RUSS COLLEGE of Engineering and Technology

A Sediment Study of Little Leading Creek

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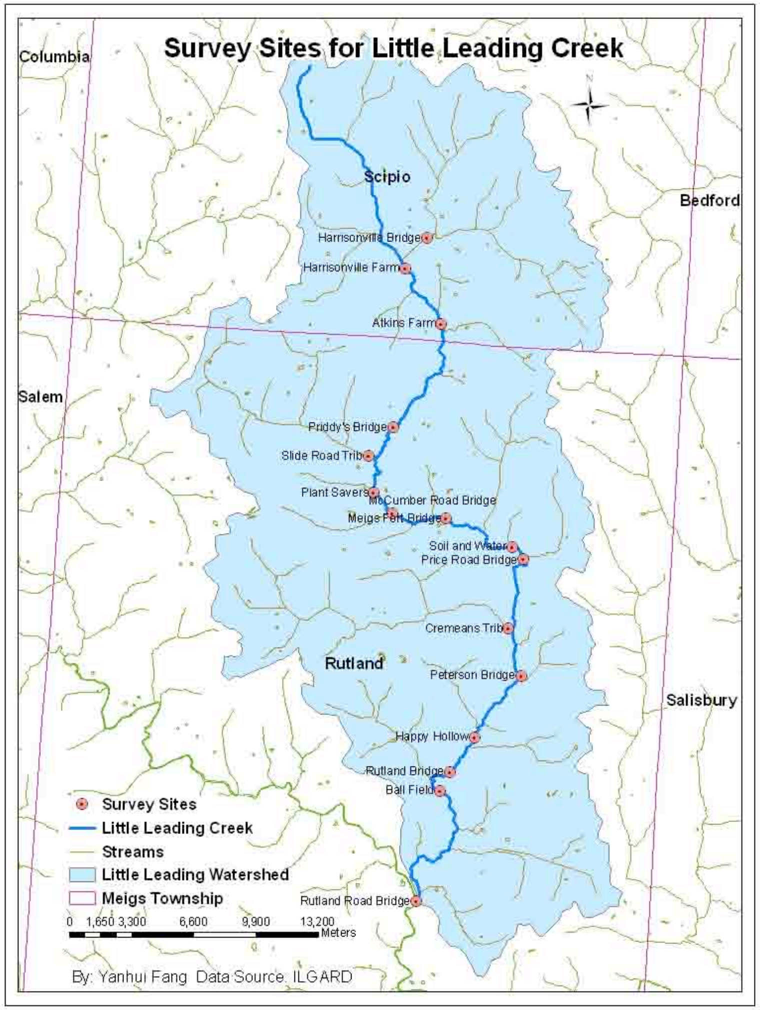
Little Leading Creek



Appalachian Plateau Region of Southeast Ohio

5^{th} Order Perennial Tributary to Leading Creek a Tributary of the Ohio River

Watershed Size	**25.6 Mi^2**
Main Stem Length	**9.1 Miles**

Impairment of Creek

- fails to meet warm water habitat criteria because of excessive sand
- filled pools results in poor breeding and few hiding places
- fish assemblages diverse but of very small size

- history of frequent flooding

Sand

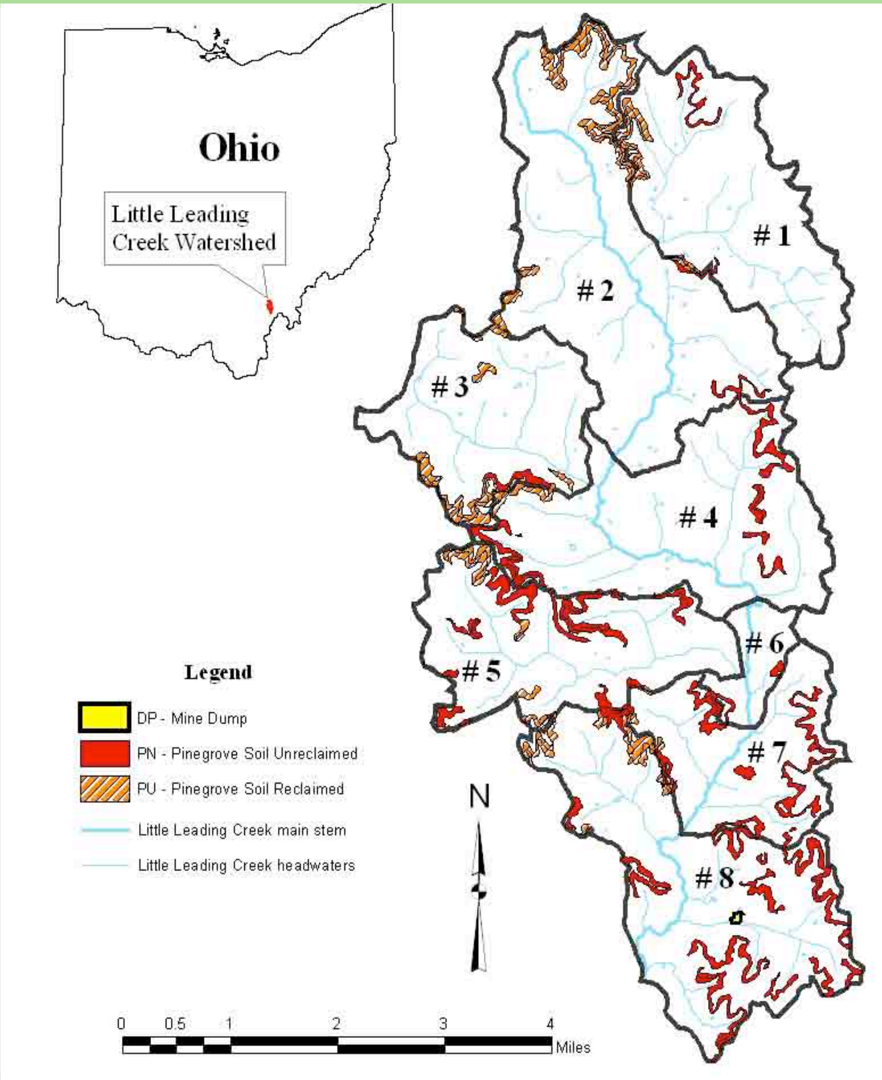
- deeply entrenched channels
- highly erodible banks
- poor habitat in channel for fish

And More Sand

- deep sand deposits in channel
- during low flow, surface water drains through the sand deposits

Mining History

- majority of the active surface mining took place between 1950 and 1964
- reclaimed AML = 1.1 Mi^2
- unreclaimed AML = 1.2 Mi^2
- 9% of watershed
- over $4 million spent on AML reclamation in Little Leading Creek watershed from 1979-1990



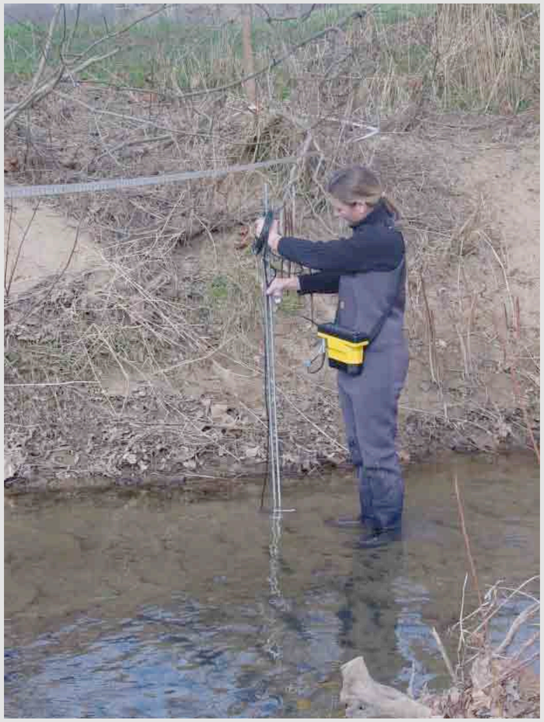
Mining Erosion

- potential erosion rate from strip mining = 200+ ton/acre (USDA, 1985)
- translates in Little Leading Creek Watershed to annual erosion of possibly 423,000+ tons for 15-40 years

