

City of Columbia BMP Manual

Unified Sizing Criteria (USC) Method



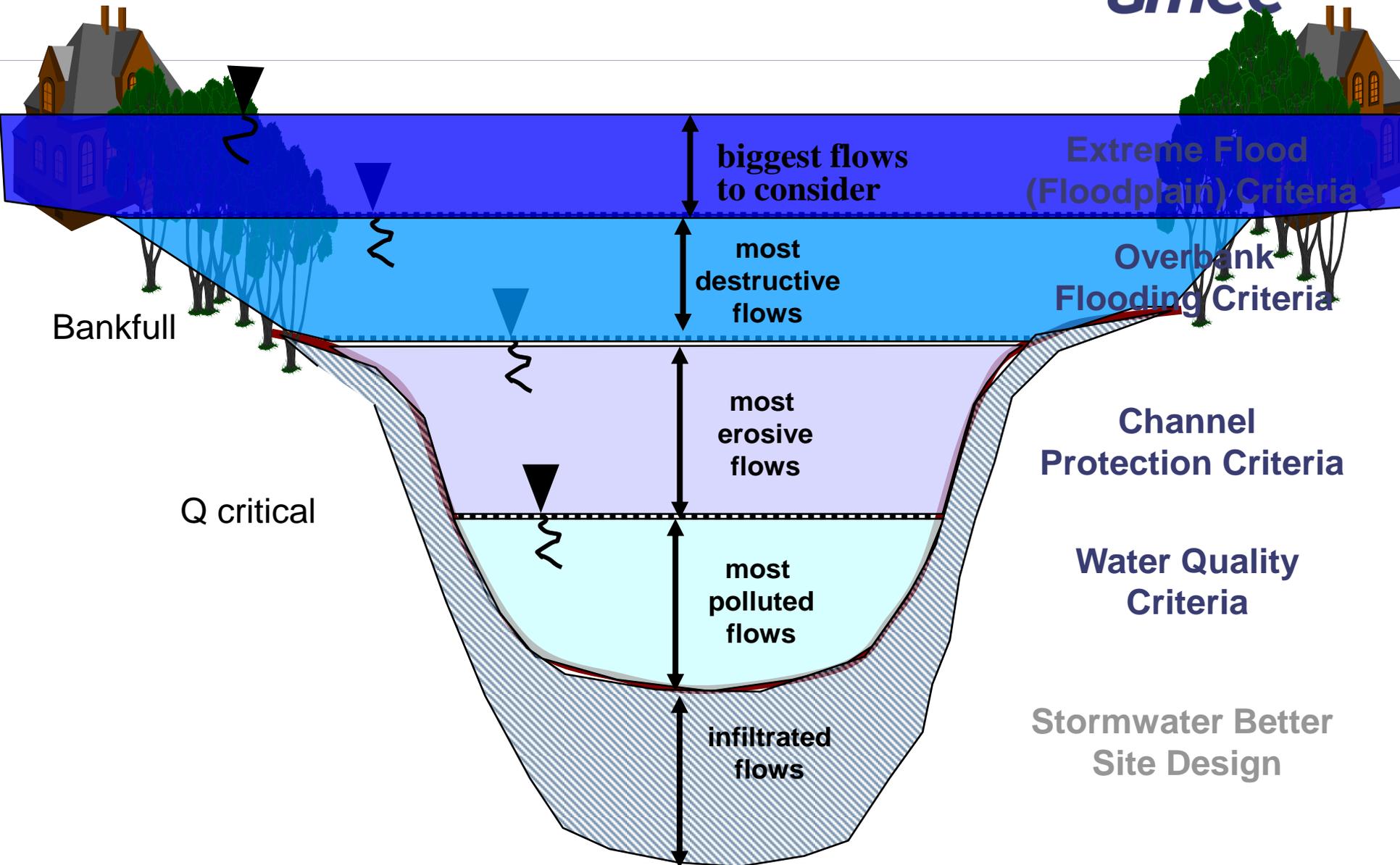
January 16, 2013

Unified Stormwater Sizing Criteria

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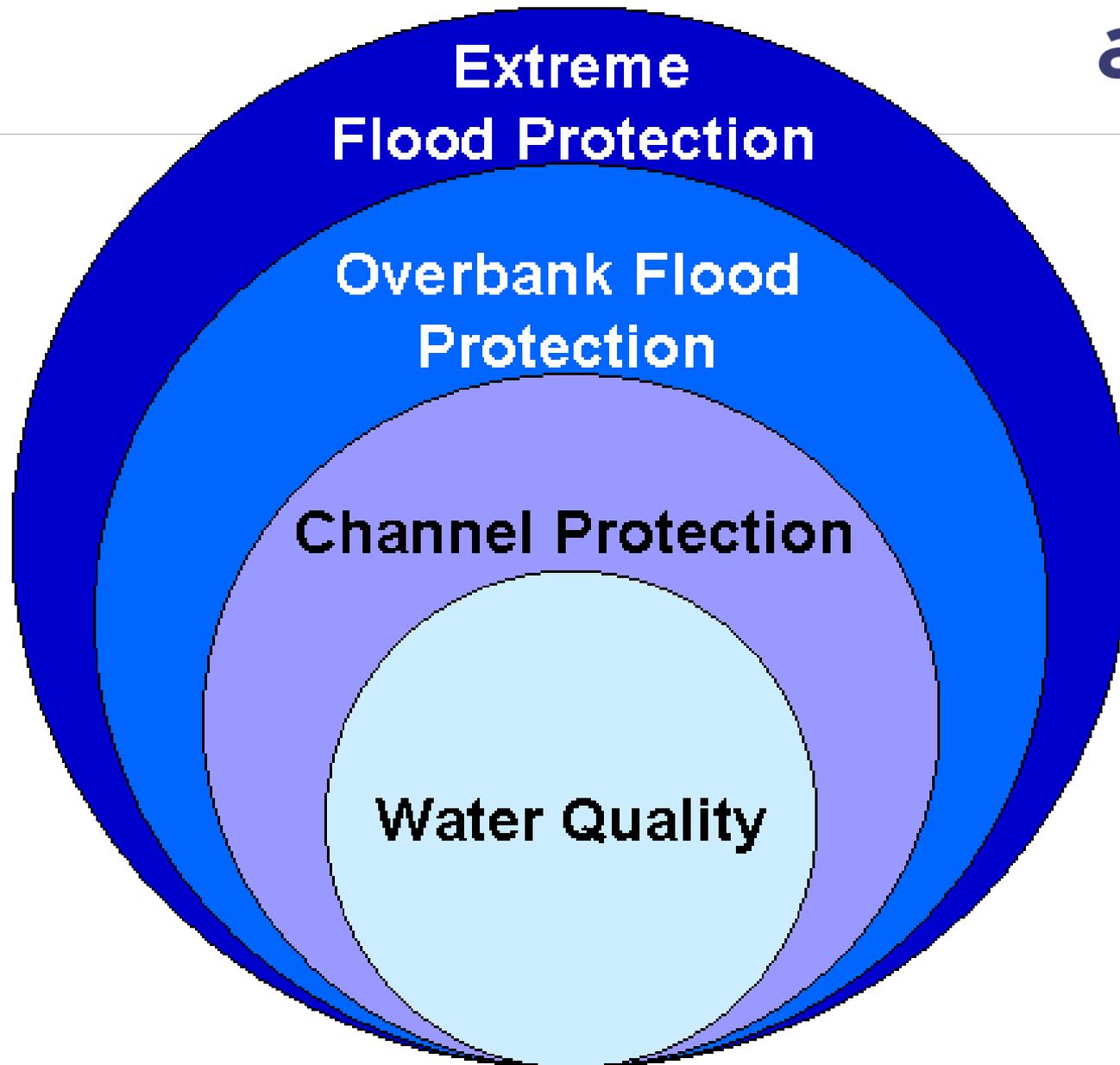
For...

