DEQ Certification Class Presentations

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July 2024

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Module 11

Energy Balance and Sheet Flow

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Module 11 Contents

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Module 11a.

The Energy Balance Method

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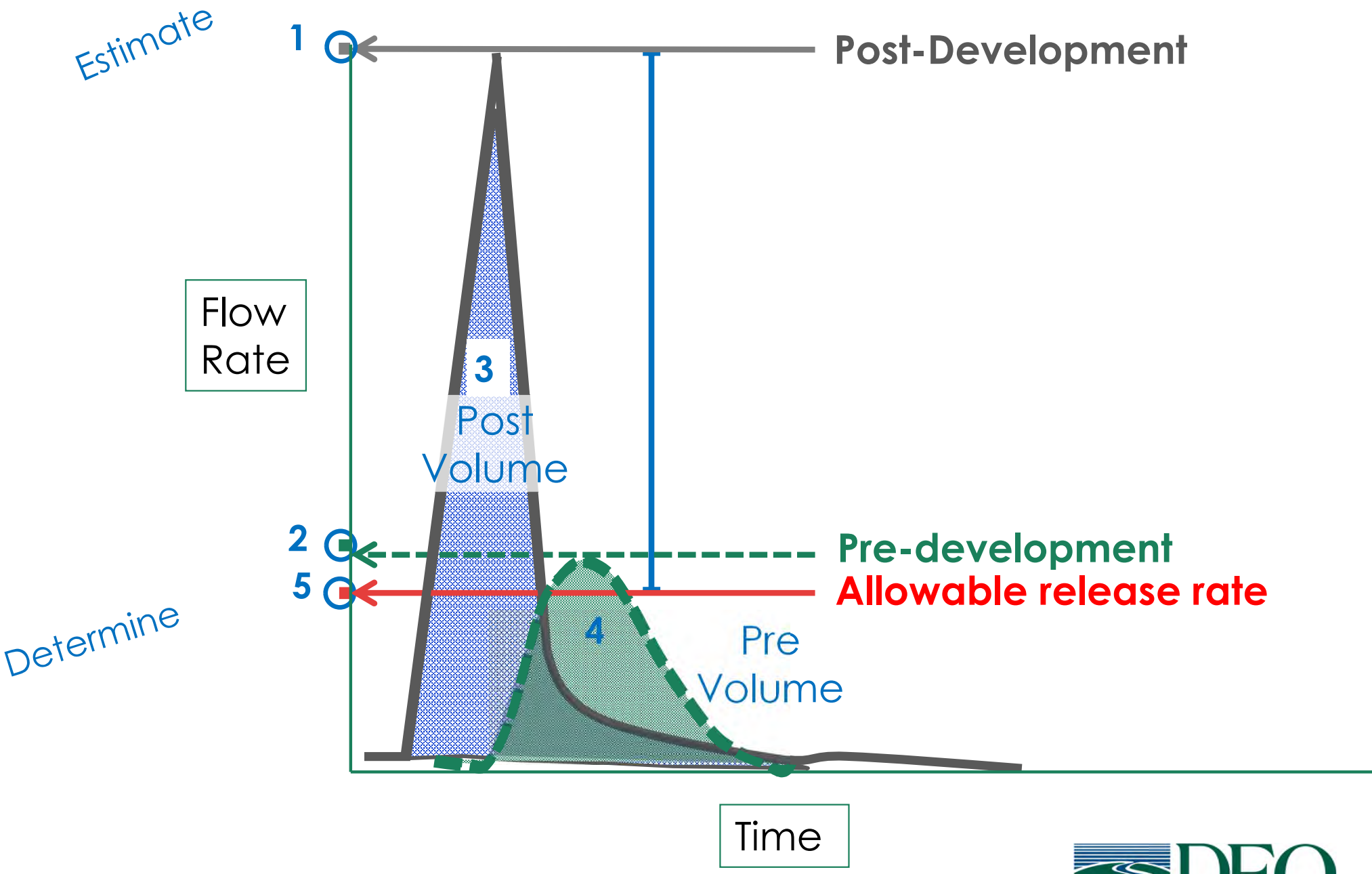
Energy Balance: 9VAC25-875-600.B.3

$$Q_{1\,post} \leq Q_{1\,pre}\left(\frac{RV_{pre\,1}}{RV_{post\,1}}\right)(IF)$$

(Regulation)