Study Objectives

- Characterize Sediment Within Stream Bed
- Measure Sediment Load and Transport Rate
- Identify Sediment Sources
- Propose Restoration Alternatives

Estimating Sediment Transport

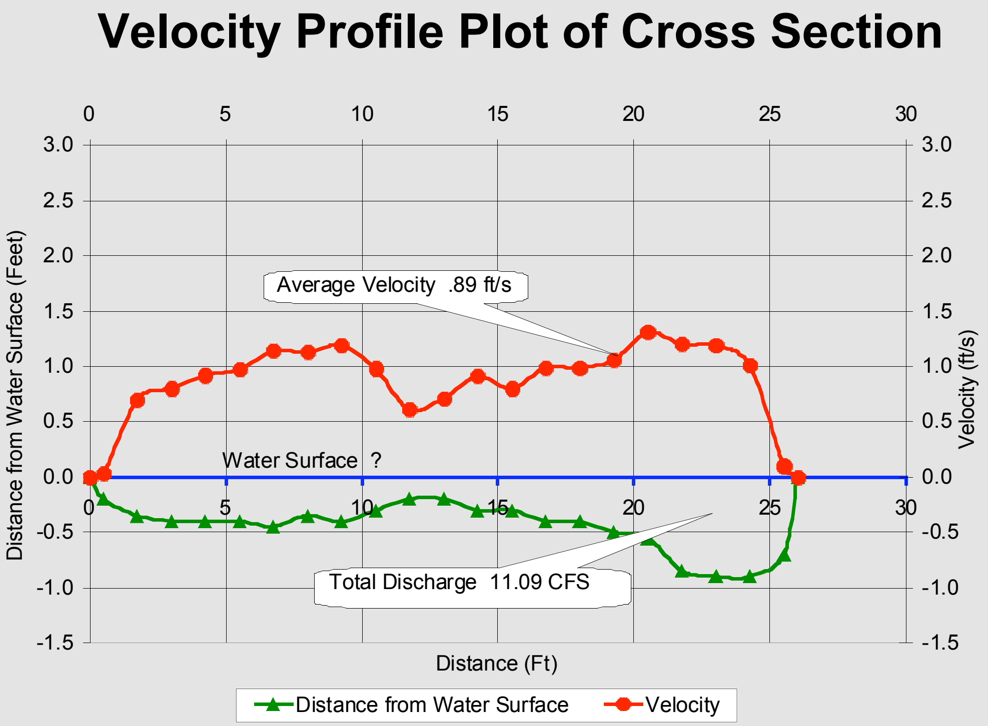


Velocity Measurements to Estimate Discharge

Continuous Stage Readings

Bed Load and Suspended Load Measurements

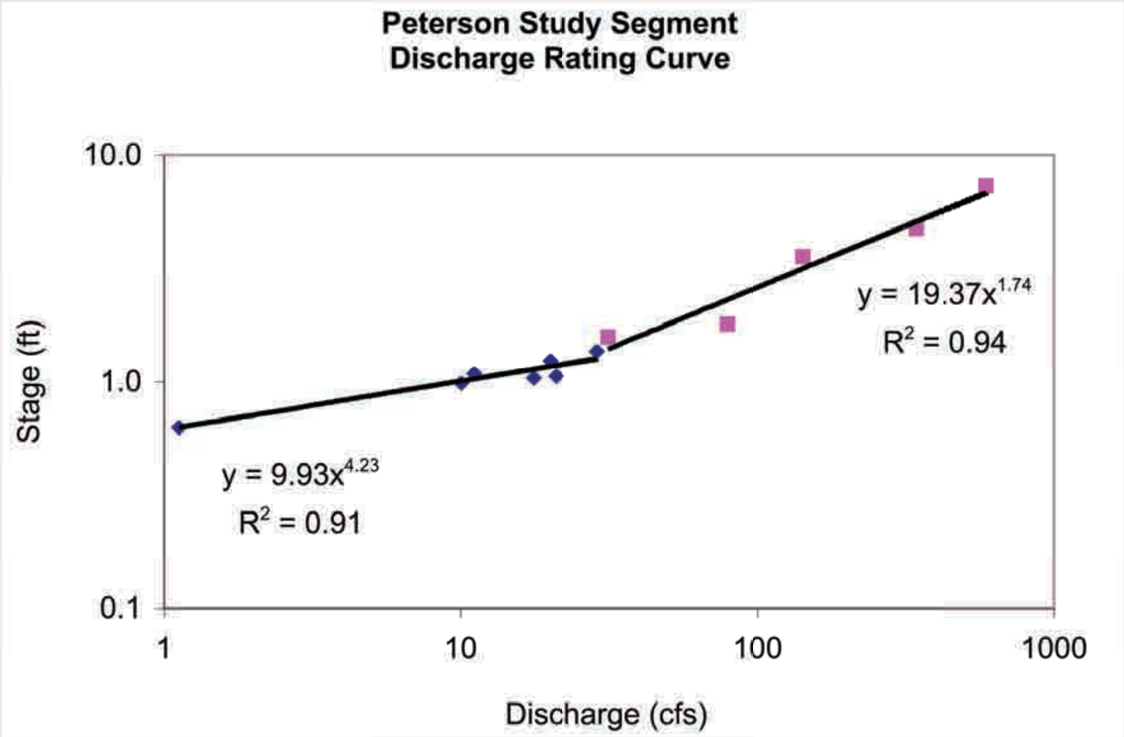
Peterson Study Segment
Velocity Measurements



Velocity Measurements recorded using an Electromagnetic Flow Meter

Discharge Rating Curve

- stage discharge measurements over range of inbank flows
- two distinct curves
- transition at 29.1 cfs represents shift from section control to channel control
- sediment only transported out of section during higher flow events



Bedload Transport Observations

- after high flow events, pools and riffles evident
  - floods scour sand out of channel
- during low flows, bedload transport still high as sand is redistributed
  - between storm events pools fill with sand

