The use of low head weirs to reconnect severely entrenched perennial streams with their floodplains:

An Anne Arundel County TMDL Watershed Implementation Plan Strategy

presented by

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ANNE ARUNDEL COUNTY MARYLAND

DPW

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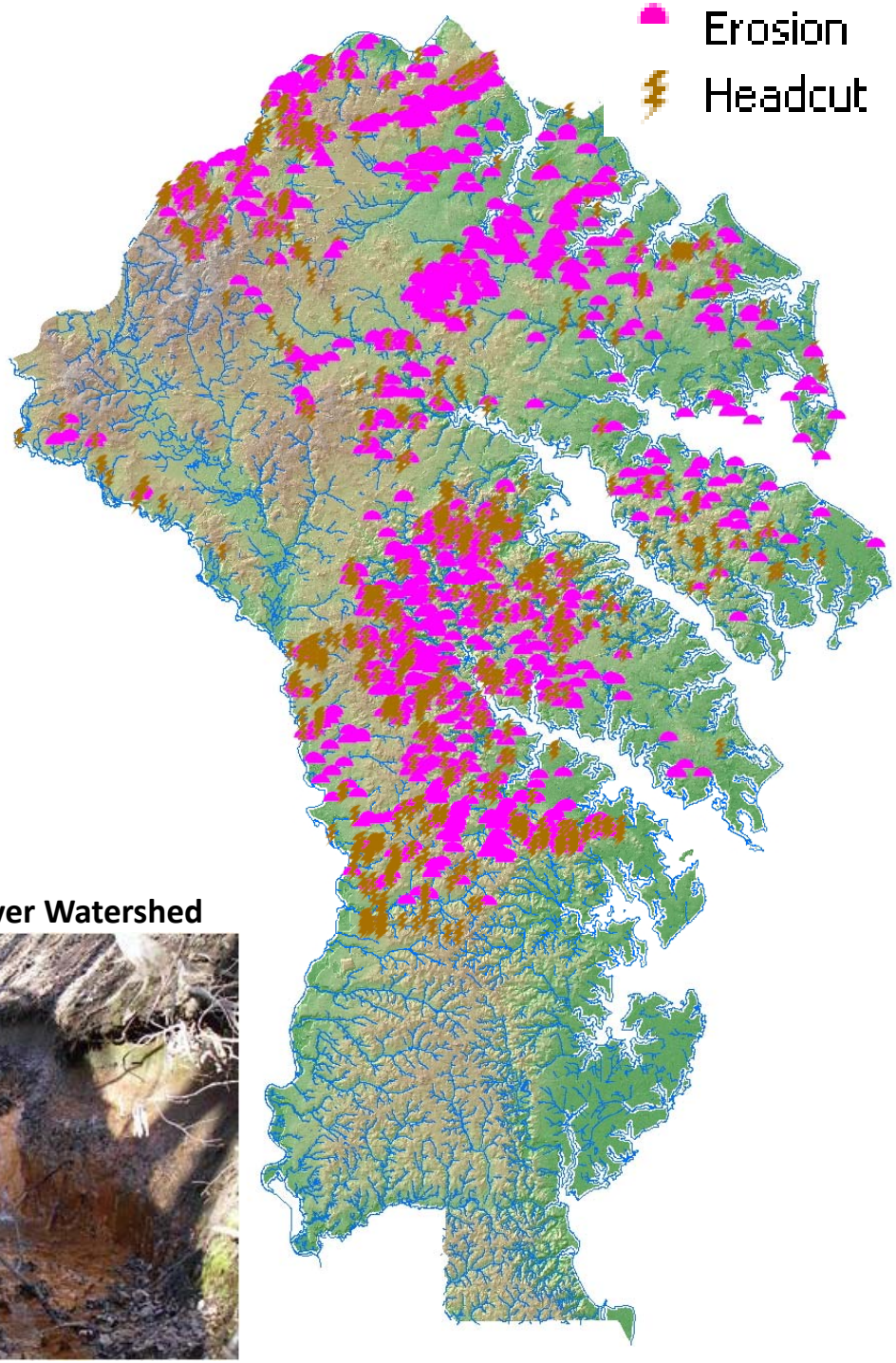
Outline

- ***Current Condition Assessment for Streams in Anne Arundel County***
- ***Instream weir design***
- ***A water quality strategy for meeting sediment and nutrient TMDLs in Maryland***
- ***Implementation examples***
- ***Conclusion***

