

Hydraulic Analysis and Successful Design for Geomorphology and Risk



By: Gerald Blackler, PE, PhD

Paradigm Shift: Treating water as a resource, not an enemy..



1930s ~1980s



1980s →



Designing for a Spectrum of Events

- High Flows

- Flooding and Damage, Avulsion and Erosion Hazards, Infrastructure, Stripping of Vegetation, Rare

- Low Flows

- Ecology and Stream Health, Long term Stability, Vegetation and Overbanks, Frequent



Combining Visual Assessment with Hydraulic Analysis

- Visually

- Transects (Sections)



- ID Stability / CEM



- Assuming past results



- Hydraulically

- Sections (Uniform Flow)

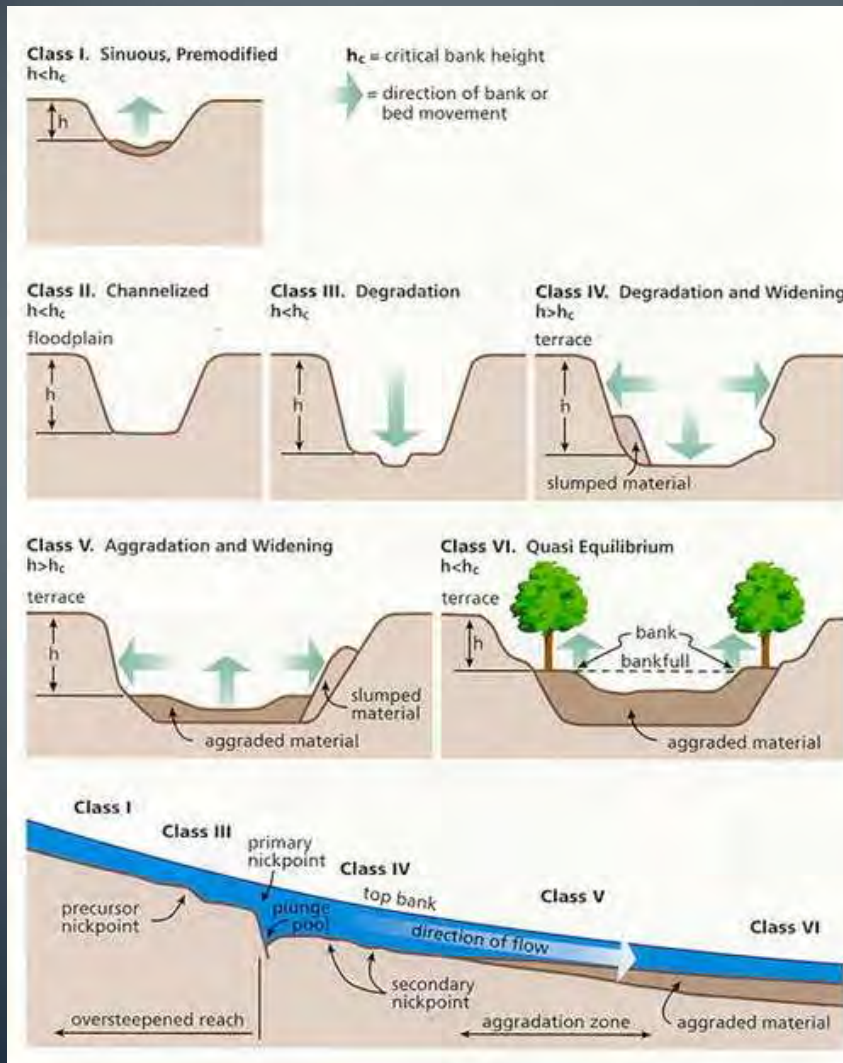
- Models (1D or 2D)

- Replicating Past

- Estimating Future Results

Visual Stream Assessment

Channel Evolution Model (CEM)



- Streams Move
 - Suddenly with one or two large events.
 - Over time with base flows and average high flows

