Presentation
to the

Upper Mississippi River Basin Environmental Management Program Workshop

by

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Engineering Design Handbook

Tributary Restoration

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Agenda

- Introduction
- Resource Problem
- Design Methodologies
- Questions
- Lessons Learned

Channel Straightening

- Why?
  - Lower flood stages
  - Improve land drainage
  - Increase farmable acreage
  - Reduce transit time for navigation

Resource Problem

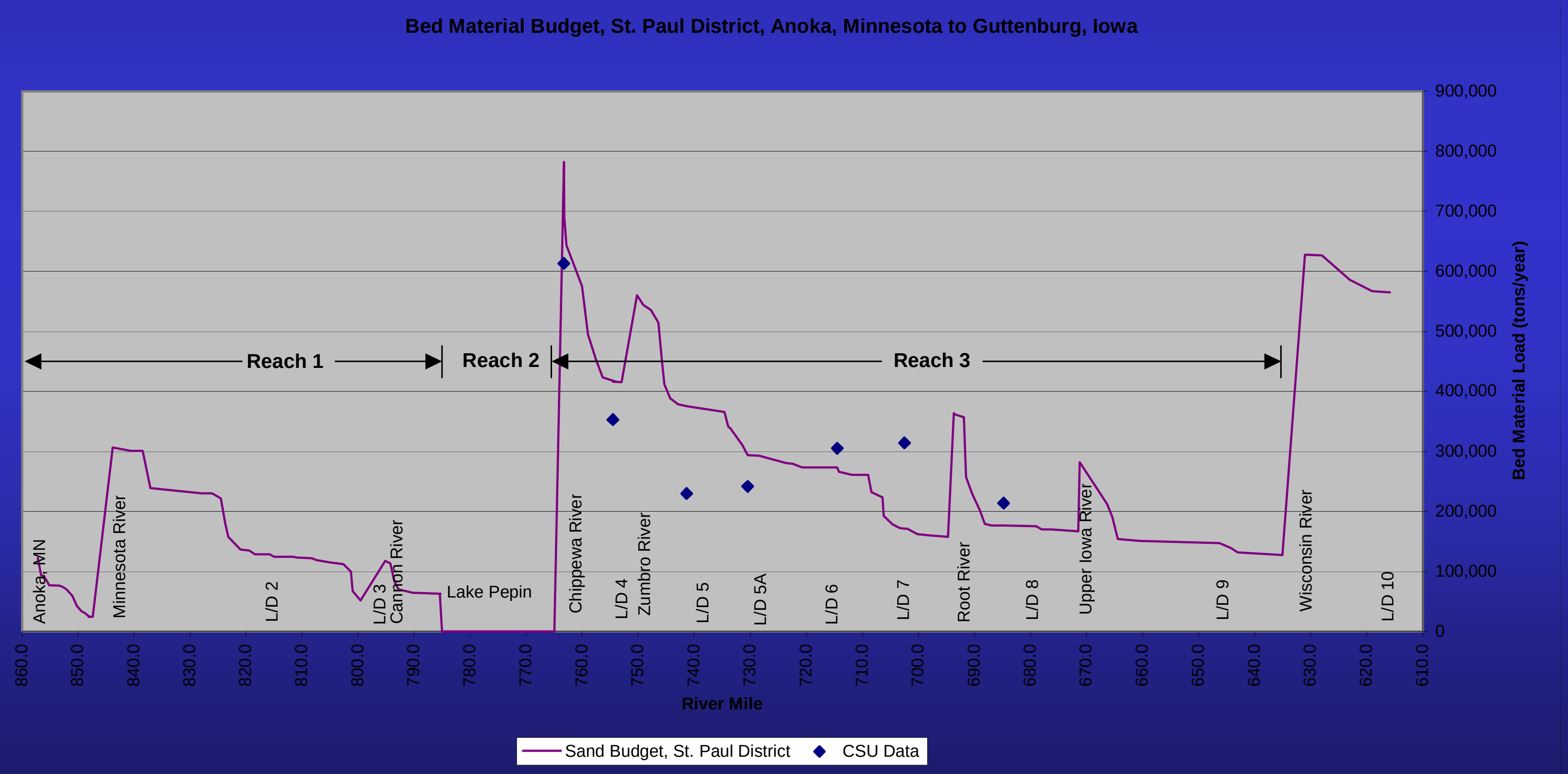
- **Loss of Ecological Diversity**

"The Government tells us we need flood control and comes to straighten the creek in our pasture. The engineer on the job tells us the creek is now able to carry off more floodwater, but in the process we have lost our old willows where the owl hooted on a winter night… We lost the little marshy spot where our fringed gentians bloomed."

- Aldo Leopold in *The Round River*, **1953**

Resource Problem

- Sediment- Ecosystem and Navigation



Resource Problem

- Sedimentation

"The prediction that ecologically productive backwaters will fill and disappear in the next 50 to 100 years is alarming and clearly identifies sedimentation as a major concern of natural resource managers."