The post-development *allowable release rate* from the site based on the 1yr, 24hr storm

Managing Stormwater



Module 9

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$$Q_{1\,post} \leq Q_{1\,pre}\left(\frac{RV_{pre\,1}}{RV_{post\,1}}\right)(IF)$$

Under no condition shall:

$$Q_{1\,post} > Q_{1\,pre}$$

$$Q_{1\,post} < Q_{1\,forest} * Forest\ Vol_1/Post\ Vol_1$$

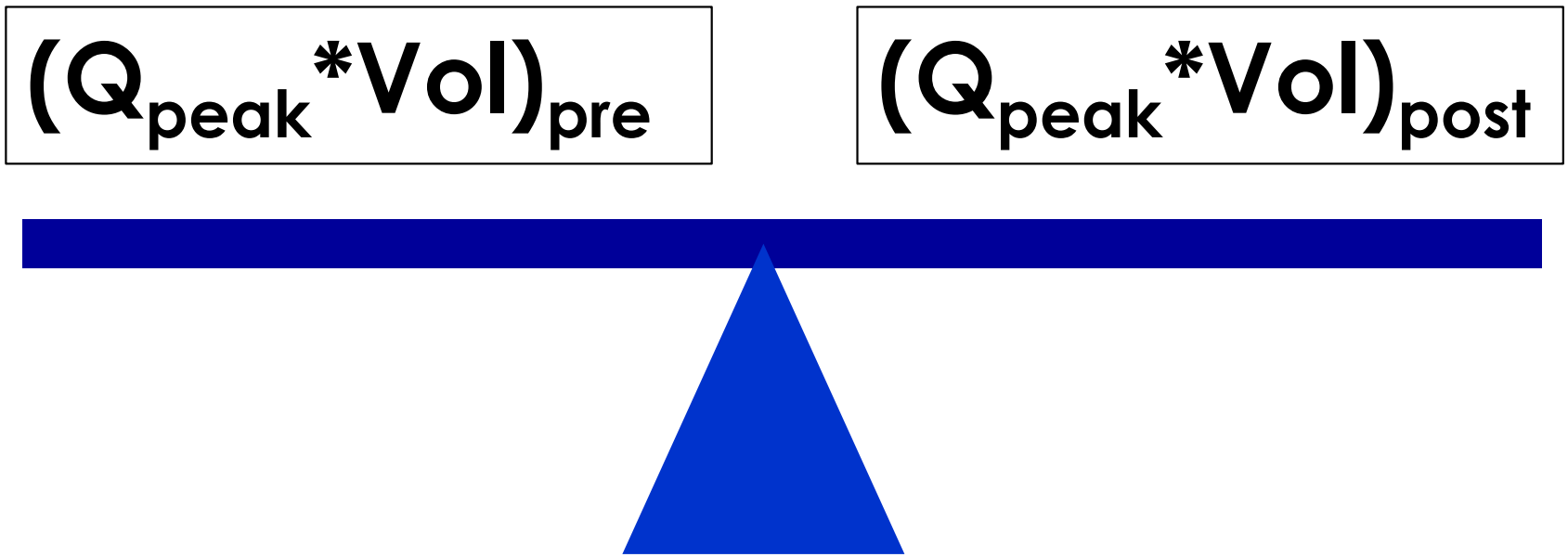
$$Q_{1\,post} \leq Q_{1\,pre}\left(\frac{RV_{pre\,1}}{RV_{post\,1}}\right)(IF)$$

$RV_{1\text{-}yr}$

Runoff Volume (RV) for pre- and post-development drainage areas must be in volumetric units (e.g., acre-feet or cubic feet) when using the Energy Balance Equation. Runoff depth measured in inches can only be used in the Energy Balance Equation when the pre- and post-development drainage areas are equal. Otherwise, runoff depth must be converted to runoff volume by multiplying by the drainage area and applying the appropriate conversion factors to obtain the desired volumetric units.