1. Pollutant removal
2. Channel protection
3. Overbank flood control
4. Extreme flood protection

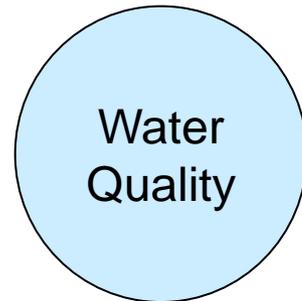


Unified Stormwater Sizing Criteria

- Water Quality: Capture & treat runoff from first 1.2 inches of rainfall
- Channel Protection: Provide extended detention of 1-yr, 24-hr storm over 24 hours
- Overbank Flood Protection: Provide peak flow attenuation of 25-yr, 24-hr storm
- Extreme Flood Protection: Manage 100-yr storm through detention or floodplain mgmt



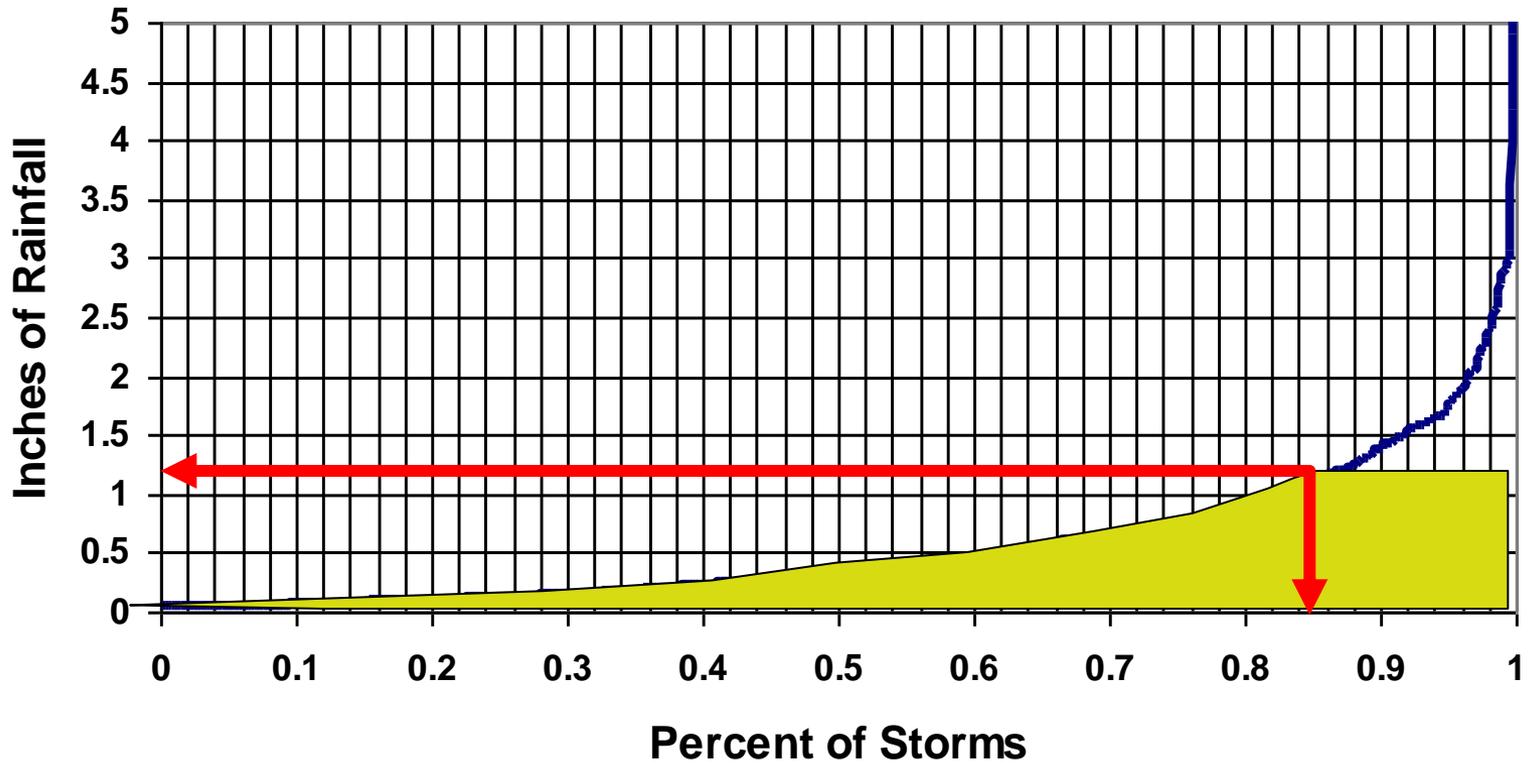
Water Quality Volume



Criteria: Remove 80% of TSS.

Capture and treat runoff from 85th percentile storm, ~1.2" of rain.

15 Minute, 6-Hour Storm



Water Quality

Volume Calculation

$$WQ_v = P (R_v)(A) / 12$$

in acre-feet

where:

P = 1.2 inches

$R_v = 0.05 + 0.009(I)$

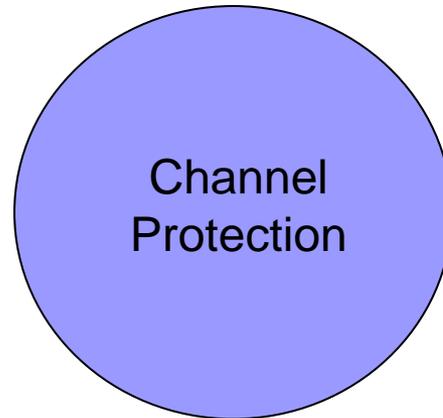
I = imperviousness (in percent)

A = total area (in acres)

