Fluvial Geomorphology and Bank Stabilization – White River at Stotts Creek Confluence

Jessica Eichhorst, P.E.

Purdue Road School

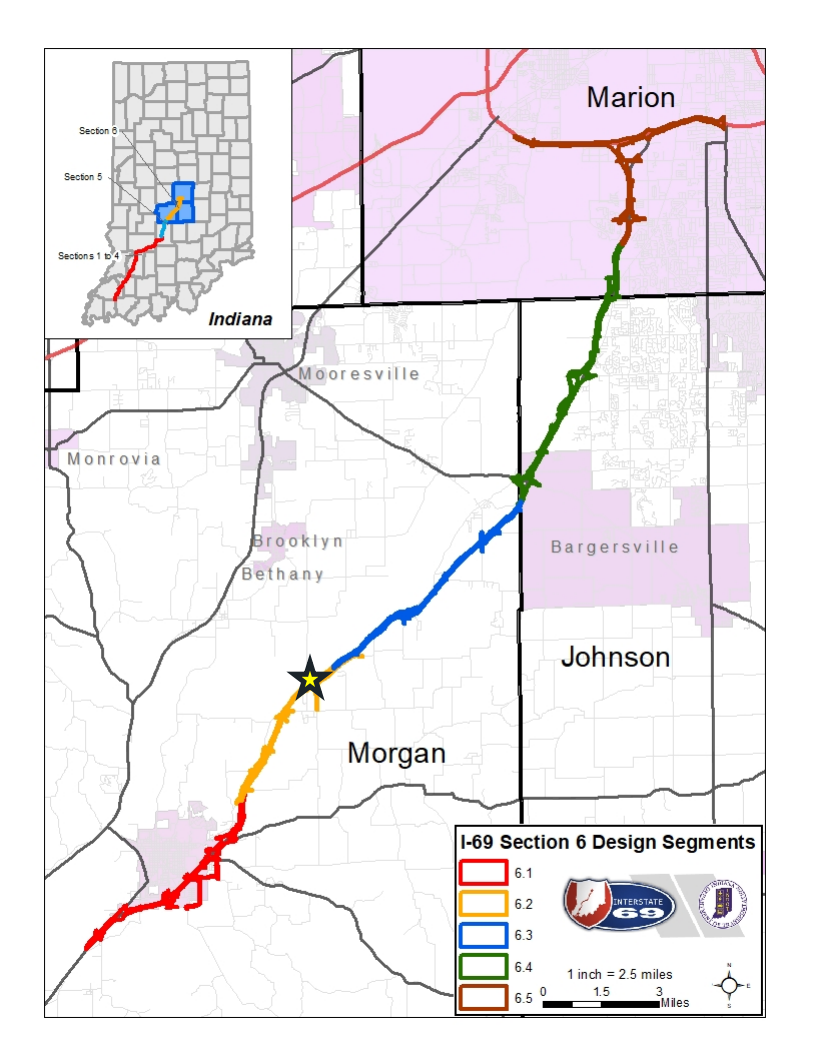
March 5, 2019

HNTB

Outline

- Project Overview
- Geomorphic Assessment
- Hydrologic Assessment
- Hydraulic Assessment
- Stability Provisions
- Conclusion