Energy Balance

Goal: Establish "balance" exerted by pre- and post-developed stormwater discharge

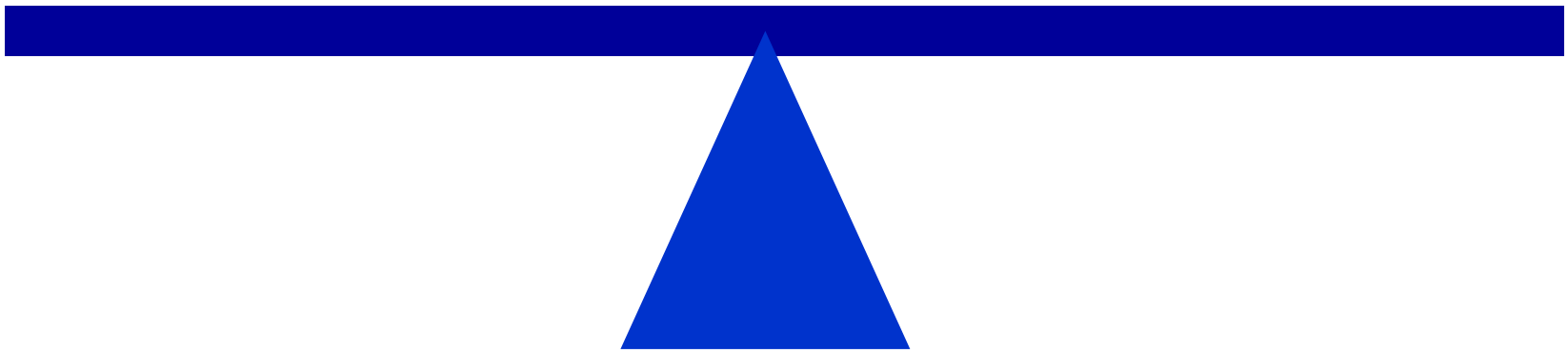


Energy Balance

Goal: Establish "balance" exerted by pre- and post-developed stormwater discharge

(Qpeak$_{pre}$*Vol) with improvement factor

$(Q_{peak}*Vol)_{pre}$ $(Q_{peak}*Vol)_{post}$



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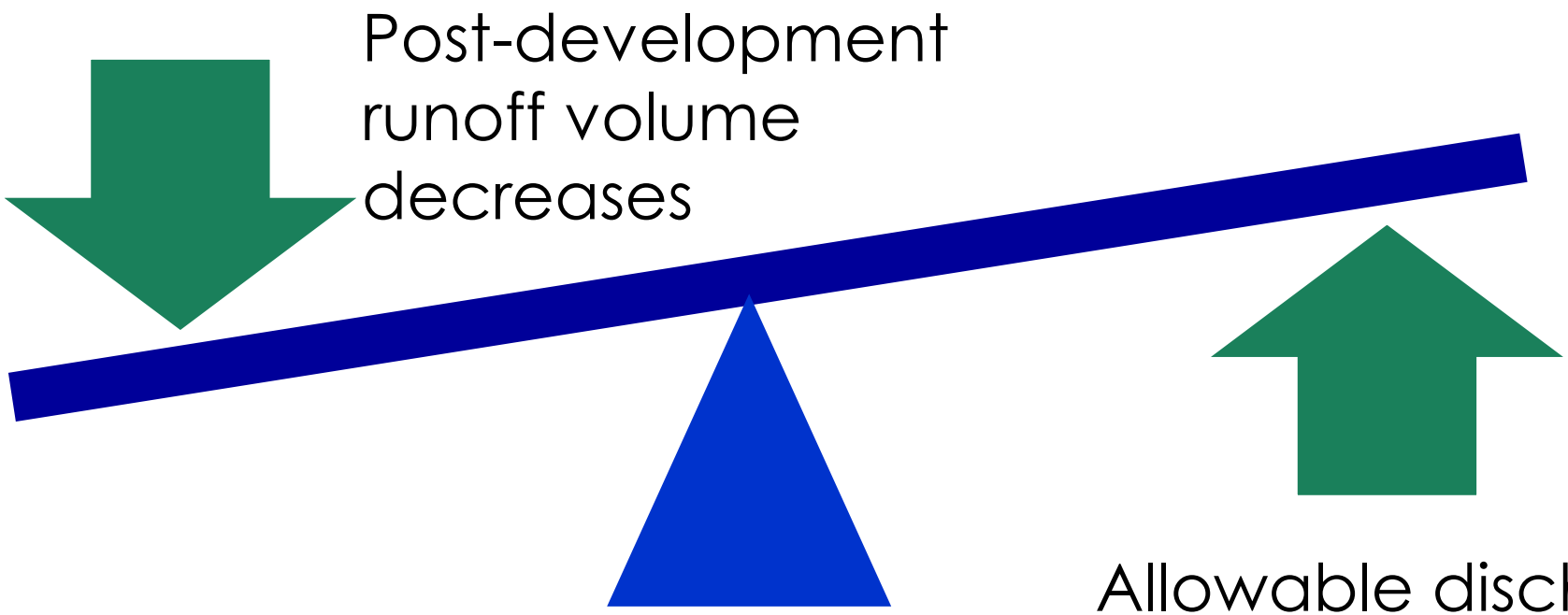
What is Energy Balance & Why use it?

