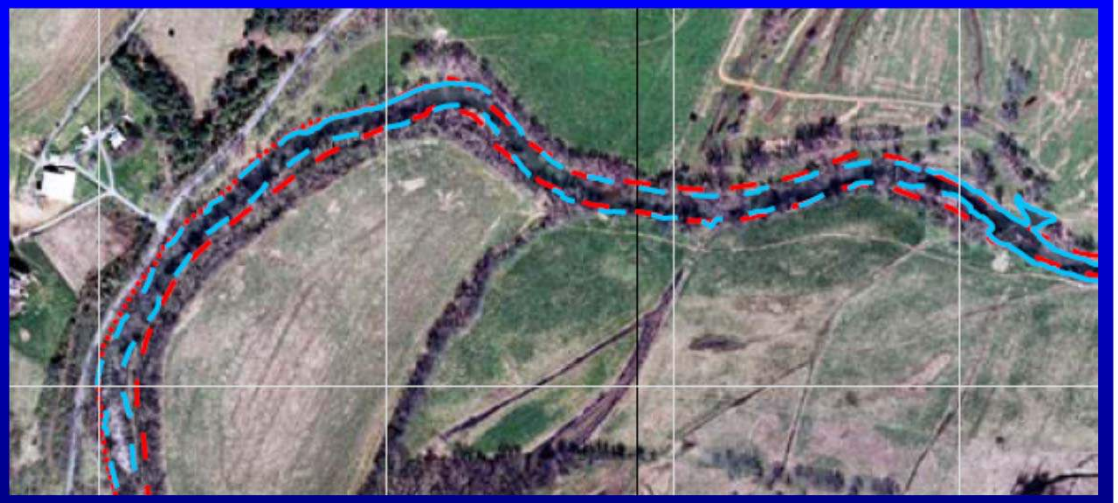
Geomorphology Update July 2006

- Channel bank migration and erosion, 1937-2005
  - Illustration of methods
- 5 Styles of bank erosion (1937-2005)
  - Typical patterns of channel change
- Final interpretation of Fine-Grained Channel Margin Deposit radiocarbon ages
- Summary of mud storage in Fine-Grained Channel Margin Deposits, Waynesboro-Port Republic
- Bed material size composition, upstream versus downstream
- Testing a simple box model of sediment-related Hg in the channel perimeter

Shoreline Changes 1937-2005

Entire study reach completed

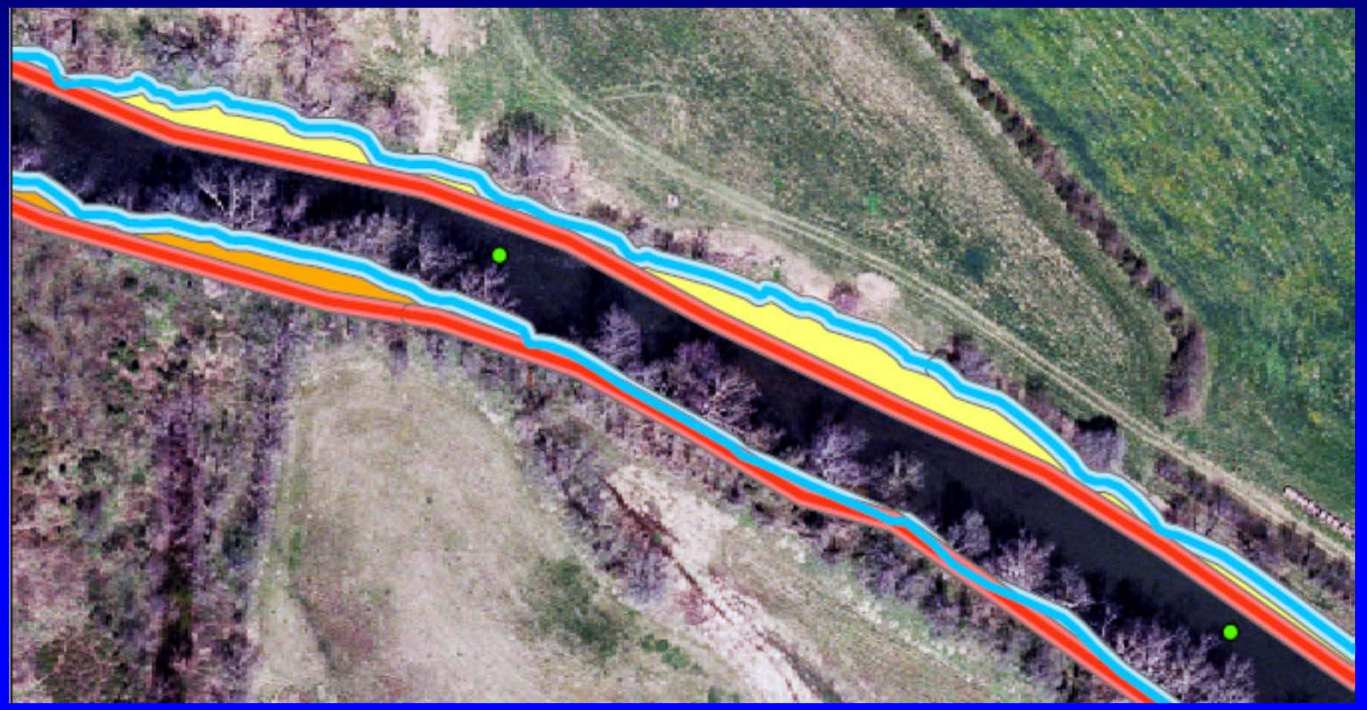


Erica L. Rhoades and Michael A. O'Neal
University of Delaware, 2006

The image displays the South River between Waynesboro and Port Republic, Virginia. Red and blue lines represent stream boundaries from 1937 and 2005, respectively. The 2005 Air Photo Base Map was used in this image.

The 1937 and 2005 shorelines were split using confidence levels 1-3, with 1 designating areas where the bank is clear and 2 designating unclear bank locations. Solid lines, dashed lines, and dotted lines represent confidence levels 1 thru 3, respectively.

Positional accuracy for the airphotos is ca. 1 m based on RMSE values from the rectification process. The stream boundaries shown in the map have this error compounded by that from landscape elements masking the water-land contact and poor photo quality. As a result of these errors, a subjective confidence level is assigned to the shoreline boundary indicated by different line types for errors of 0-2 meters (solid), 2-4 (dashed), and 4-6 (dotted).



0 40 80 160 240 Meters

Scale 1:5,000

NAD 1983, State Plane (North), FIPS 4501

The image above displays the South River (mile markers 10.6 and 10.7), with red and blue lines representing stream boundaries from 1937 and 2005, respectively. The 2005 Air Photo Base Map was used to display areas of erosion and accretion along the river. Areas of erosion are shown in yellow and areas of accretion are shown in orange. A buffer of 2 meters was placed around each stream boundary to include the errors involved in locating the bank.

1937 - 2005 Areas of Erosion and Accretion, South River, Virginia

Erica L. Rhoades and Michael A. O'Neal, University of Delaware, 2006

4 "Styles" of Bank Erosion (based on 1937-2005 aerial photographs)

1. No resolvable erosion
    1. Not uncommon
2. Small areas of erosion (caused by ??)
3. Classic bend migration
    1. Particularly where banks are not protected by bedrock, inerodible bank sediments, or riparian vegetation.
4. Erosion related to tributaries from Blue Ridge
    1. Confluence bars "push" flow into adjacent banks?
5. Island development
    1. Side channel formation, expansion, closure