Suspended Sediment Collection

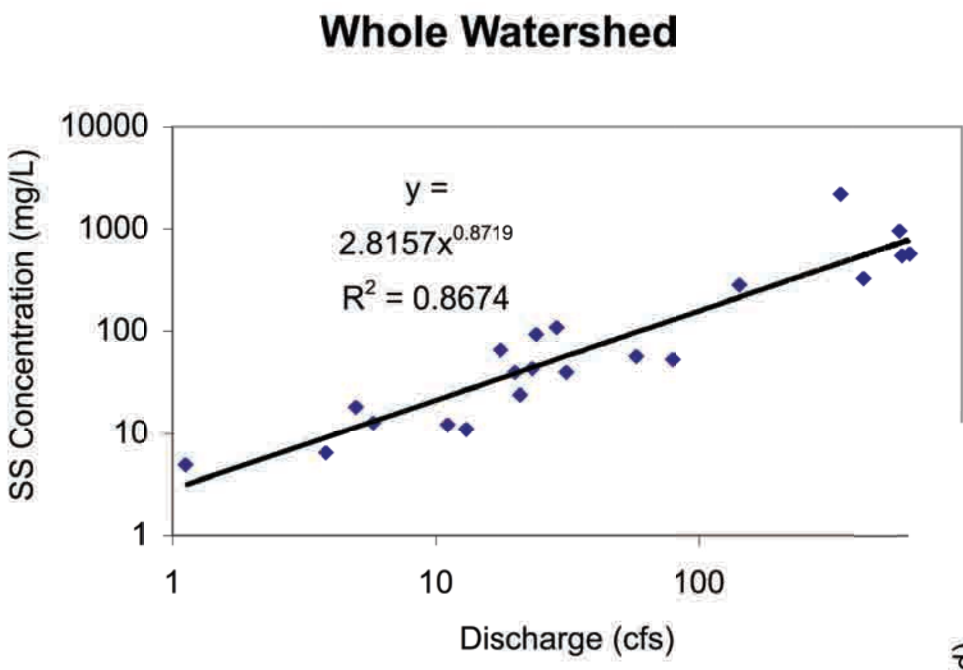
Wadable Flows

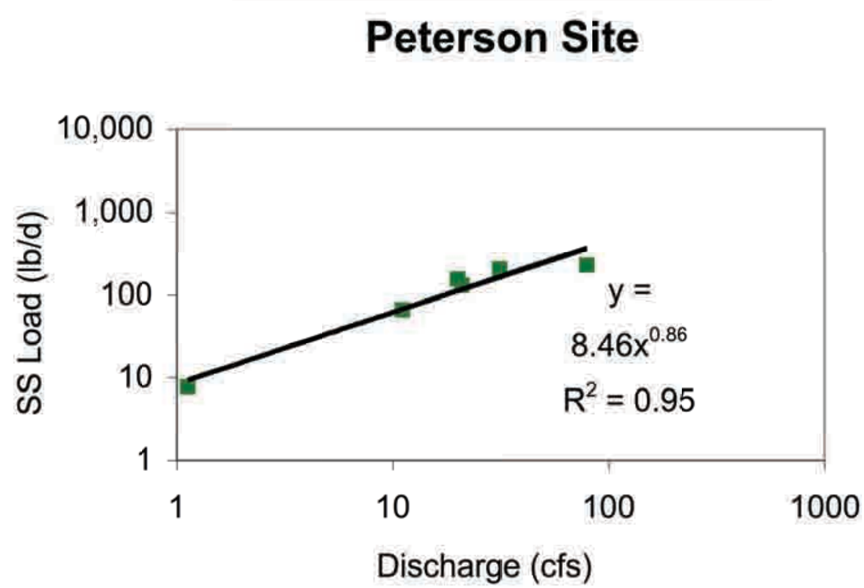
- Depth Integrated
- Hand Held Sampler Model Number USDH-48