Project Overview



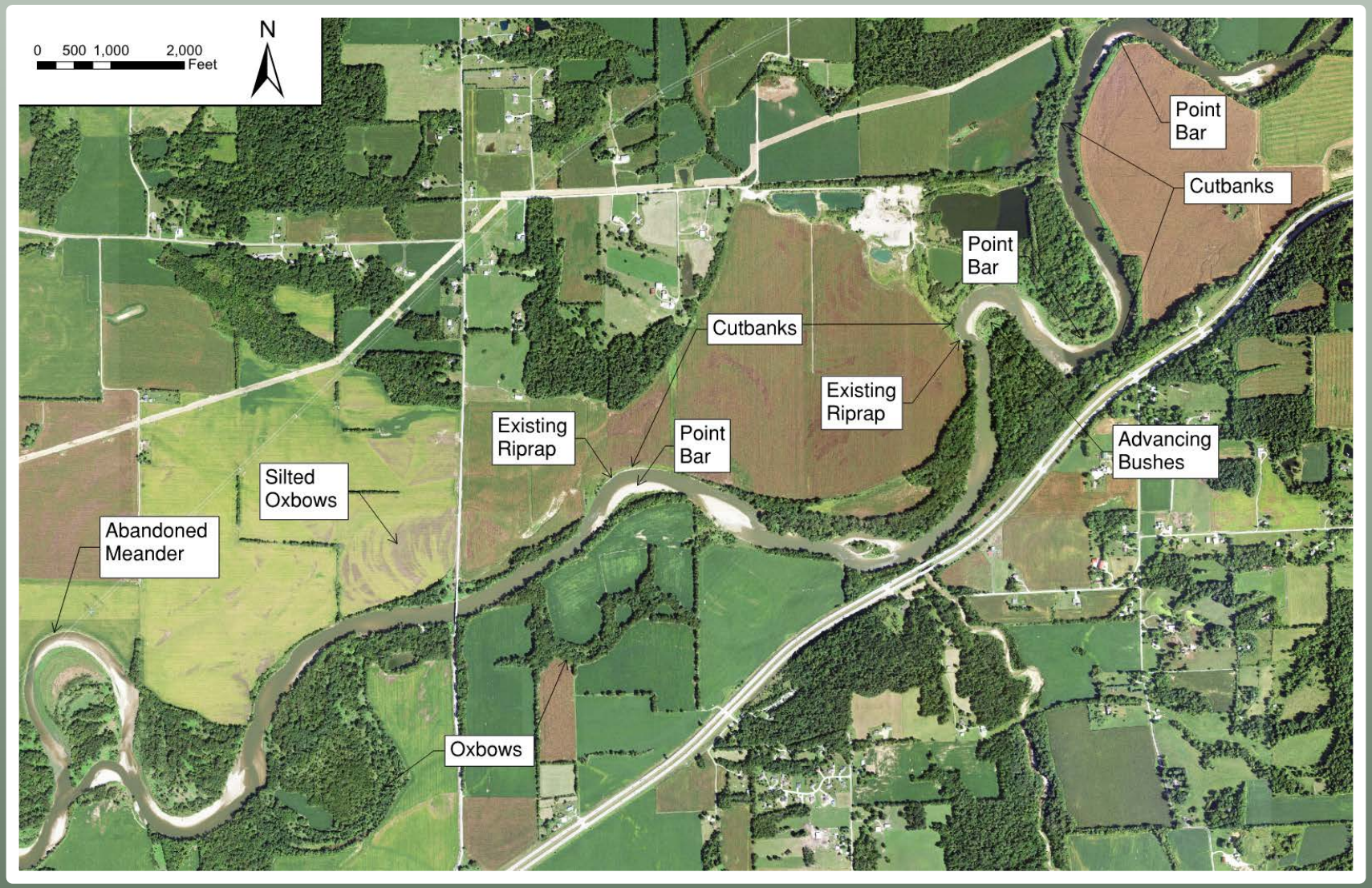
- SR 37 to I-69
  - Completes interstate connection from border to border.
- Significant lateral channel migration at the confluence of Stotts Creek with the White River.
- Protect I-69 from the River:
  - Geomorphic Assessment
  - Preliminary Bank Stabilization
  - Sediment Transport Modeling

