

Reconnaissance of South River Fluvial Processes and Morphology, March 2004

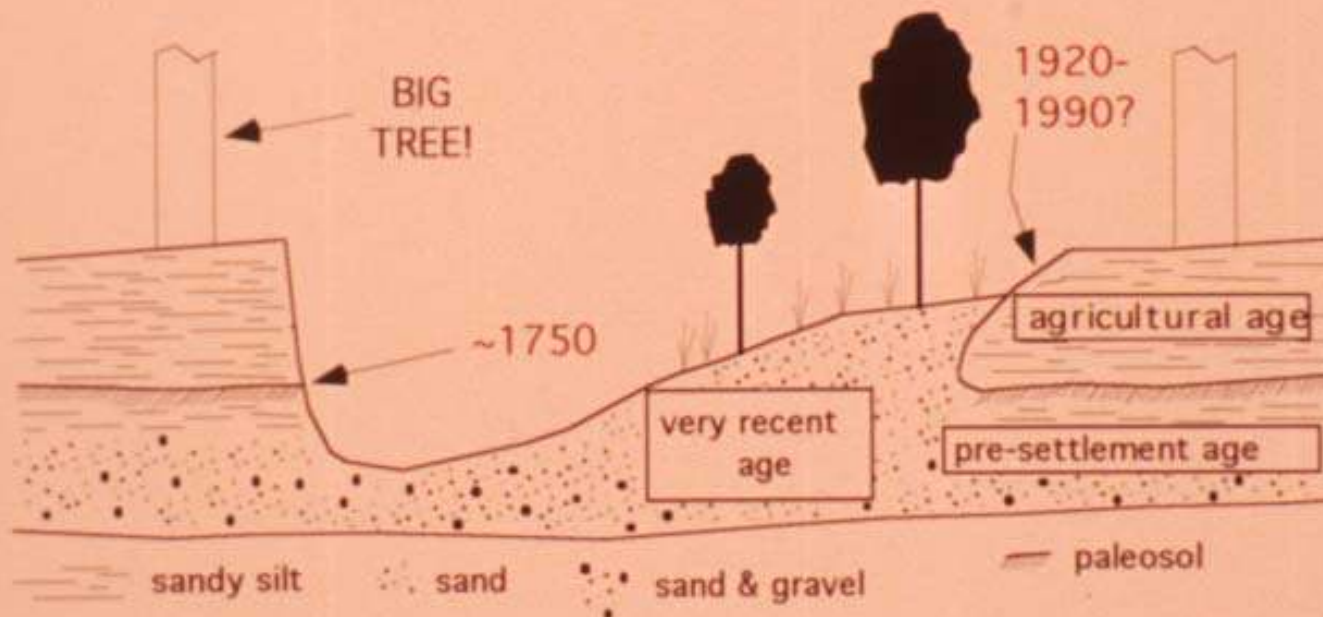
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OUTLINE

- General characteristics of E. Coast streams
 - History (~1750 to present)
 - Significance of riparian vegetation, geologic setting
 - Rates of lateral migration
 - Morphology in plan
- Geomorphic characteristics of South River downstream of Waynesboro
- “Back of the envelope” sediment and sediment related Hg budgets for a 5 km reach
- Proposed additional work

Some Typical Deposits

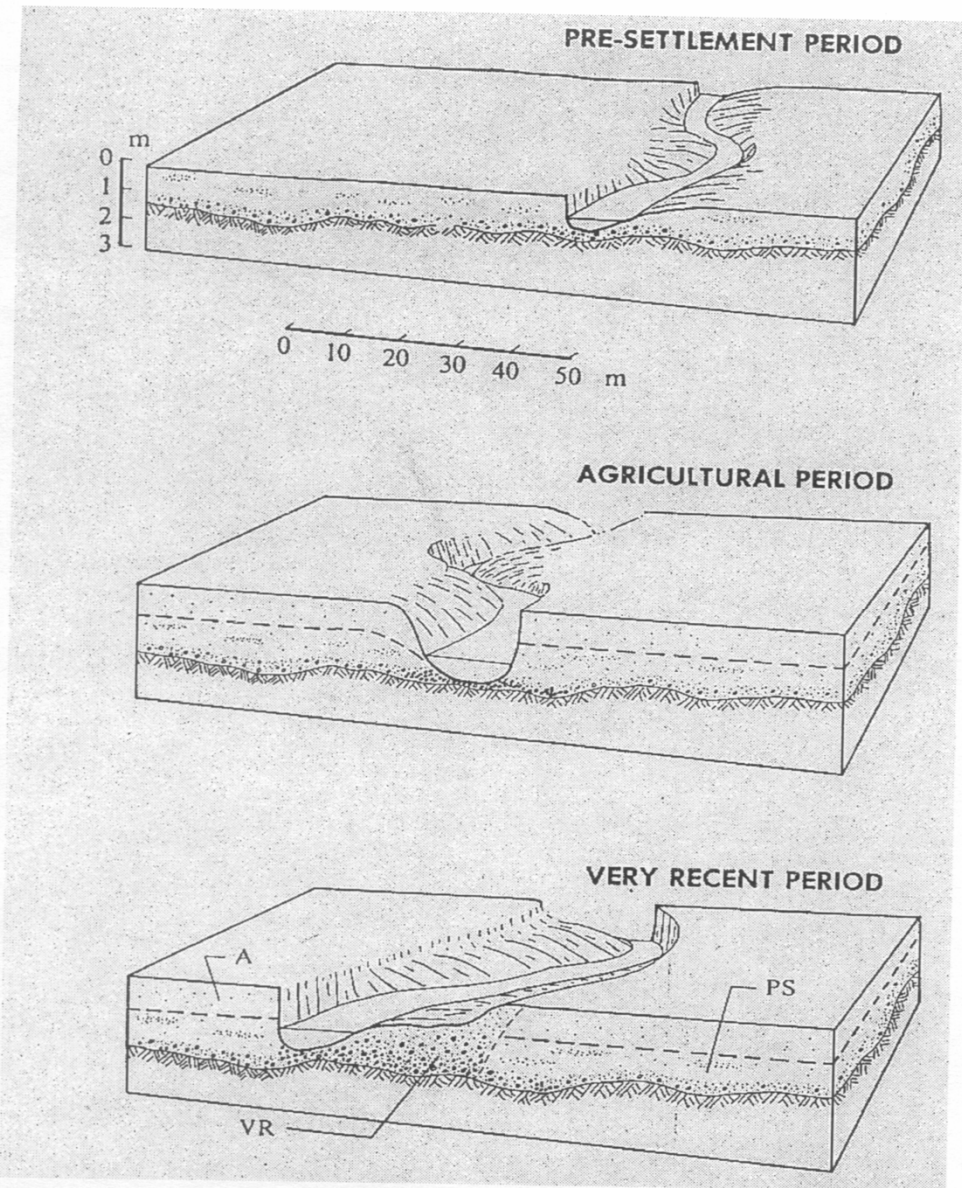
Typical Stratigraphic Cross-section
of an Alluvial Reach of Paint Branch
(after Jacobson and Coleman, 1986)



