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

Jessica Eichhorst, P.E.
Purdue Road School
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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
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

Abandoned Meander
Silted Oxbows
Existing Riprap
Point Bar
Cutbanks
Existing Riprap
Oxbows
Point Bar
Cutbanks
Advancing Bushes
Study Reach

Legend
- Study Reach

- 1 Mile Downstream of Stotts Creek Confluence
- 1 Mile Upstream of Stotts Creek Confluence
- SR 37 Bridge at Stotts Creek Confluence
- Stotts Creek
Field Investigation

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

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

- USGS Gauge 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

<table>
<thead>
<tr>
<th>Reach</th>
<th>Coordinated Discharge (cfs)</th>
<th>Calculated (cfs)</th>
<th>Design Flow in Model (cfs)</th>
<th>Percent of Flow at Centerton</th>
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<tbody>
<tr>
<td>Above Stotts Creek (100-yr)</td>
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<td>34330</td>
<td>34330</td>
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<tr>
<td>Stotts Creek (50-yr)</td>
<td>-</td>
<td>10170</td>
<td>10170</td>
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<tr>
<td>Below Stotts Creek - Above White Lick Creek (100-yr)</td>
<td>-</td>
<td>44500</td>
<td>44500</td>
<td>62.24%</td>
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<tr>
<td>White Lick Creek (50-yr)</td>
<td>27000</td>
<td>-</td>
<td>27000</td>
<td>37.76%</td>
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<tr>
<td>White River at Centerton (100-yr)</td>
<td>71500</td>
<td>-</td>
<td>71500</td>
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</tbody>
</table>
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

\[ y = 0.0004x^{0.8536} \]

\[ R^2 = 0.8536 \]

<table>
<thead>
<tr>
<th>Class</th>
<th>Diameter (mm)</th>
<th>% Finer</th>
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<tbody>
<tr>
<td>Clay</td>
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<td>51</td>
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<tr>
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<tr>
<td>FM</td>
<td>0.016</td>
<td>65</td>
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<td>MM</td>
<td>0.032</td>
<td>72</td>
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<tr>
<td>CM</td>
<td>0.0625</td>
<td>78</td>
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<tr>
<td>VFS</td>
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<tr>
<td>FS</td>
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<td>96</td>
</tr>
<tr>
<td>MS</td>
<td>0.5</td>
<td>100</td>
</tr>
</tbody>
</table>
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....

[Images of various bank stabilization options with their respective URLs provided]
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

Key
15-25 feet

Weir
33-55 feet

Original bankline

1V:1.5H max slope

Seasonal mean water

Seasonal low water

$12 \text{ feet}$

$\text{Tw}$

$610 \text{ feet}$

$608 \text{ feet}$

$610 \text{ feet}$

$d_{100} \text{ (min)}$
Bendway Weirs Plan View
Conclusion

- Project Overview
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Questions

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