HNTB

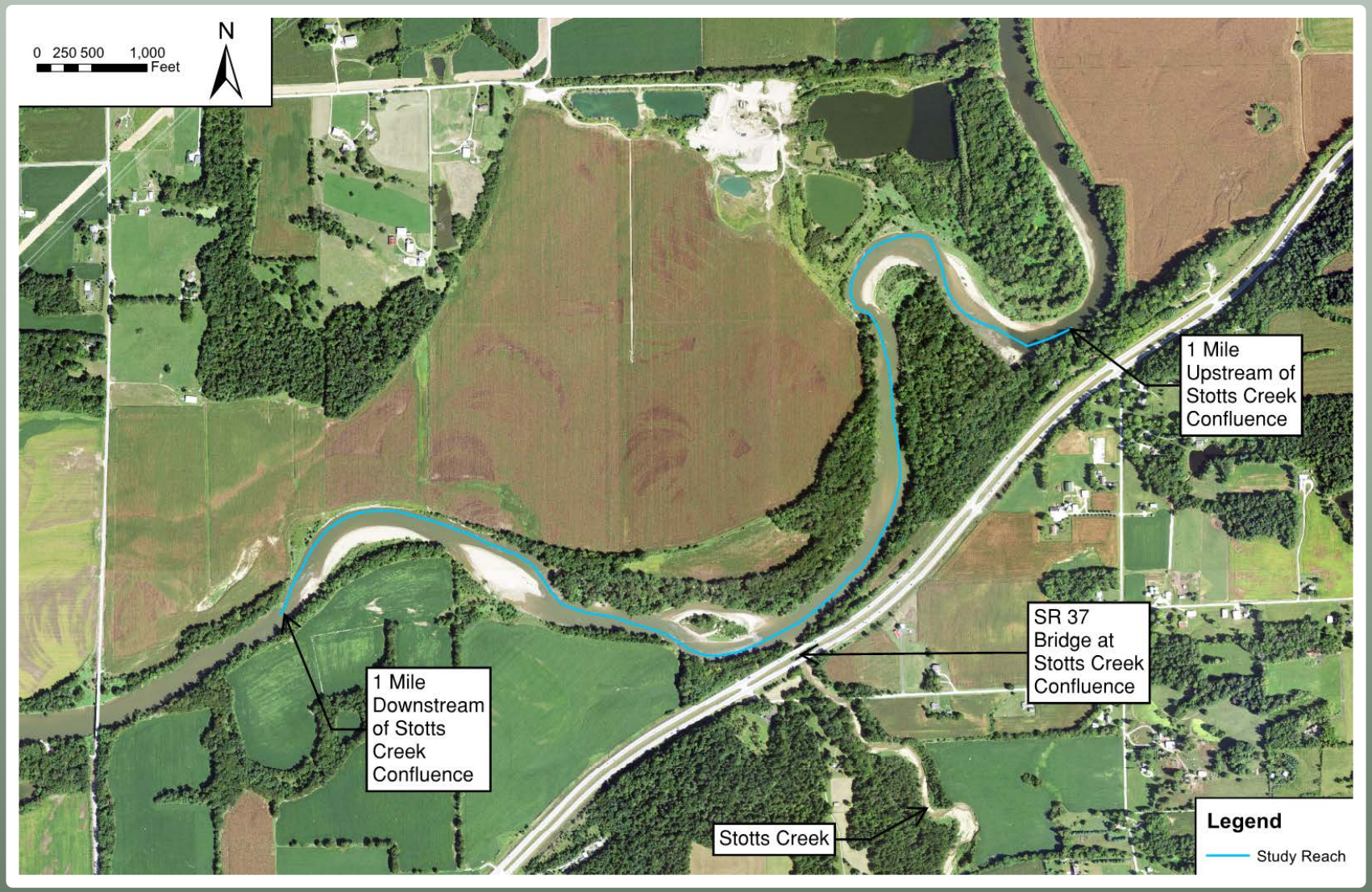
Fluvial Geomorphology

- The study of how rivers and streams move or change their cross section and adjacent land form over time under the influence of water.
- High flows pick up sediment, redistribute as flow subsides and velocity decreases.
- Affected by human activities
  - Deforestation
  - Farming
  - Impervious Areas