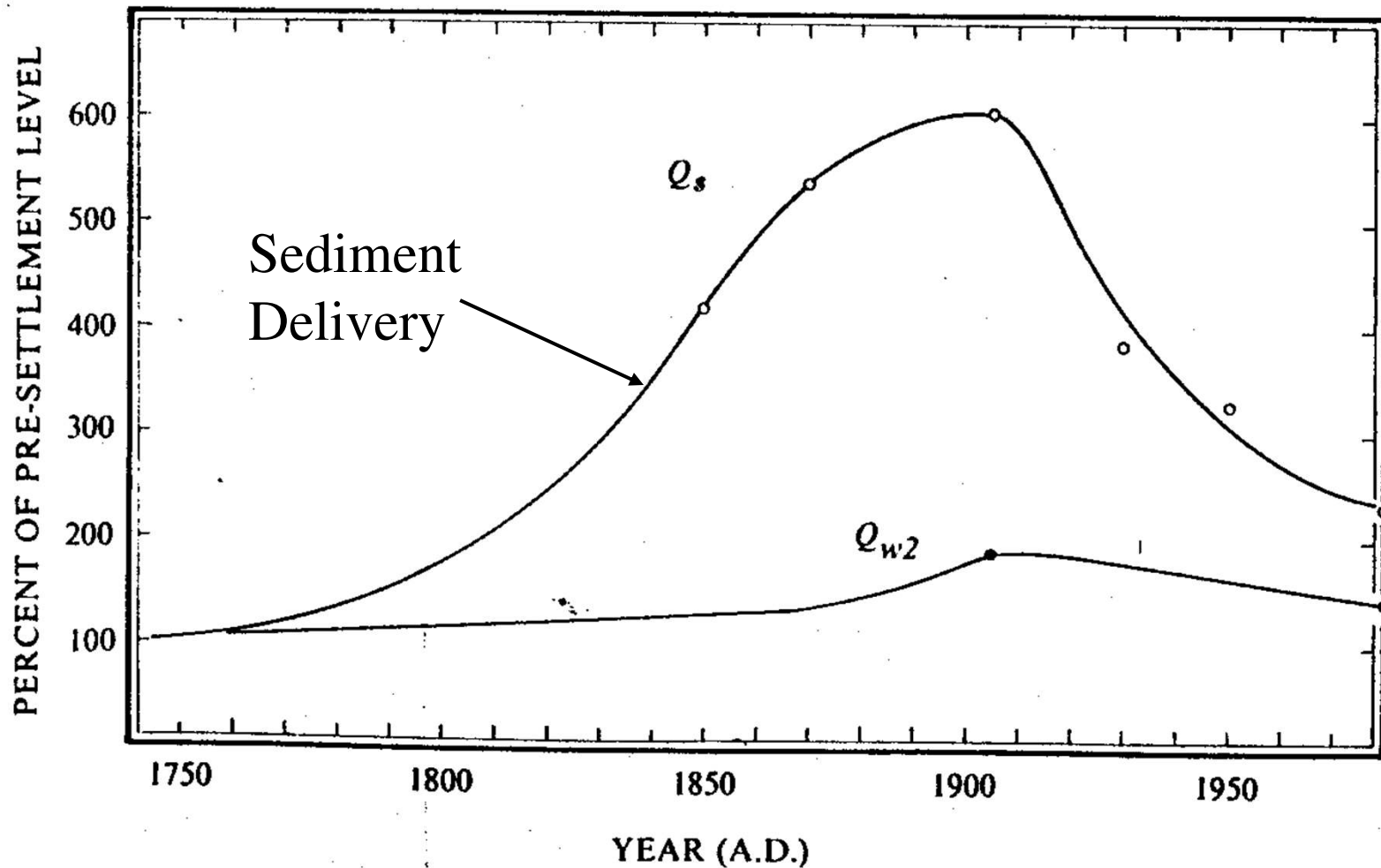
Typical Buried Pre-Settlement Soil Horizon



**Jacobson and
Coleman's
(1986)
interpretation**



History of Sediment Yield and Runoff (Jacobson and Coleman, 1986)



Sediment Budget Implications...

1. Little deposition occurs on fine-grained Ag. Age floodplains.
2. They are currently a source of fine-grained sediment.
3. Post-settlement deposits are composed primarily of sand and gravel.