Non-wadable Flows

- US DH-59

Suspended Sediment Rating Curve

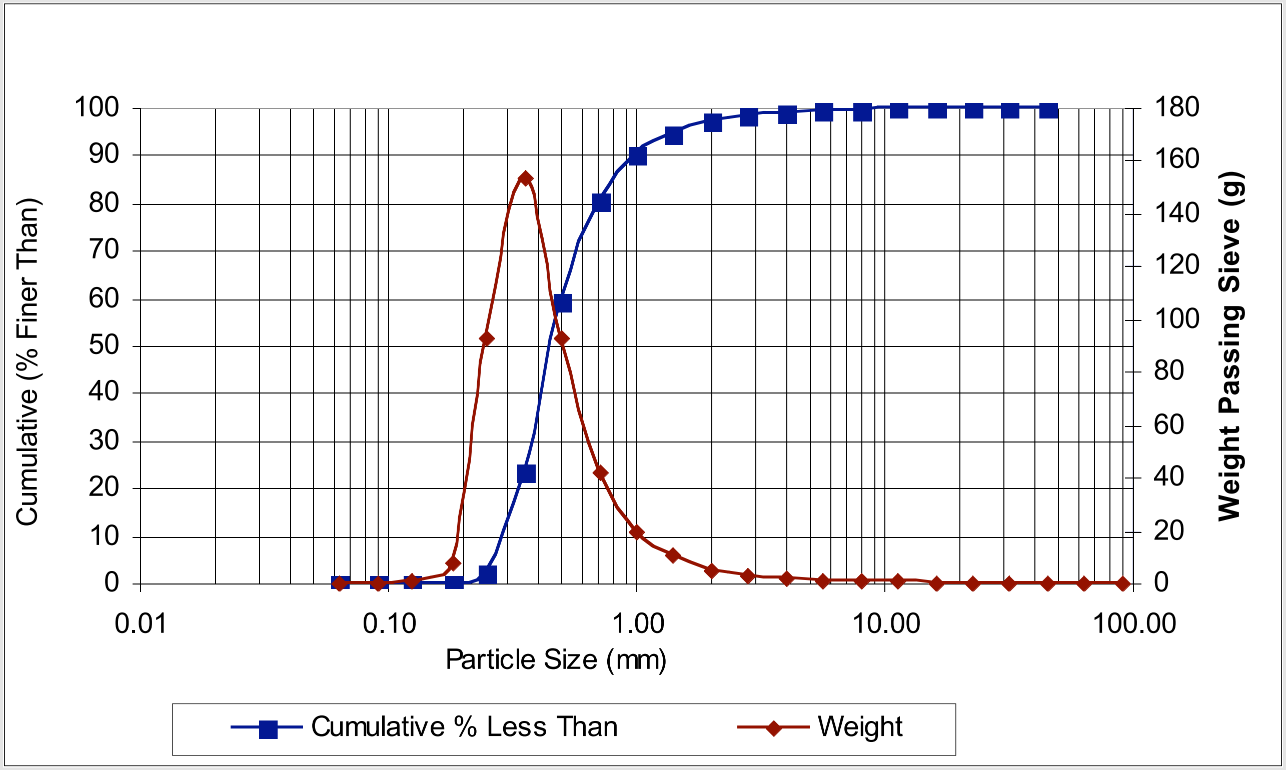




Bed Load Collection

Helley Smith Hand Held Sampler
Model No. 8015

Sieved Bedload

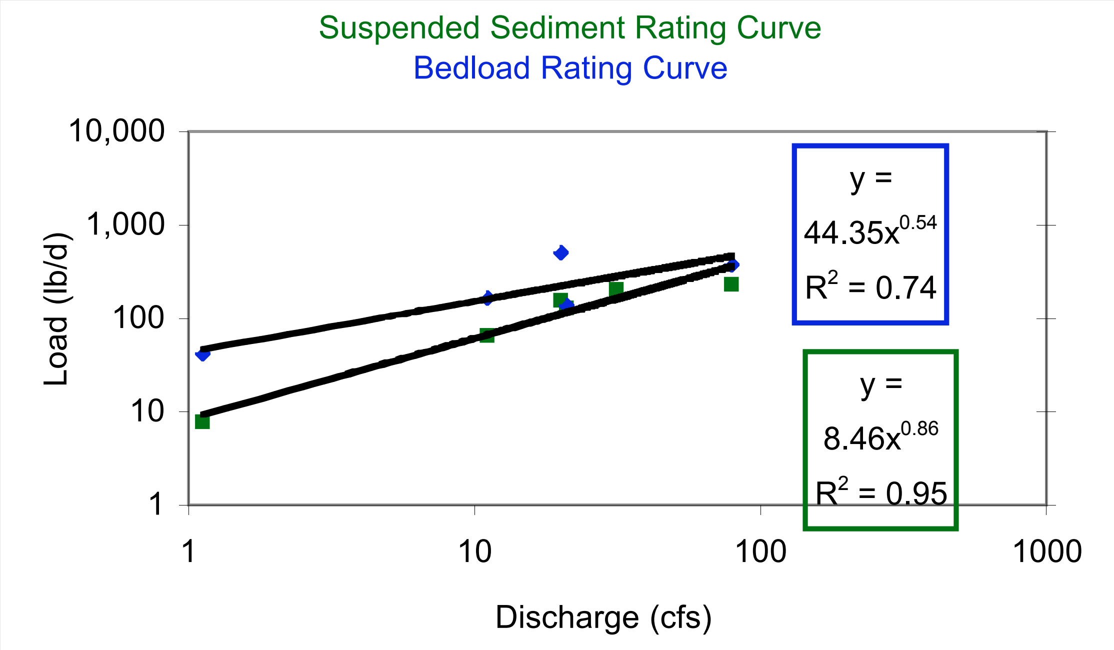


% Finer Than	Particle Size
D16	0.36
D50	0.50
D84	1.80

poorly graded coarse sand

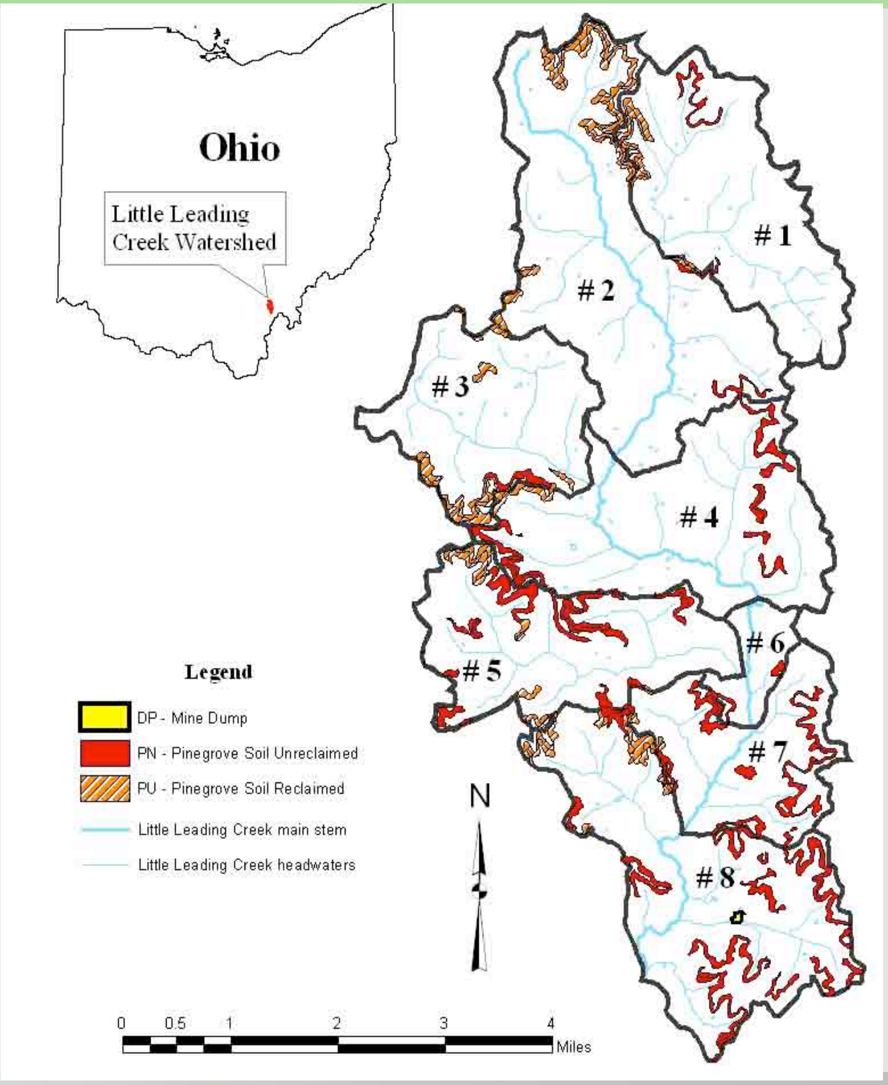
Bedload Transport Rates

- higher bedload observed than suspended sediment
- at higher flows suspended sediment may exceed bedload
- estimated section transport
  - SS = 10 ton/yr
  - BL = 18 ton/yr
- estimated channel transport
  - SS = 7 ton/yr
  - BL = 8 ton/yr



Assessment of AML Reclamation

- headwater and tributary creeks had well graded sediments including gravel and large stones
- often pavement apparent
- sites vegetated and no obvious erosion problems
- where is all this sand coming from?