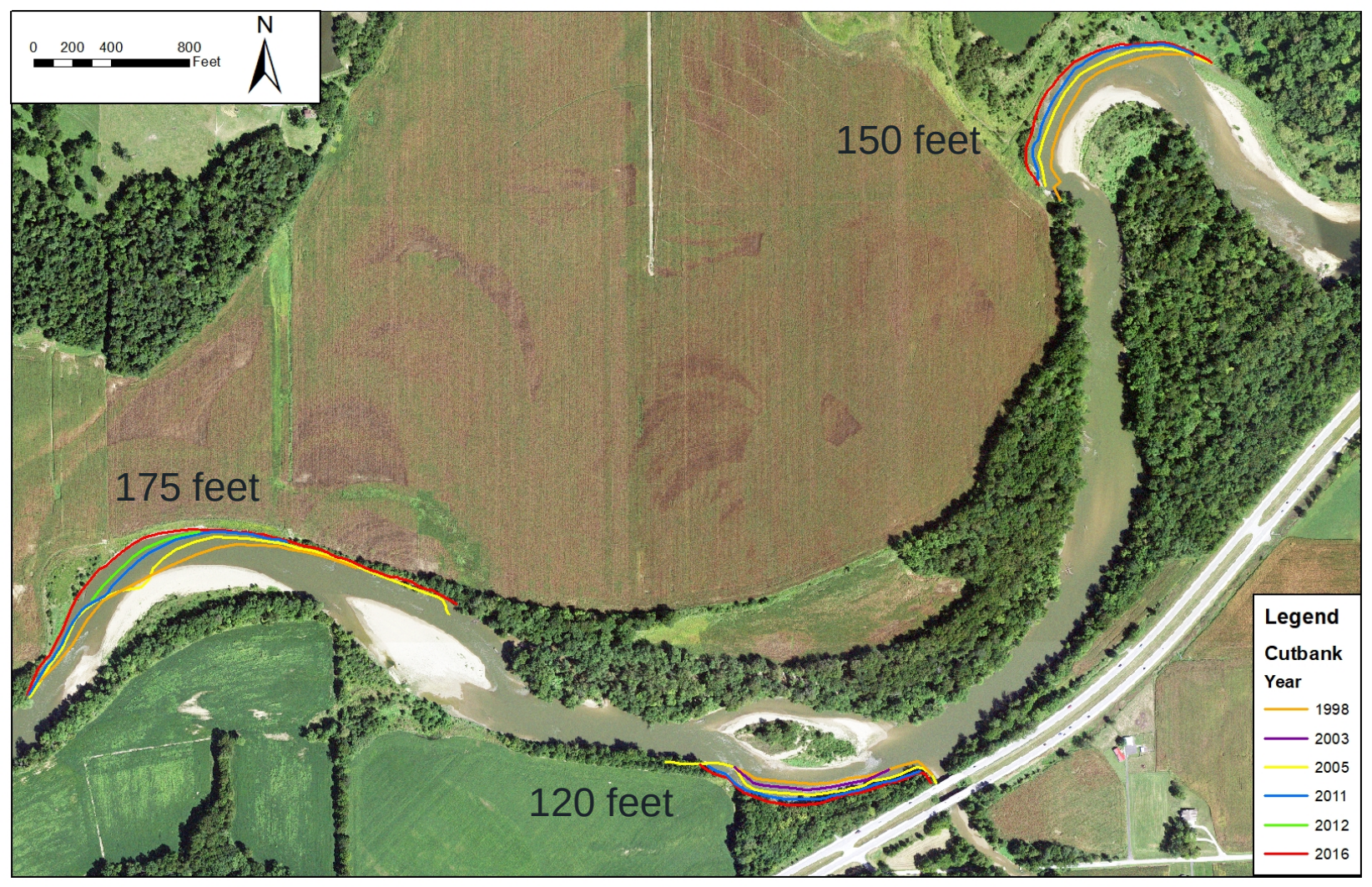
Meandering Channel Features



Study Reach


0 250 500 1,000
Feet
N
1 Mile Upstream of Stotts Creek Confluence
SR 37 Bridge at Stotts Creek Confluence
1 Mile Downstream of Stotts Creek Confluence
Stotts Creek
Legend
Study Reach

Cutbank Movement



Field Investigation

- Kayaked and photographed
- Existing condition of the river
- Existing bank protection in-place
- Test pits at various locations