-USGS, Ecological Status and Trends, 1999

A Tale of Two Streams

Black River, WI

Upper Iowa River, IA

Black River

- Never significantly channelized
- Excellent habitat
- No efforts need to be pursued to manage this system (WI DNR)

Upper Iowa River

- Channelized in 1956
- Dredged material placed on banks to contain the river

- Poor habitat in river and backwaters
- Increased dredging in Pool 9
- River isolated from floodplain

Maquoketa River

Design Methodologies

- Tributary Restoration is new and untested in the EMP program.

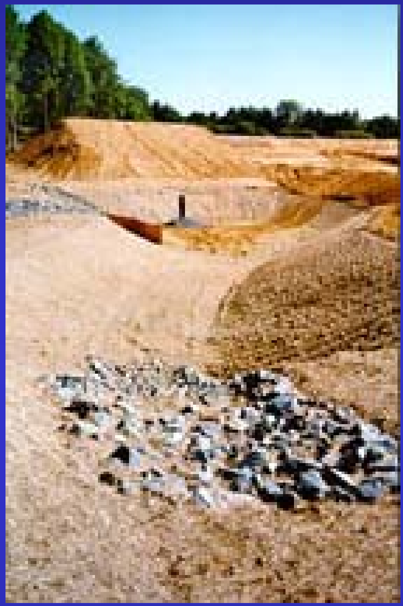
- EMP and NESP offer opportunities, but probably limited to restoration of tributary channels where tributary enters the Mississippi River Valley.

Design Methodologies

- 3 Types of Solutions:
  - Hydrologic: Modify runoff or flow regime
  - Hydraulic: Modify geomorphic characteristics of the channel
  - Habitat: Construct structures or features to modify biologic function

Hydrologic

- Sediment Basins:
  - Reduce erosion
  - Trap sediment
  - Reduce and manage runoff
  - Improve downstream water quality