Sandy post-settlement floodplain

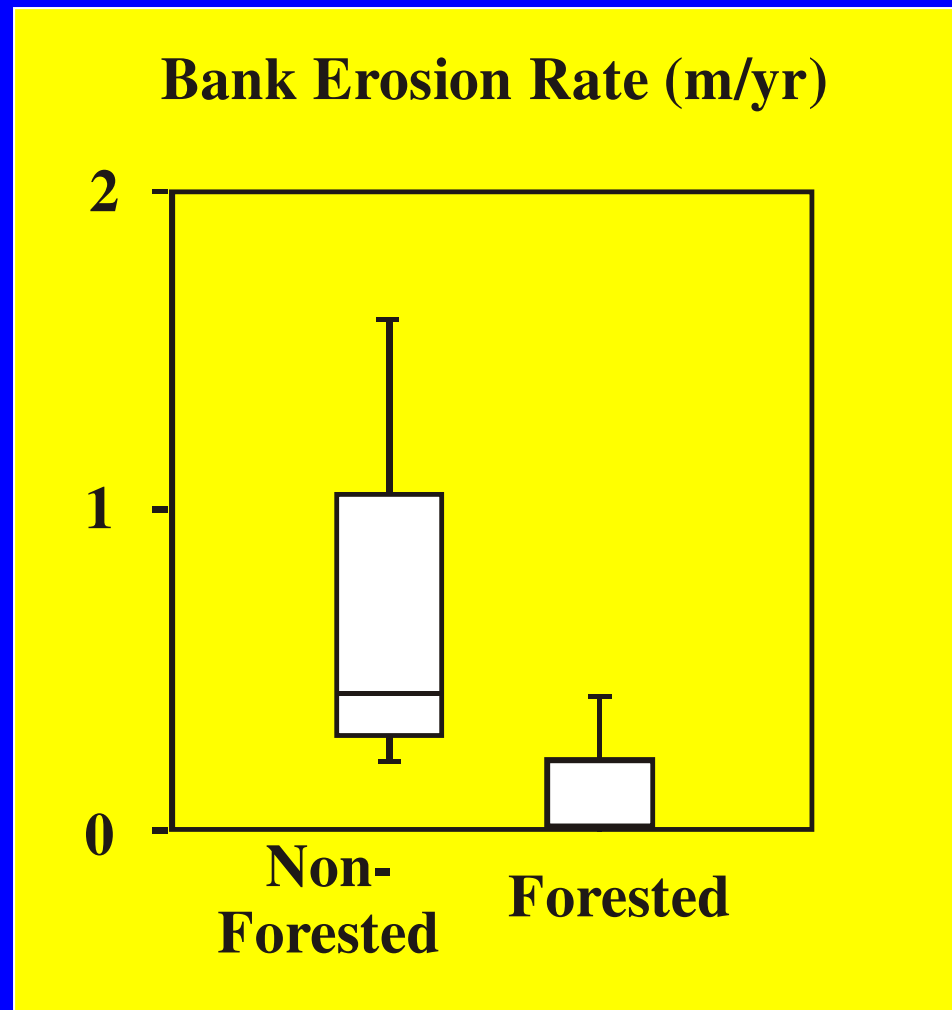
Eroding Ag. Age floodplain



Typical Rates of Lateral Migration

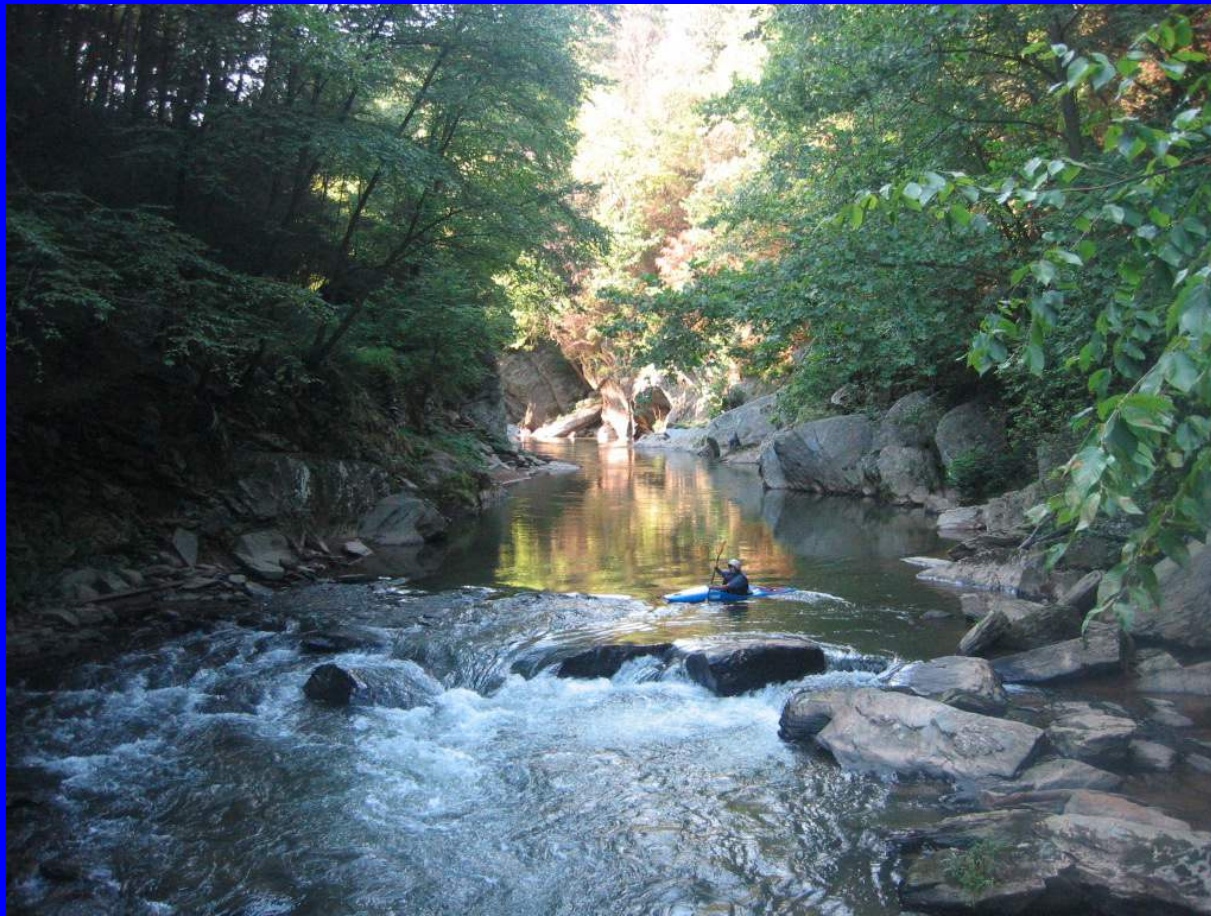
- These control rates of erosion of the Agricultural Age Floodplain!

Trees Reduce Bank Erosion Rates on East Coast Streams!

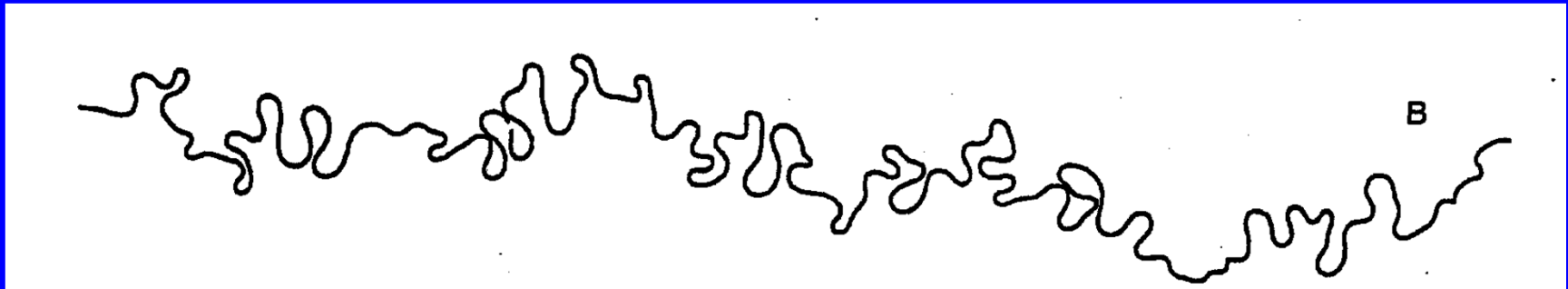


Source:
Allmendinger
et al., in review

Bedrock Reduces Lateral and Vertical Erosion Rates...