DEGRADED MORPHOLOGY

Example of F and G channels – Highly Instable



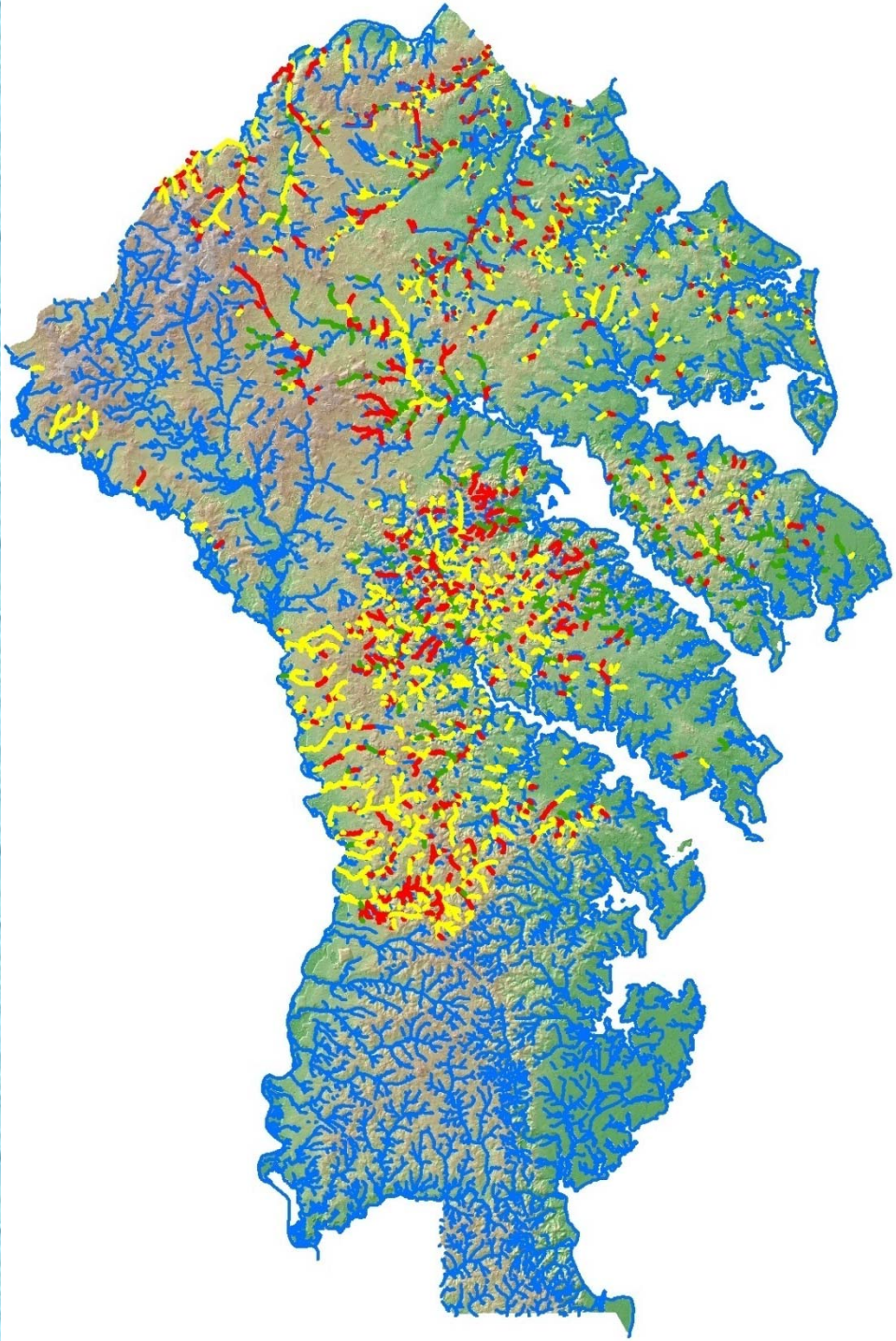
Erosion -- Patuxent River Watershed

Headcut -- South River Watershed

ESTIMATED SEDIMENT YIELD

Perennial Stream Miles Assessed: 406

Sediment Yield	
High	133
Moderate	211
Low	62
Not Assessed	



Conventional upland BMPs do not necessarily correlate with a stable downstream!