SCALE 1 : 1,000

RRM: 2.12 - 2.19

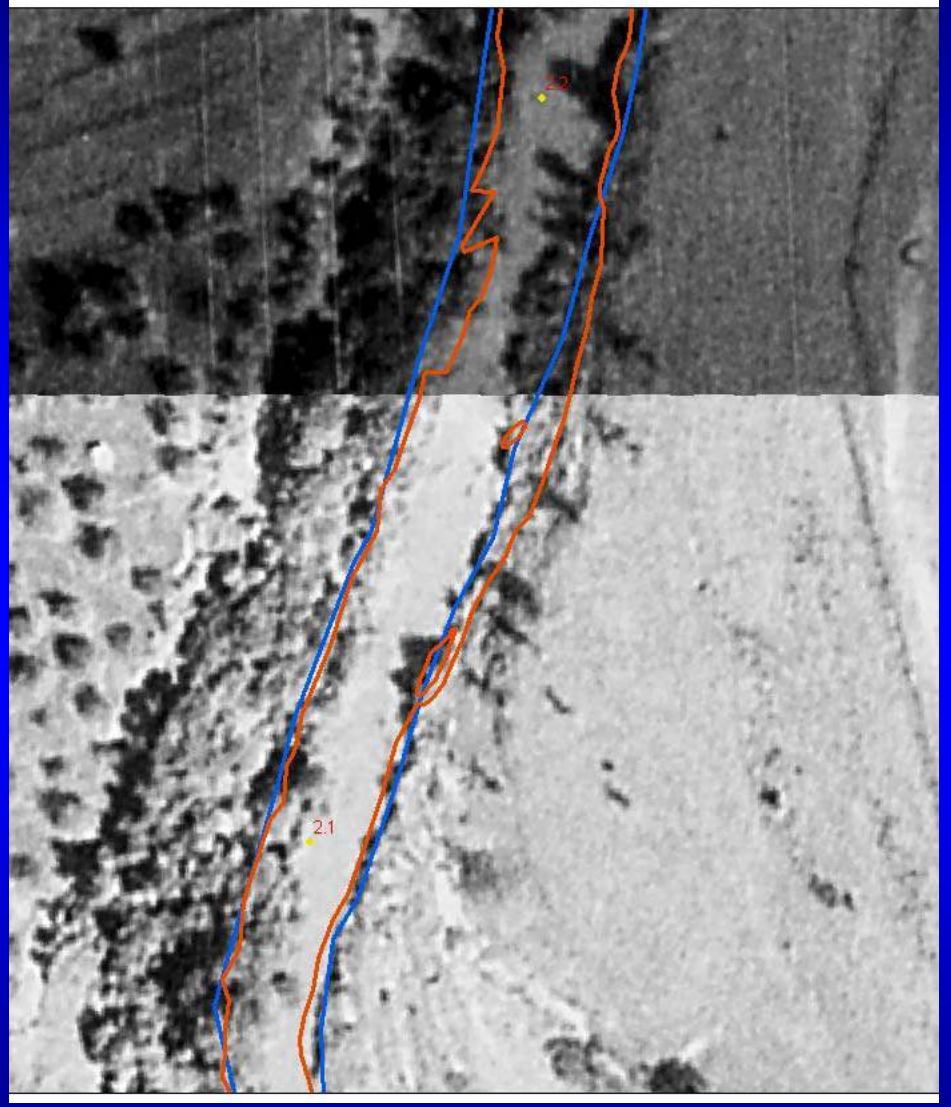
SHORELINE_1937

SHORELINE_2005

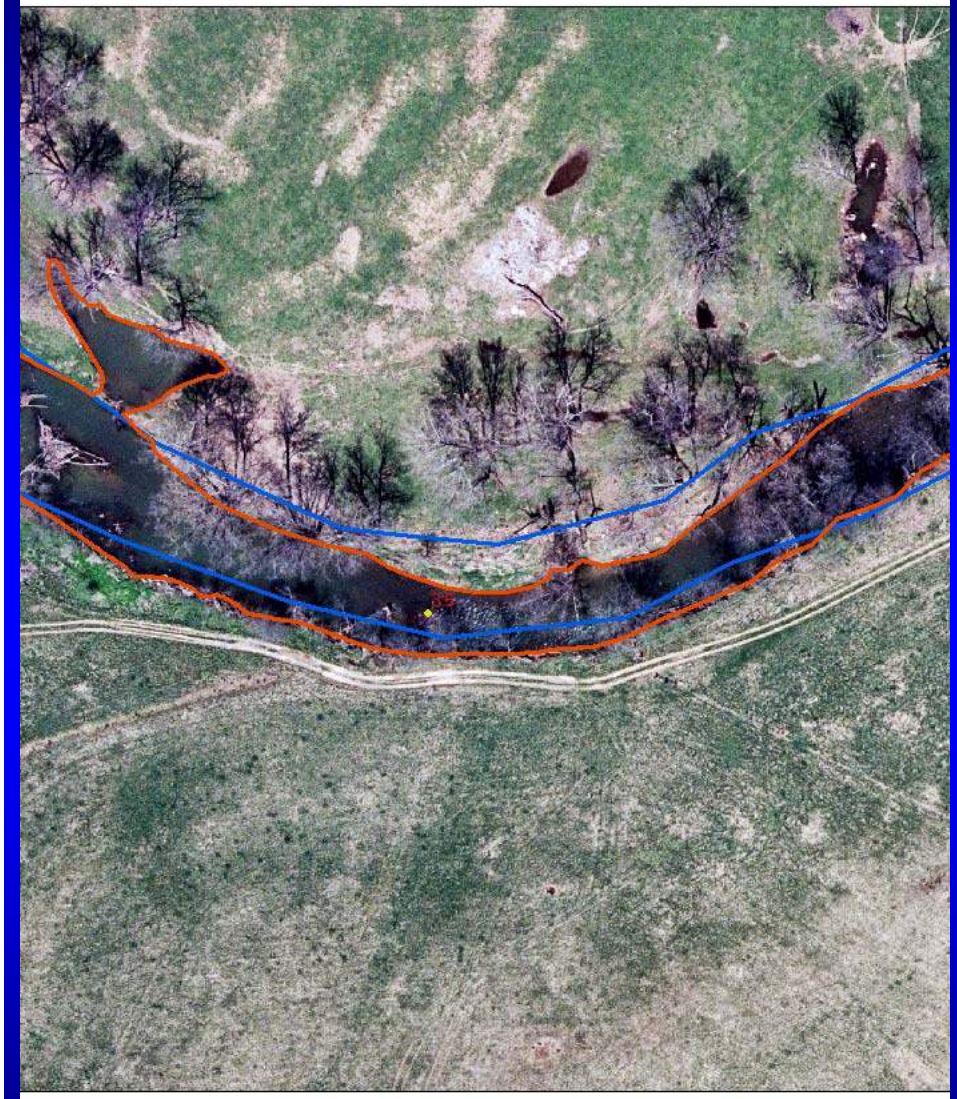
N

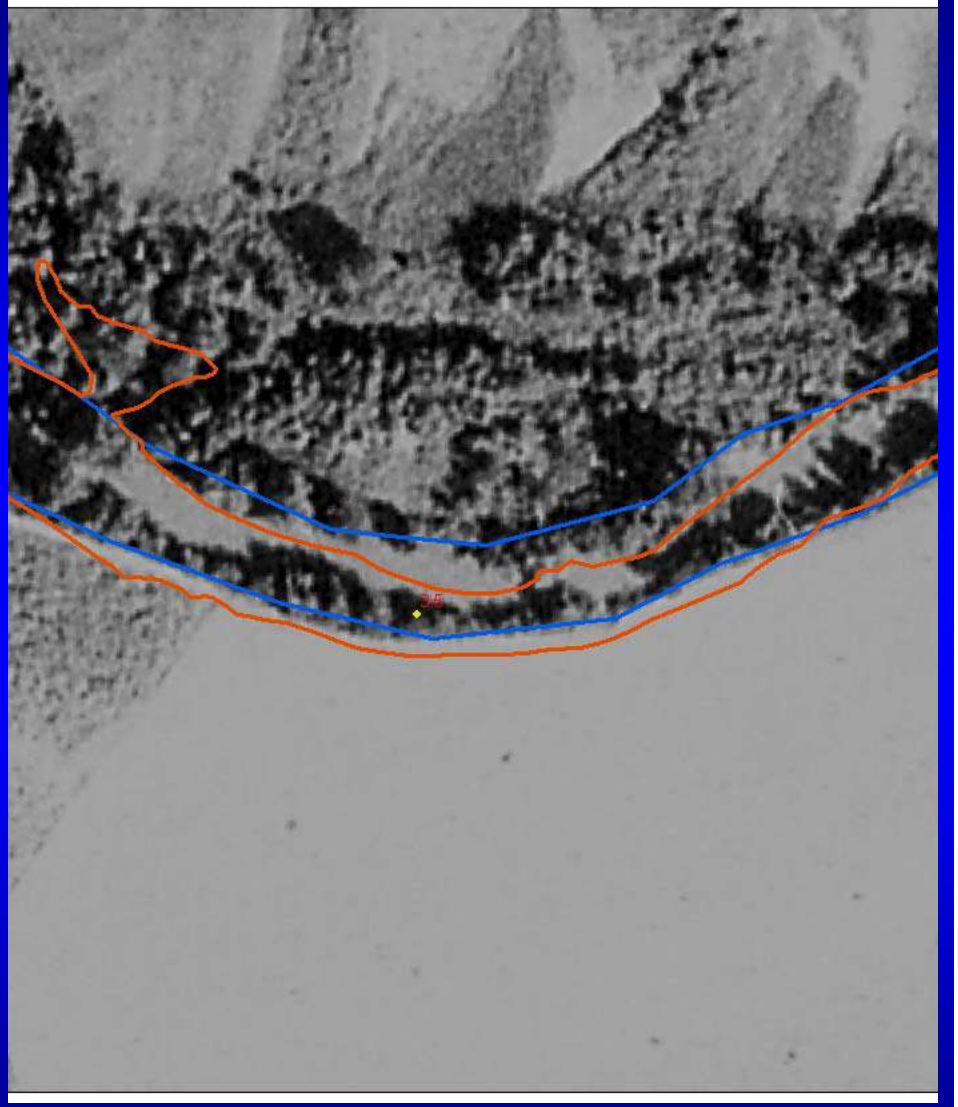
W E

S