Free Meandering Planform Morphology From a Numerical Model



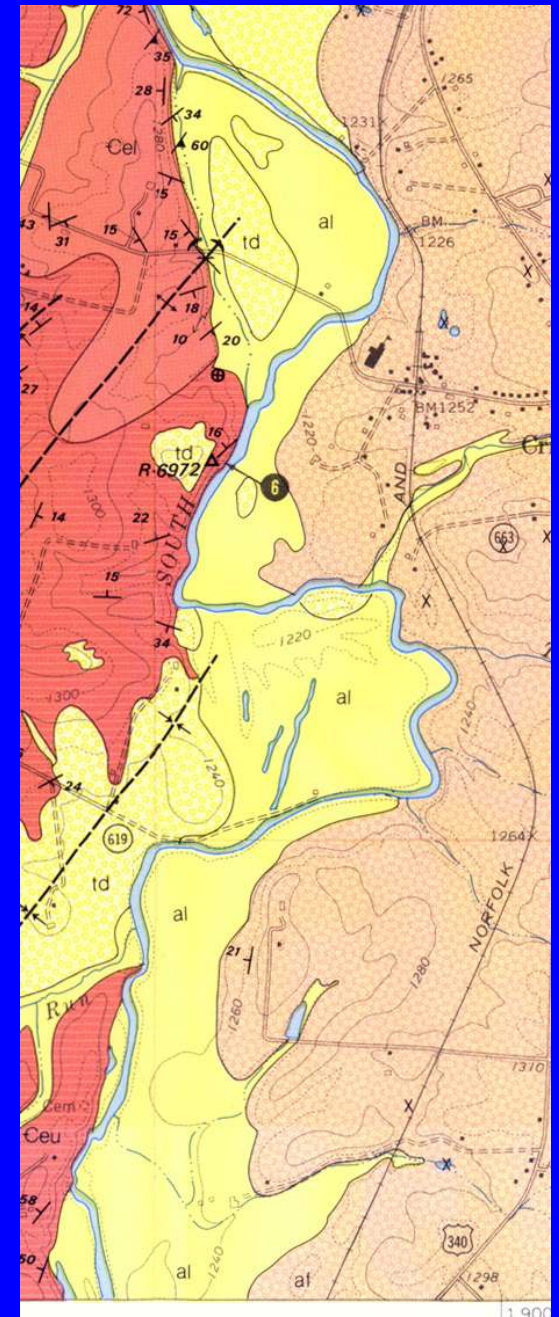
Note highly sinuous, characteristic “looping” morphology

Source: Stolum, 1998

Closeup of S. River, Crimora Quad

A meandering tendency, but
“constrained” by bedrock,
forested banks, and thick, cohesive
Agricultural Age floodplains

A typical E. coast stream channel.



SUMMARY OF REGIONAL STREAM CHARACTERISTICS

- Rapid floodplain alluviation during late 1800s and early 1900s
- These deposits are no longer forming, and are now eroding, providing sources of fine-grained sediments.
- Currently forming floodplains are lower in elevation and composed of sand and gravel.

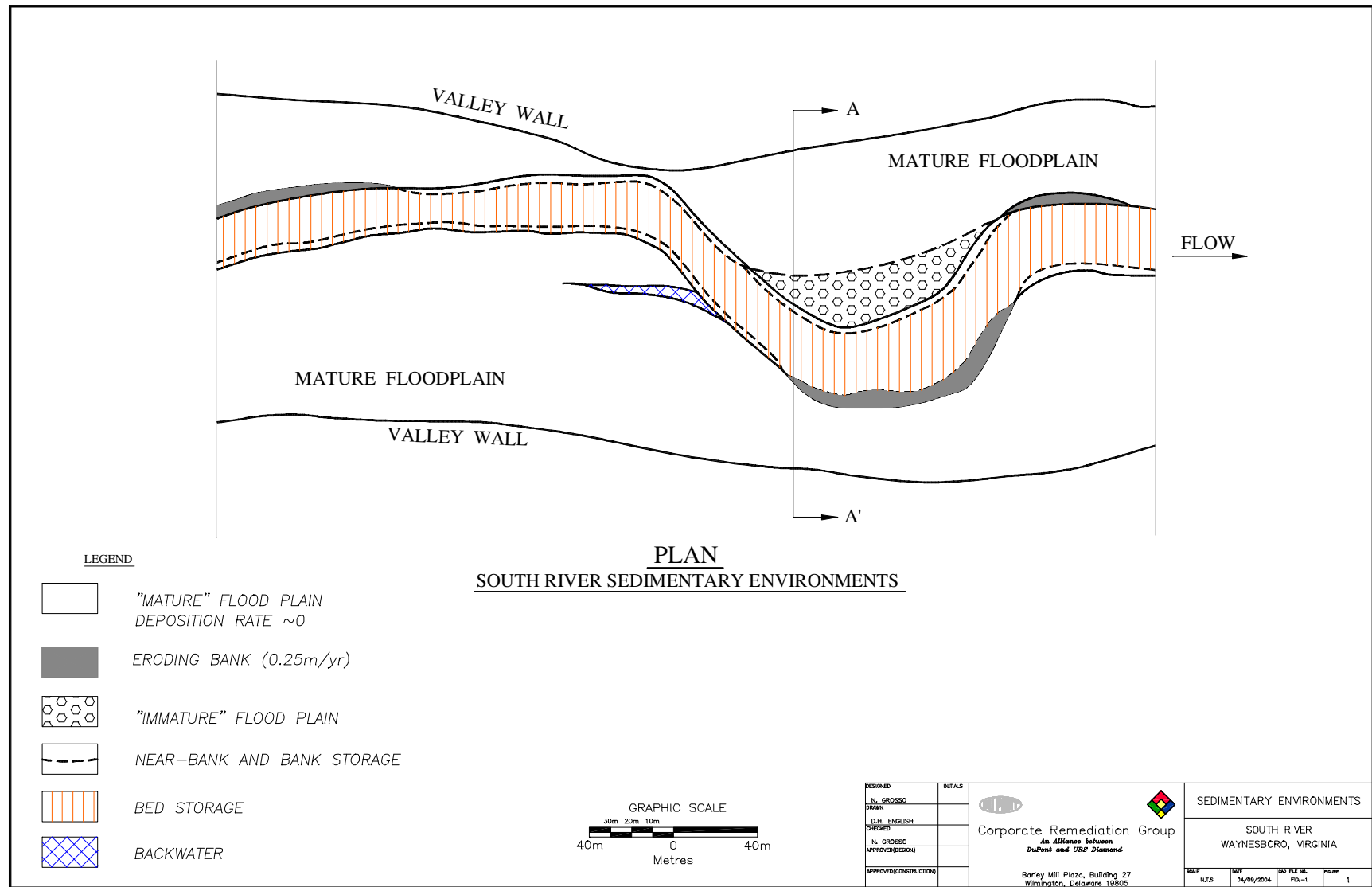
SUMMARY OF REGIONAL STREAM CHARACTERISTICS, cont'd