Simple "balance" offsets increase in volume and peak flow of developed condition hydrology



Plans Approved **After** 7/1/14

Channel Protection from Concentrated Runoff to a **Natural Conveyance System**

Natural

EB

- When a site outlets to a natural channel, it must meet Energy Balance:
  - Post-development discharge rate and runoff volume from the 1-year storm is managed to be similar to pre-development
  - Usually achieved by reducing post-development runoff volume*

Plans Approved **After** 7/1/14

Channel Protection from Concentrated Runoff to a **Natural Conveyance System**

Natural

EB

- Compliance reminders:
  - EB for Channel Protection ONLY
  - All points of discharge to natural conveyances must meet EB
  - Still required when site discharges to man-made system that *transitions* to natural system prior to hitting the LOA terminus
  - EB must be met when site discharges directly to large natural systems (i.e., James River)

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Energy Balance Equation

Post ($Vol_{1\text{-}yr}$ * Peak $Q_{1\text{-}yr}$) **≤ Pre** ($Vol_{1\text{-}yr}$ * Peak $Q_{1\text{-}yr}$)

$$Q_{1post} \leq Q_{1pre} * \frac{PreVol_{1}}{PostVol_{1}} * IF$$

IF = Improvement Factor:
(0.8 for sites > 1 acre or 0.9 for sites ≤ 1 acre)

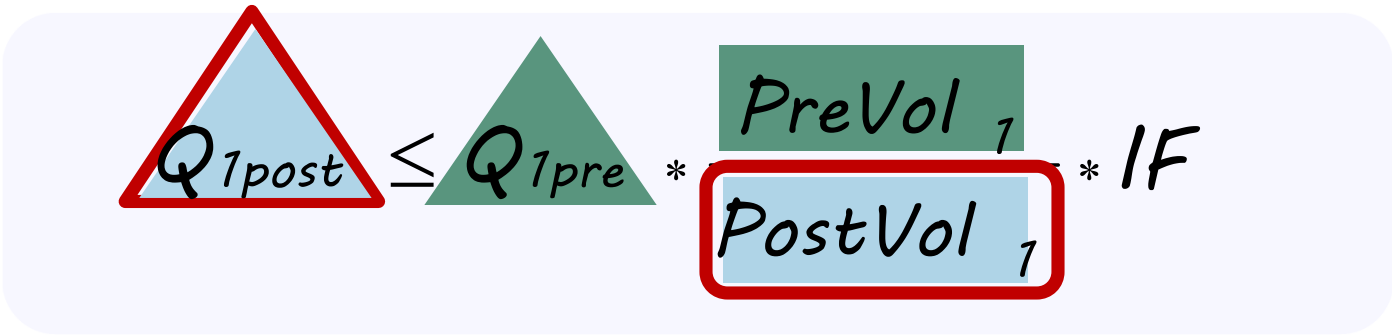
Improvement Factor (*IF*)

