



Part 438 of the Energy Independence and Security Act

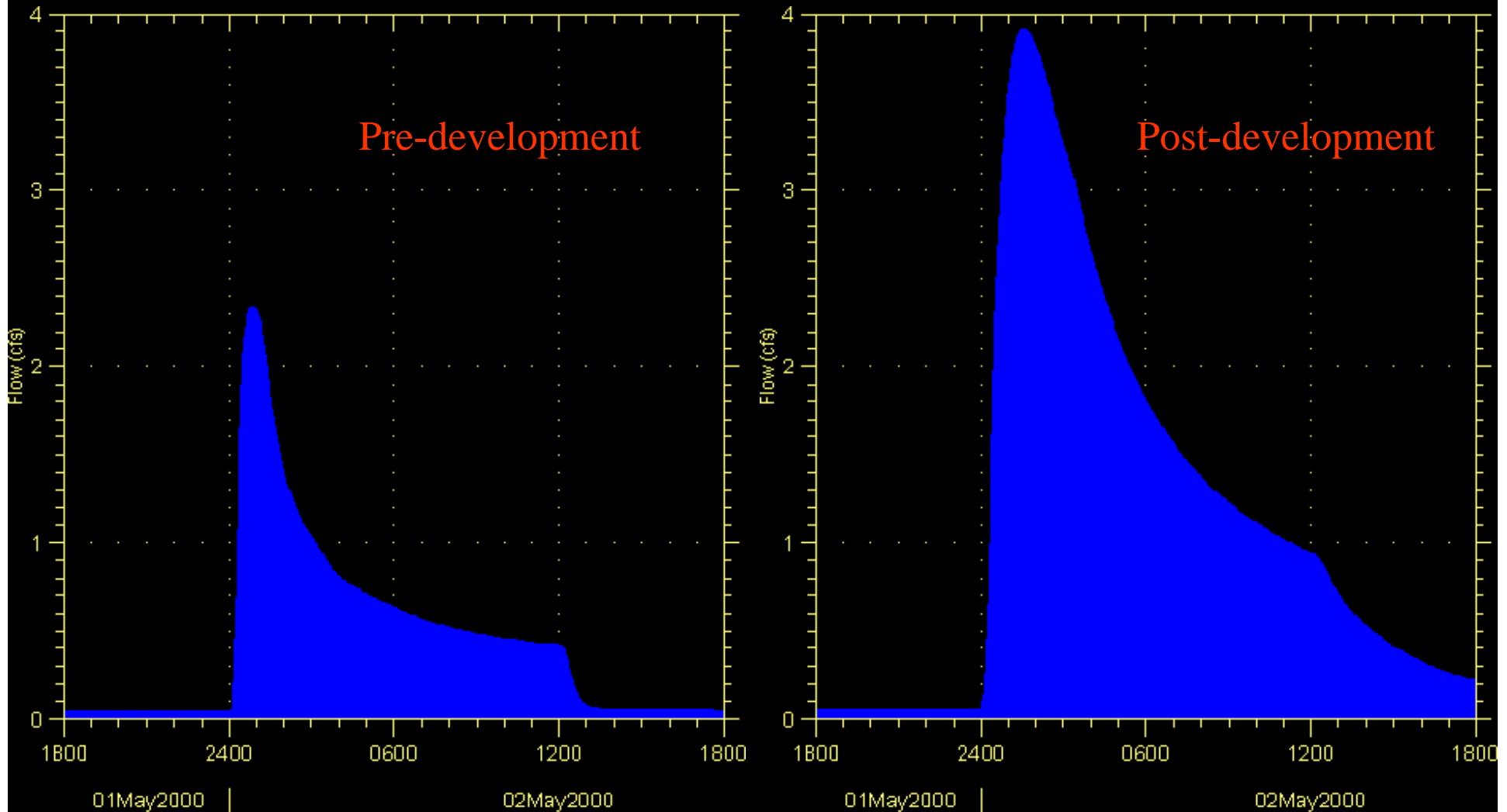


Blakeslee Creek, Michigan

70% increase in peak flow.

170% increase in runoff volume.

Former instantaneous peak flow now lasts ~4 hours.



Era of the Big Basin

Stormwater management designs that manage only discharge rates often exacerbate the

Natural systems respond to runoff volumes, frequencies, durations and temperatures as well.