Exposed Roots

Fallen Trees

Stotts Creek Bridge

Stotts Creek Confluence Looking Downstream

Stotts Creek Confluence Looking Upstream

Cut Bank near SR 37

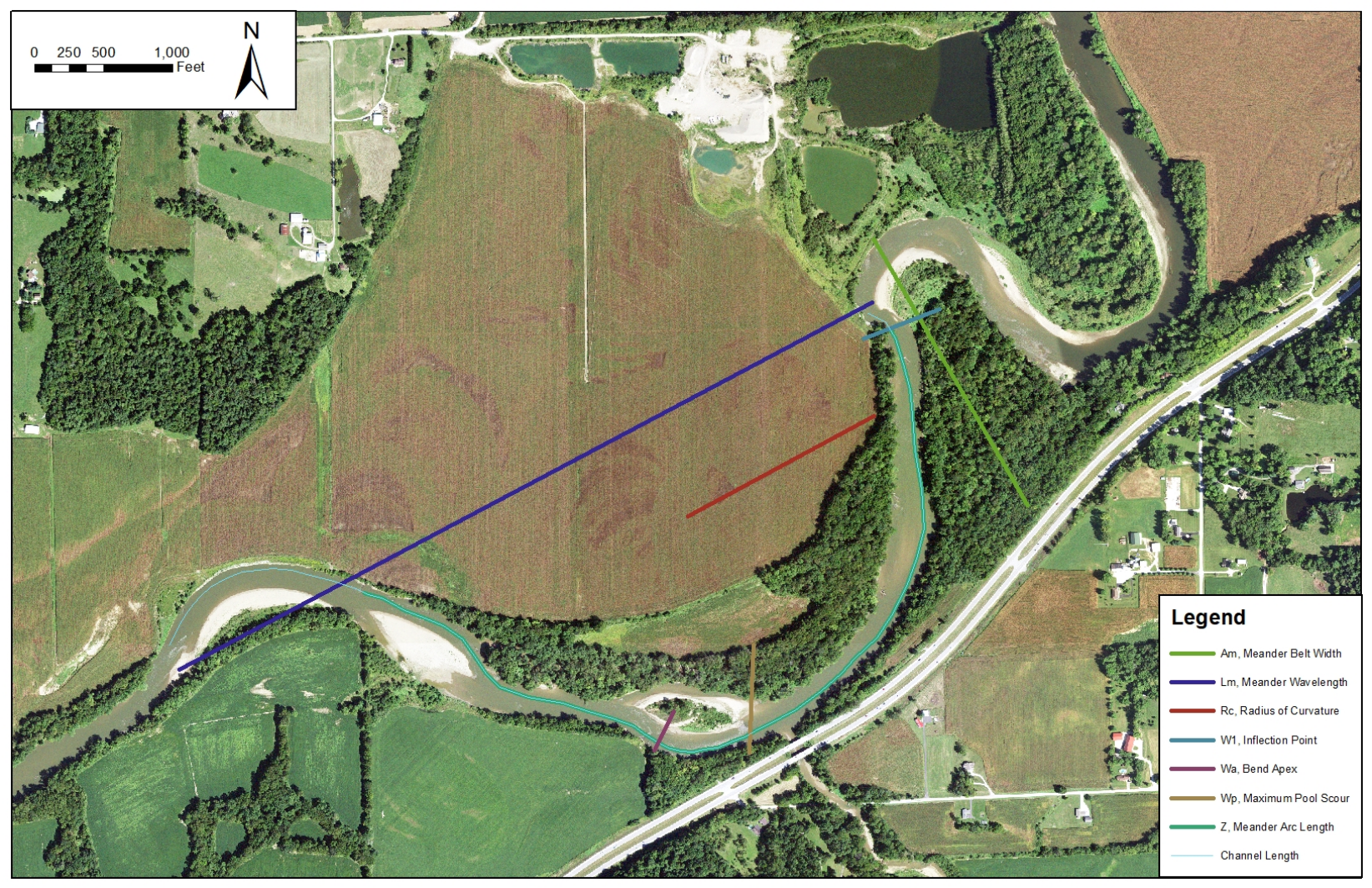
Significant Erosion near SR 37

Existing Protection In-place

Planform Data

Parameter	Value	Units	Source
Basin Slope	0.0004	ft/ft	FIS Profile
Meander Belt Width, Am	2214	ft	Aerial Photography
Meander Wavelength, Lm	5657	ft	Aerial Photography
Flow Length (for Sinuosity)	8527	ft	Aerial Photography
Radius of Curvature, Rc	1522	ft	Aerial Photography
Sinuosity, P	1.5	-	Calculated
Meander Arc Length (Riffle Spacing), Z	6647	ft	Aerial Photography
Reach Average Bankfull Width, W	373	ft	FIS Cross Sections
Floodplain Width	5596	ft	FIS Cross Sections
Width at Meander Inflection Point, Wi	200	ft	LiDAR
Width at Maximum Scour Location, Wp	835	ft	FIS Cross Section
Width at Meander Bend Apex, Wa	300	ft	LiDAR and Aerial
Mean Depth, Dm	15	ft	FIS Cross Section

Planform Measurements

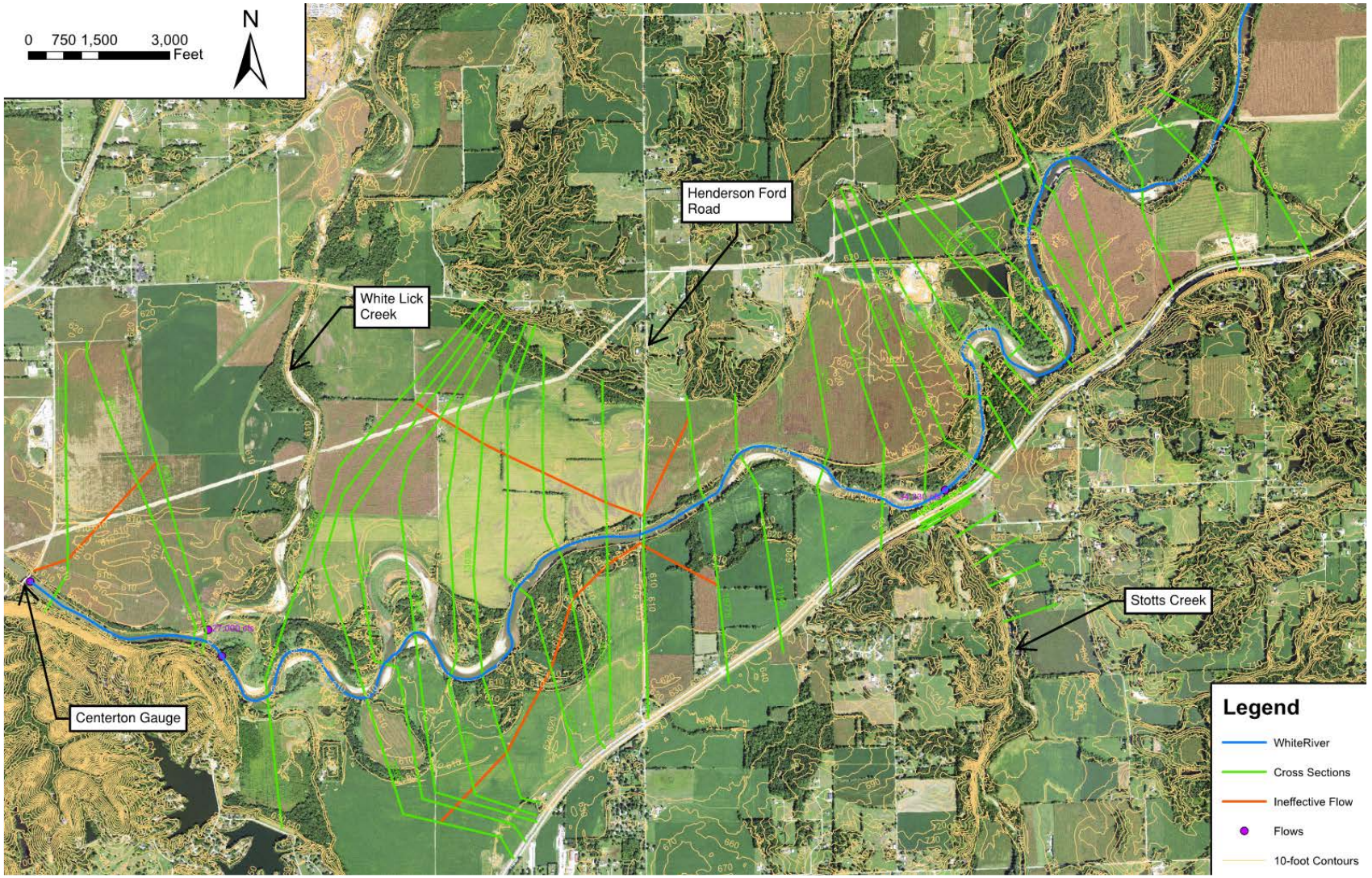


Hydrologic Assessment

- USGS Guage Station – White River Near Centerton
  - Daily flow and temperature data available from 1948 to present
- Joint Probability Analysis
  - White River = 2,500 sq. mi., Stotts Creek = 60 sq. mi., White Lick Creek = 290 sq. mi
- Steady flow
- percentages