Meeting the Water Quality *amec*[®] Volume Criteria

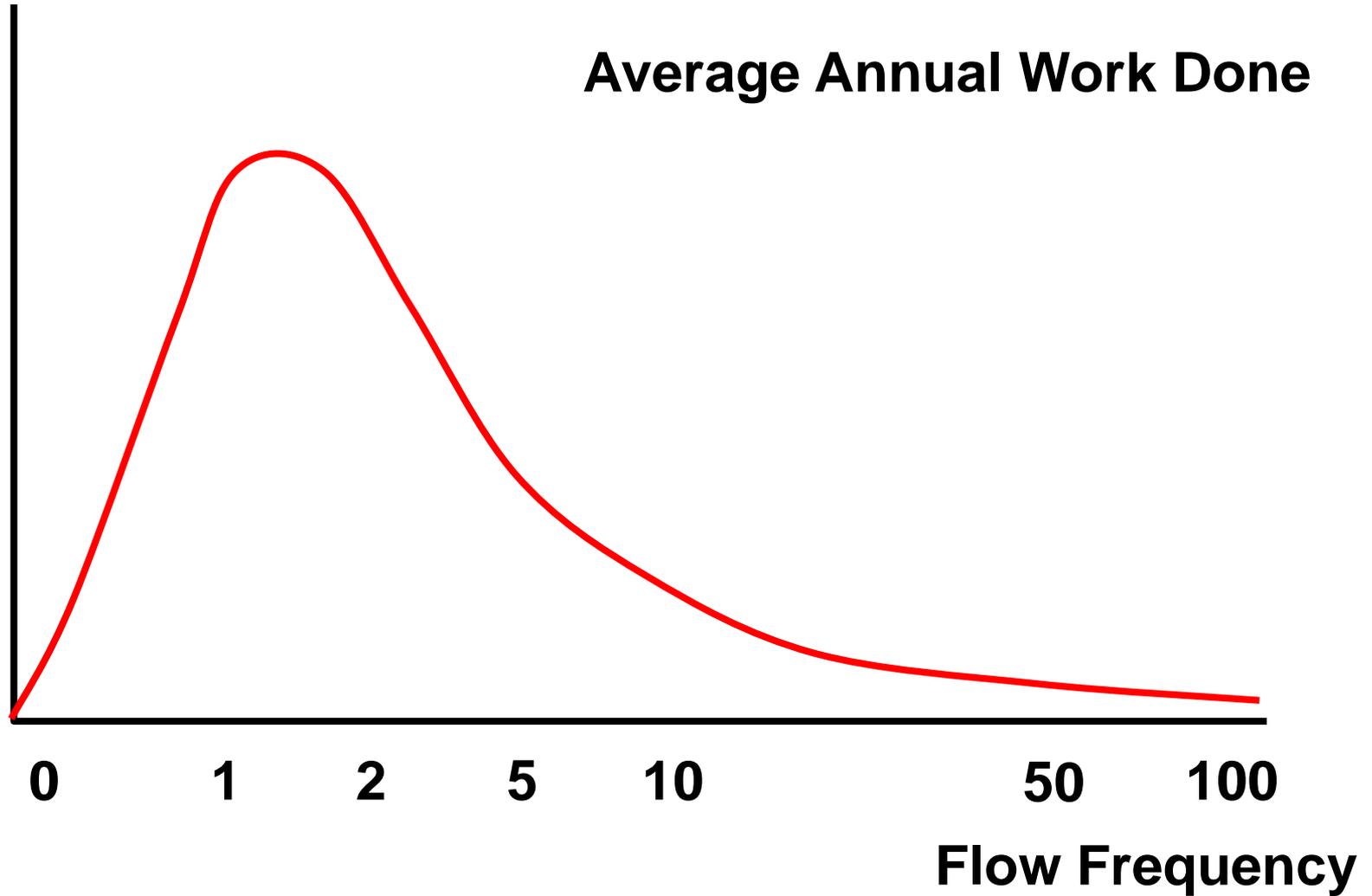
- Measure impervious area, calculate WQv
- Design treatment train system 80% removal
- Structural and nonstructural measures (credits)

Channel Protection Volume

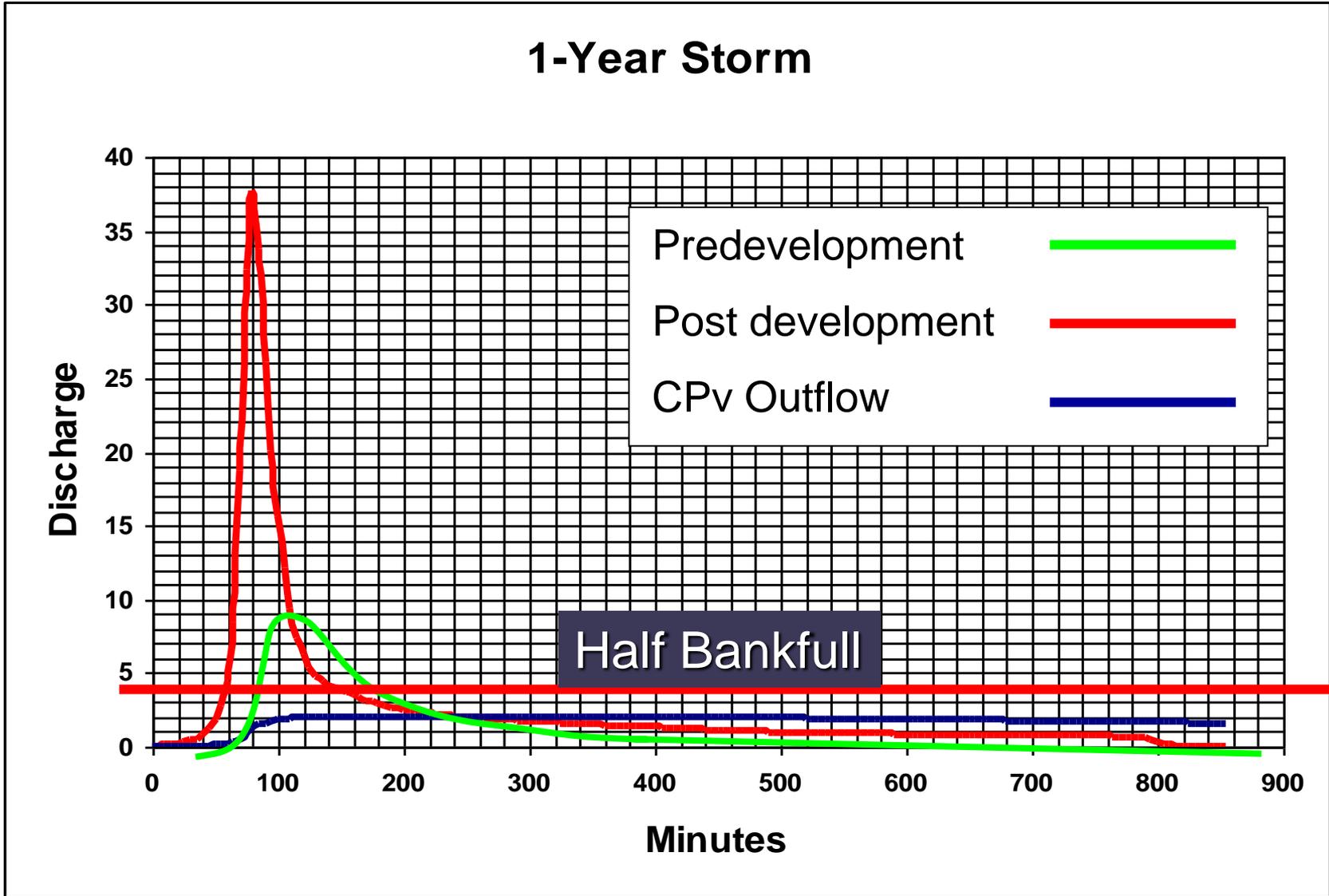


Criteria: Extended detention of 1-year storm over 24 hours to protect stream channels from erosive velocities.

“Work” to Move Sediment



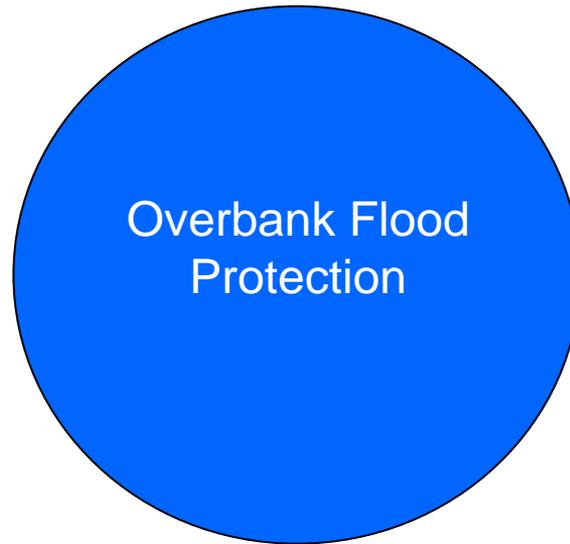
Less Bank-full Flow...