Stormwater detention ponds are wet structures that are often used to capture and detain stormwater runoff from residential and commercial areas.

Erosion and Headcut Inventory

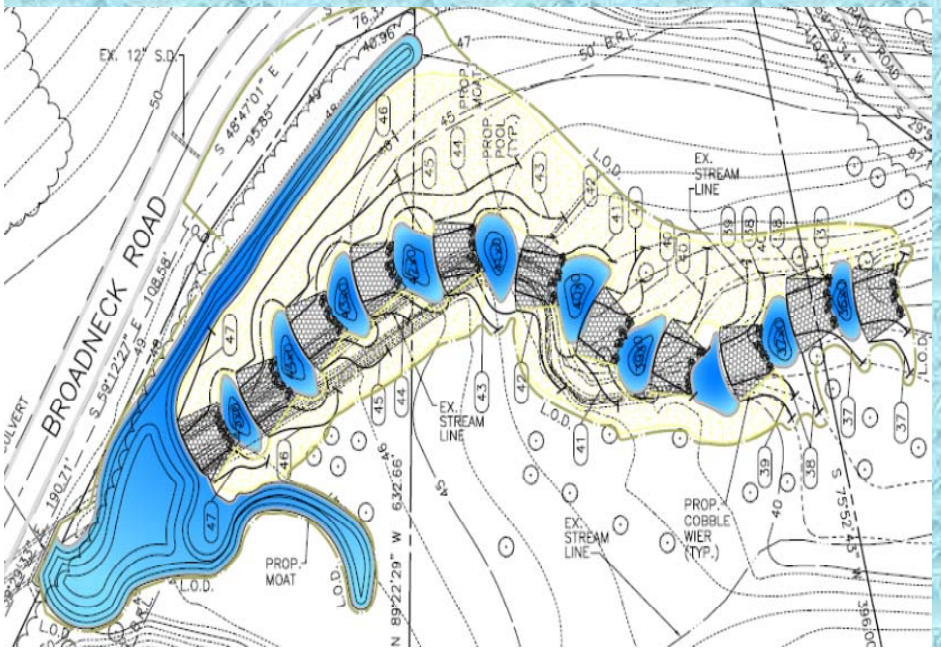
Impervious Area Draining to BMP

- Less than 20%
- 20%< and >50%
- 50%< and >75%
- More than 75%

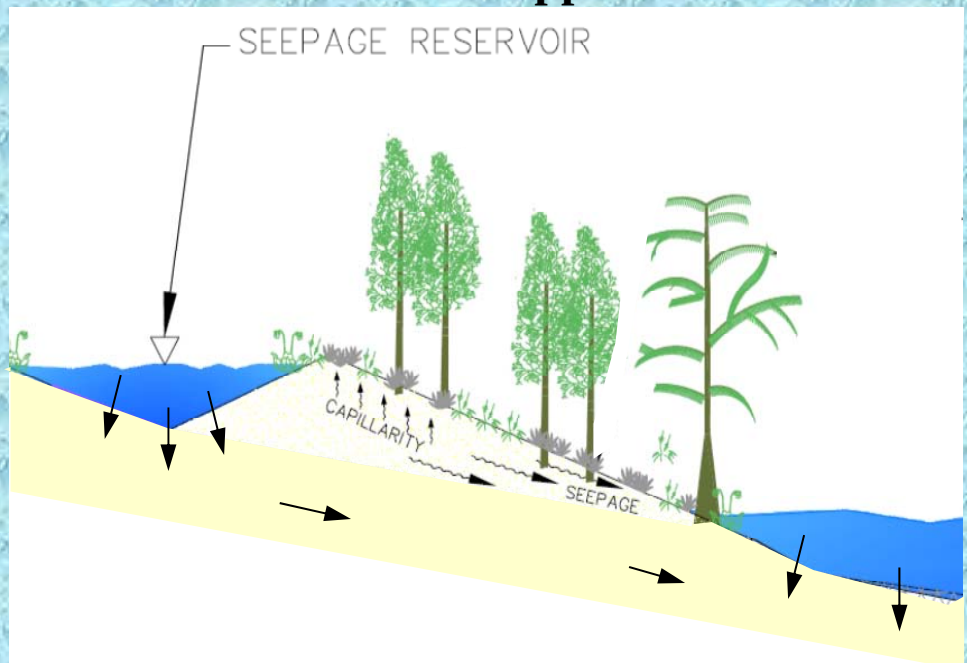
SPSCs – What are they?