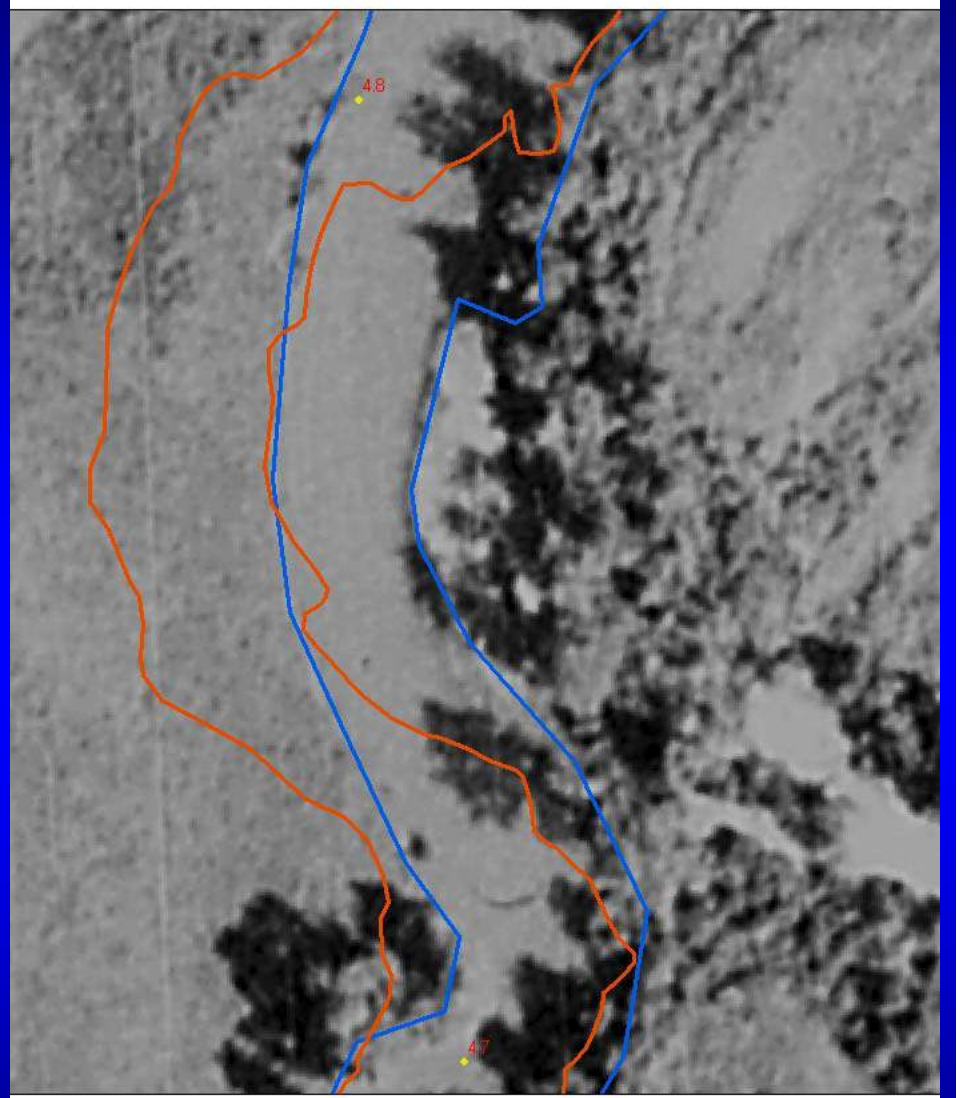


A “small area”…

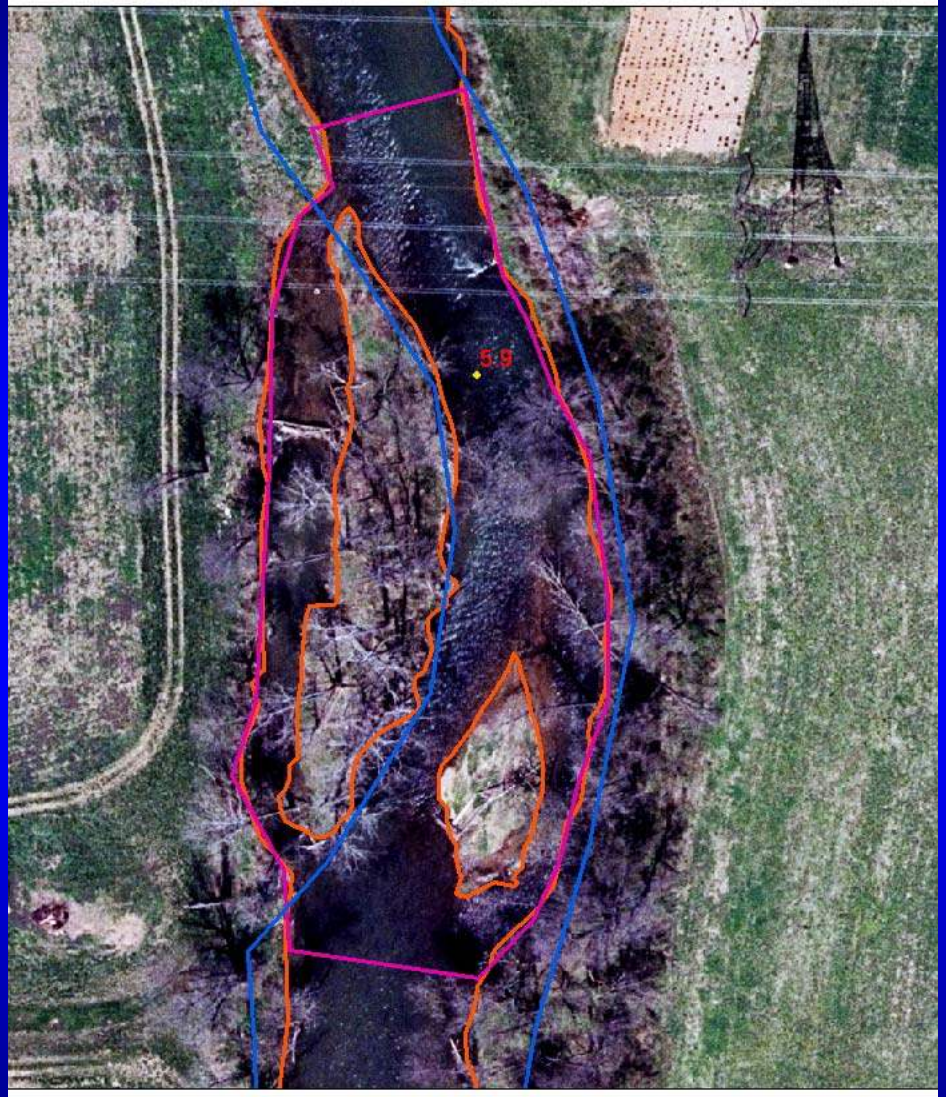


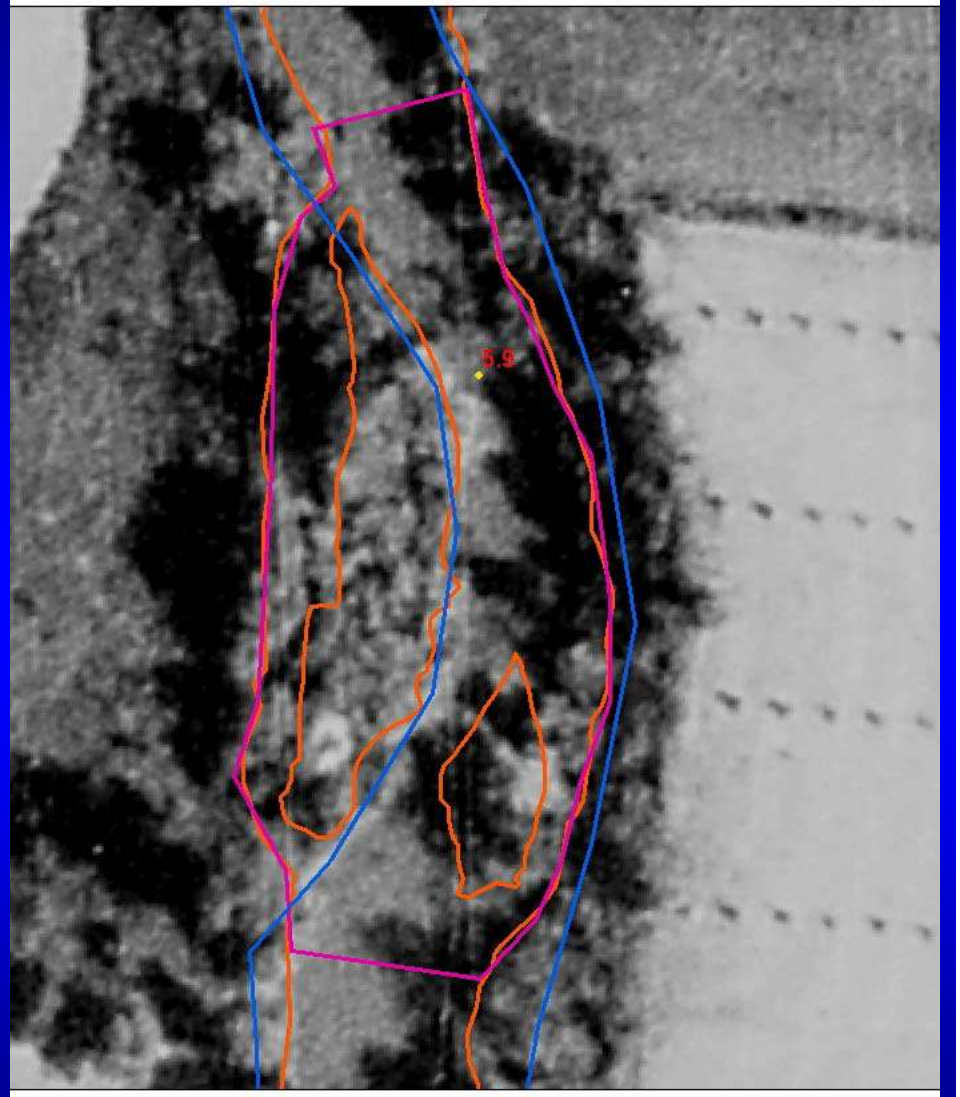


Classic bend migration (no bedrock Or large trees….)