§ 62.1-44.15:28

- Requires stormwater regulations to *improve upon contributing share of existing predevelopment runoff characteristics and site hydrology . . . .*
- At minimum, pre-developed discharge will be reduced using factor of 0.8 or 0.9

Energy Balance Equation

Post ($Vol_{1\text{-}yr}$ * Peak $Q_{1\text{-}yr}$) **≤ Pre** ($Vol_{1\text{-}yr}$ * Peak $Q_{1\text{-}yr}$)



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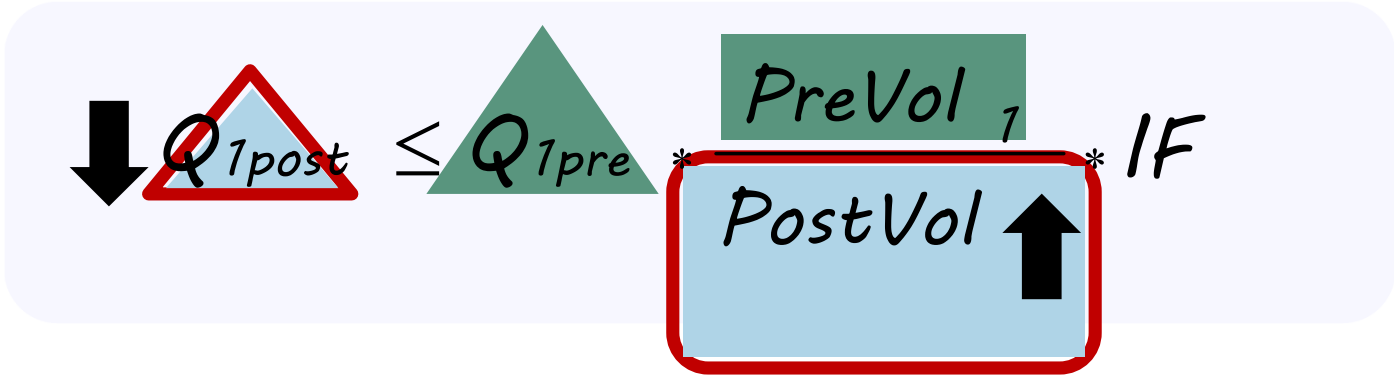
Energy Balance Equation

Post ($Vol_{1\text{-}yr}$ * Peak $Q_{1\text{-}yr}$) **≤ Pre** ($Vol_{1\text{-}yr}$ * Peak $Q_{1\text{-}yr}$)



IF = Improvement Factor:
(0.8 for sites > 1 acre or 0.9 for sites ≤ 1 acre)

How Does Energy Balance Encourage SD?

Runoff Reduction

Decrease volume with self-crediting site design:

- ❖Minimize impervious cover
- ❖Preservation of native vegetation
- ❖Preservation of native soils