SPSCs are open-channel conveyance structures that convert, through attenuation pools and a sand seepage filter, surface storm flow to shallow groundwater flow.

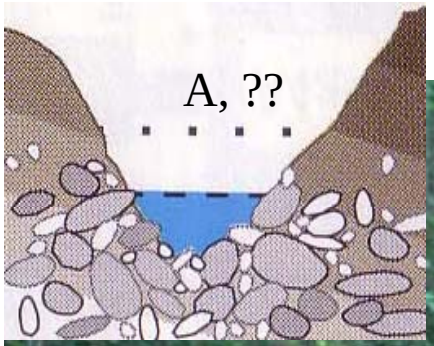
Step Pool Storm Conveyance
Ephemeral Application

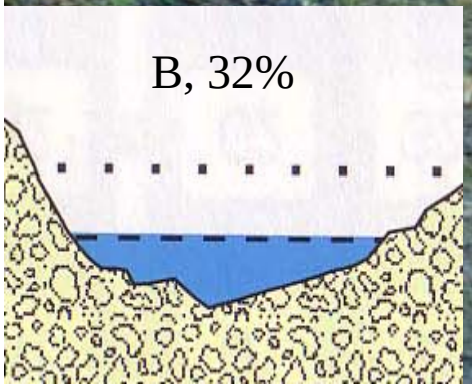


Wetland Seepage System
Perennial Application



STEP POOL STORM CONVEYANCE FOR EPHEMERAL OUTFALLS





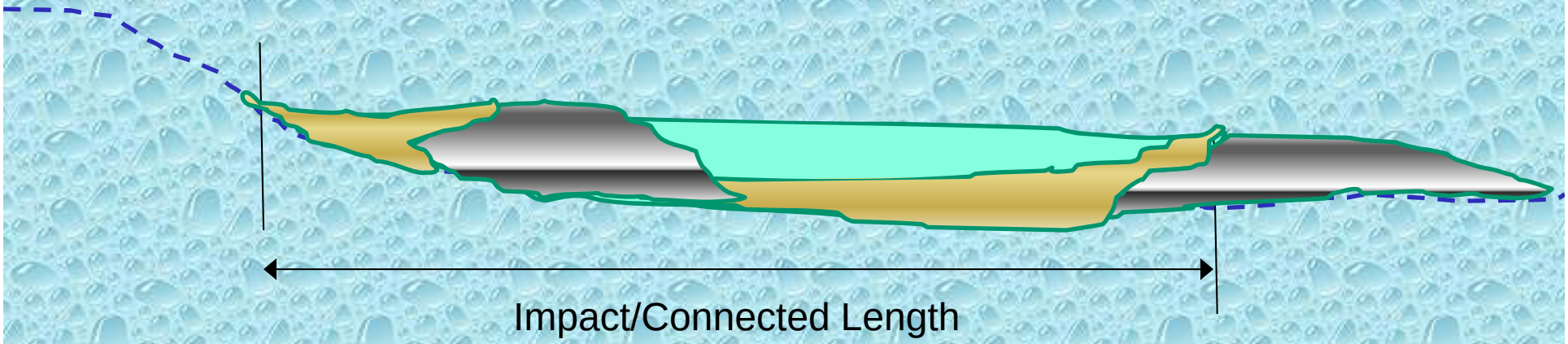
The physical characteristics of the SPSC channel are best characterized by the Rosgen A or B stream classification types, where "bedform occurs as a step/pool, cascading channel which often stores large amounts of sediment in the pools associated with debris dams" (Rosgen, 1996).