Evaluating Bank Erosion

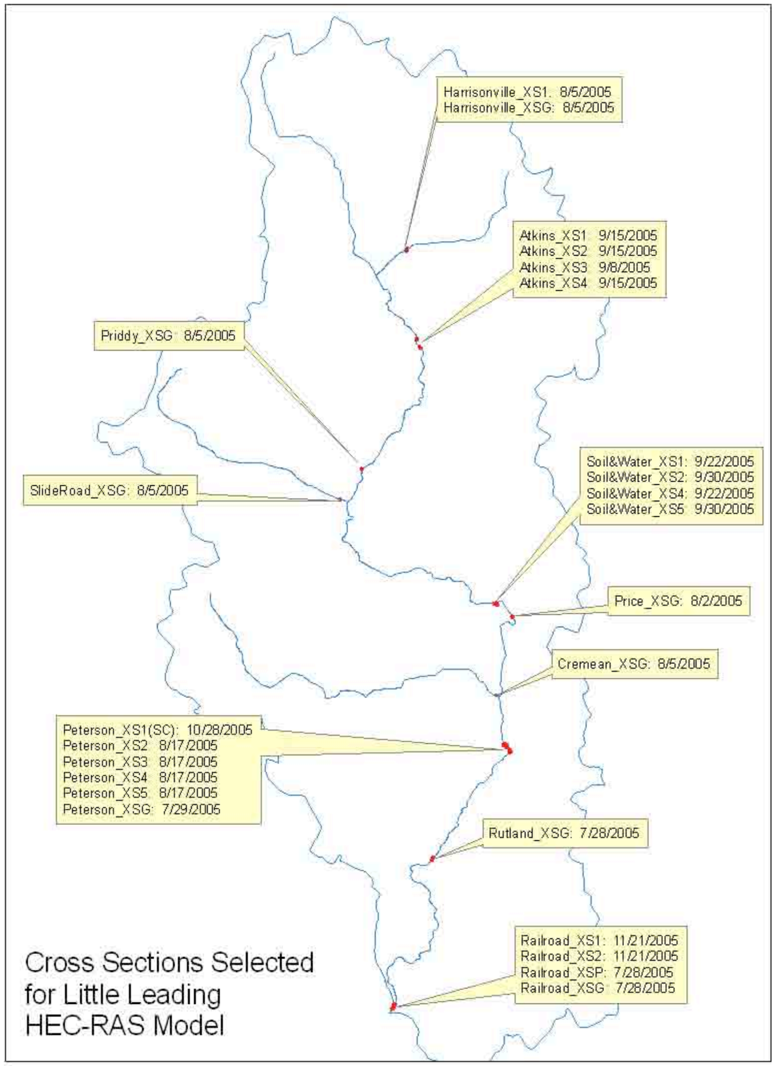
Method: Repeat Survey

Multiple Cross-sections

and

Longitudinal Profiles

Study Segments



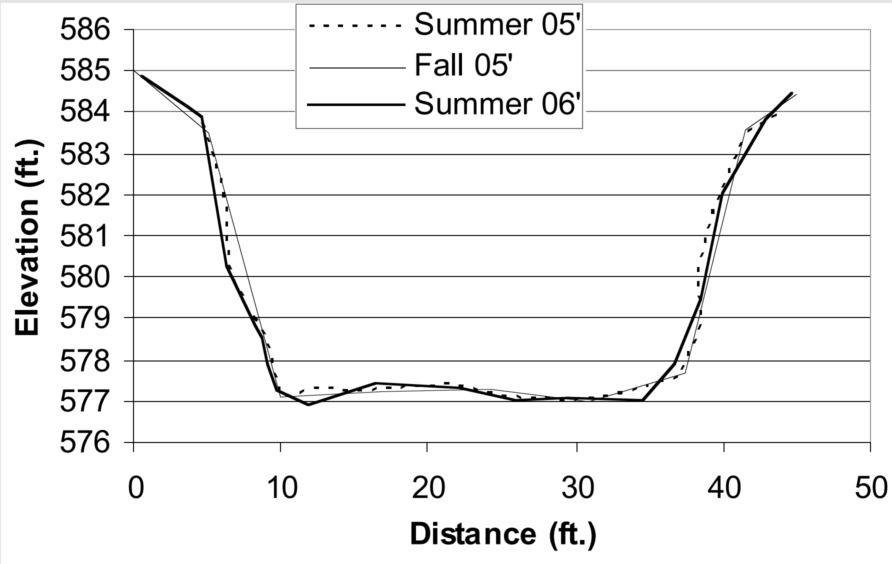
Main Stem Study Segments

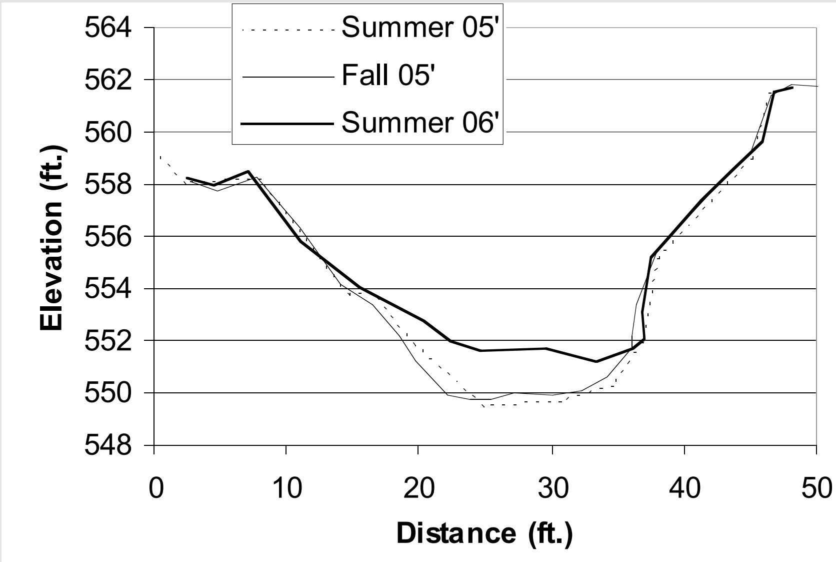
Rail Road Bridge	.05
Rutland Bridge	1.9 River Mi
Peterson Bridge	3.1 River Mi
Soil and Water	4.6 River Mi
Priddy Bridge	7.0 River Mi
Adkins	8.2 River Mi

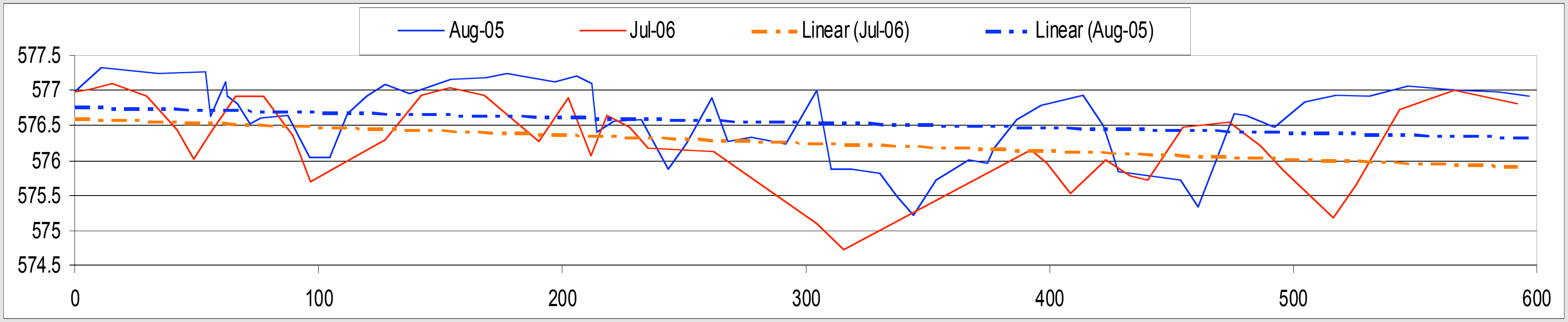
Tributary Study Segments

Cremean	3.6 River Mi
Side Road	6.65 River Mi
Harrisonville	9.3 River Mi

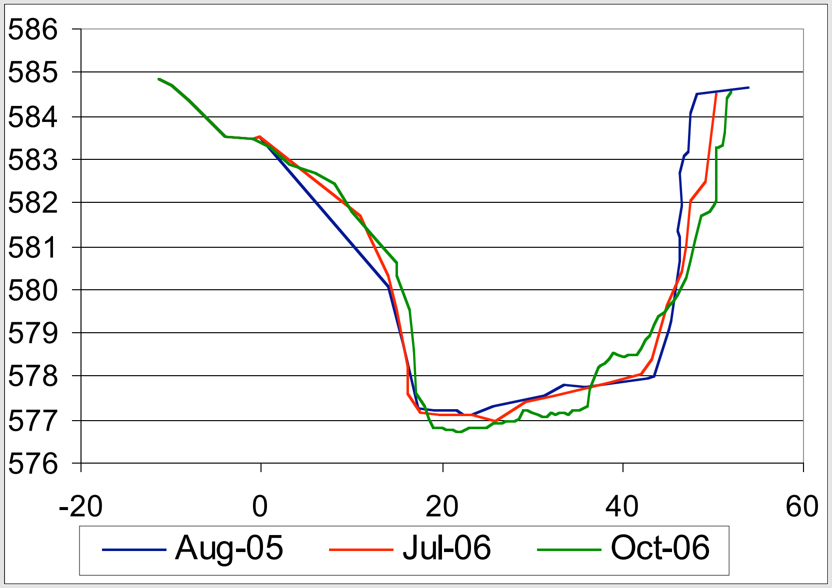
Subtle Channel Changes







Peterson Cross-section



Dimension	Change %		
	Yr 1	Yr 2	Cumulative
Area (Ft^2)	3.2	0.8	4.0
Width (Ft)	4.2	1.0	5.3
Dmean (Ft)	0.0	0.0	0.0
Dmax (Ft)	1.4	4.1	5.5

Bank Erosion Common on Mainstem

- deeply entrenched channel
- poorly vegetated and easily erodable banks
- in many locations cattle have access to creek
- bank erosion likely primary sediment source

Sediment Origin

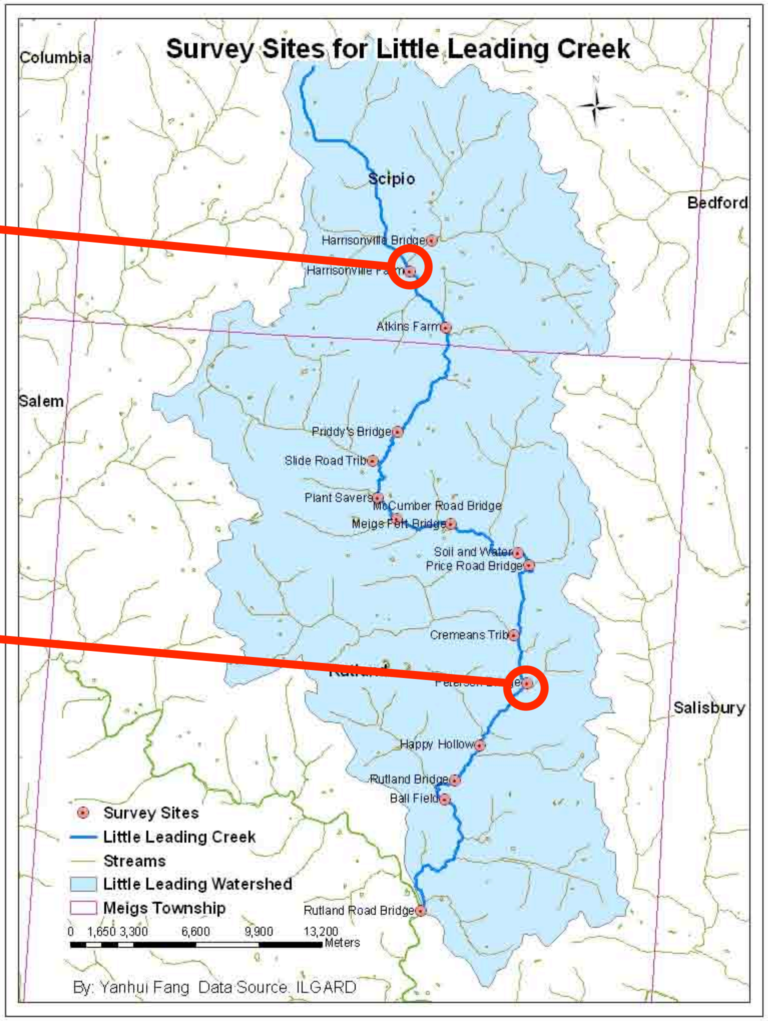
- borings to reveal depths of sediment in floodplain
- presence of large amounts of coal and orange staining may be good indicators for mining related erosion