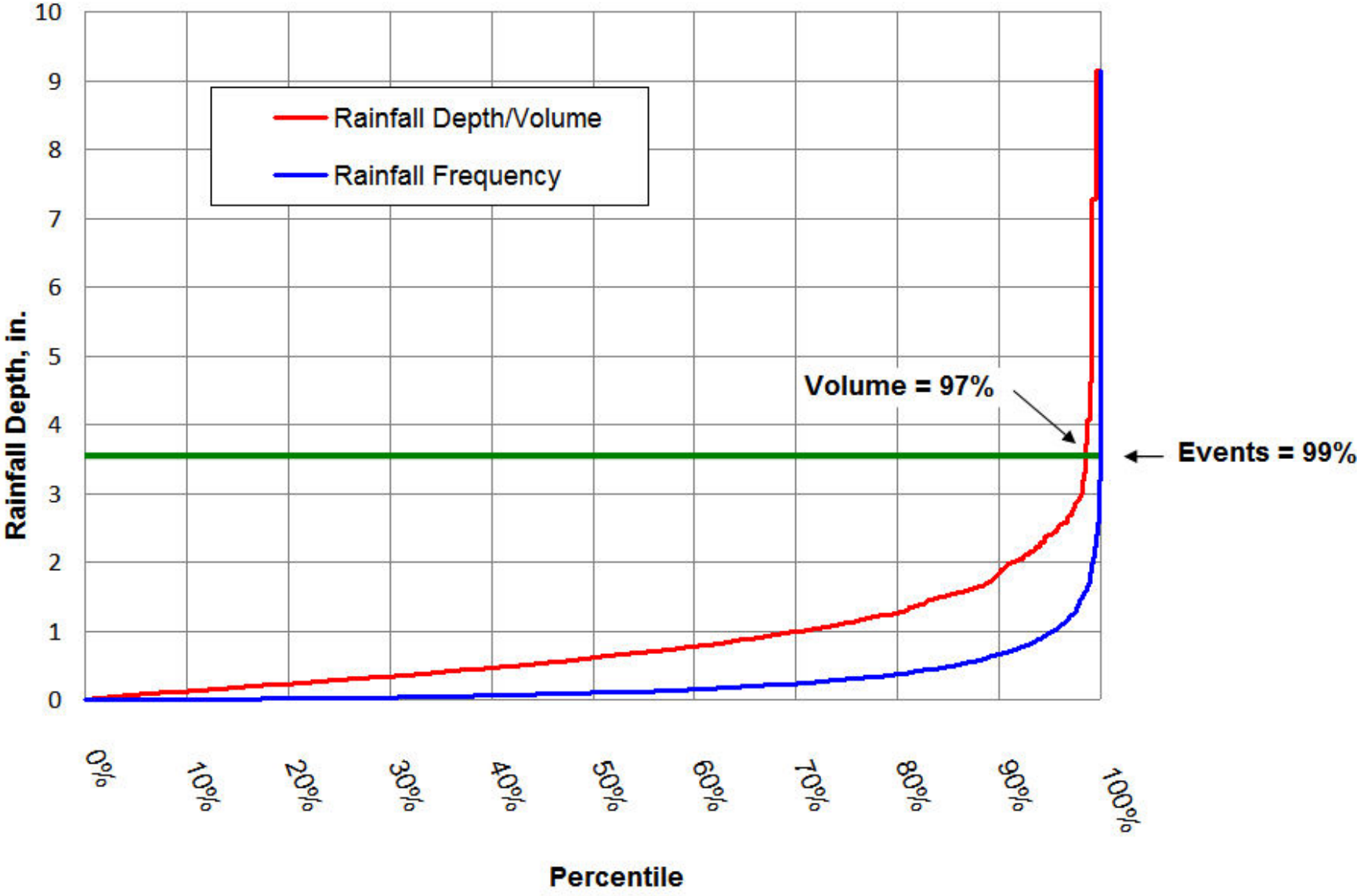


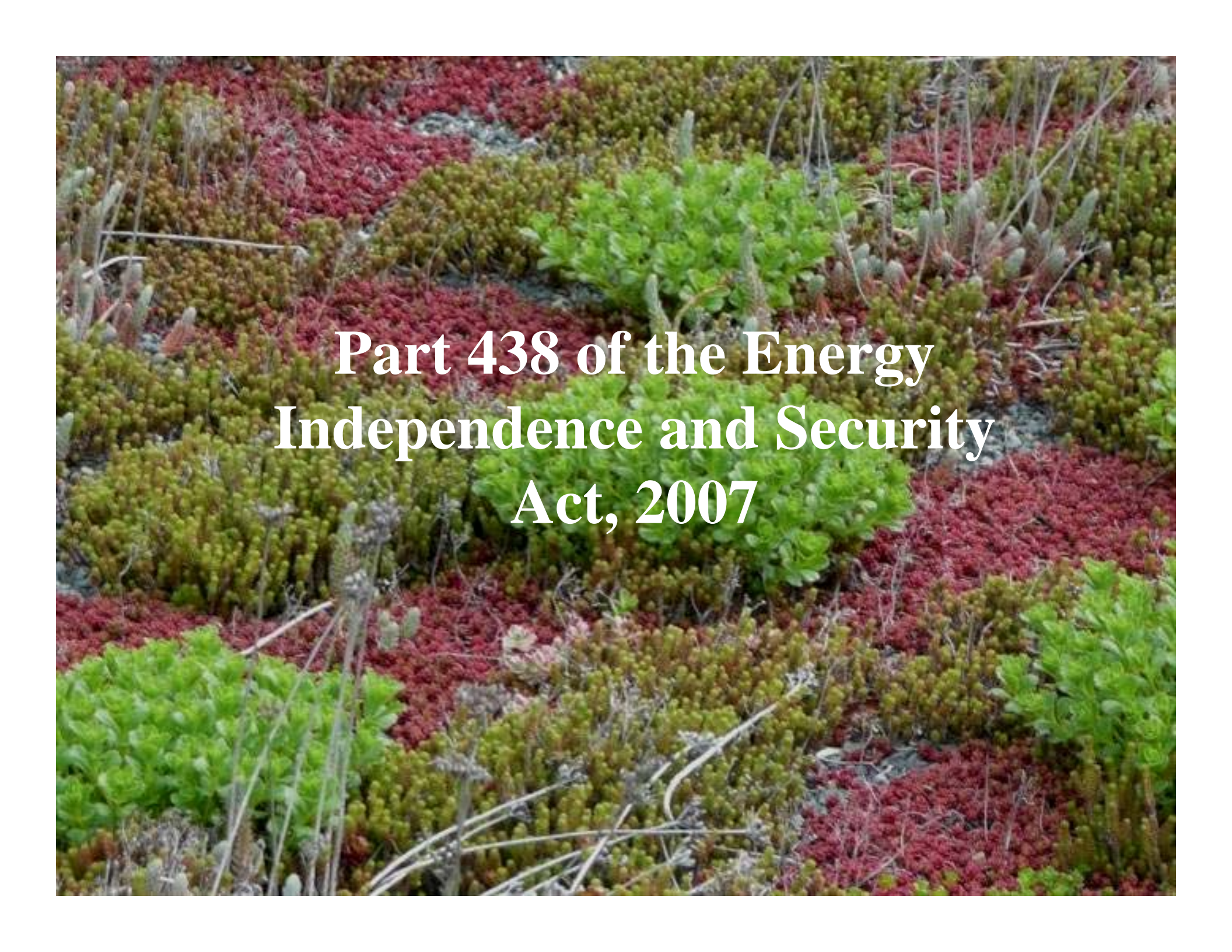
Performance Standards

Performance Standards

- Regulations and standards need to be specific about what the objectives of the relevant provisions are, and will be most successful when stipulating a specific standard.
- In general performance standards are preferable because they leave less room for ‘gaming’ the system (e.g., creative interpolation of runoff curves), and also focus on an outcome that can be linked to receiving water integrity.
- Performance standards also provide more flexibility for innovation since often a variety of combinations of technologies and approaches can be used to meet a stipulated performance standard.