WETLAND SEEPAGE RESTORATION TECHNIQUE FOR PERRENIAL STREAMS

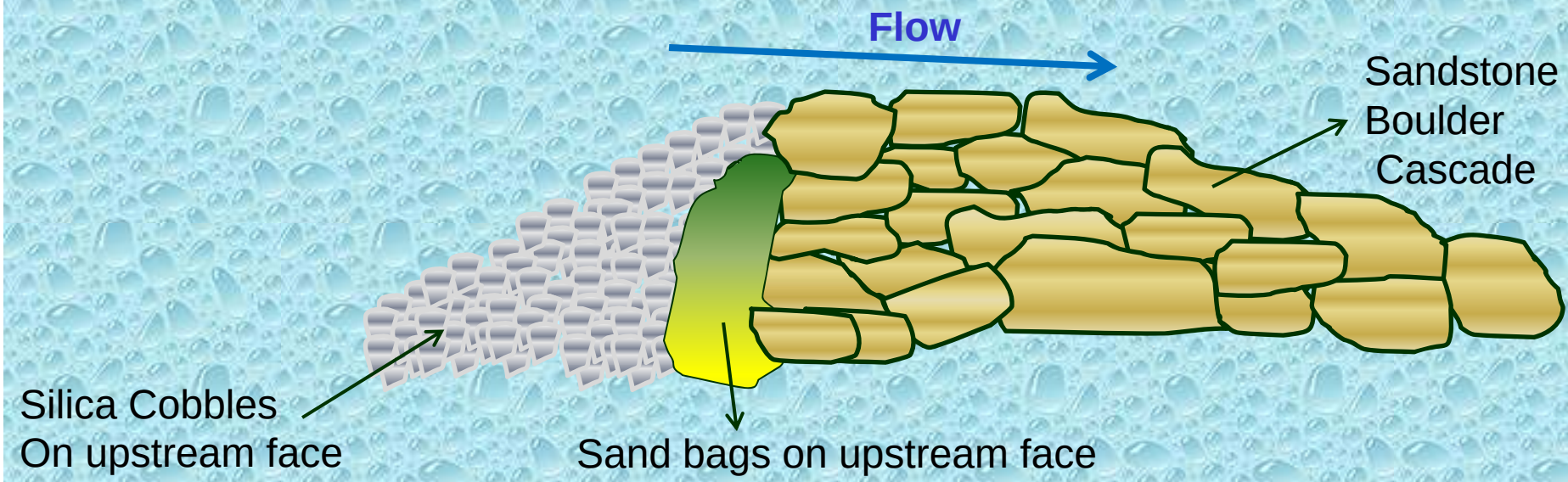
What are In-stream Weirs:

-Sandstone cobble Weirs are used to form 4 ft low head dam lifts to encourage the upstream floodplain to build up to its restored levels