Soil Borings

- sets of soil borings were drilled at two creek cross-sections
- continuous split spoon sampling 4-14’
- cores collected in plastic sleeves for extraction and analysis in lab

Soil Boring Locations

- Harrisonville
  - site of initial flooding problems
  - wide flat pasture
  - significant entrenchment and erosion
- Peterson
  - wooded
  - more narrow valley section
  - relatively stable banks
  - rock pavement observed after scour events



Typical Cores

- mostly poorly graded sand with between clay layers
- coal chips and fines spread through soil
- some layers with lots of coal
- significant orange staining often adjacent to heavy coal layer

Deeper Cores

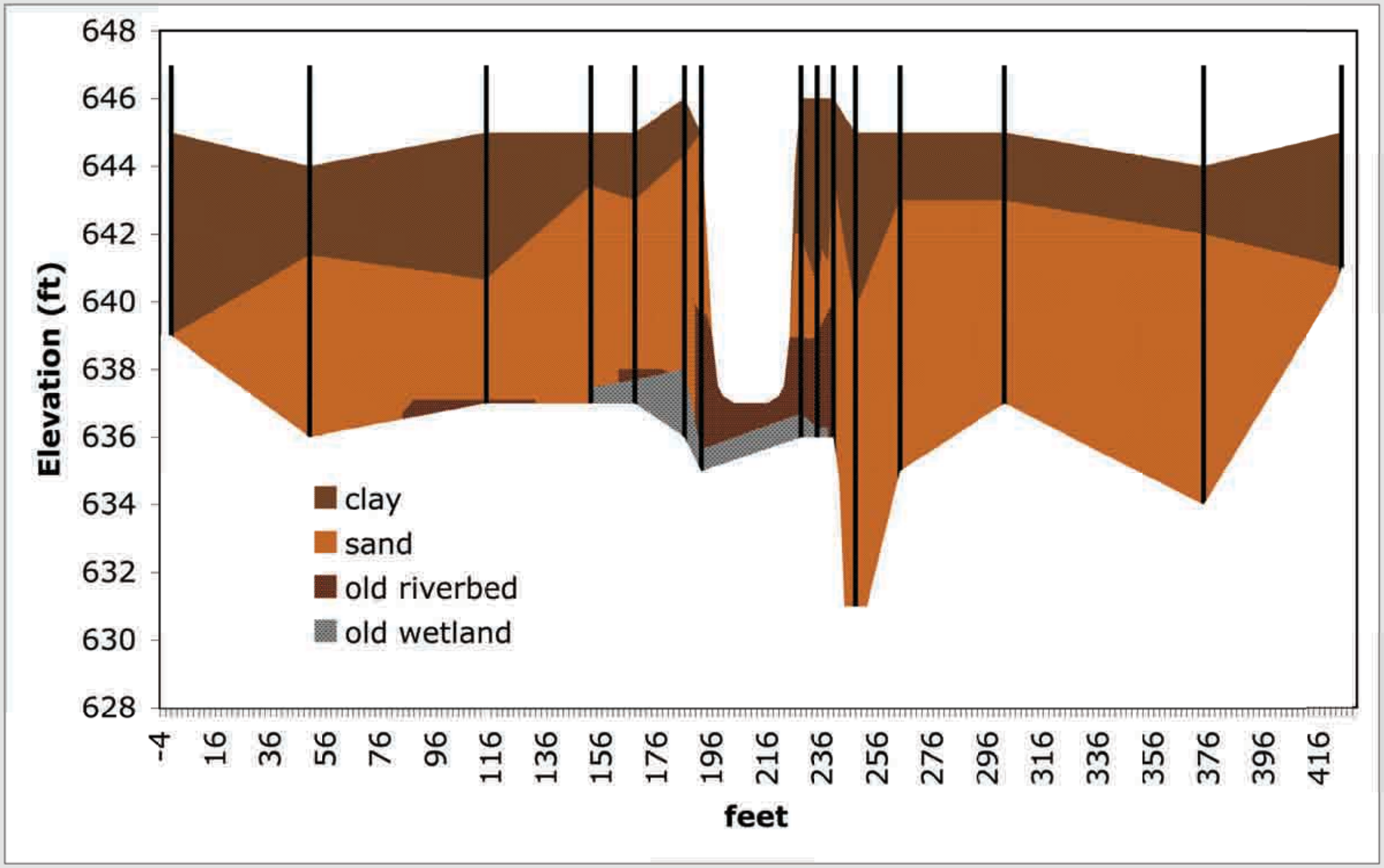
- at 6-10 feet most soils turned from tan or brown to grey or black
- occasionally at depth several inches of carbonized, recently deposited leaves, sticks, logs, and grass present

Coal?

- coal chips difficult to distinguish from other black deposits (particularly when wet)
- need to closely inspect each fragment
- coal fines need to be identified with a microscope