Channel Protection Volume Calculation

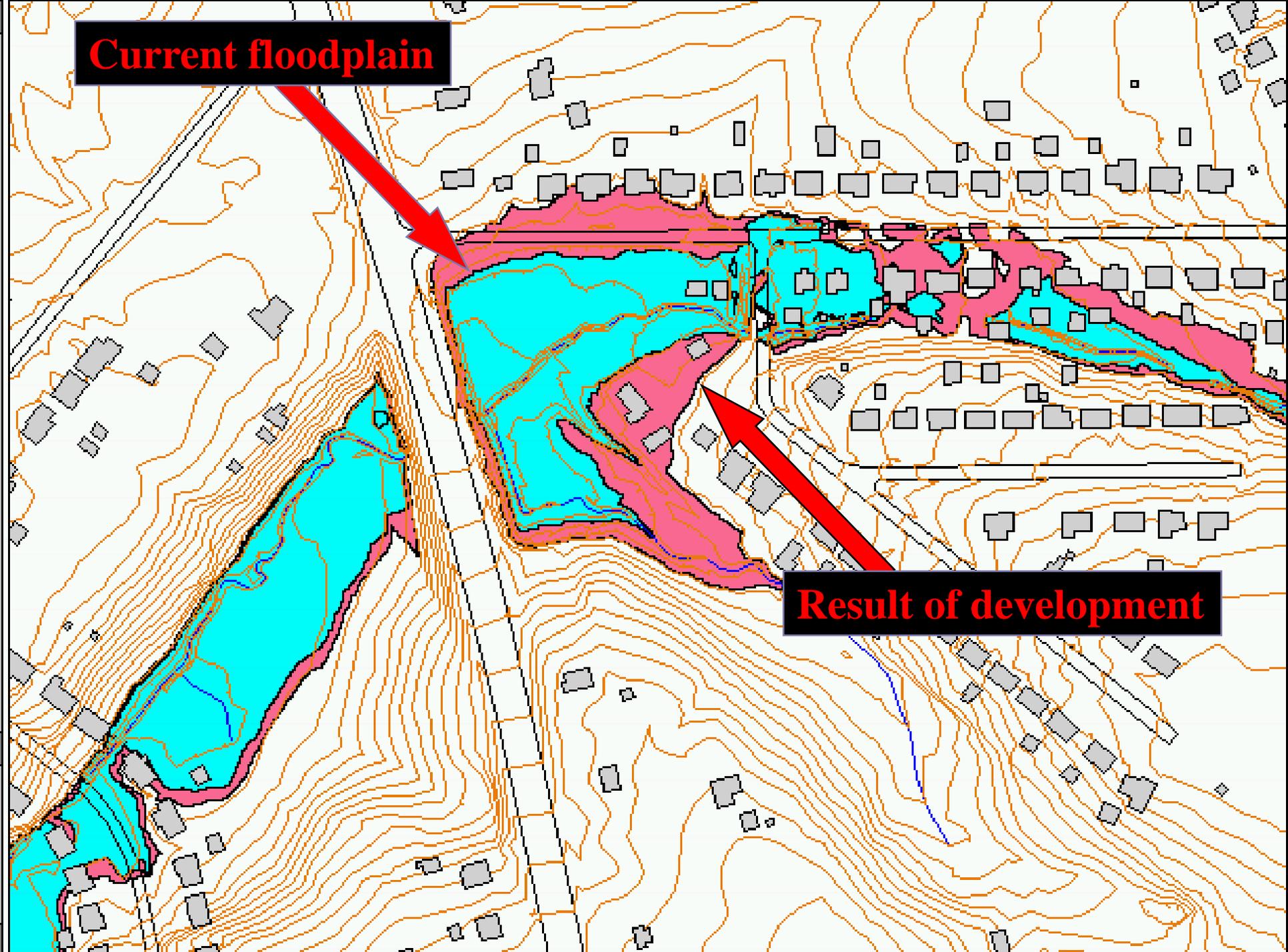
- Rainfall tables in Appendix A
- Can use TR-55 shortcut method
- Off-site areas modeled as “present condition”
- Can be distributed proportionally to each area

Overbank Flood Protection Volume



Criteria: Maintain pre-development discharge rate for the 25- and 100-year storm

Current floodplain



Result of development

Stormwater “Volume” Site Design Credits

Practice	Description
Natural area conservation	Undisturbed natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics.
Stream buffers	Stormwater runoff is treated by directing sheet flow runoff through a naturally vegetated or forested buffer as overland flow.
Use of vegetated channels	Vegetated channels are used to provide stormwater treatment.
Overland flow filtration/infiltration zones	Overland flow filtration/infiltration zones are incorporated into the site design to receive runoff from rooftops and other small impervious areas.

Structural Stormwater Controls Overview

Structural Stormwater Controls

- Treat stormwater runoff
- Mitigate effects of increased:
 - Peak flow rate
 - Volume
 - Velocity

Primary Categories

**General Application
Structural Controls**

**Limited Application
Structural Controls**

**Detention
Structural Controls**

General Application Structural Controls

- For use with wide variety of land uses
- Able to treat WQ_v - 80% TSS removed
- “Might” provide partial/full WQ control

General Application Structural Controls

- Stormwater Ponds
- Stormwater Wetlands
- Bioretention Areas
- Infiltration Trench
- Enhanced Swales

Stormwater Ponds

General Application Structural Controls

- Constructed stormwater retention basin with a permanent pool of water where runoff is detained and treated



Stormwater Wetlands

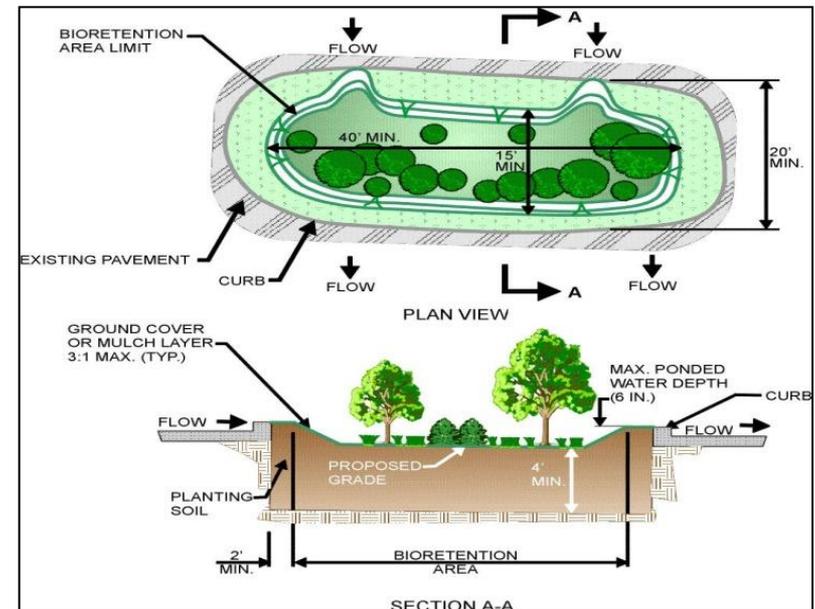
- Constructed wetland systems used for stormwater management