Reach	Coordinated Discharge (cfs)	Calculated (cfs)	Design Flow in Model (cfs)	Percent of Flow at Centerton
Above Stotts Creek (100-yr)	-	34330	34330	48.01%
Stotts Creek (50-yr)	-	10170	10170	14.22%
Below Stotts Creek - Above White Lick Creek (100-yr)	-	44500	44500	62.24%
White Lick Creek (50-yr)	27000	-	27000	37.76%
White River at Centerton (100-yr)	71500	-	71500	N/A

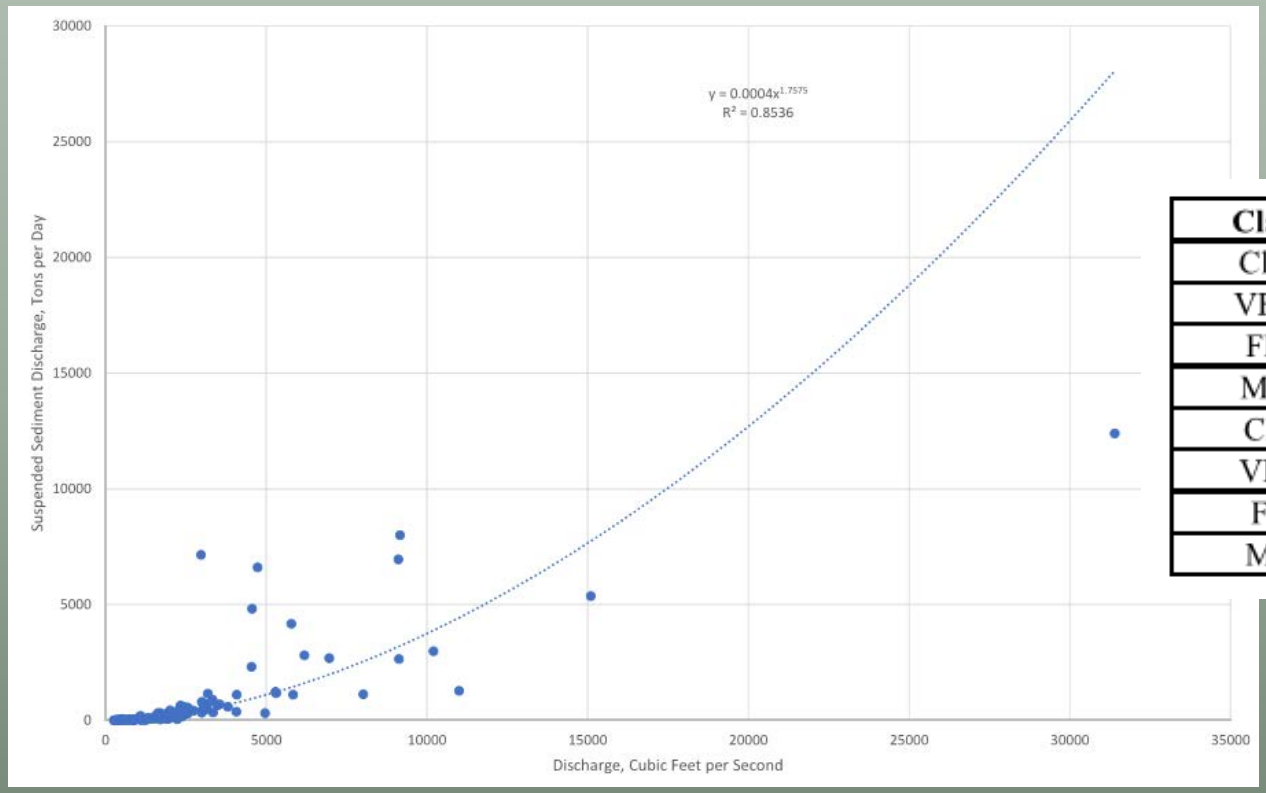
HEC-RAS Modeled Reach



Sediment Transport Modeling Data

- Quasi Unsteady Flow
  - Flow Duration (hours)
  - Computational Increment (hours)
  - Daily Flow (cfs)
  - Temperature (°F)
- Sediment Data
  - Daily data from Centerton Guage
  - Suspended Sediment Rating Curve
  - Suspended Sediment Soil Gradation