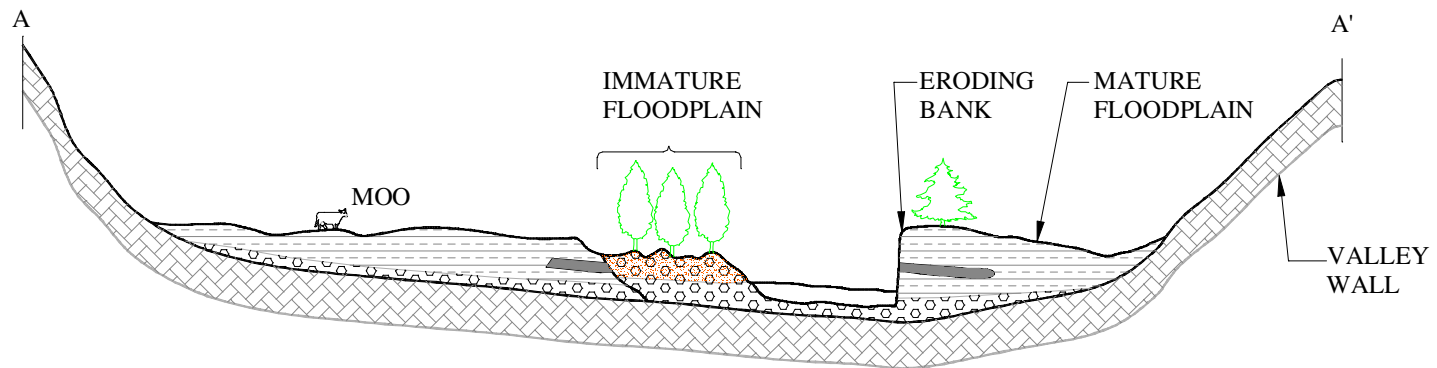
- Bend migration rates average about 20 cm/yr, but are strongly influenced by trees and bedrock
- Planforms are sinuous rather than freely meandering
- Lateral migration constrained by bedrock and forested, cohesive banks

Observations of S. River below Waynesboro, VA

- Characteristic landforms and deposits
- Sediment and Hg budget implications

Characteristic Landforms and Deposits of S. R.