Bioretention Areas

General Application Structural Controls

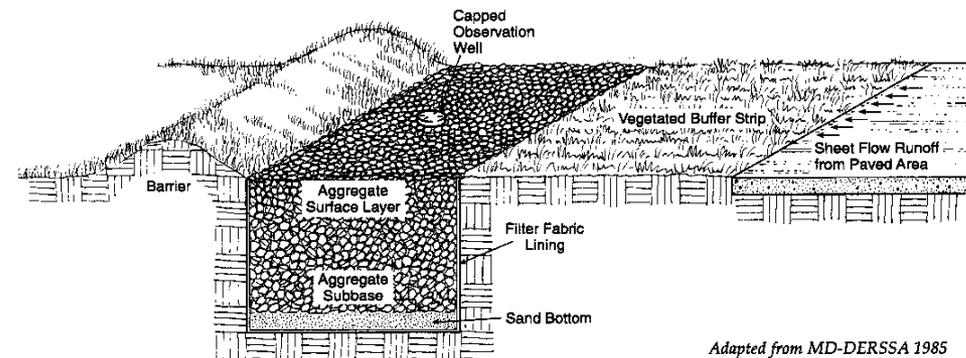
- Shallow stormwater basins or landscaped areas which utilize engineered soils and vegetation to capture and treat runoff



Infiltration Trench

General Application Structural Controls

- An excavated trench filled with stone aggregate used to capture and infiltrate stormwater runoff



Adapted from MD-DERSSA 1985

Enhanced Swales

General Application Structural Controls

- Vegetated open channels that are explicitly designed and constructed to capture and treat runoff within dry or wet cells



Pollutant Removal



Table 3.1.2-1 Design Pollutant Removal Efficiencies for Structural Stormwater Controls

Structural Control	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Fecal Coliform	Metals
<i>General Application Structural Controls</i>					
Stormwater Ponds	80	50	30	70*	50
Stormwater Wetlands	80	40	30	70*	50
Bioretention Areas	80	60	50	---	80
Sand Filters	80	50	25	40	50
Infiltration Trench	80	60	60	90	90
Enhanced Dry Swale	80	50	50	---	40
Enhanced Wet Swale	80	25	40	---	20

Limited Application Structural Controls

- For special site or design conditions:
 - <80% TSS removal
 - To address specific conditions
 - High maintenance requirements?
- Some used as pretreatment
- For commercial & industrial sites

Limited Application Structural Controls

- Filter Strip
- Grass Channel
- Organic Filter
- Underground Sand Filter
- Submerged Gravel Wetland
- Gravity (Oil-Grit) Separator
- Porous Concrete
- Modular Porous Paver Systems
- Alum Treatment
- Proprietary Systems

Filter Strip

Limited Application Structural Controls

- Uniformly graded and densely vegetated strips of land that serve as biofilters



Grass Channel

Limited Application
Structural Controls

- Vegetated open channels designed to filter stormwater runoff



Porous Concrete

Limited Application Structural Controls

- Porous pavement that allows for the rapid infiltration of water and overlays a stone aggregate reservoir



Modular Porous Paver Systems

Limited Application
Structural Controls

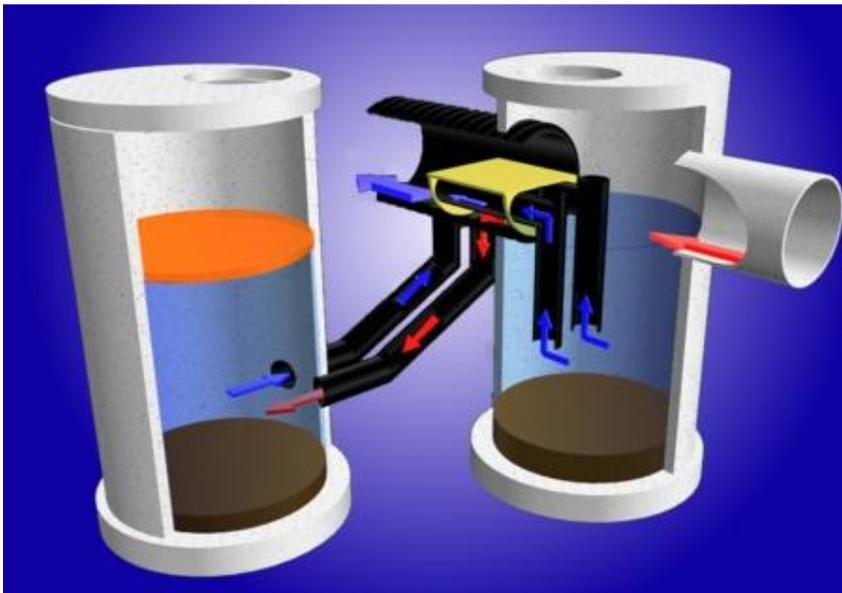
- Porous pavement surface composed of structural units with void areas that allow for the infiltration of runoff



Proprietary Systems

Limited Application
Structural Controls

- Manufactured structural stormwater control systems available from commercial vendors



Pollutant Removal



Table 3.1.2-1 Design Pollutant Removal Efficiencies for Structural Stormwater Controls

Structural Control	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Fecal Coliform	Metals
Filter Strip	50	20	20	---	40
Grass Channel	50	25	20	---	30
Organic Filter	80	60	40	50	75
Underground Sand Filter	80	50	25	40	50
Submerged Gravel Wetland	80	50	20	70	50
Gravity (Oil-Grit) Separator	40	5	5	---	---
Porous Concrete	**	50	65	---	60
Modular Porous Paver Systems	**	80	80	---	90
Alum Treatment	90	80	60	90	75
Proprietary Systems	***	***	***	***	***

Detention Structural Controls

- Provide only water quantity control (CP_v , Q_{p25} and/or Q_f)
- Typically used downstream of a general application or limited application structural control

Stormwater Controls Selection

Step 1 -- Overall Applicability

- Stormwater Treatment Suitability
 - Ability to treat/control Unified Stormwater Sizing criteria (WQ_v , CP_v , Q_{p25} , Q_f)
- Water Quality Performance
 - Ability to provide removal of TSS, Nutrients, and Bacteria
 - Ability to accept hotspot runoff

Step 1 -- Overall Applicability

- Site Applicability
 - Drainage area minimum / maximum
 - Space required (space consumed)
 - Slope requirements
 - Minimum head
 - Water table
- Implementation Considerations

STRUCTURAL CONTROL CATEGORY	STRUCTURAL CONTROL	STORMWATER TREATMENT SUITABILITY				WATER QUALITY PERFORMANCE*			
		Water Quality	Channel Protection	Overbank Flood Protection	Extreme Flood Protection	TSS / Sediment Removal Rate	Nutrient Removal Rate (TP/TN)	Bacteria Removal Rate	Hotspot Application
Stormwater Ponds	Wet Pond	✓	✓	✓	✓	80%	50%/30%	70%	✓
	Wet ED Pond	✓	✓	✓	✓				✓
	Micropool ED Pond	✓	✓	✓	✓				✓
	Multiple Ponds	✓	✓	✓	✓				✓
Stormwater Wetlands	Shallow Wetland	✓	✓	✓	✓	80%	40%/30%	70%	✓
	Shallow ED Wetland	✓	✓	✓	✓				✓
	Pond/Wetland	✓	✓	✓	✓				✓
	Pocket Wetland	✓	✓						✓
Bioretention	Bioretention Areas	✓	⊛			80%	60%/50%	<i>Insuff. data</i>	✓
Sand Filters	Surface Sand Filter	✓	⊛			80%	50%/25%	40%	✓
	Perimeter Sand Filter	✓	⊛						✓
Infiltration	Infiltration Trench	✓	⊛			80%	60%/60%	90%	
Enhanced Swales	Dry Swale	✓	⊛			80%	50%/50%	<i>Insuff. data</i>	✓
	Wet Swale	✓	⊛			80%	25%/40%	<i>Insuff. data</i>	✓