Minneapolis/St. Paul Int. Airport Rainfall Data





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Independence and Security
Act, 2007**

Energy Independence and Security Act of 2007

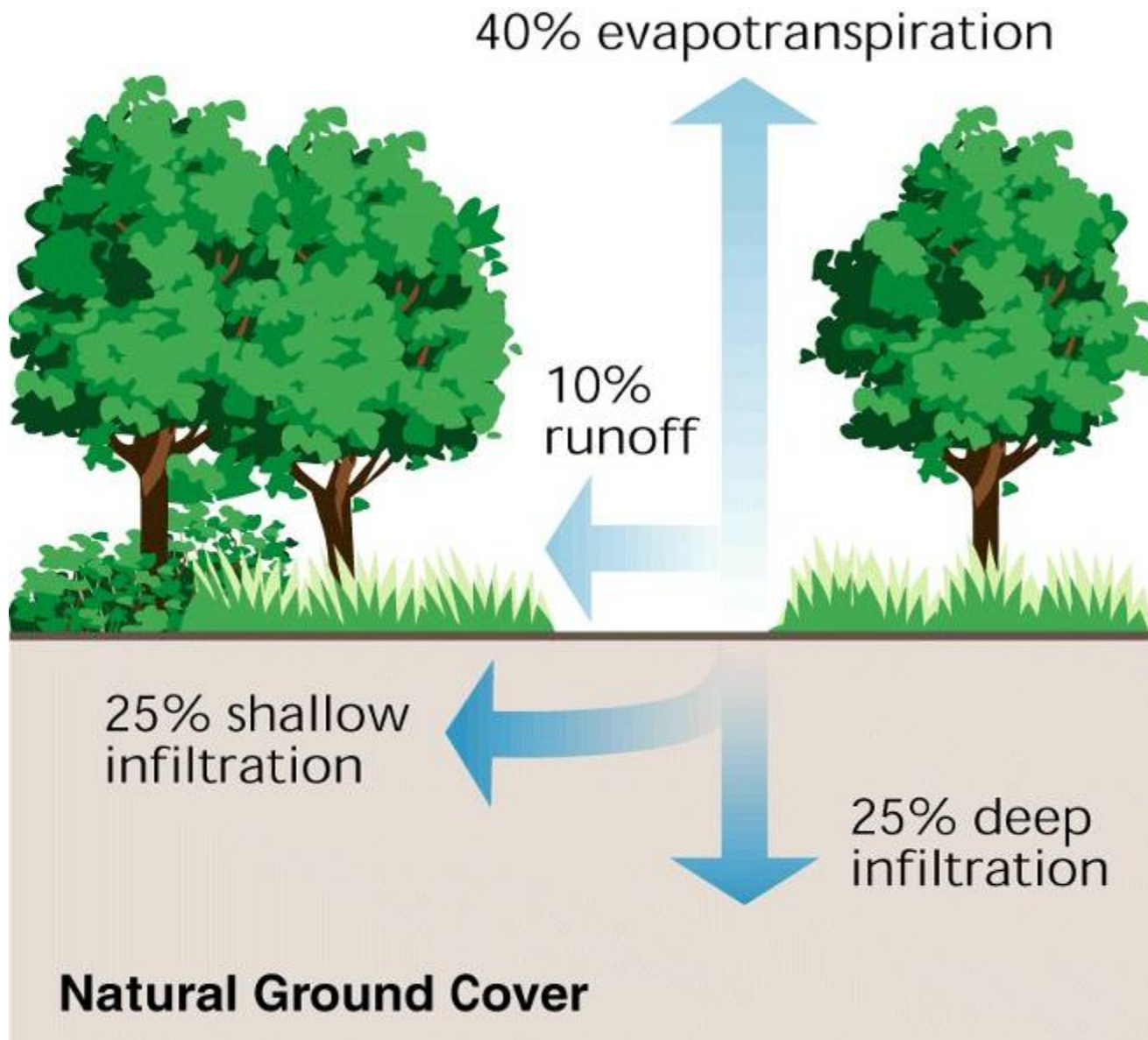
“Sec. 438. Storm Water Runoff Requirements for Federal Development Projects. The sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the **predevelopment hydrology** of the property with regard to the **temperature, rate, volume, and duration of flow.**”