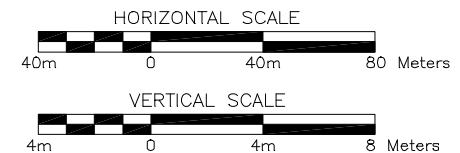


ILLUSTRATIVE CROSS SECTION

LEGEND

-  BEDROCK
-  GRAVEL
-  SAND
-  SILT (50% SILT,
30% SAND, 20% CLAY)
-  PRE-SETTLEMENT PALEOSOL

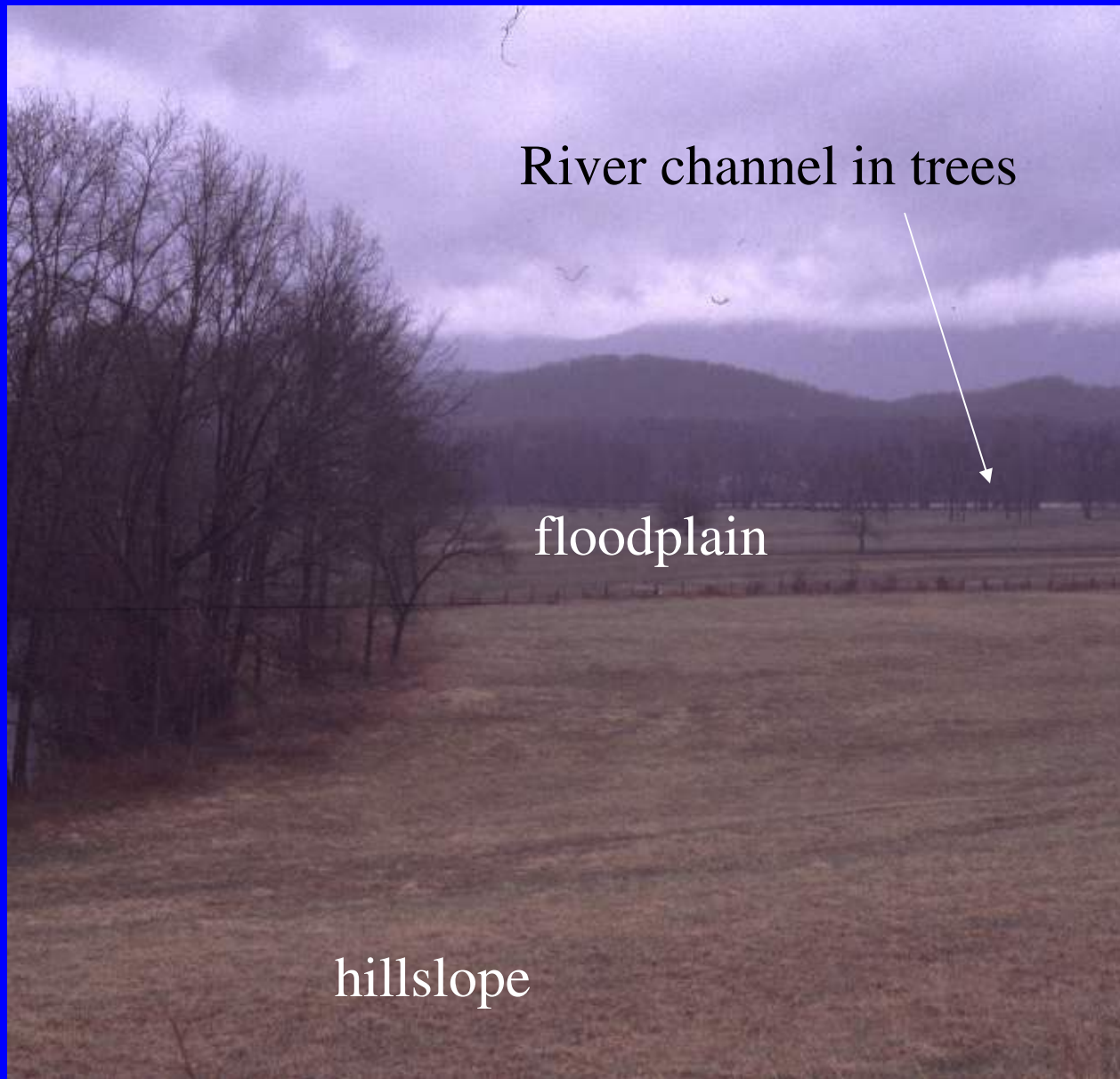
10X VERTICAL EXAGGERATION



DESIGNED N. GROSSO	INITIALS	 Corporate Remediation Group <i>An Alliance between</i> <i>DuPont and URS Diamond</i>	CROSS SECTION A-A'			
DRAWN D.H. ENGLISH			SOUTH RIVER			
CHECKED N. GROSSO			WAYNESBORO, VIRGINIA			
APPROVED (DESIGN) N. GROSSO			SCALE	DATE	DWG FILE NO.	FIGURE
APPROVED (CONSTRUCTION)			N.T.S.	04/08/2004	FIG.-2	2

Barley Mill Plaza, Building 27
Wilmington, Delaware 19805

Floodplain View



River channel in trees

floodplain

hillslope

Eroding Ag. Age Floodplain near Waynesboro

Possible
Buried pre-
settlement
soil?



Agricultural and “Recent” Floodplains

“Recent” sandy
floodplain

Eroding fine-grained
Agricultural
Age floodplain



“Recent” Floodplain

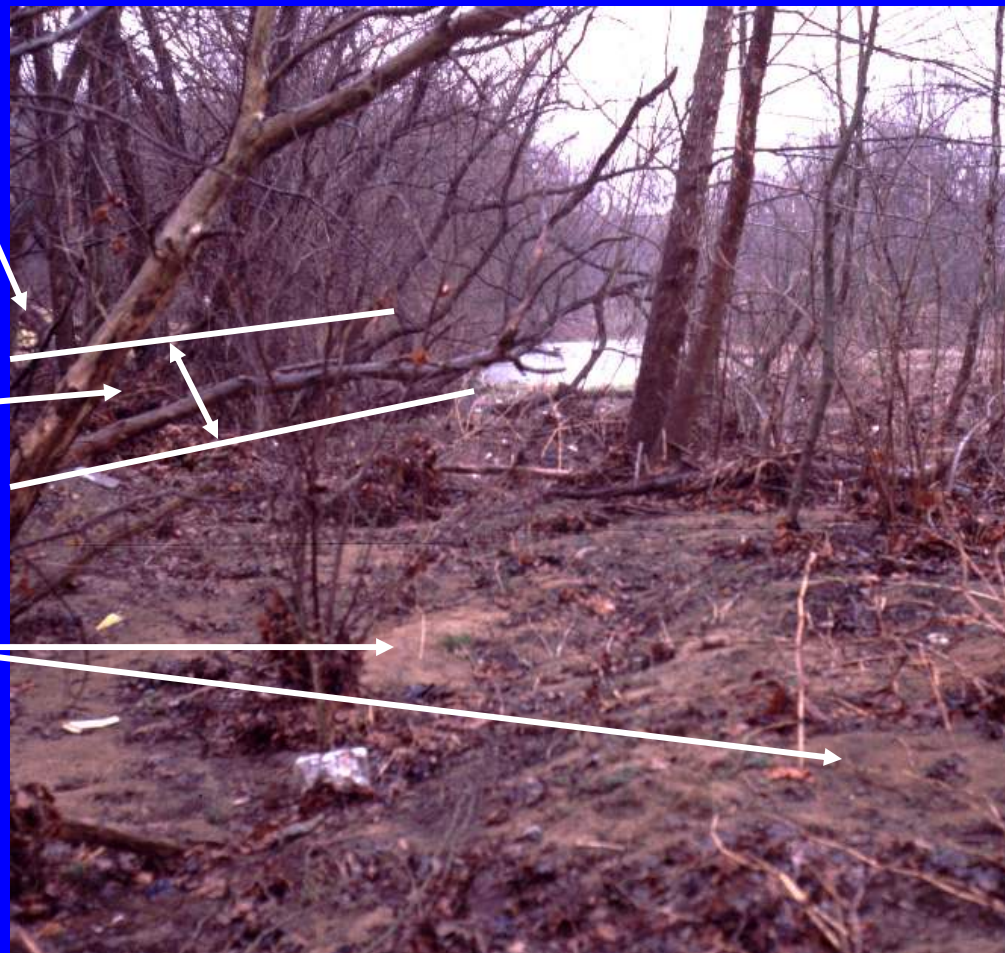


Sandy deposition on “recent floodplain”