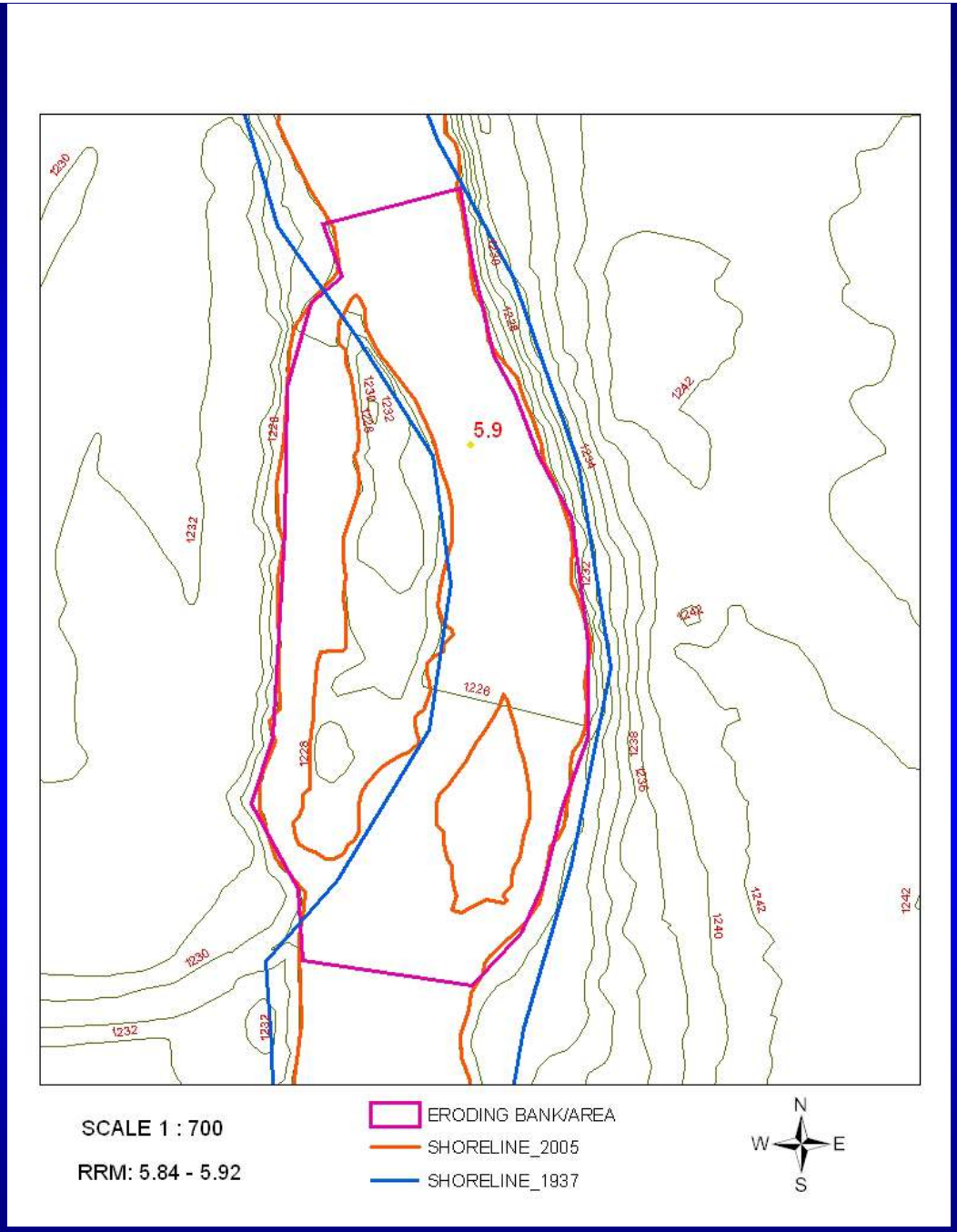
Tributary confluence
Sedimentation……

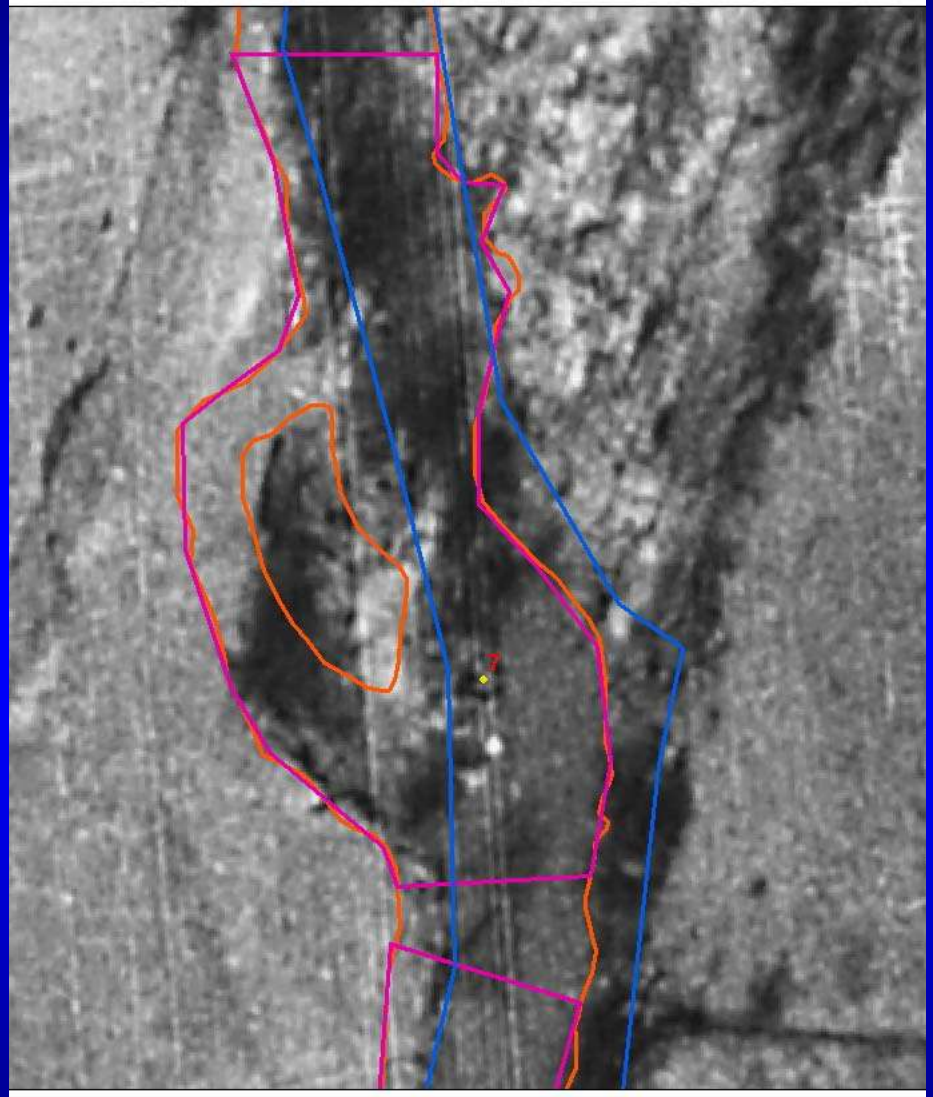




Island development

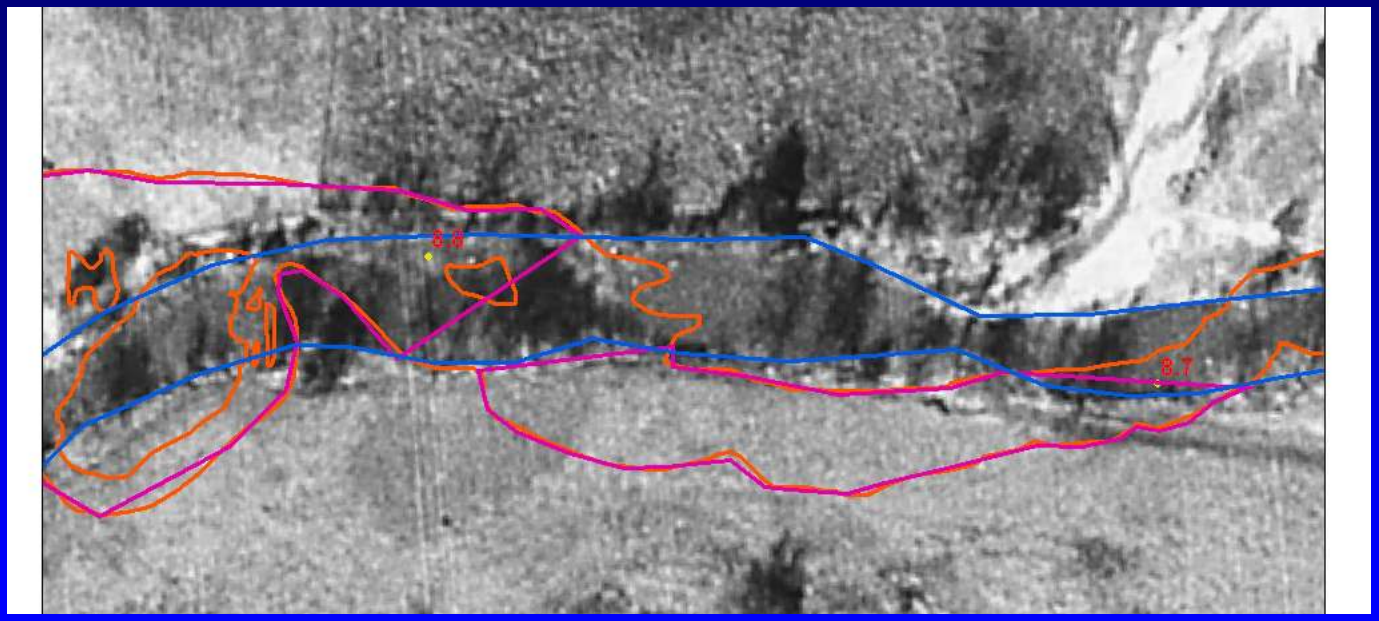
Side Channel Forms on Lower floodplain





Island development

Tributary Sedimen-tation



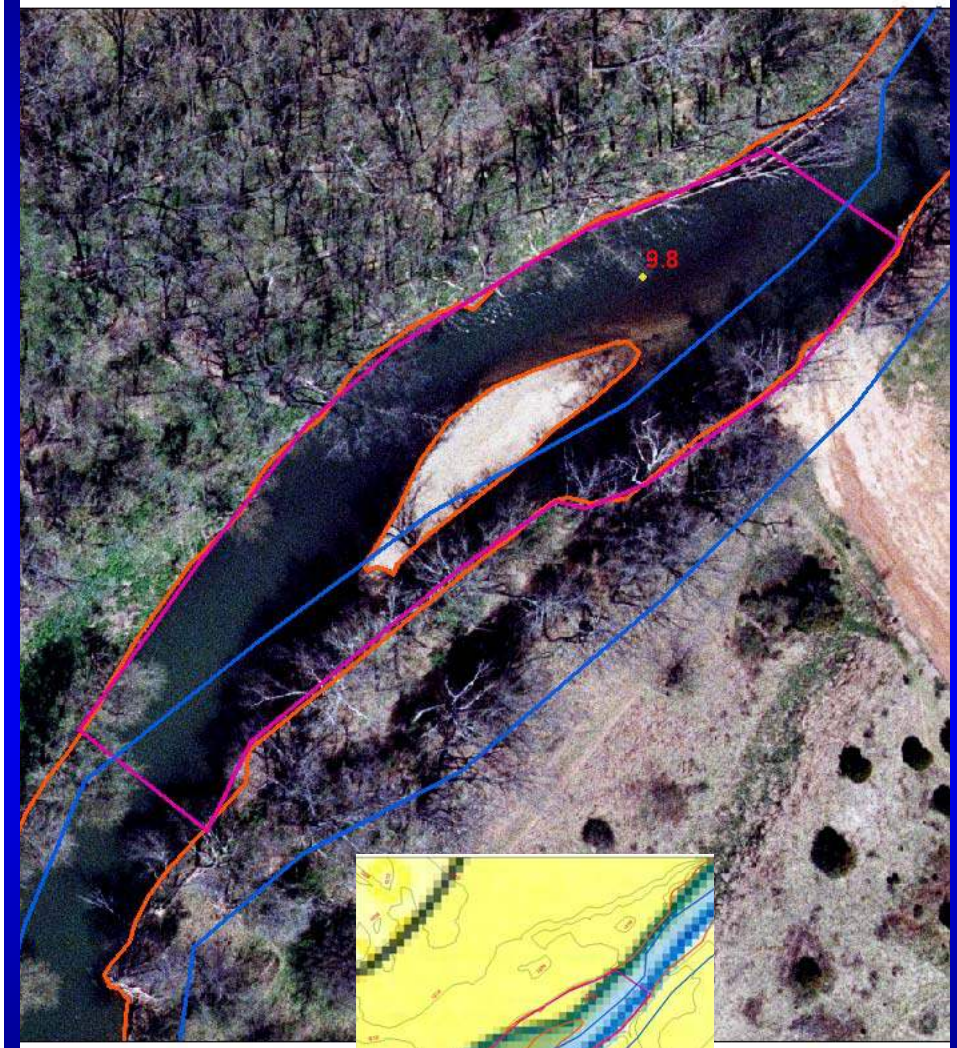
N
W E
S

ERODING BANK/AREA
SHORELINE_2005