Performance Options

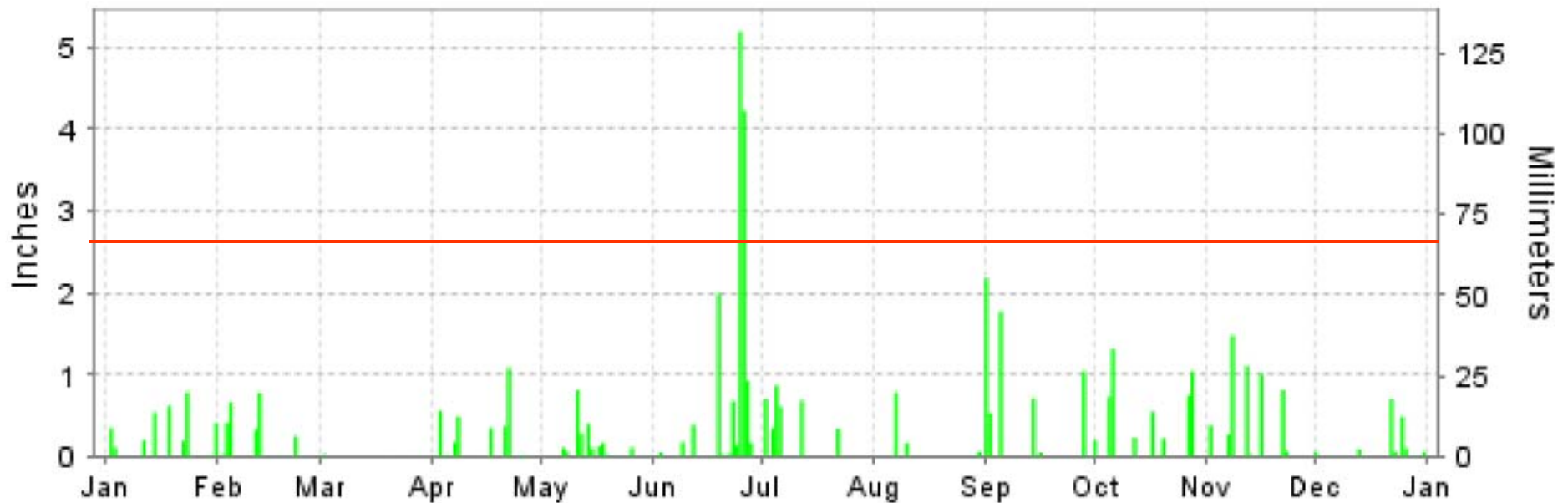
Option 1: Control 95th Percentile Rainfall Event

- Manage rainfall onsite
- Infiltrate, Evapotranspire, Harvest and Use
Runoff

Note: The 95th percentile rainfall event is the event whose precipitation total is greater than or equal to 95 percent of all 24-hour storms on an annual basis.



2006 Precipitation Washington DC



95th Percentile Event = 1.7”

Design to Control a Specified Volume

% Average Annual Rainfall Approach

	<u>90%</u>	<u>95%</u>	<u>99%</u>
Washington DC	1.2"	1.7"	2.4"
Seattle WA	1.3"	1.6"	1.7"
Salt Lake City UT	0.6"	0.8"	1.2"

Example 95th Percentile Storms

City	95 th Percentile Event Rainfall Total (in)	City	95 th Percentile Event Rainfall Total (in)
Atlanta, GA	1.8	Kansas City, MO	1.7
Baltimore, MD	1.6	Knoxville, TN	1.5
Boston, MA	1.5	Louisville, KY	1.5
Buffalo, NY	1.1	Minneapolis, MN	1.4
Burlington, VT	1.1	New York, NY	1.7
Charleston, WV	1.2	Salt Lake City, UT	0.8
Coeur D'Alene, ID	0.7	Phoenix, AZ	1.0
Cincinnati, OH	1.5	Portland, OR	1.0
Columbus, OH	1.3	Seattle, WA	1.6
Concord, NH	1.3	Washington, DC	1.7
Denver, CO	1.1		

Performance Options

Option 2: Preserve predevelopment hydrology (rate, volume, duration & temperature)

- Conduct hydrologic and hydraulic analyses
- Quantify post-construction hydrographs for the following storm sizes:
 - 1, 2, 10 and 100 year 24 hour storm events
- Maintain pre-development hydrographs for these storm events

Maximum Extent Technically Feasible

- Stormwater control practices that are effective in reducing the volume of stormwater discharge must be used.
- The Federal facility must use all known, available and reasonable methods of stormwater retention and/or reuse to prevent the off site discharge of stormwater runoff consistent with the performance standard.
- In cases when a facility seeks or claims an exception, it is expected that there will be a serious and documented attempt to comply.