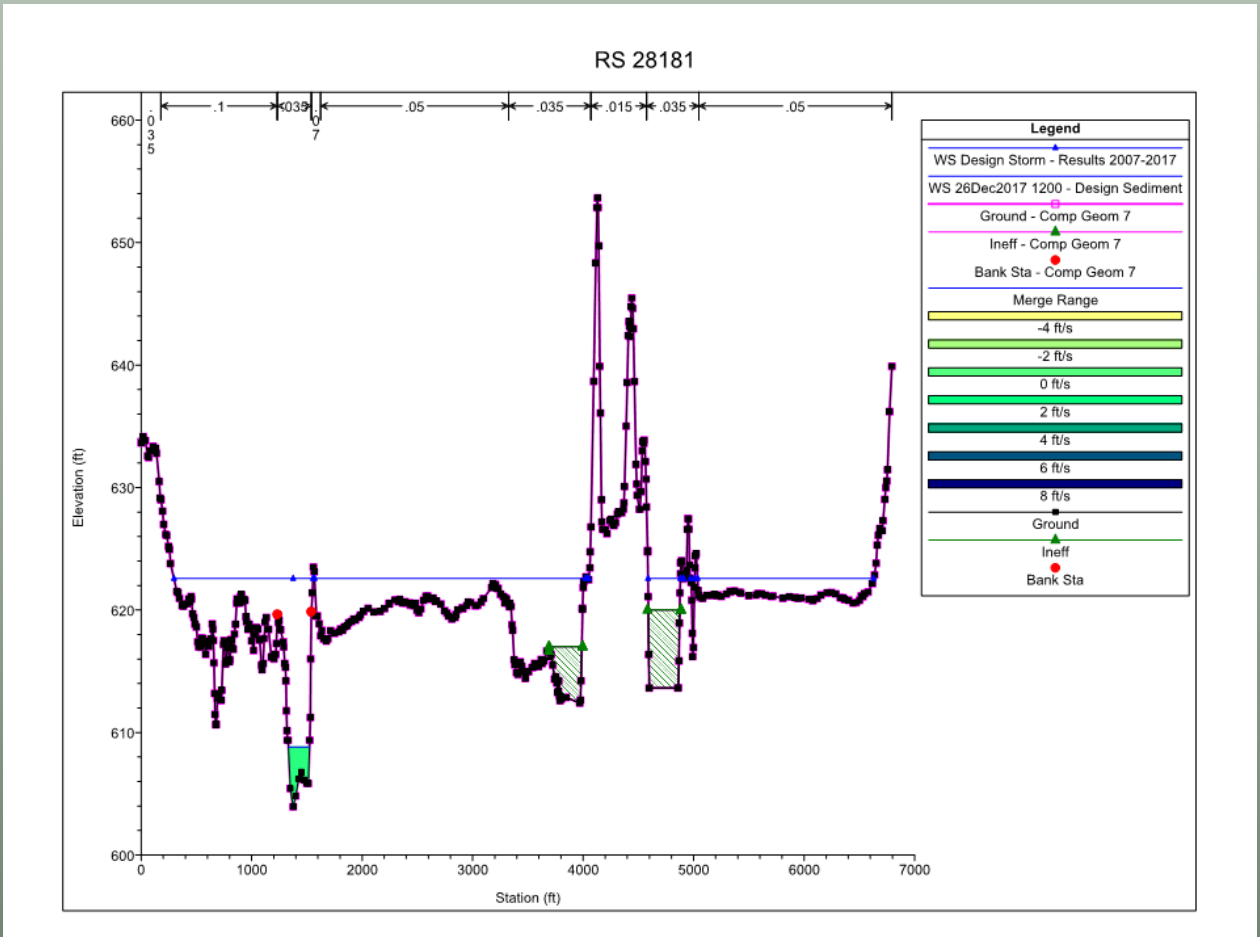
Suspended Sediment Rating Curve and Soil Gradation



Class	Diameter (mm)	% Finer
Clay	0.004	51
VFM	0.008	58
FM	0.016	65
MM	0.032	72
CM	0.0625	78
VFS	0.125	83
FS	0.25	96
MS	0.5	100

Sediment Transport Modeling Results

- Stabilizing bank at SR 37 did not result in changes to the other cross sections



Functions of Bank Stability Provisions

- Establish grade control
- Reduce bank erosion
- Facilitate sediment transport
- Enhance fish habitat
- Maintain width/depth ratio
- Maintain river stability
- Dissipate excess energy
- Withstand large floods
- Maintain channel capacity
- Natural channel design
- Visually acceptable

Bank Stabilization Options

- Cross-Vanes
- W-Weirs
- J-Hooks
- Bendway Weirs
- Check Dams
- Riprap
- Geogrid/Geoweb
- Gabion Baskets
- Retaining Wall
- And more….