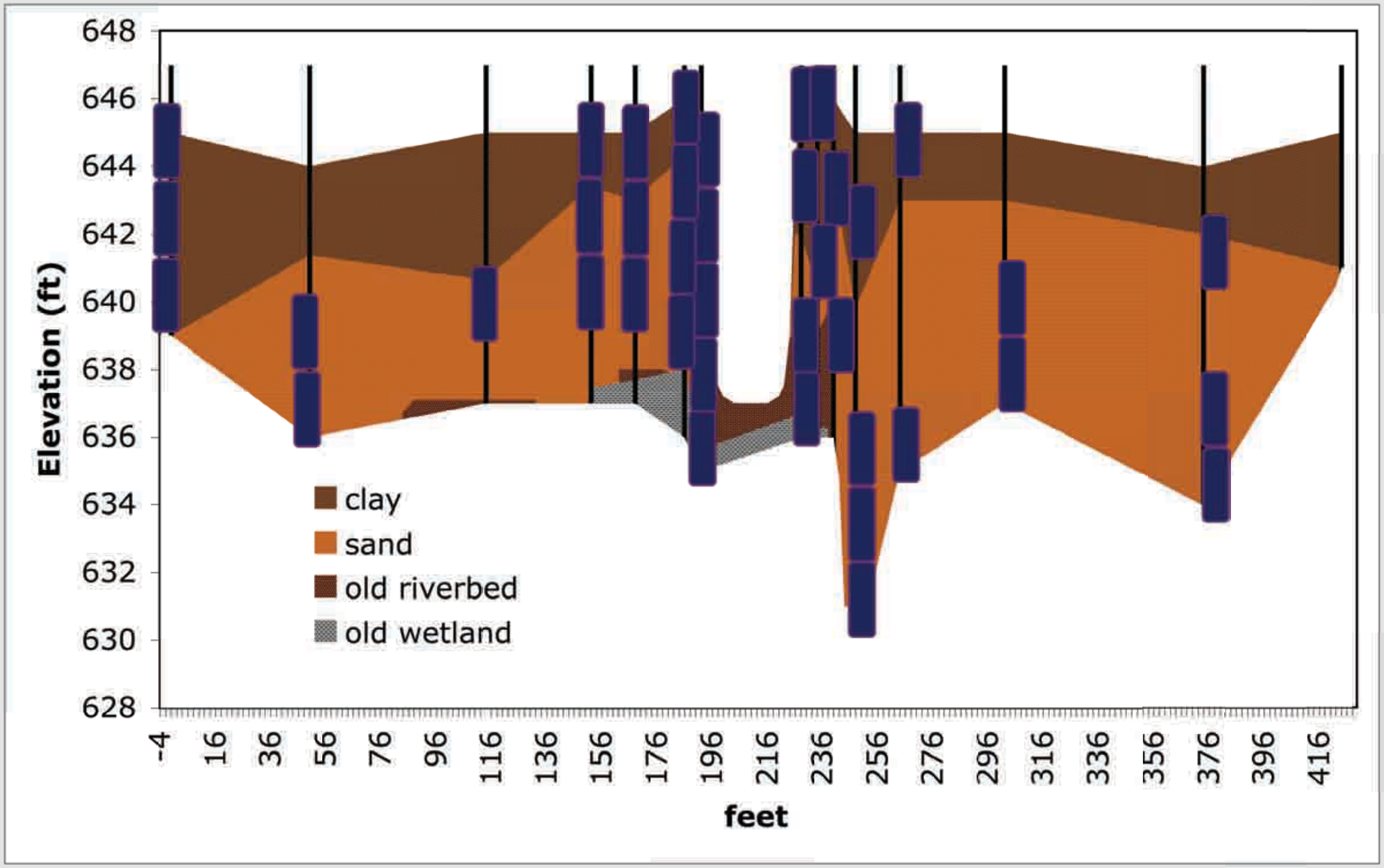
Harrisonville Stratigraphy

- sand and clay found up to 14 ft deep and over 200 ft from channel
- old river beds found over 100 feet from channel



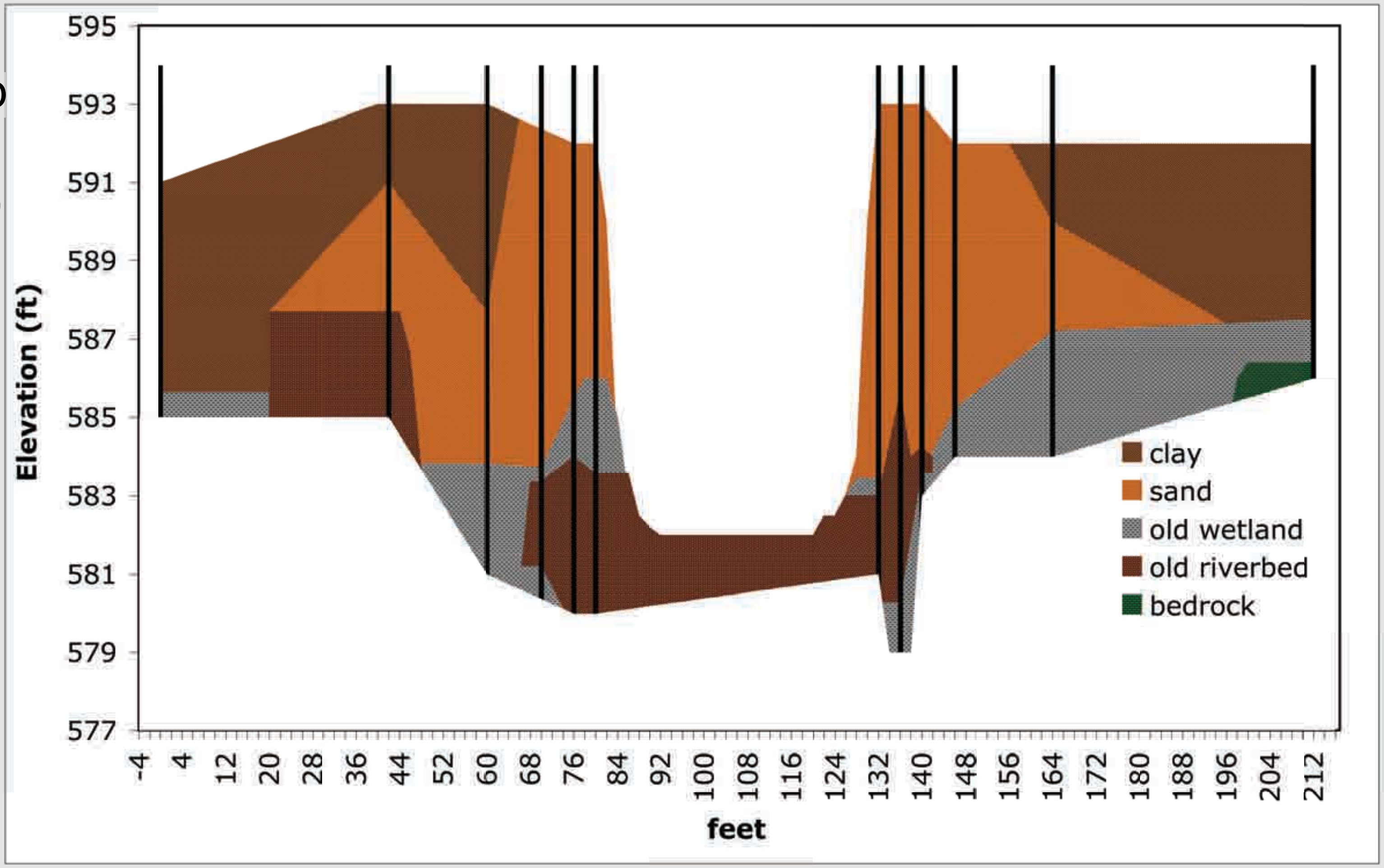
Coal in Harrisonville Cores

- coal chips and fines found throughout
- valley inundated with sediment from the strip mining over 14 feet deep