Process for Accountability

Each Agency or Department is responsible for ensuring compliance. The final design and as-built drawings of each facility shall be reviewed by a registered professional engineer. The Agency or Department shall develop and maintain documentation of the following design criteria:

- Site evaluation and soils analysis
- Calculations for the 95th percentile rainfall event or the pre-development runoff volumes
- The site design and stormwater management practices employed on the site
- Design calculations for each stormwater management practice
- The respective volume of stormwater managed by each practice
- Operations and maintenance protocols

Modeling Scenarios

- Demonstrate how to calculate 95th percentile event.
- Show procedure for site assessment and determining appropriate control techniques.
- Provide modeling protocols and outputs to demonstrate verification of compliance.
- Give general performance capabilities of control techniques.

Analyses of 95% Event Volumes



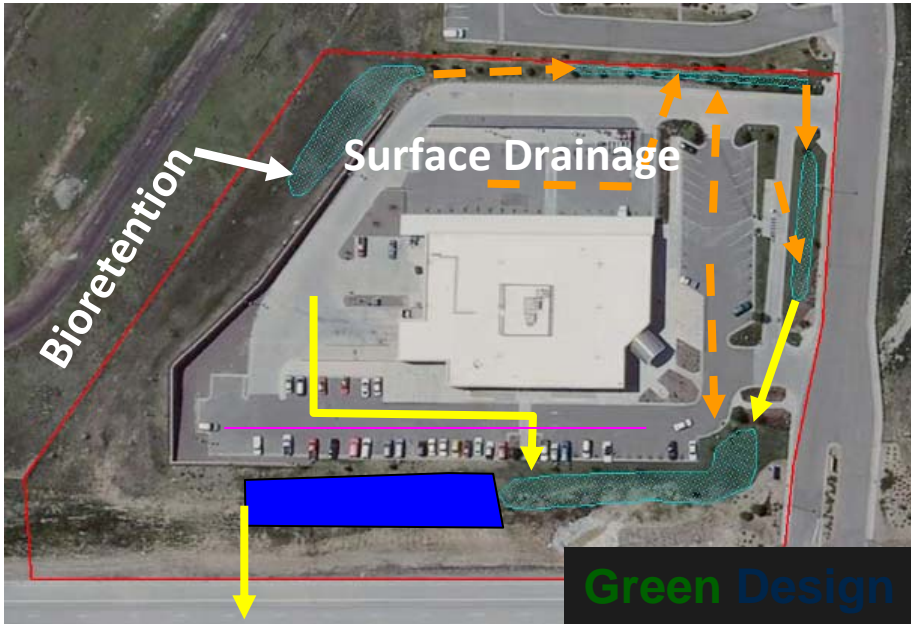
Location	95% Rainfall Events (in)
Charleston, WV	1.23
Denver, CO	1.07
Cincinnati, OH	1.45
Portland, OR	1.00
Phoenix, AZ	1.00
Boston, MA	1.52
Atlanta, GA	1.77