Step 2 -- Specific Criteria

- Physiographic Factors
- Soils
- Special Watershed or Stream Considerations

Table 3.1.2-2 Structural Control Screening Matrix 2 – Specific Criteria

General Application Controls

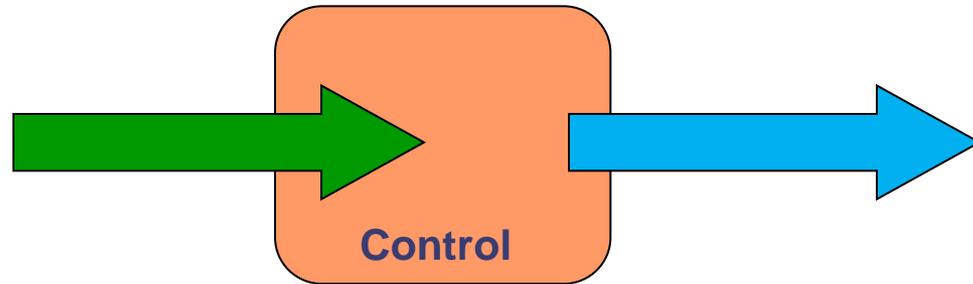
STRUCTURAL CONTROL CATEGORY	PHYSIOGRAPHIC FACTORS			SOILS	SPECIAL WATERSHED CONSIDERATIONS				
	Low Relief	High Relief	Karst		Trout Stream	High Quality Stream	Aquifer Protection	Reservoir Protection	Shellfish / Beach
Stormwater Ponds	Limit maximum normal pool depth to about 4 feet (dugout) Providing pond drain can be problematic	Embankment heights restricted	Require poly or clay liner Max ponding depth Geotechnical tests	"A" soils may require pond liner "B" soils may require infiltration testing	Limit use of due to thermal impacts Limit ED to 12 hrs Offline design and provide shading	Evaluate for stream warming	May require liner if "A" soils are present Pretreat hotspots 2 to 4 ft separation distance from water table		Moderate bacteria removal Design for waterfowl prevention Provide 48 hr ED for max coliform dieoff
Stormwater Wetlands		Embankment Heights restricted	Require poly-liner Geotechnical tests	"A" soils may require pond liner	Limit use of due to thermal impacts Offline design and provide shading	Evaluate for stream warming	May require liner if "A" soils are present Pretreat hotspots 2 to 4 ft separation distance from water table		Provide 48 hr ED for max coliform dieoff
Bioretention & Sand Filters	Several design variations will likely be limited by low head		Use poly-liner or impermeable membrane to seal bottom	Clay or silty soils may require pretreatment	Evaluate for stream warming	Evaluate for stream warming	Needs to be designed with no exfiltration (i.e. outflow to groundwater)		Moderate to high coliform removal
Infiltration	Minimum distance to water table of 2 feet	Maximum slope of 6% Trenches must have flat bottom	GENERALLY NOT ALLOWED	Infiltration rate > 0.5 inch/hr			Maintain safe distance from wells and water table No hotspot runoff	Maintain safe distance from bedrock and water table Pretreat runoff	Maintain safe distance from water table
Enhanced Swales	Generally feasible however slope <1% may lead to standing water in dry swales	Often infeasible if slopes are 4% or greater					Hotspot runoff must be adequately treated	Hotspot runoff must be adequately treated	Poor coliform removal

Step 3 -- Location and Permitting

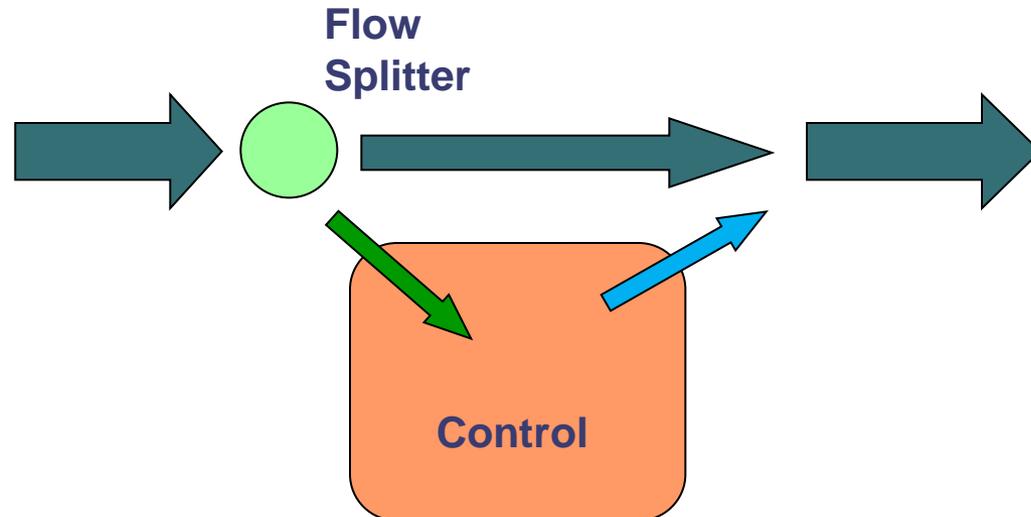
- Jurisdictional Waters and Wetlands
- Special Issues
 - Groundwater Recharge
 - Water Supply Watersheds
- Floodplains
- Local Buffer Requirements
- Utilities, Roads, Structures, Wells, Septic