SHORELINE_1937

SCALE 1 : 1000

RRM: 8.70 - 8.90

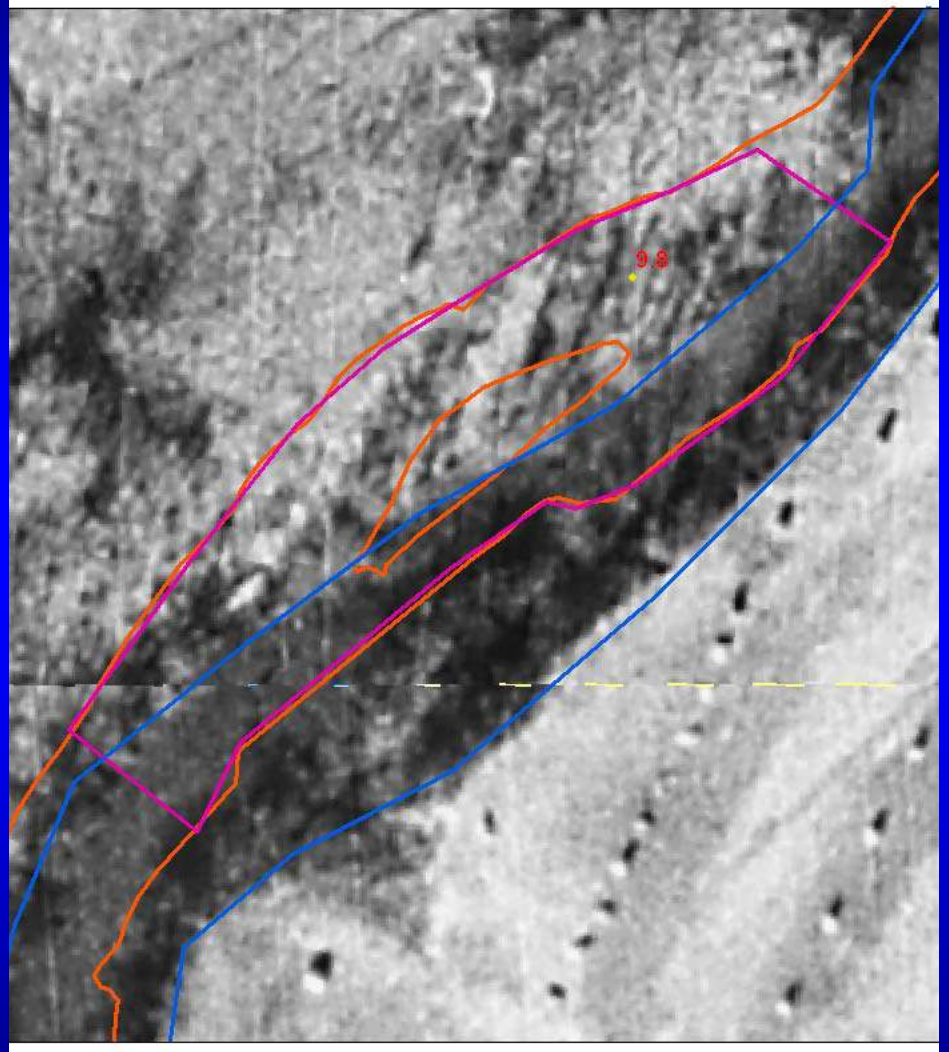
Classic bend migration, or related to dams and bridges, or..?



SCALE 1 : 700

RRM: 9.73 - 9.81

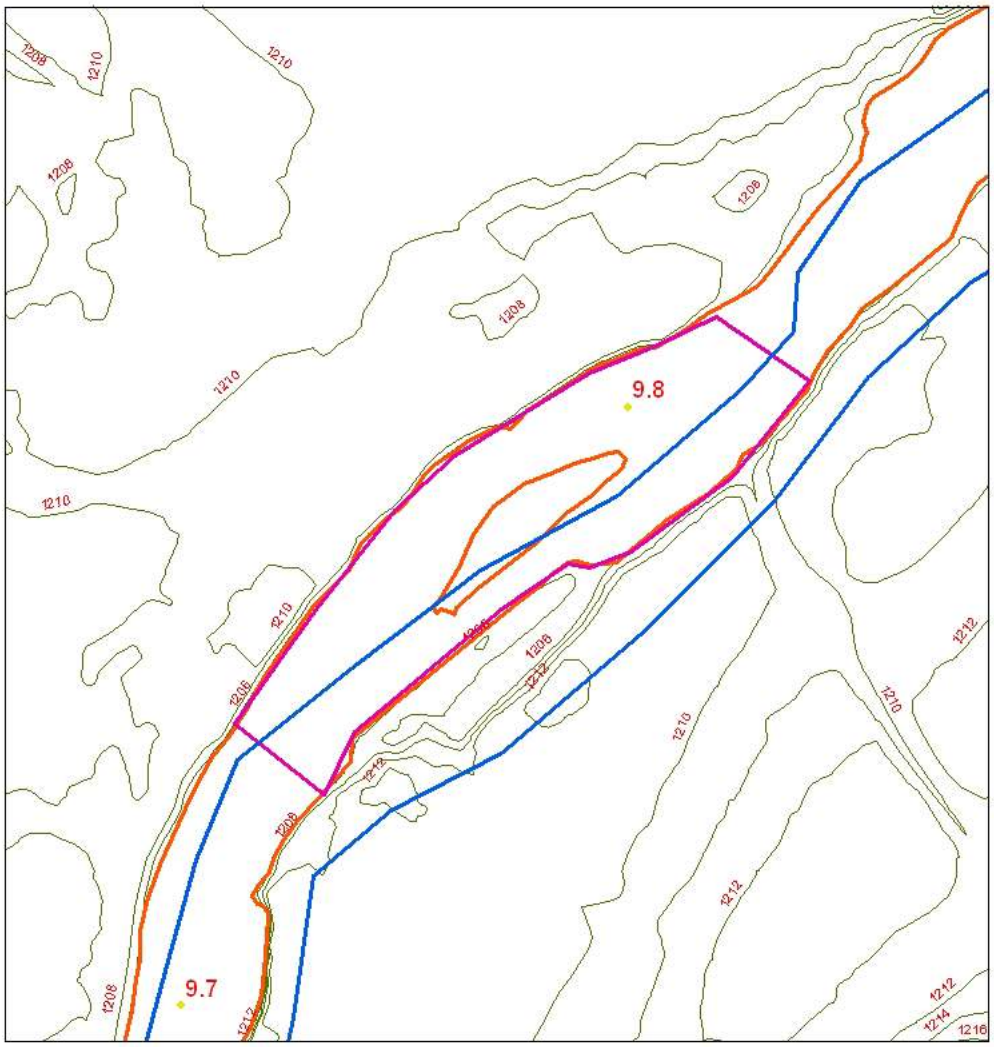
N
W E
S

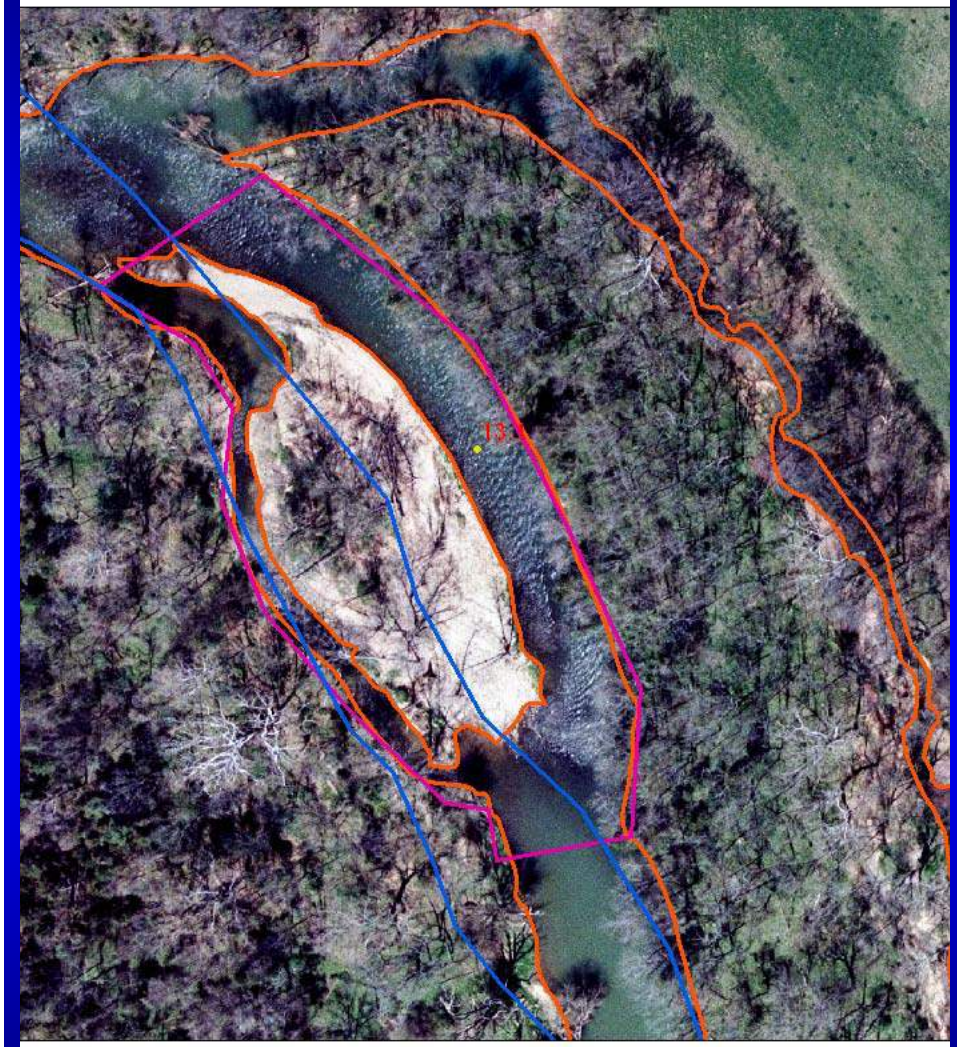


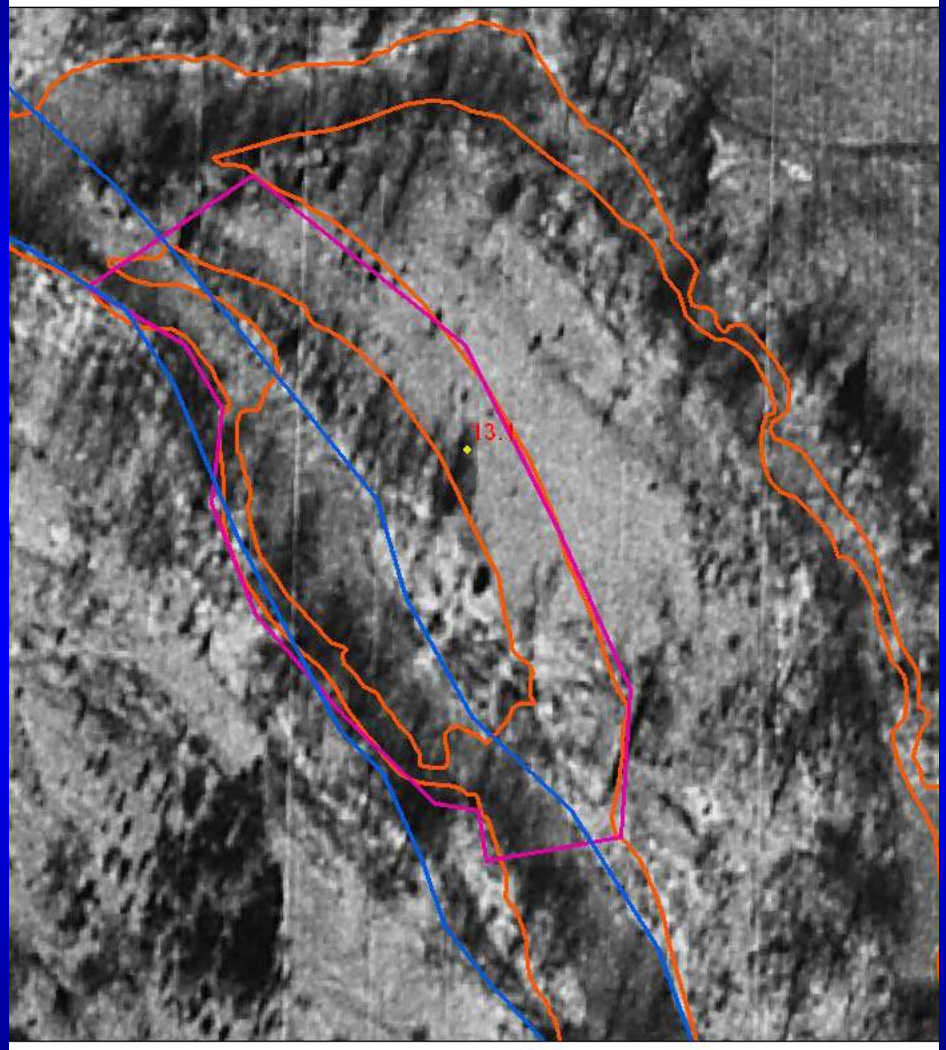
ERODING BANK/AREA
SHORELINE_2005
SHORELINE_1937