Denver, Colorado

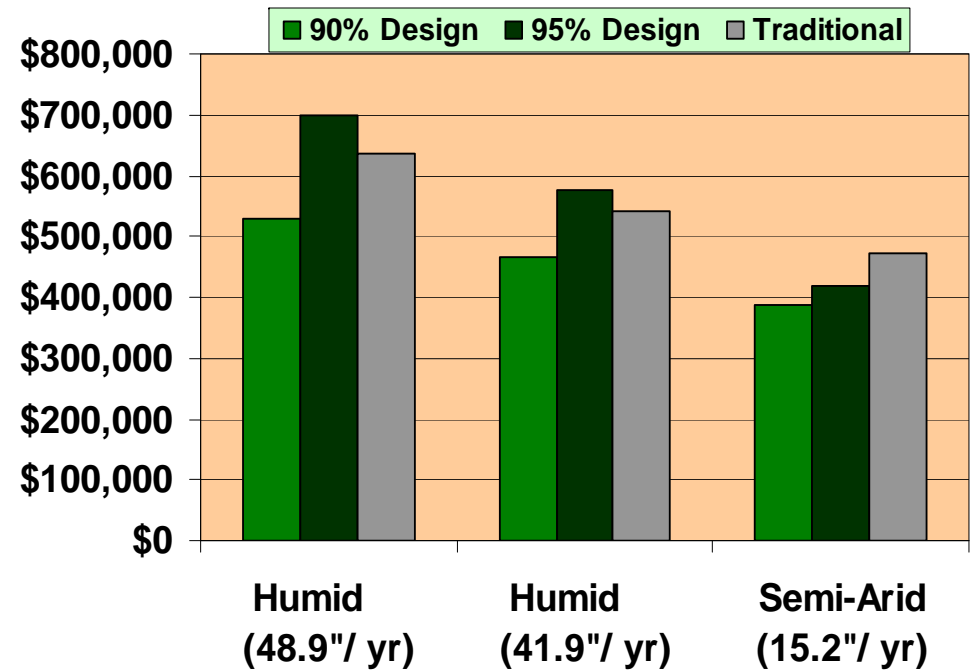
Total Area (acres)	4.5	
Estimated Imperviousness (%)	55%	
95 th Percentile Rainfall Event (inches)	1.07	
Expected Runoff for the 95 th Percentile Rainfall Event (inches)	0.53	
Stormwater Management Area Required	Hydrologic Soil Group	
	B	C
Bioretention estimated by the Direct Determination method (acres)	0.16	0.3
Bioretention estimated by Rational Method (acres)	0.16	0.28
Off-site storage necessary to control the 10-yr event of 3.2 inches (acre-ft)	0.35	0.52



55% Imperviousness



Cost Comparison (capital costs for entire site)



Total Area (acres)	19	
Estimated Imperviousness (%)	51%	
95 th Percentile Rainfall Event (inches)	1.45	
Expected Runoff for the 95 th Percentile Rainfall Event (inches)	0.68	
Stormwater Management Area Required	Hydrologic Soil Group	
	B	C
Bioretention estimated by the Direct Determination (acres)	0.8	1.3
Off-site storage necessary to control the 10-yr event of 4.2 inches (acre-ft)	2.42	3.24



Cincinnati, Ohio



Total Area (acres)	27	
Estimated Imperviousness (%)	95%	
95 th percentile Rainfall Event (inches)	1.00	
Expected Runoff for the 95 th Percentile Rainfall Event (inches)	0.86	
Stormwater Management Area Required	Hydrologic Soil Group	
	B	C
Paver block area estimated by Direct Determination (acres)	1.4	3.5*
Bioretention estimated by Direct Determination (acres)	0.4	
Green Roof estimated by Direct Determination (acres)	1.7	
Cistern volume estimated by Direct Determination (gallons)	50,000	
Off-site storage necessary to control the 10-yr event of 3.7 inches (acre-ft)	5.37	5.62