Sediment Basin

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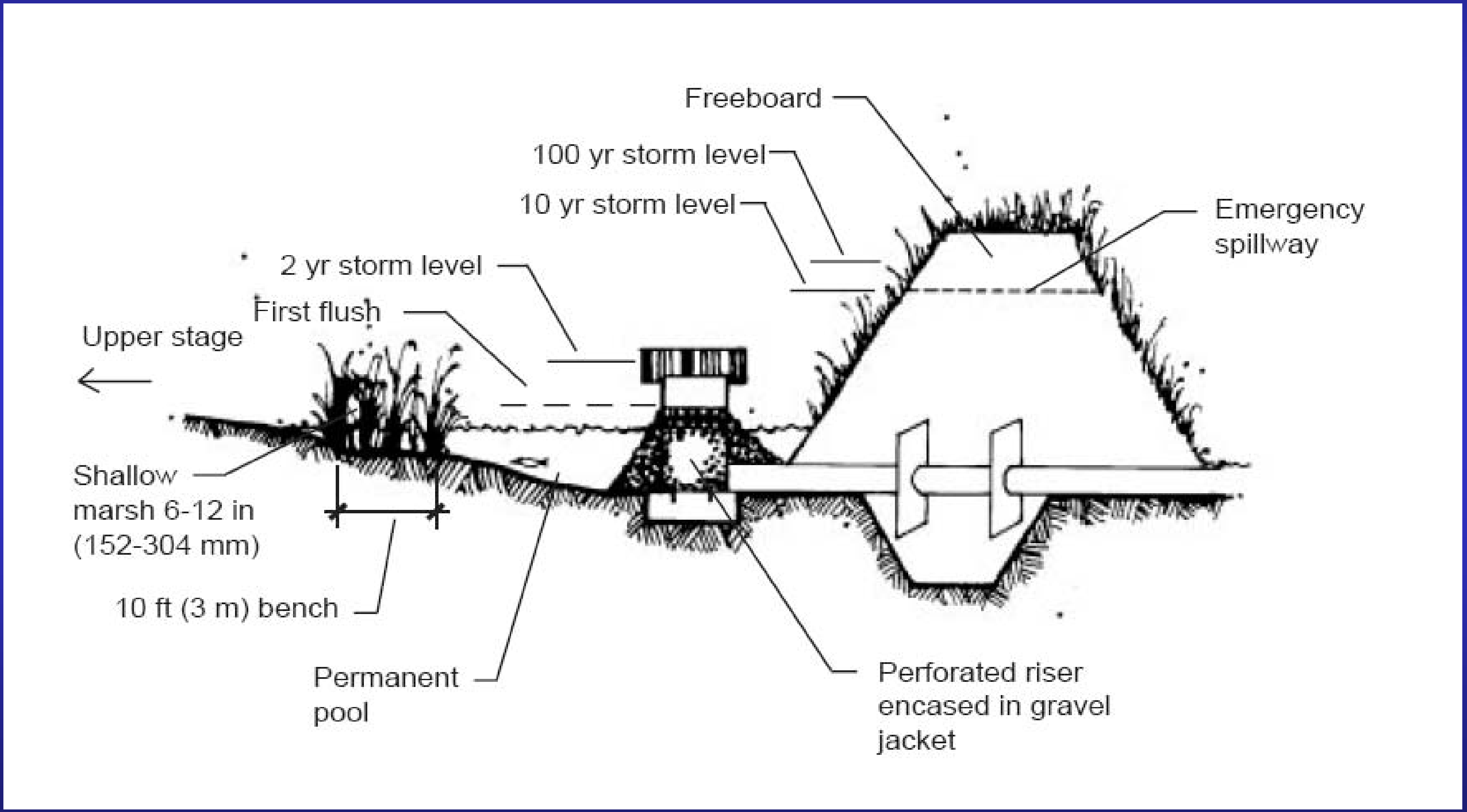


Sediment Basin Design

- Alignment
- Cross-Section- top width=6-8', side slopes 2:1 to 5:1
- Capacity: 10-yr, 24-hr storm, 10 years of sediment accumulation
- Outlets
- Vegetation: reduce erosion

Sediment Basins in EMP

- Upland sediment control generally not pursued, although not excluded under authorization
- Swan Lake and Batchtown: most cost-effective way of protecting habitat in project area. Included hillside retention ponds, terracing, and other measures to reduce sediment delivery to project area. Partners with NRCS.

Lessons Learned

- Sediment Basins:

  - Baseline and Post-Project Monitoring. How much sediment is trapped? Are sediment basins truly cost-effective?