On-Line vs. Off-Line Controls

On-Line
System



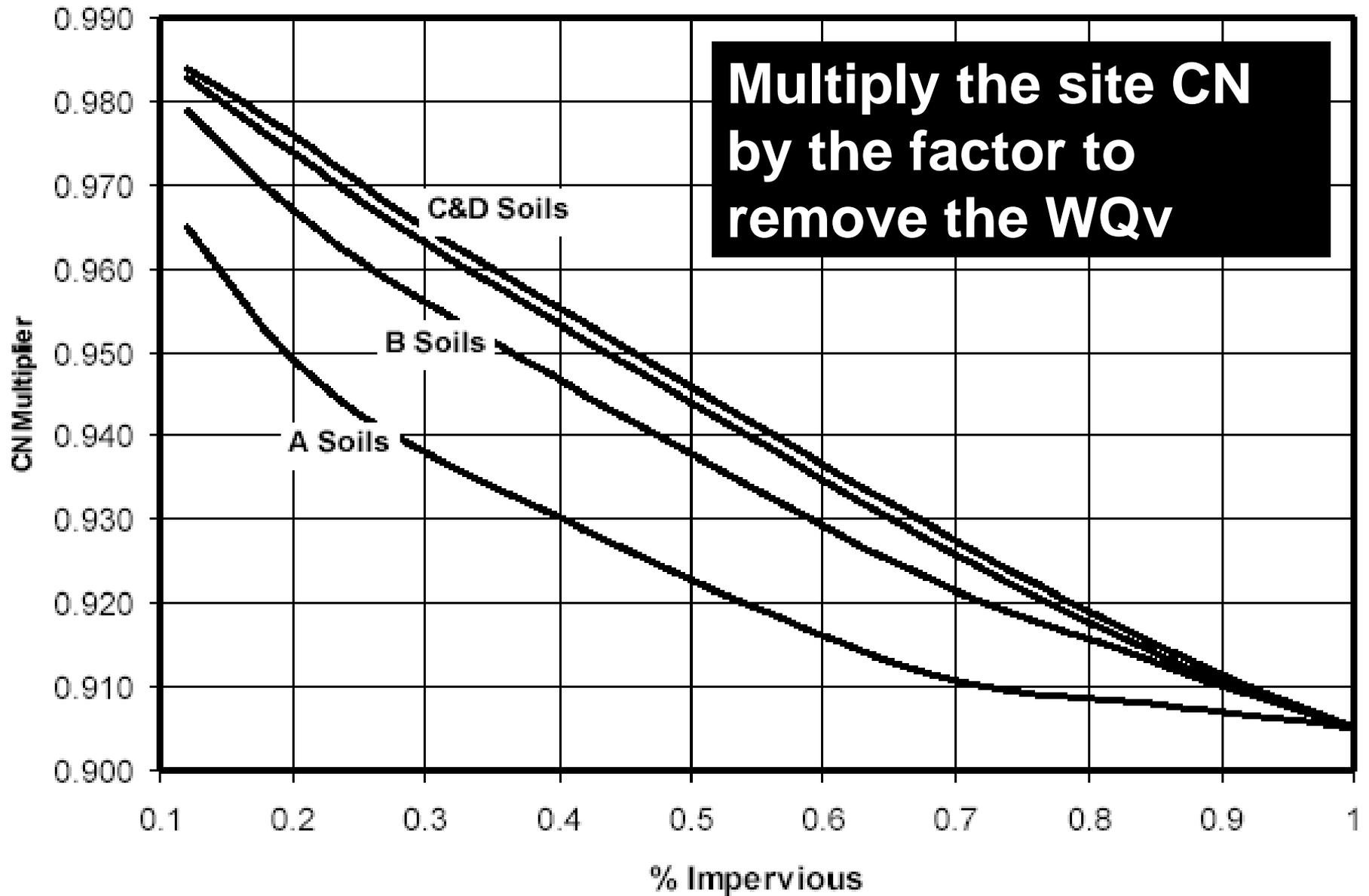
Off-Line
System



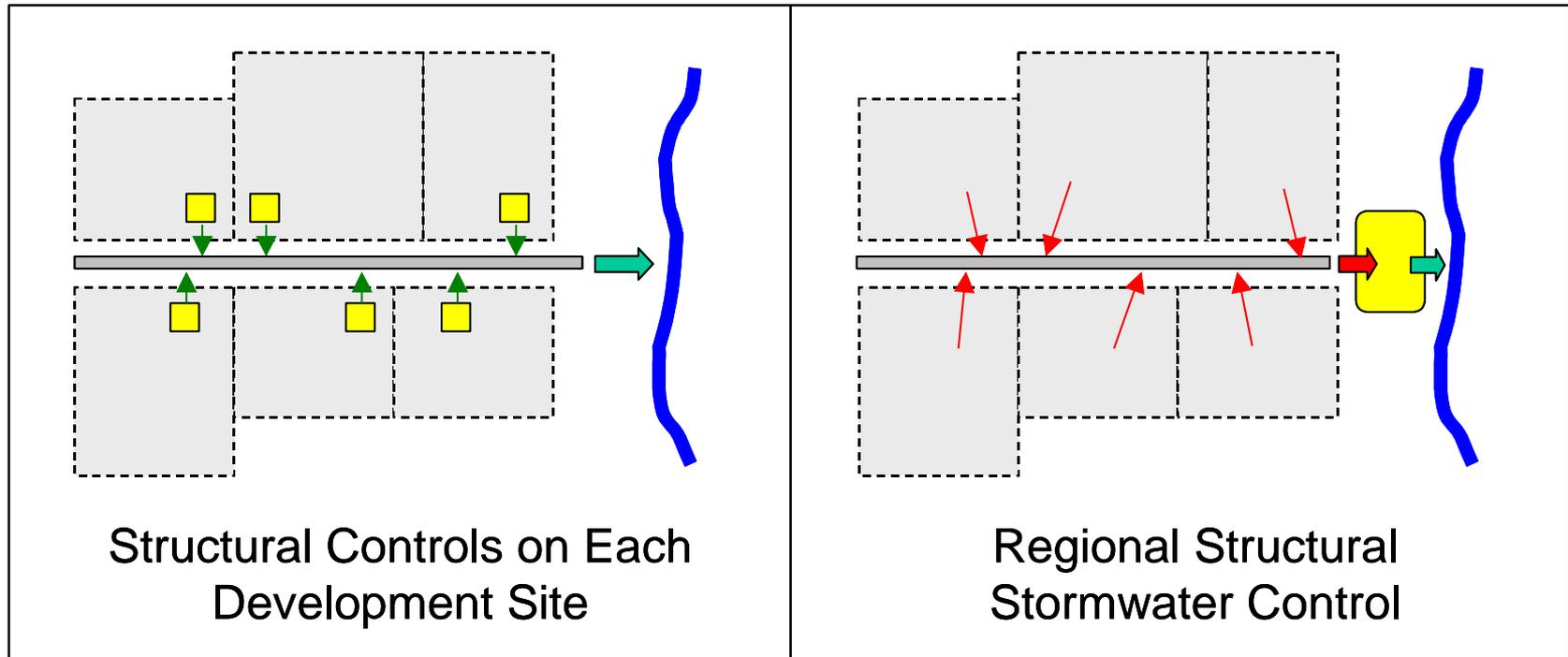
Removing WQv

Situation: off line control removes the WQv from a downstream detention pond.