“Older”
Floodplain

scarp

New sand
deposits



Stream Bed



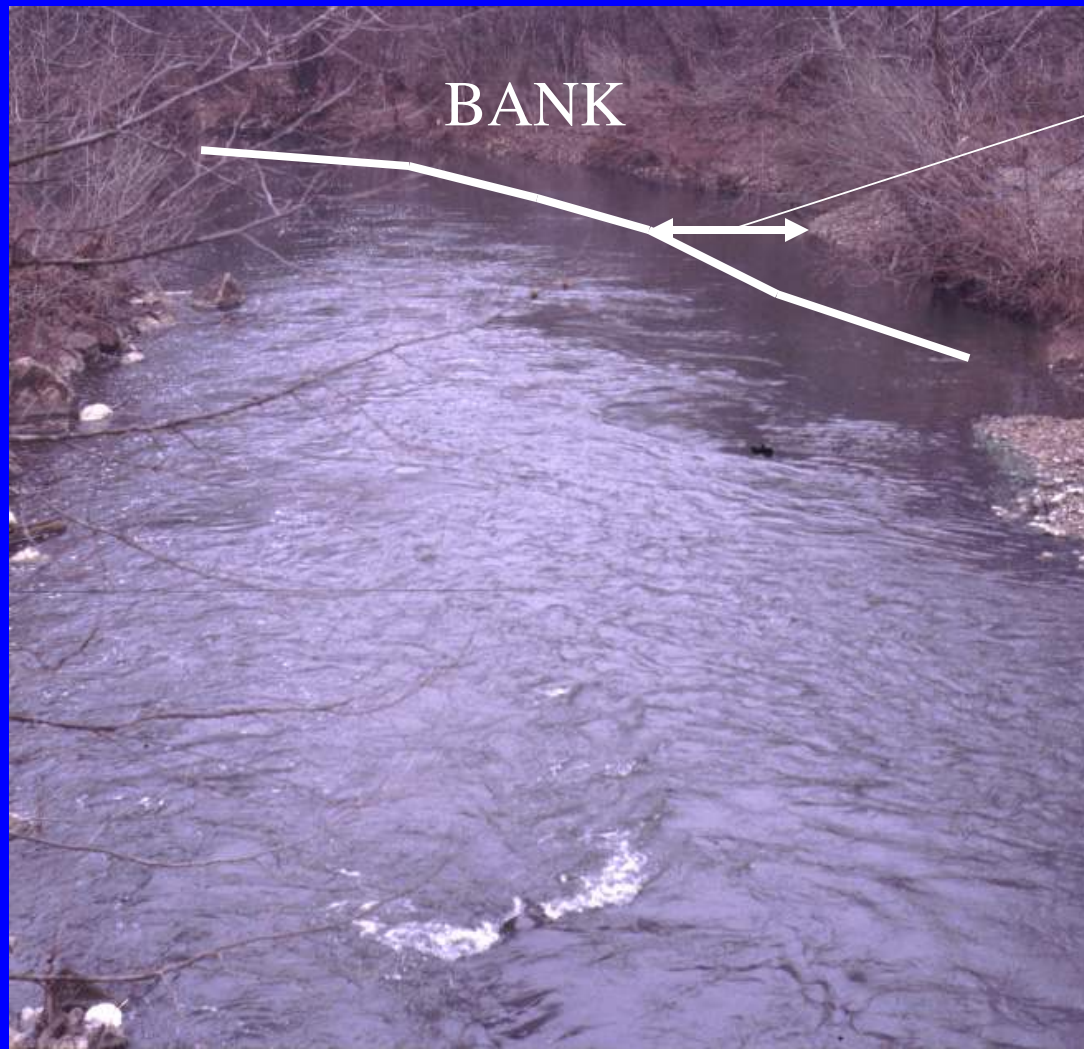
Stream Bed Cobbles



Stream Bed

- Mostly composed of gravel (> 2 mm diameter) with significant quantities of sand
- Bed probably “in motion” only a few times per year
- Fine-grained sediment (silt and clay) stored in pores between gravel and sand
- Volume of storage $\sim 10\%$ of annual mud transport ?? (estimate from only 1 study)
- Residence time ~ 1 year (?) (poorly known)

“Near-Bank” and Bank Storage – significance poorly documented!



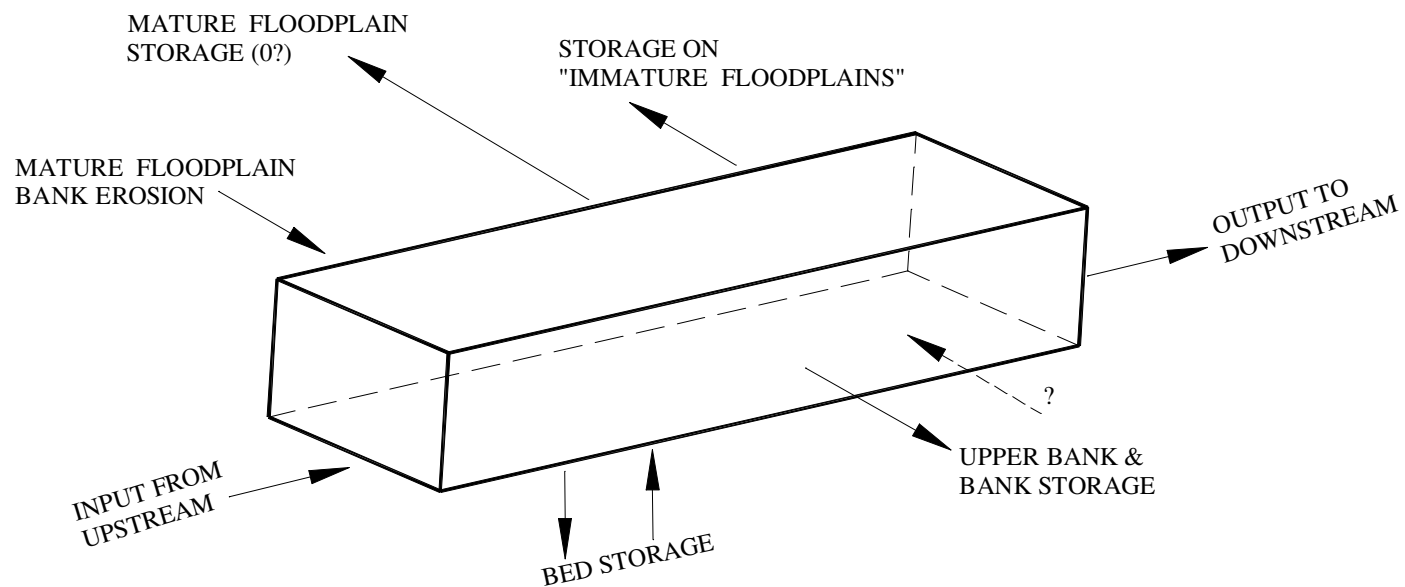
Backwater Areas



“Back of the Envelope” Sediment Budget

- 5 km reach downstream of Waynesboro
- For a “typical” year...
- Ignores backwater areas (need survey data)
- This is an example only, based on many untested assumptions!!

ANNUAL WATER COLUMN SEDIMENT BUDGET FOR SILT AND CLAY



DESIGNED	INTSLS	 Corporate Remediation Group <i>An Alliance between</i> <i>DuPont and URS Diamond</i>	WATER COLUMN SEDIMENT FOR SILT & CLAY		
DRAWN			SOUTH RIVER WAYNESBORO, VIRGINIA		
CHECKED					
APPROVED (DESIGN)					
APPROVED (CONSTRUCTION)			SCALE	DATE	FIG. NO.
		Barley Mill Plaza, Building 27 Wilmington, Delaware 19805	N.T.S.	04/09/2004	FIG.-3
					PAGE 3

Some ‘Reasonable’ Constants

Length of reach (km)				5
Channel width (m)				20
Mature Floodplain Height Above Riverbottom (m)				2
Immature Floodplain Height (m)				1.5
Sediment bulk density (kg/cu. m)				1800

MATURE FLOODPLAIN STORAGE ? 0?

