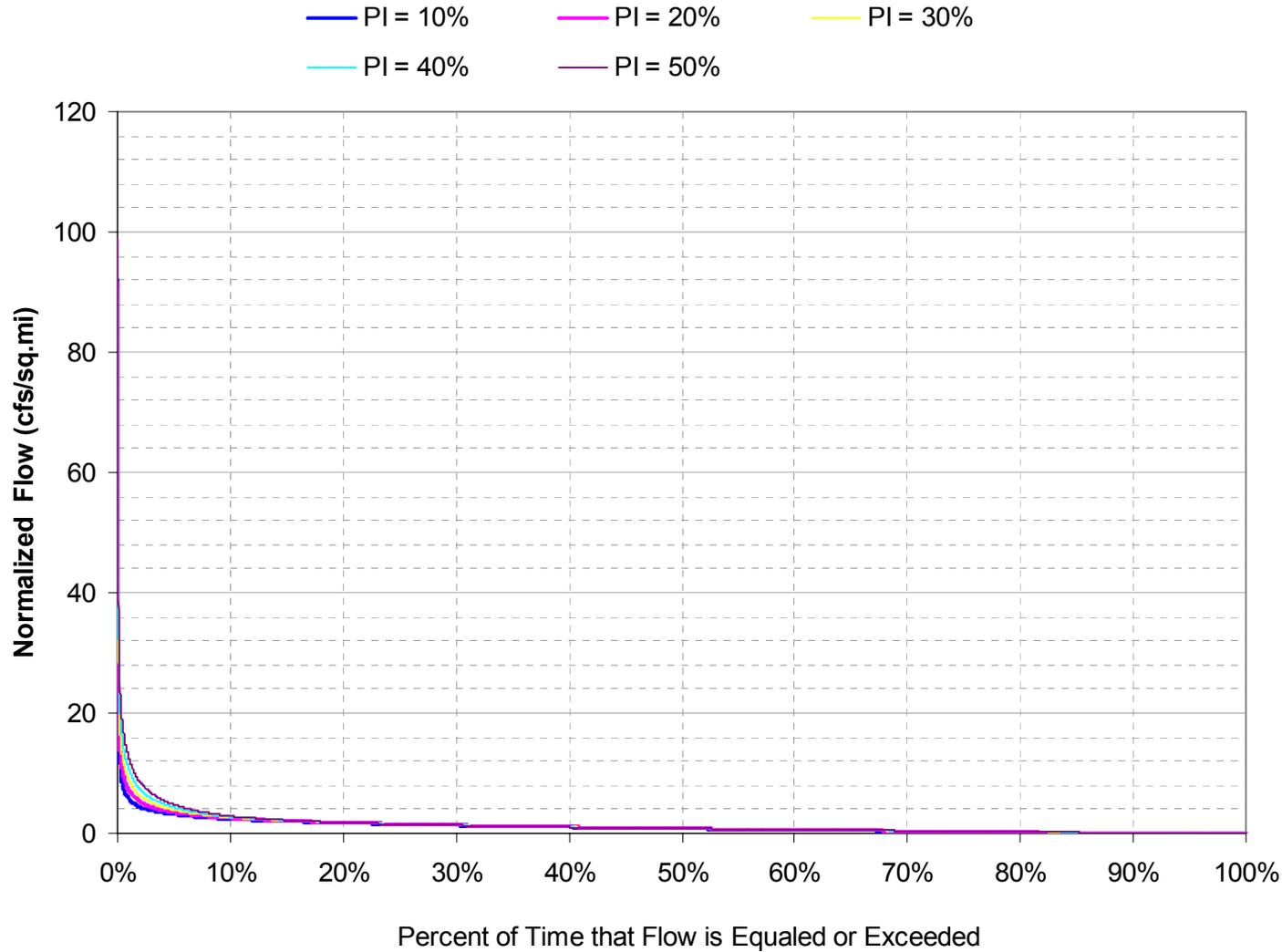
FDC: Moon & Mallets



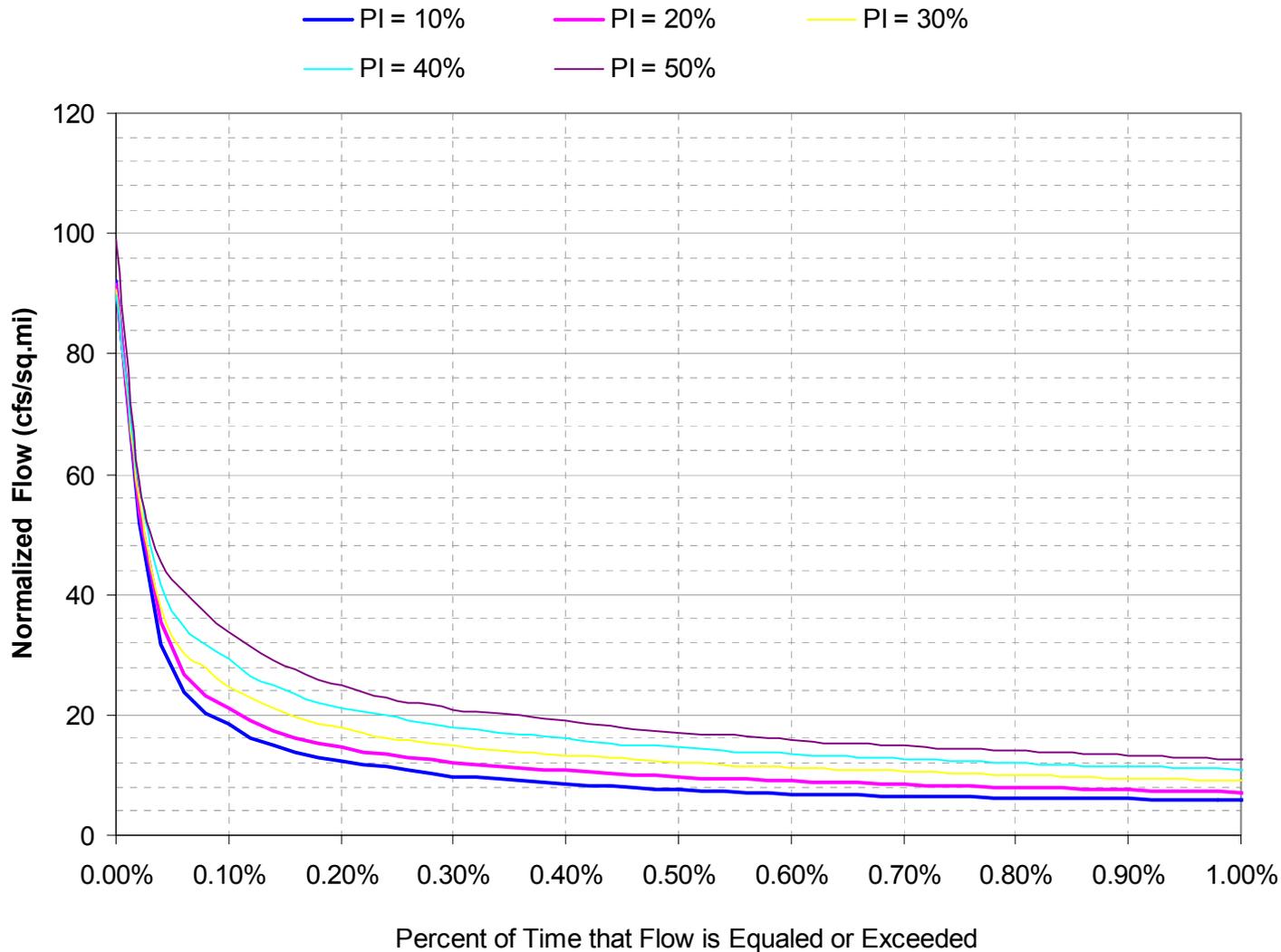
FDC: Moon & Mallets



Sensitivity of FDC to PI: Potash Brook



Sensitivity of FDC to PI: Potash Brook



Sensitivity of FDC to PI