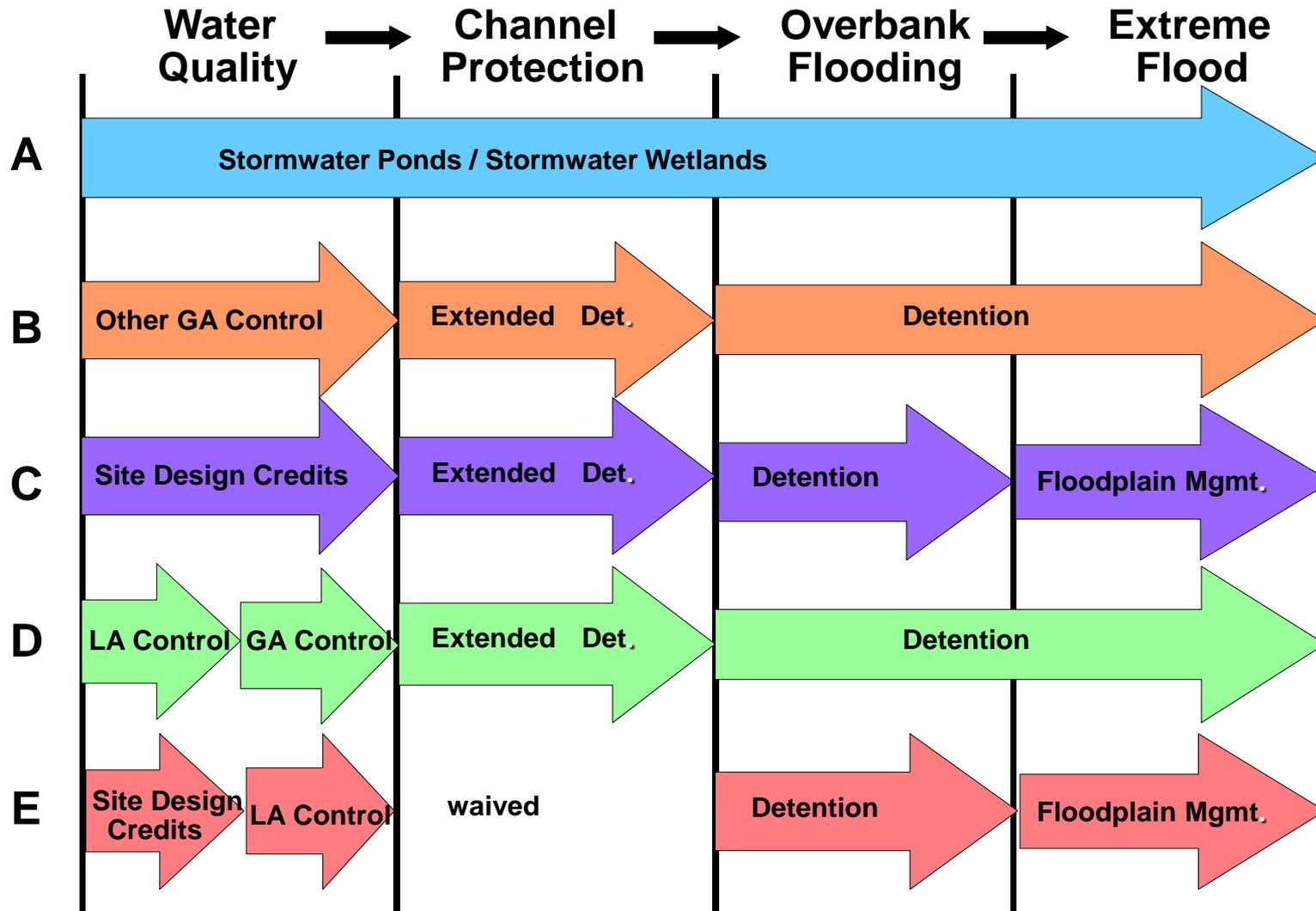
- Facilitates the use of standard models
- Removes the WQv
- For controls w/ drawdown ≥ 24 hrs
 - bioretention, infiltration, filters



Regional vs. On-Site Controls



Using Controls in Series

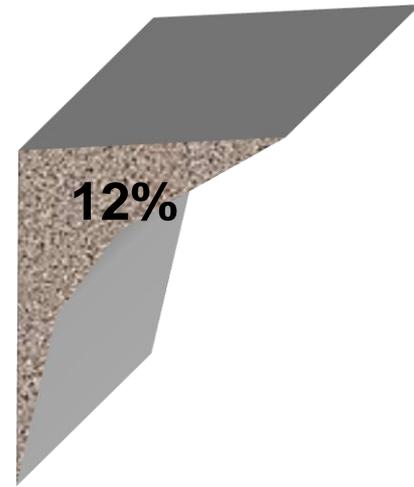


Series Removals

Clay

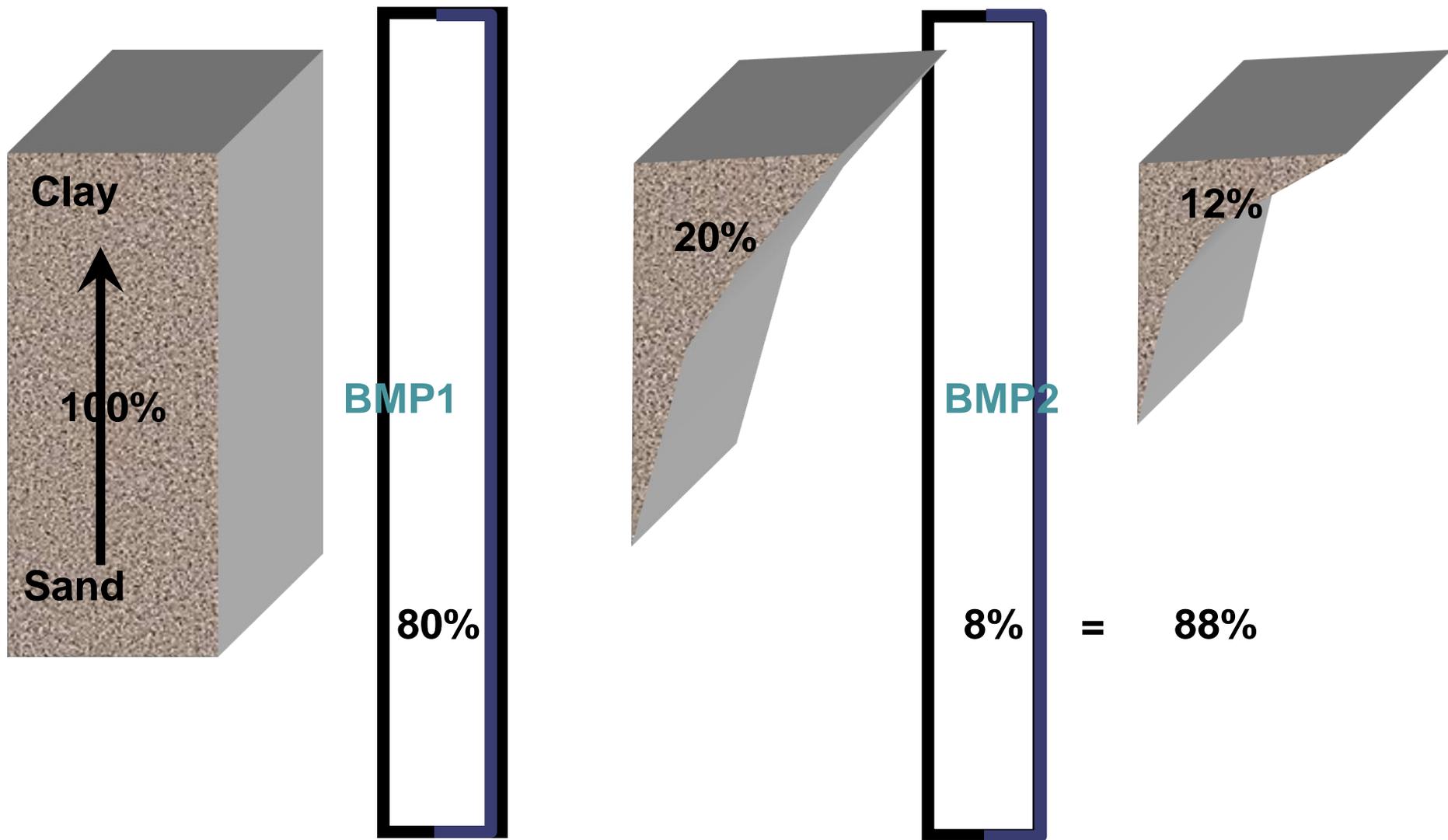


Sand



= 88%

Series Removals



$$80\% / 2 * 20\% \text{ left} = 8\%$$

Questions?