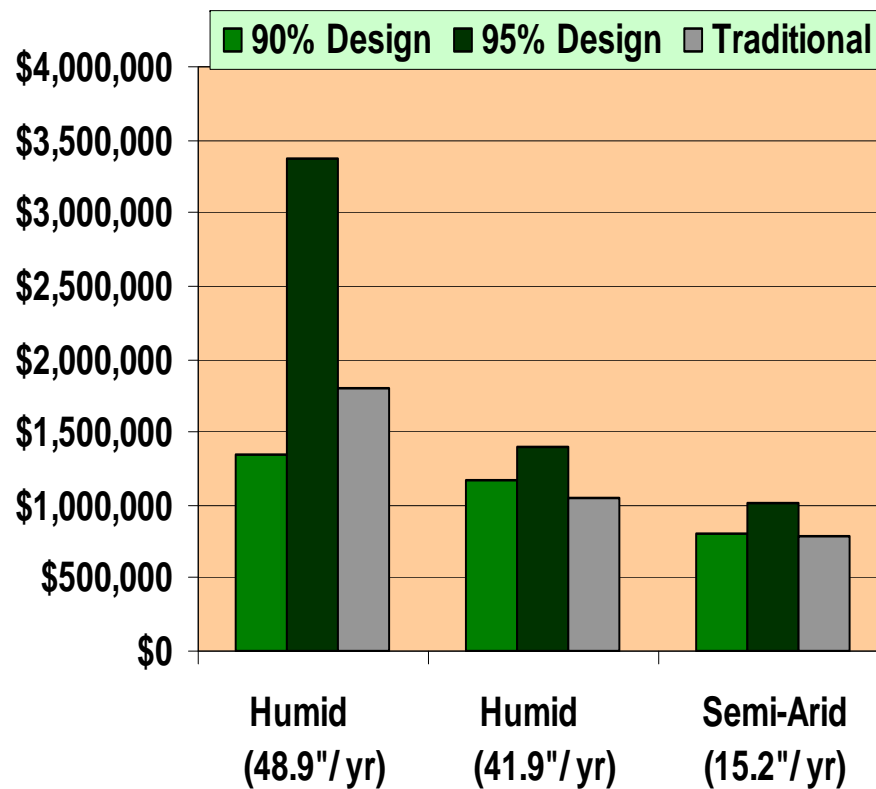


Portland,
Oregon

95% Imperviousness



Cost Comparison (capital costs for entire site)



Phoenix, Arizona



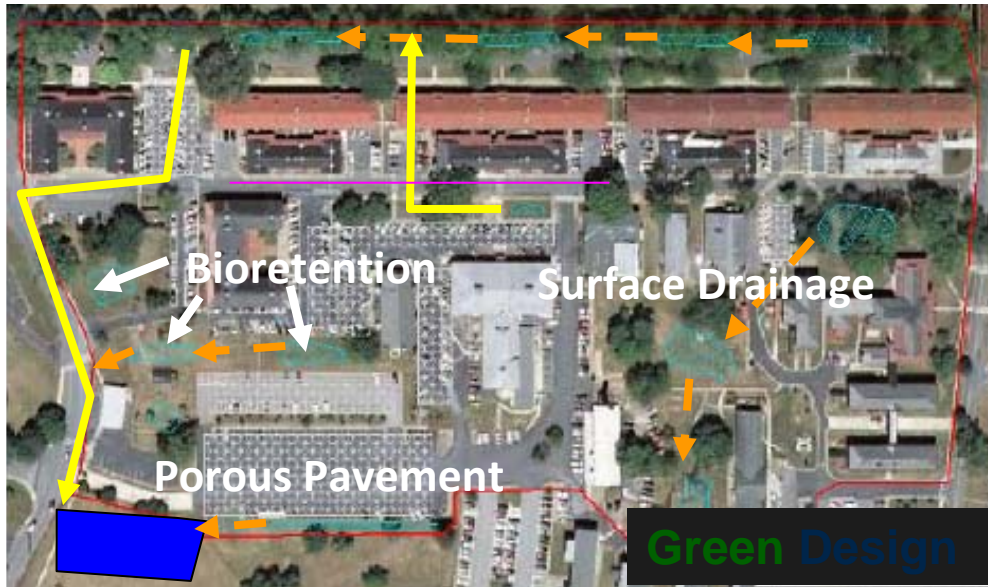
Total Area (acres)	2	
Estimated Imperviousness (%)	47%	
95 th Percentile Rainfall Event (inches)	1.00	
Expected Runoff for the 95 th Percentile Rainfall Event (inches)	0.42	
Stormwater Management Area Required	Hydrologic Soil Group	
	B	C
Bioretention estimated by the Direct Determination (acres)	0.06	0.1
Off-site storage necessary to control the 10-yr event of 2.4 inches (acre-ft)	0.05	0.12

Atlanta, Georgia

Total Area (acres)	21	
Estimated Imperviousness (%)	70%	
95 th Percentile Rainfall Event (inches)	1.77	
Expected Runoff for the 95 th Percentile Rainfall Event (inches)	1.17	
Stormwater Management Area Required	Hydrologic Soil Group	
	B	C
Bioretention estimated by the Direct Determination (acres)	0.9	
Paver block area estimated by the Direct Determination (acres)	0.9	3.2*
Bioretention estimated by TR-55	0.8**	0.9
Paver block area estimated by TR-55	0**	1.84
Off-site storage necessary to control 10-yr event of 6.0 inches (acre-ft)	5.85	6.62



70% imperviousness



Cost Comparison (capital costs for entire site)