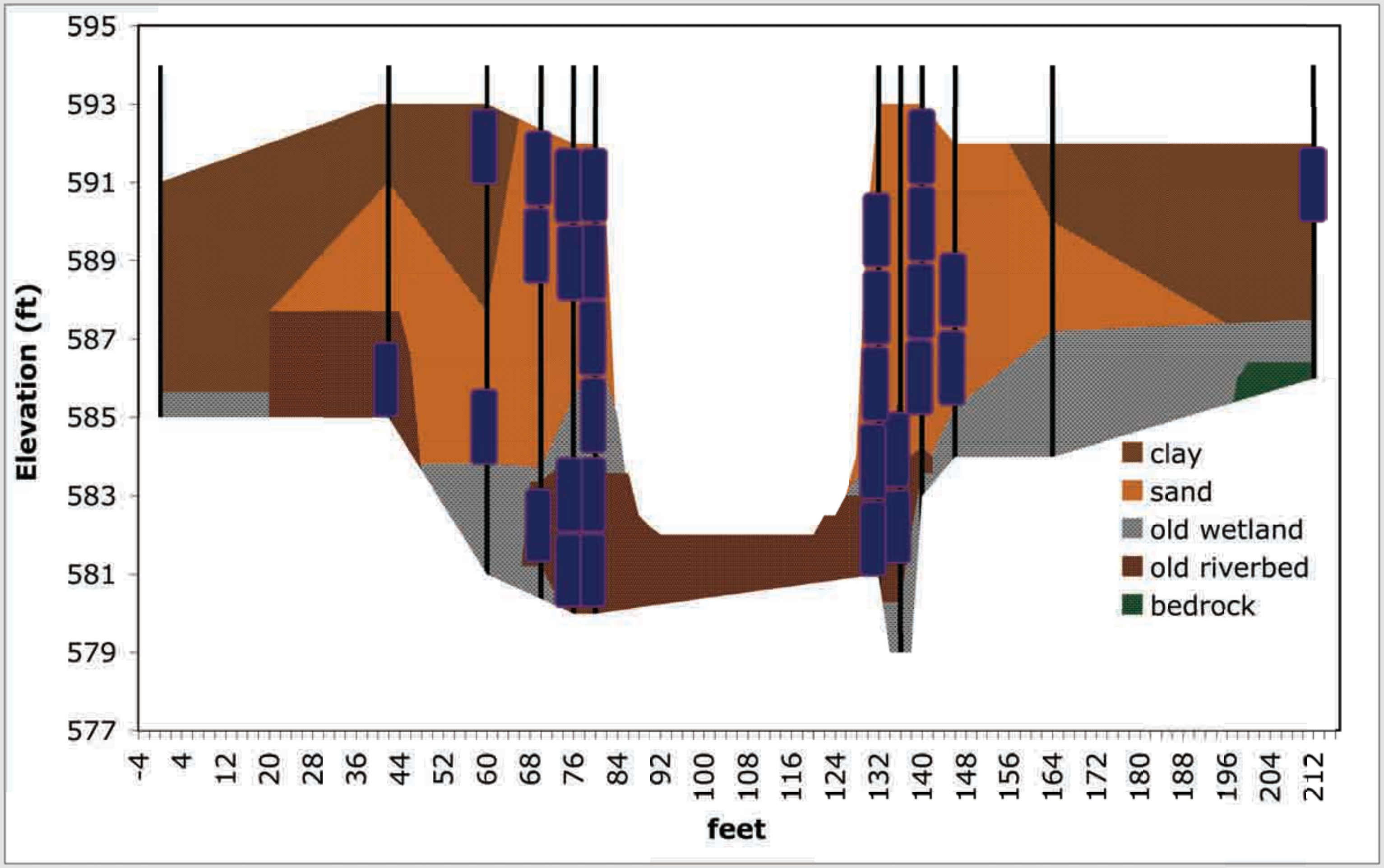
Peterson Stratigraphy

- sand and clay found up to 10 ft deep and over 100 ft from channel
- old river beds and thick layers of recently deposited organic matter found



Coal in Peterson Cores

- coal found as deep as 12 feet
- no coal found in or below wetland sediments
- possibly original floodplain before inundated with sand



Likely History of Little Leading Creek

- during and after strip mining very large sediment loads inundated the watershed forming valley plugs
- during this period Little Leading Creek resembled a braided stream that filled the hollows and valleys with sand and clay
- after AML reclamation, the sediment source was removed and the channel began to cut downward through the easily erodable material
- the result is deeply entrenched banks with persistant sediment source to the creek from the valley and floodplain deposits
- low gradient areas act as sediment traps, locking sediments in the system except during high flow

Conclusions

- large quantities of sand transported within the system primarily as bedload
- uniform sand the dominant deposit
- sand trapped in channel, only leaves the system during high flow events
- major source of sediment currently from bank erosion
- floodplain deposits highly erodable and a direct result of strip mining

Restoration Recommendations

1. Bank Stabilization

- limit primary sediment source to the creek
- stabilize 2.75 miles of the most degradable stream banks
  - reconnect channel to floodplain
  - raparian revegitation
  - proper channel design
- coexist with cattle
  - exclusion from channel
  - drill wells to provide alternate water source
  - established crossings

Failing Banks	River Mile	Total
Howard/Clark Property	9.1 through 9.4	0.3
Jewell Property	7.8 through 8.4	0.6
Johnson/Priddy Property	6.9 through 7.0	0.1
Wm Sterns Property	6.3 through 6.9	0.6
Fort Meigs	5.3 through 5.5	0.2
Soil and Water Property	4.8 through 4.95	0.15
Soil and Water Property	4.55 through 4.65	0.1
Colman Property	4.1 through 4.4	0.3
Barrett Property	3.6 through 3.7	0.1
Peterson Property	3.1 through 3.2	0.1
Casto Property	2.5through 2.6	0.1
Rutland BaseBall Fields	1.65 through 1.75	0.1
Total		**2.75**

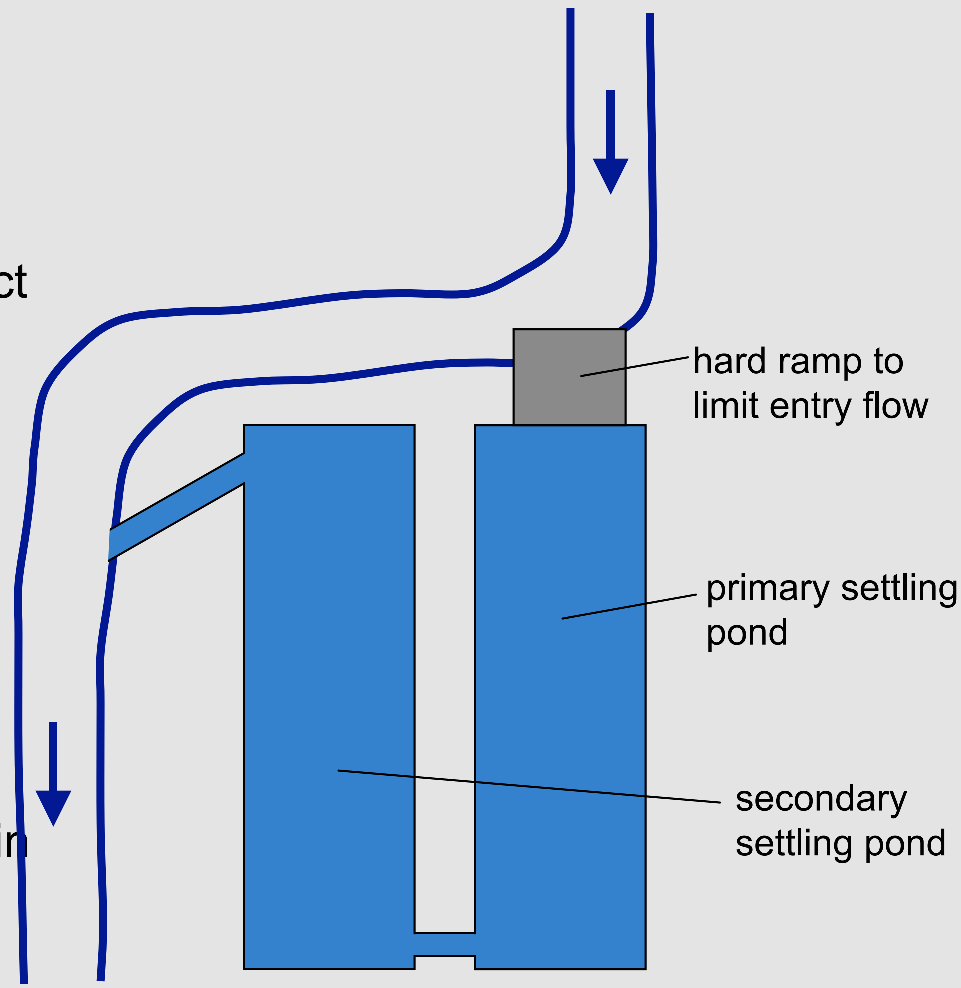
Restoration Recommendations

2. Sediment Trap

- remove existing sediment from channel
- during bankfull or greater flow collect transported sand in a pair of ponds
- will require periodic sand removal

3. Habitat Improvement Structures

- install downstream of sediment trap
- generate enough velocity to maintain pools
- log vanes, vortex weirs, ...



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