- **Maximum slope is 10%**
- **Maximum Height = 4 ft.**

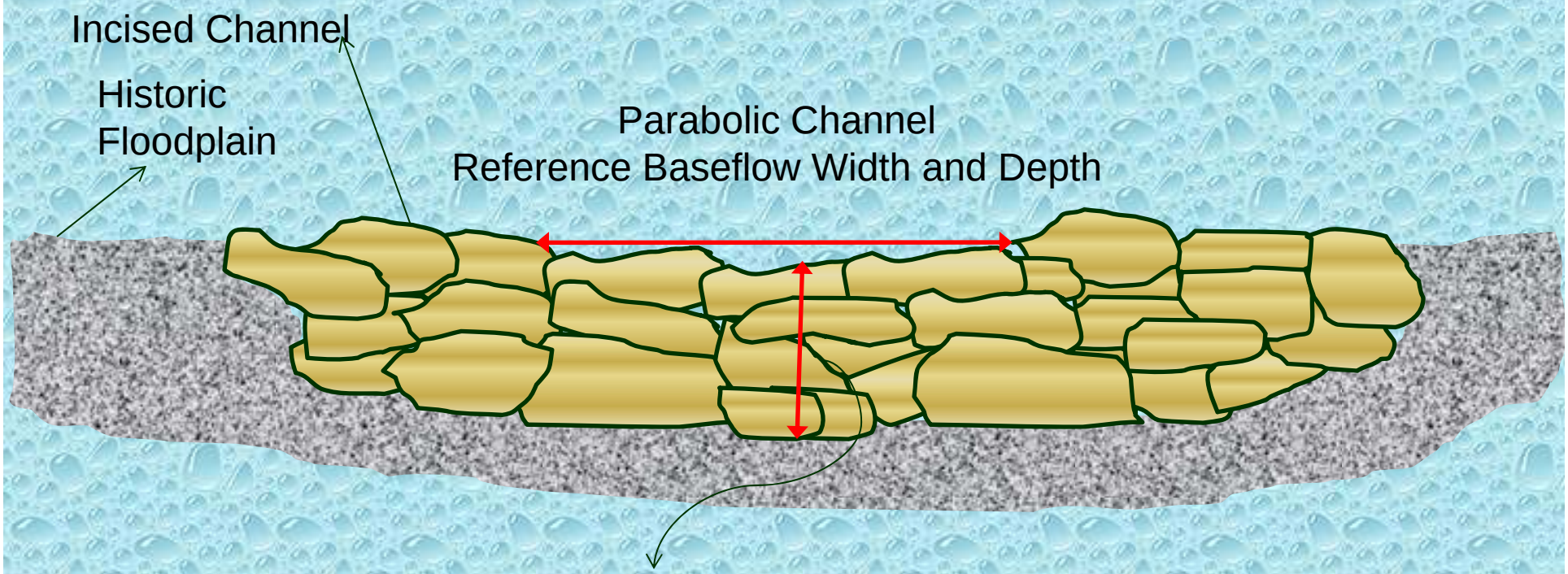


In-stream Weir Typical Detail:



Profile along channel Centerline

In-stream Weir Typical Detail:



Instream Weir/Cascade Cross-Section

In-stream Weir Implementation Scenarios:

- Restoring incised perennial channels

- Connecting perennial streams to floodplain

- Arresting Headcut

- Protecting public infrastructure

A breakdown of the cost of Stream Restoration per MDE standards

Baseline Credit (TN = 0.02 lb/LF, TP = 0.0035 lb/LF, TSS = 2.55 lb/LF)

MDE Criteria:

Stream stabilization and restoration projects that connect incised and degraded streams to their Floodplain.
AACO uses **Instream Weir** technology at incised Sections to connect a stream segment to the floodplain

MDE specifies Impervious acreage treated =
1 acre/100 linear feet of stream connected/restored

Severn Run Mainstem, 3 feet high 30 ft long instream weir was used to connect 150 feet of stream to the floodplain.

Historic Cost Records for In-stream Weir projects in AA

County: Project Name	Restoration Length (Ft)	Cost	Unit Cost ($/LF)	Unit Cost ($/Impervious Acres)
Wells Branch @ Gambrills Road	170	$ 15,000	88	4412
Wells Branch @ Aurora Hills	150	$ 15,000	100	5000
Science Drive Stream Restoration	650	$ 75,000	115	5769
Picture Spring Branch Instream Weir	500	$ 60,000	120	6000
Severn Run Instream Weir	150	$ 30,000	200	10000

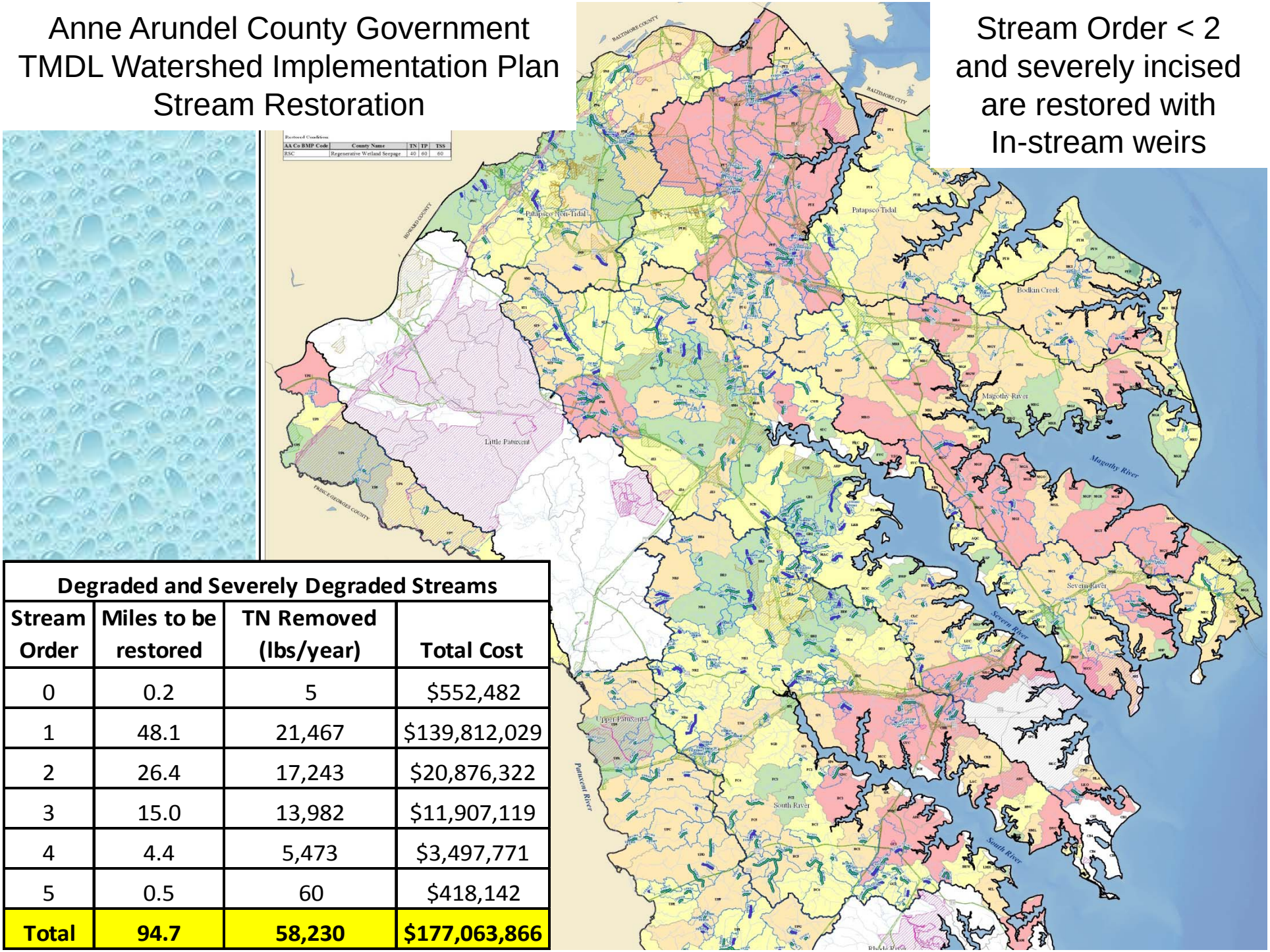
Unit Cost Comparison for TMDL Implementation Strategies