Cross-Vane, www.montgomerycountymsd.gov

Geoweb, www.acfenvironmental.com

J-Hook, www.Carleton.edu

W-Weir, www.conejoscanyonranch.com

Gabian Baskets, www.gabions.co.nz

Bendway Weirs

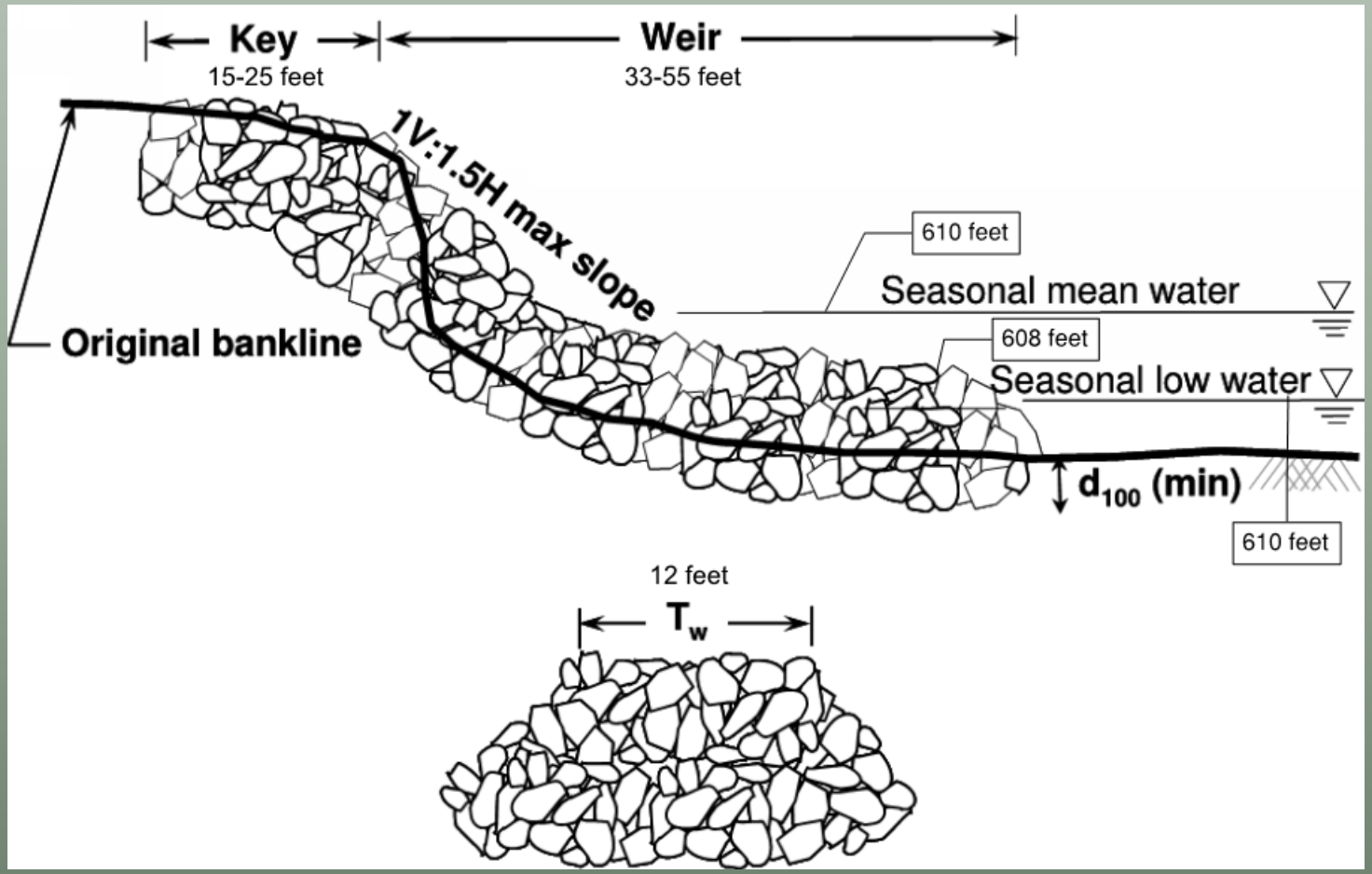
- a.k.a Stream or Bank Barbs
- Flow Deflector
- Used with Stone Toe Protection
- Intended to be overtopped
- Better for larger streams
- Environmentally friendly
- Keyed into bank, more stable
- FHA HEC 23 for design

Photograph Source: WES Stream Investigation and Streambank Stabilization Handbook

(a) Bendway Weirs on Harland Creek

(b) Bendway Weirs in Combination with Longitudinal Peaked Stone Toe Protection

Bendway Weir Profile & Cross-Sectional Views



Bendway Weirs Plan View

Conclusion

- ✓ Project Overview
- ✓ Geomorphic Assessment
- ✓ Hydrologic Assessment
- ✓ Hydraulic Assessment
- ✓ Stability Provisions
- ✓ Conclusion

Questions

Contact Information:
jeichhorst@hntb.com
317-972-5310 (direct line)