MATURE FLOODPLAIN BANK EROSION	
% of reach with eroding banks	10
Annual erosion rate (m/yr)	0.25
% silt-clay	50
TOTAL (kg)	2.25E+05

IMMATURE FLOODPLAIN STORAGE	
% of reach with immature floodplains	5
Lateral growth rate	0.25
% silt-clay	10
TOTAL (kg)	1.69E+04

INPUT FROM UPSTREAM	
2.72E+06 kg/yr (from L,M, and S)	

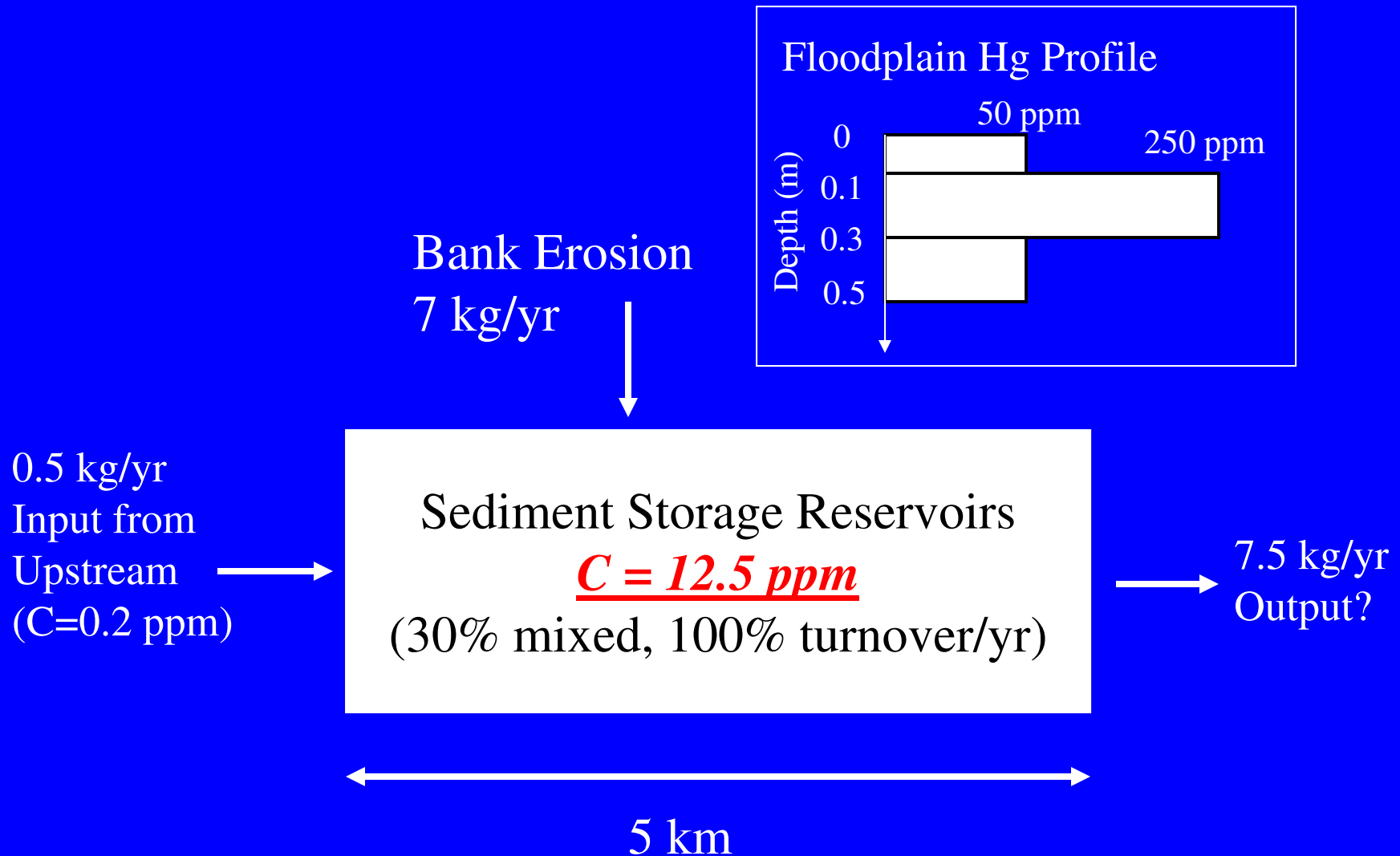
WATER COLUMN CONTROL VOLUME

OUTPUT

BED STORAGE	
Thickness of active bed (m)	0.2
% silt-clay in bed	5
TOTAL (kg)	1.80E+06

NEAR-BANK STORAGE	
Thickness (m)	0.1
Width of Deposit	0.3
TOTAL (kg)	2.70E+05

SIMPLE SEDIMENT-RELATED ANNUAL Hg BUDGET



FUTURE WORK TO BETTER UNDERSTAND SEDIMENT AND SEDIMENT-RELATED Hg BUDGETS

- Quantify Bank Erosion Rates
- Improve estimates of sediment input rates from upstream
- Map Present Distribution of Alluvial Landforms
- Map Alluvial Landforms ca. 1950
- Measure Selected Floodplain Deposition Rates
- Estimate Cycling of Fine-Grained Sediment in the Stream Bed

Quantify Bank Erosion Rates

- Map locations of eroding Agricultural Age floodplains
- Monitor bank erosion rates for 1 year (minimum) through on site surveying
- Use aerial photographs to determine longer term rates of erosion

Improve estimates of sediment input rates from upstream

- Analyze previous estimates
- Look in the literature for recent regression models developed for Chesapeake Bay watershed

Map Present Distribution of Alluvial Landforms

- Use field surveys and aerial photos
- When combined with dating and process rates, provides necessary data for sediment budgeting

Measure Selected Floodplain Deposition Rates

- Required for sediment budgeting!
- Dendrochronology and burial of trees
- Lead-210
- Mercury profiles provide additional constraints

Estimate Cycling of Fine-Grained Sediment (mud) in the Stream Bed

- Map extent of storage of mud in bed
- Monitor frequency and depth of scour using scour chains, marked particles, etc.

OBSERVATION

- Fine-grained sediment transport processes are poorly understood.
- Results of field studies such as those described above are required to provide the conceptual basis for modeling
- “The usual models” of river transport do not:
 - properly parameterize bank erosion
 - Do not typically utilize the best models of gravel/sand transport (only 1 in the literature, from 2003)

CONCLUSIONS

- Do not include exchange of fine-grained sediment with coarse grained alluvial stream beds!!!
- S. River appears to be similar in geomorphic character and history to other E. Coast gravel-bedded streams
- Geomorphic mapping and measurement of key rates of erosion, deposition, and transport provide the basis for budgets of fine-grained sediment and associated Hg.
- These studies will facilitate more accurate modeling of fine-grained transport processes.

Study Timeline for 25 km Reach

[illegible]