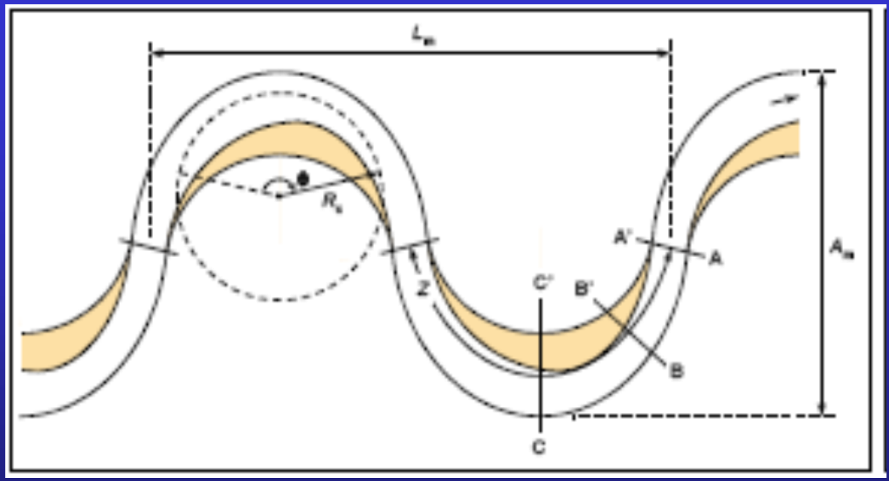
  - Prioritize and strategic placement.

  - Public interest slow at first, but then program ran out of money.

  - NRCS was a great partner: experience and contracting procedures.

Hydraulic

- Channel Dimensions and Geometry- "Natural Channel Design"
- Prevent Streambank Erosion



Natural Channel Design

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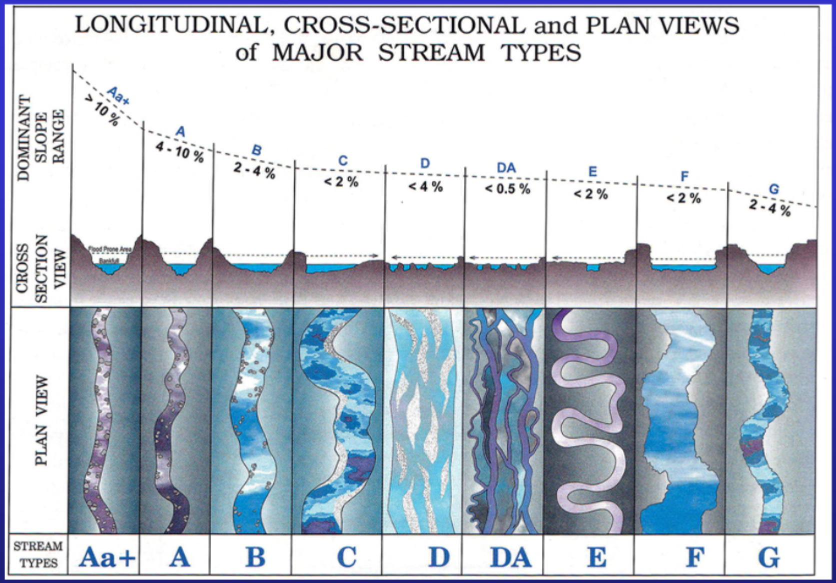
- 3 main approaches:
  - Analog
  - Empirical
  - Analytical

Analog

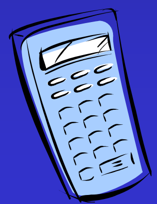
- Find a "reference reach" of same stream type, measure channel characteristics, and apply to design channel



Empirical

- **Use universal equations.**

  Danger: "Universal" equations are not universal



$L = 1.4\, A^{0.6}$; L= stream length (km), A= drainage area (km^2)

Meander wavelength= 5-7 times channel width

Meander length= 11-16 times width

Analytical

- Use computer models to calculate water surface elevations, shear for bed and bank design, extent and duration of inundation, appropriate channel geometry, sizing bed material, and sediment continuity.
- HEC-RAS, HEC-6, SAM, etc.
- Model is only as good as the data

Pros and Cons

- Analog- PRO: replicate an existing natural stable channel   CON: replicate an existing natural unstable channel or differing conditions
- Empirical- PRO: quick and easy CON: quick and easy wrong answers
- Analytical- PRO: useful for unstable channels and reduces uncertainty CON: expensive, only as good as input data

Habitat

- Habitat: Modify biologic function
  - In stream cover
  - Low flow channels
  - Scour holes
  - Riparian plants
  - Substrate modification

http://aged.ces.uga.edu/

Habitat Structures

Lessons Learned

- **Any experience with natural channel design on small streams or tributaries to the Mississippi River?**

QUESTIONS???