ALLUVIUM
TERRACE

Erosion Occurs On lower Side of floodplain

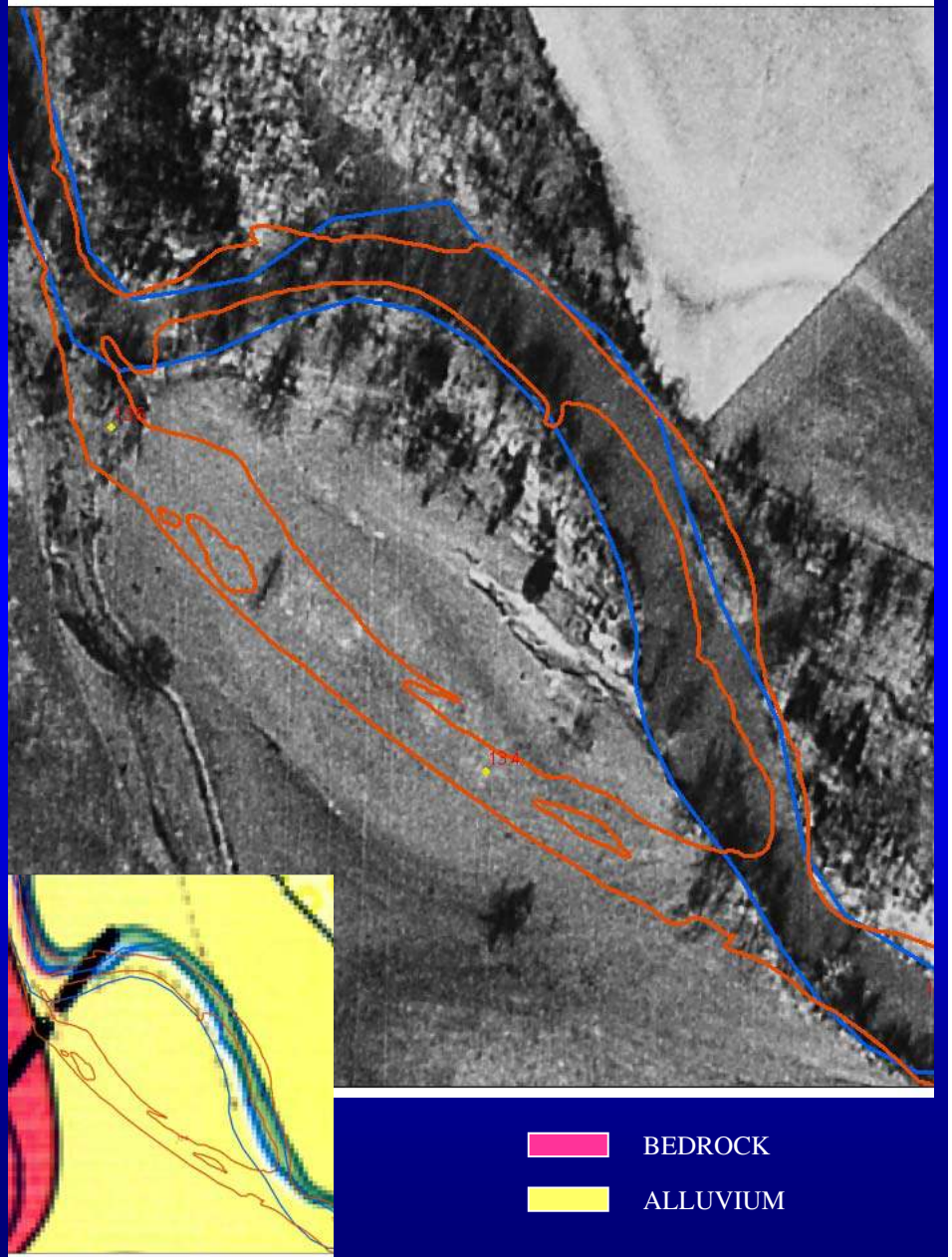




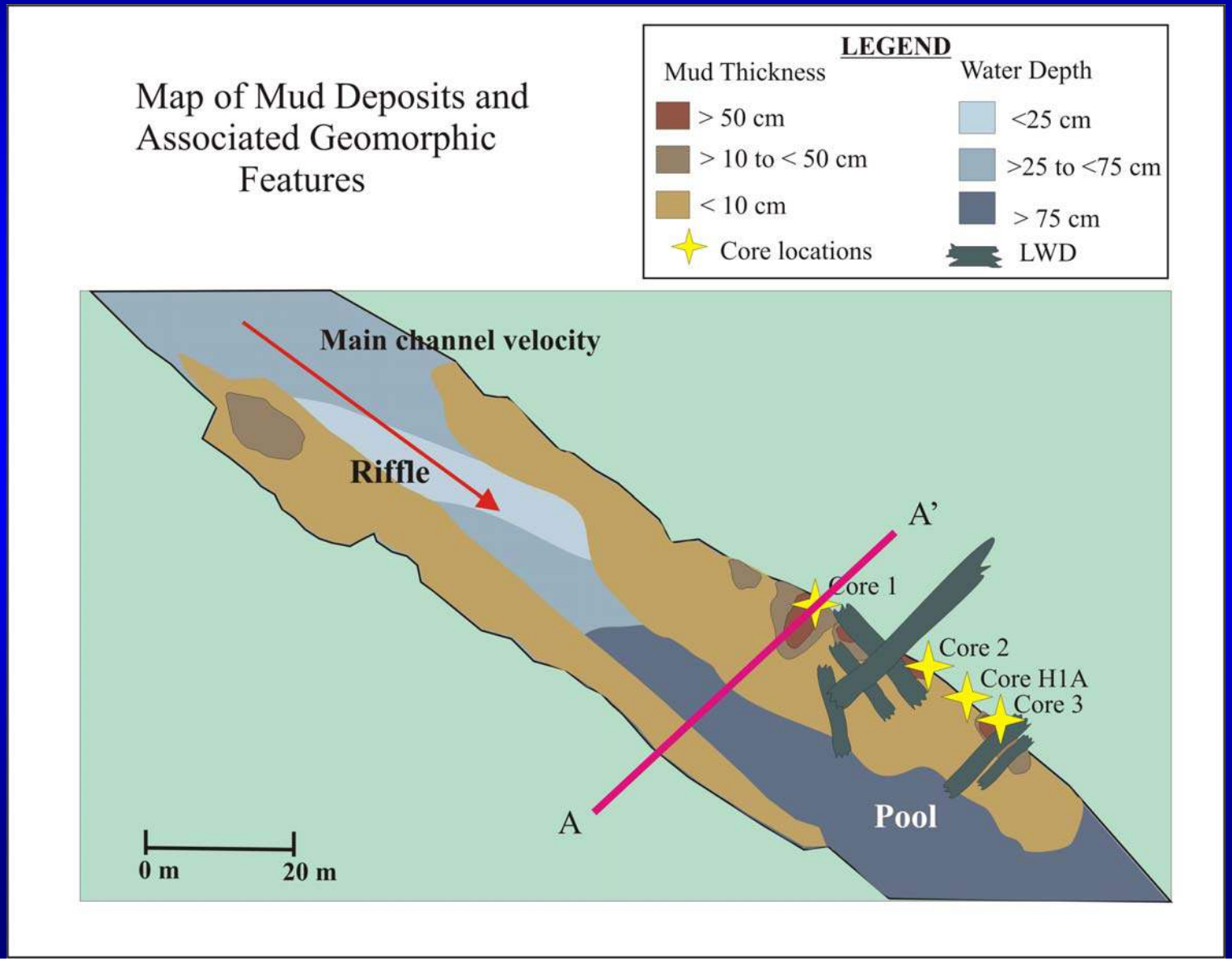


Island development

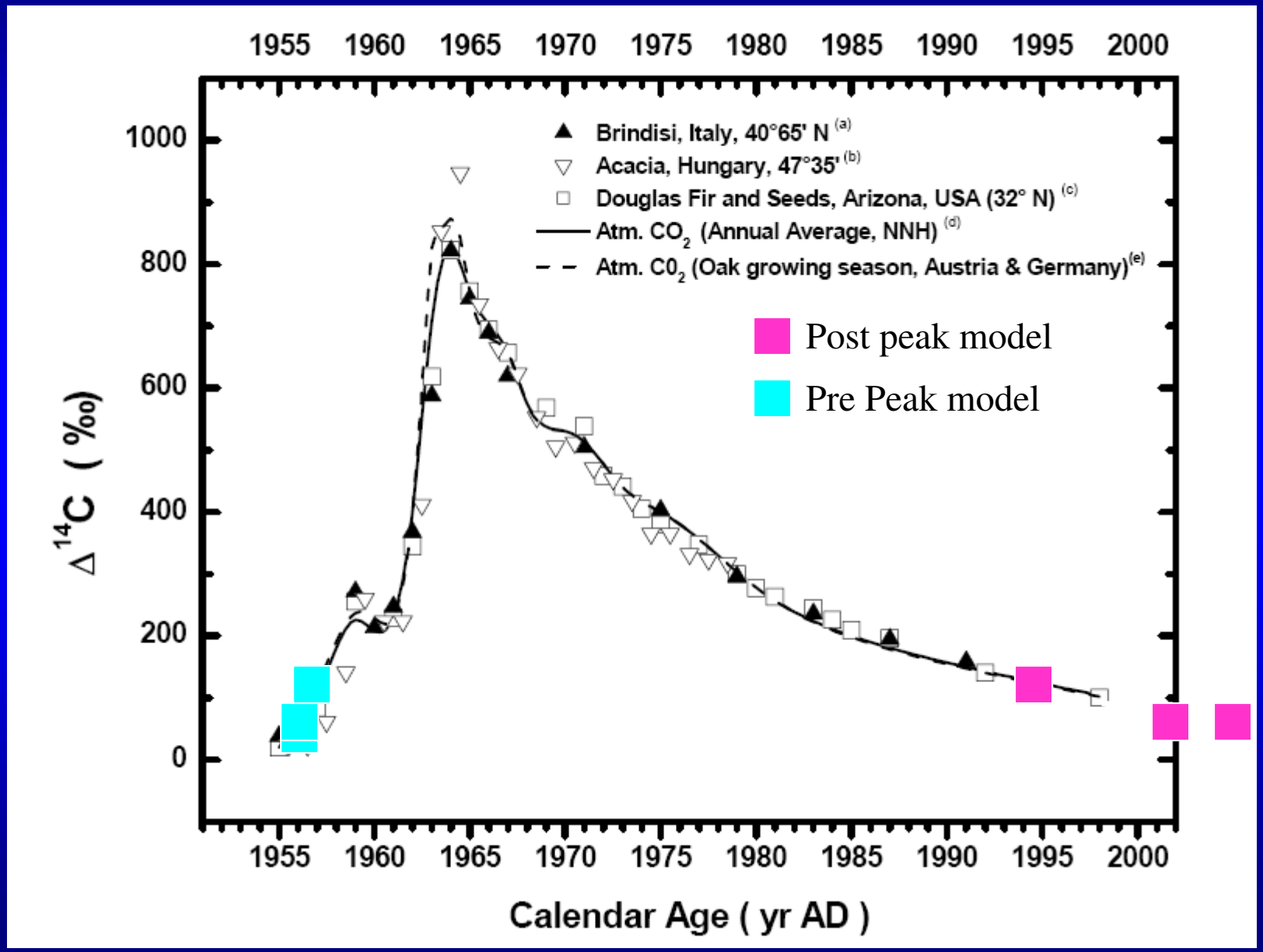
Island development



Map of Pool/Riffle Channel Margin Fine-Grained Deposit H1A (Core 1 – 600 ppm Hg at base)



Two Possible Ages for Bomb Radiocarbon Analyses



Why we prefer the younger ages…

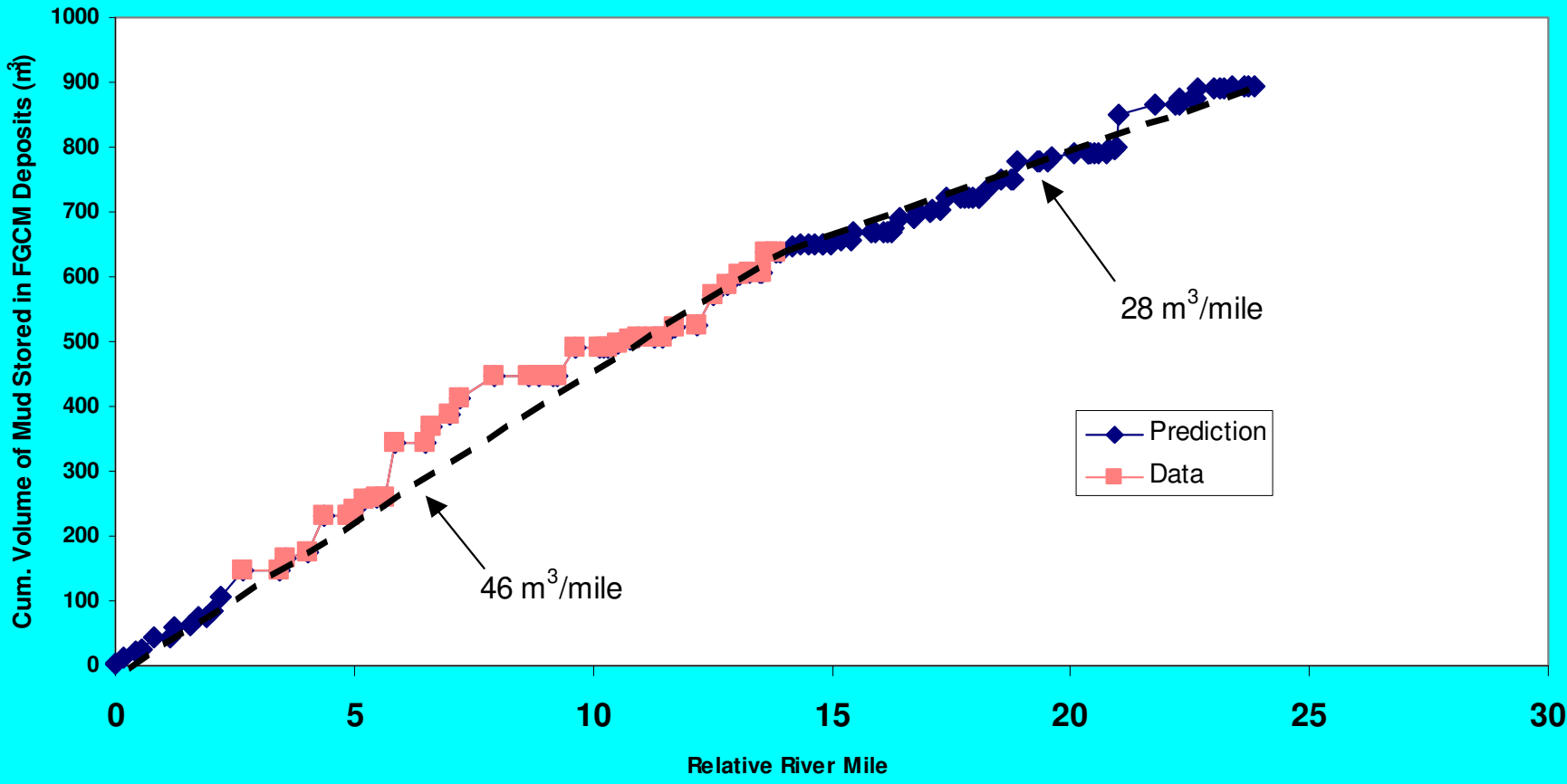
- Younger ages maintain stratigraphic superposition, with older deposits underlying younger deposits
- Deposit H2A is formed as a result of a bank obstruction in the form of a tree that is only 24 years old, inconsistent with an age of the deposit from the late 1950s.
- Ages in the late 1950s would require the uppermost few centimeters these deposits to have remained completely undisturbed by floods and other processes for more than 50 years, which we believe is very unlikely.