WIP BMP strategy	$/(Acres of Impervious Area Treated)	$/(lbs TN Removed)
Rain Gardens (Bioretention)	$51,581	4,604
Rain Barrels	$104,544	23,327
Planting of Urban **Pervious Lands**	$59,125	9,430
Pond Retrofits	$25,966	4,932
Ephemeral Stream/Pipe Outfall Retrofits with regenerative SPSC Systems	$34,859	2,854
Perennial Stream Restoration (Instream Weir)	$8,077	4,039
Perennial Stream Restoration (regenerative Wetland Seepage)	$20,414	3,215
Average	$43,509	$7,486

Unit cost of Conservation planting is per pervious acre and not impervious acre since it is cost prohibitive to remove impervious to plant trees.

Anne Arundel County Government
TMDL Watershed Implementation Plan
Stream Restoration

Stream Order < 2 and severely incised are restored with In-stream weirs



Degraded and Severely Degraded Streams			
Stream Order	**Miles to be restored**	**TN Removed (lbs/year)**	**Total Cost**
0	0.2	5	$552,482
1	48.1	21,467	$139,812,029
2	26.4	17,243	$20,876,322
3	15.0	13,982	$11,907,119
4	4.4	5,473	$3,497,771
5	0.5	60	$418,142
Total	**94.7**	**58,230**	**$177,063,866**


National Business Park – Instream weir downstream of outfall restoration
Mitigation for upstream development draining to an inadequate oufall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Severn Run Mainstem – Before Instream Weir – Temporary Fix
Stream incision exposed sewer line crossing

Severn Run Mainstem – directly after construction – Sewer Crossing

Severn Run Mainstem – After Tropical Storm Lee – Sewer line crossing

Severn Run Mainstem – Upstream Channel Clarity

Aurora Hills - Tributary to Wells Branch Restoration
Protect upstream tributary restoration

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Wells Branch – Upstream of Instream Weir – 2010

Wells Branch – Upstream of Instream Weir - 2011

Gambrills Road Culvert Replacement
Arrest downstream headcut


Gambrills Road Culvert Replacement
Arrest downstream headcut

Conclusion

- *In-stream low head weirs are designed as stable systems*
- *Instream weirs can be designed to provide fish passage*
- *Instream weirs connect the upstream channel to the floodplain.*
- *Instream weirs encourage upstream building of incised channel by trapping transported material.*
- *Instream weirs are a cost effective strategy for stream restoration.*