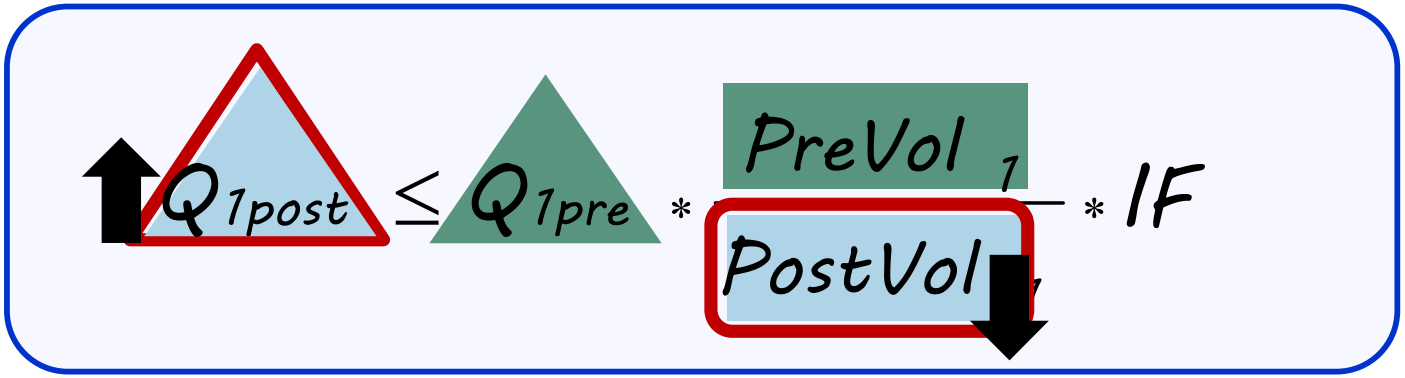
Runoff Reduction practices

9VAC25-875-600.B Channel Protection

How Does Energy Balance Encourage SD?

As *Post Vol*$_1$ reduced,

- *Pre Vol*$_1$ to *Post Vol*$_1$ ratio increases
- Allowable Q_{1post} increases



***Decreases storage required for peak flow**

Energy Balance Terminology

$$Q_{1\,post} \leq Q_{1\,pre}\left(\frac{Pre\ Vol_{\ 1}}{Post\ \ Vol_{\ 1}}\right)(IF)$$

Description	Units	Term
NRCS TR-55		
Runoff Depth	inches (in)	*Q*
Runoff Volume	cubic feet (ft^3) or acre feet (ac.ft.)	*Vr*
Storage Volume	cubic feet (ft^3) or acre feet (ac.ft.)	*Vs*
Peak Discharge	cubic feet per second (cfs)	q_p
VRRM Treatment Volume Runoff Coefficients		
Unit-less Volumetric Runoff Coefficients		*Rv*
VRRM Curve Number Adjustment		
Runoff Depth	inches	*RV*
VSMP Regulations Channel Protection Criteria (4VAC50-60-66.B)		
Peak Discharge	cubic feet per second (cfs)	*Q*
Runoff Volume*	cubic feet (ft^3) or acre feet (ac.ft.)*	*RV*

*Units of volume in the VSMP regulations Channel Protection Criteria can also be expressed in terms of *watershed-inches* or inches (consistent with Runoff Depth as expressed in the VRRM *CN* adjustment.

Energy Balance: 9VAC25-875-600.B

Rewriting the equation:

$$Q_{1\,post} \le Q_{1\,pre}\left(\frac{RV_{pre\,1}}{RV_{post\,1}}\right)(IF) \quad \textit{(Regulation)}$$

$$Q_{1\,post} \le Q_{1\,pre}\left(\frac{Pre\ Vol_{\,1}}{Post\ \ Vol_{\,1}}\right)(IF) \quad \textit{(Clarified)}$$

$$q_{1\,post} \le q_{1\,pre}\left(\frac{Vr_{pre\,1}}{Vr_{post\,1}}\right)(IF) \quad \textit{(TR-55)}$$

Module 11b.

Evaluating Sheet Flow

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Evaluating Sheet Flow: 9VAC25-875-600.D

- Sheet flow expected:
  - Pervious areas (lawn)
  - Disconnected impervious areas
  - Level spreaders
- Any areas where sheet flow is expected must be shown on plans and evaluated

Evaluating Sheet Flow

Pages 9-11 provide helpful tips and strategies for evaluating sheet flow:

- what is downstream?
- what is intended use?
- topos shown beyond site?
- check maps for downstream waterways?
- potential for reconcentrating?

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QuickPoll

Using SD, a site's total post-development runoff volume is reduced. What happens to the allowable release rate in this case?

a. Release rate unaffected
b. Release rate goes up
c. Release rate goes down

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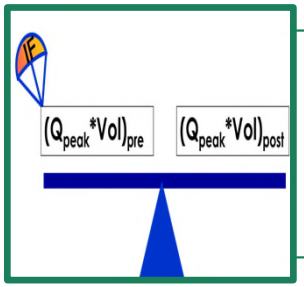
Q&A



Energy Balance

Evaluating Sheet Flow