- The sediments are stratified and reflect deposition in place by the river, as opposed to mass slumping from nearby banks, etc.

24 year old tree (Silver Maple at Deposit H2A

Final Maximum ^{14}C Ages of Fine-Grained Channel Margin Deposits

Core	Age at Base (years)
Core 1	> 55
H1A	19
H2A	14
H2C	13
D5A	10
D7A	11

Final Estimate of Mud (silt and clay) stored in Fine-Grained Channel Margin Deposits

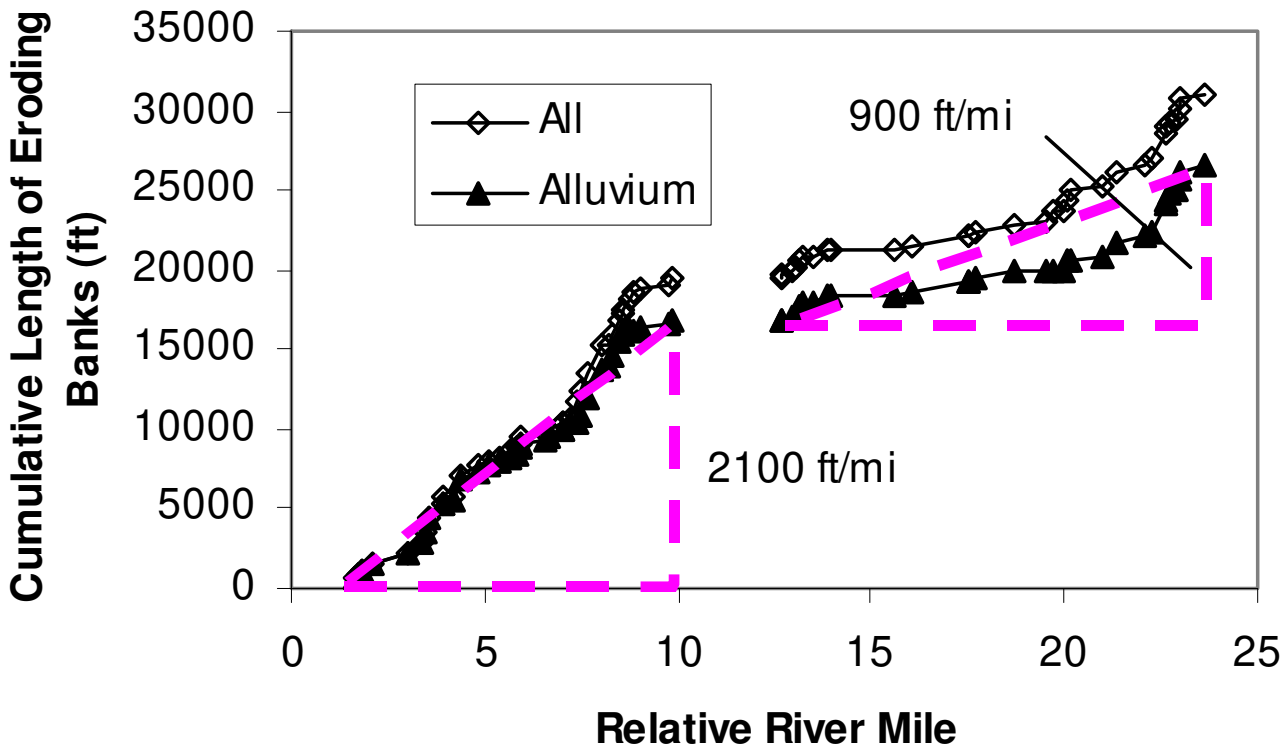


Upstream/Downstream Average Bed Material Composition

Table 3. Average visual estimates of bed material composition obtained as part of a habitat evaluation of South River (URS Corporation, 2006). Upstream averages represent data from 8 sites from RM 0.6 to RM 13.1. Downstream averages represent data from 3 sites from RM 14.6-22.4). Averages are obtained directly from the data sheets, and may not necessarily sum to 100%. Boulders are > 256 mm in diameter, cobbles are 64-256 mm in diameter, pebbles and granules are 2-64 mm in diameter, and sand is < 2 mm in diameter.

Size of Material	**Average Upstream Value (%)**	**Average Downstream Value (%)**
Exposed bedrock	5	12
Boulders	12	41
Cobbles	45	28
Pebbles and granules	31	16
Sand	8	10

Upstream/Downstream Current Eroding Banks



Testing a Simple Box Model of Sediment-Related Hg in South River Channel Perimeter

"Hg rich" sediment from eroding banks

Banks

Upstream

Channel perimeter

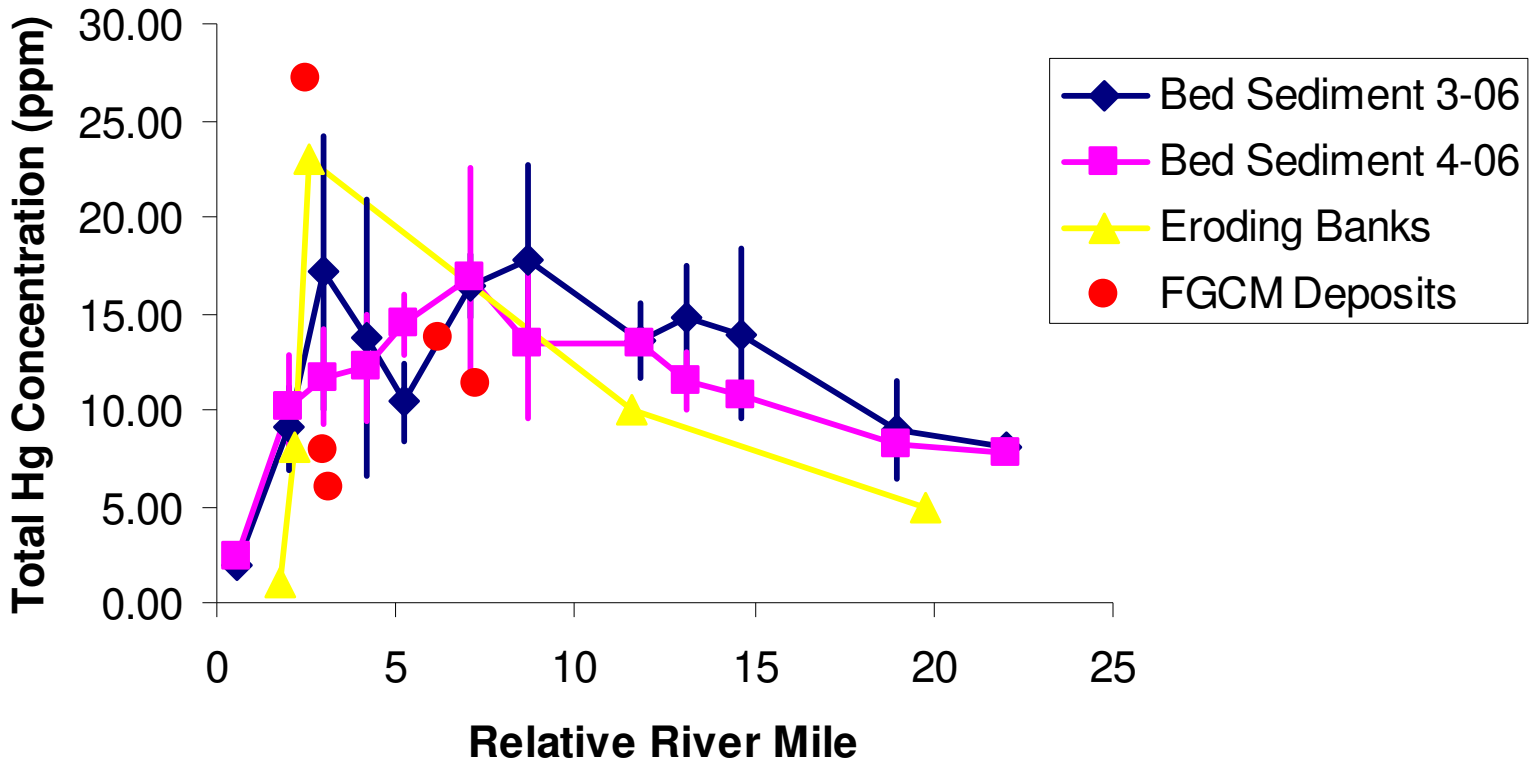
Lots of "clean" suspended sediment from upstream (10x supply from eroding banks)

Hg on sediment in channel represents a diluted mixture from both sources

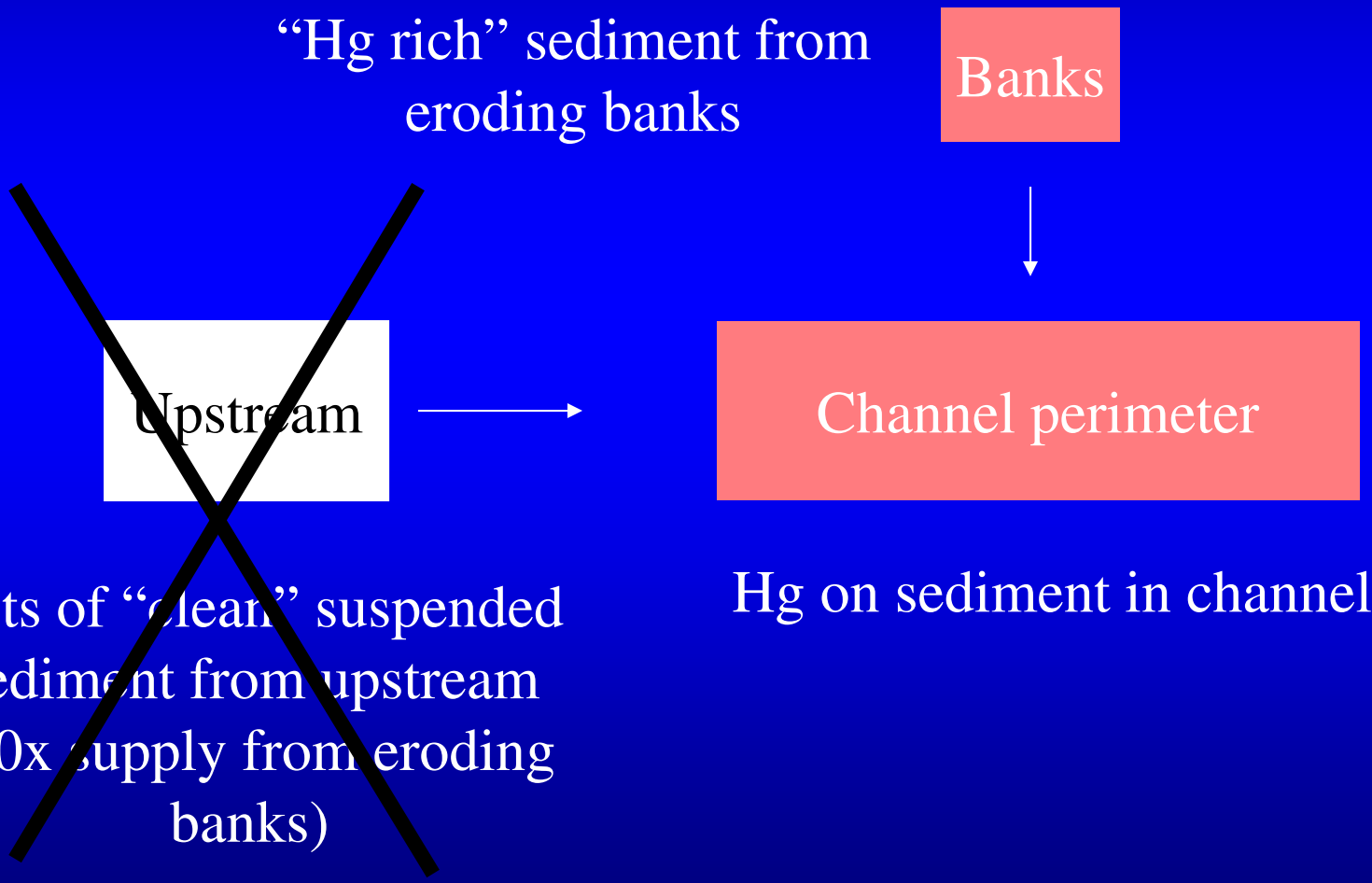
Average Hg Concentration In "Eroding" Banks

Name	RRM	Date Sampled	Average Hg Concentration (ppm)	Average % Mud	Loss On Ignition (%)(mean, range)	Comments
Allied Ready Mix	1.78	8-10-2005	1	34	3,1-7	
Basic Park	2.18	8-10-2005	8	37	4,2-7	
Hopeman Parkway	2.6	October, 2004	23	NA (not sampled for grain size)	NA (not measured)	Sampled by Ralph Turner and Richard Jensen
Forestry Station	11.58	8-11-2005	10	64	5,3-10	Likely reservoir deposits sampled in bank
Grand Caverns	19.84	7-14-2005	5	14	2,1-3	Sampling site ~ 20 m from bank in floodplain

Mean Eroding Bank Hg Similar to Mean Hg in Mud Sampled on Bed, FGCM Deposits
NO DILUTION FROM UPSTREAM SEDIMENT SOURCES



A Better Model of Sediment-Related Hg in South River Channel Perimeter



Working Hypotheses to Explain Why Channel Sediment and Eroding Bank Hg Concentrations Appear Similar

- Eroded bank sediment is directly stored in the channel without dilution
  - Bank erosion occurs at relatively lower flows when upstream supply is minimal
  - During big storms, upstream supply is moved through the study area without significant storage and therefore without diluting Hg in the channel system that is sampled between storms
- Something entirely different….

Conclusions

- Quantitative summary of bank erosion/accretion 1937-2005 will be finished shortly
- 5 Styles of bank erosion (1937-2005)
  1. No change
  2. Small areas of change (not easily explained)
  3. Classic bend migration
  4. Erosion related to tributary confluence sedimentation
  5. Erosion related to evolution and formation of islands
- Fine-Grained Channel Margin Deposits range in age from > 55 to 10 years.
  - Average age ~ 13 years for those younger than 55 years
- Upstream reaches store 46 m^3 of mud /mile, downstream reaches store 28 m^3 of mud/mile of mud in Fine-Grained Channel Margin Deposits
- Average Hg concentration in eroding banks is indistinguishable from Hg concentration in sediment from the river channel.
  - Large supply of "clean" suspended sediment from upstream does not result in significant dilution!