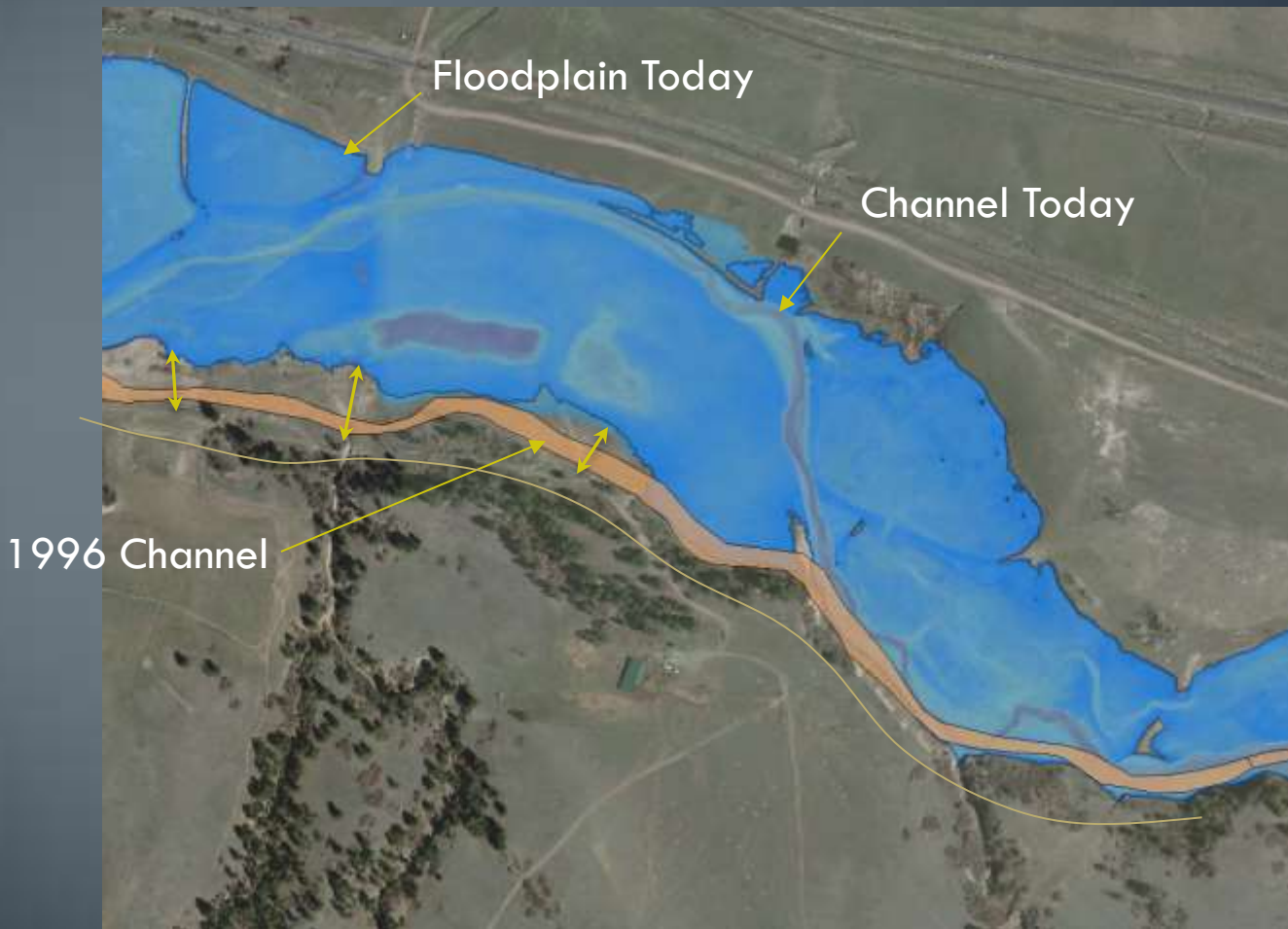
Visual: Mobil Bed / Active Avulsion/Erosion



Visual: Debris Height, Secondary Channels, Armoring Size

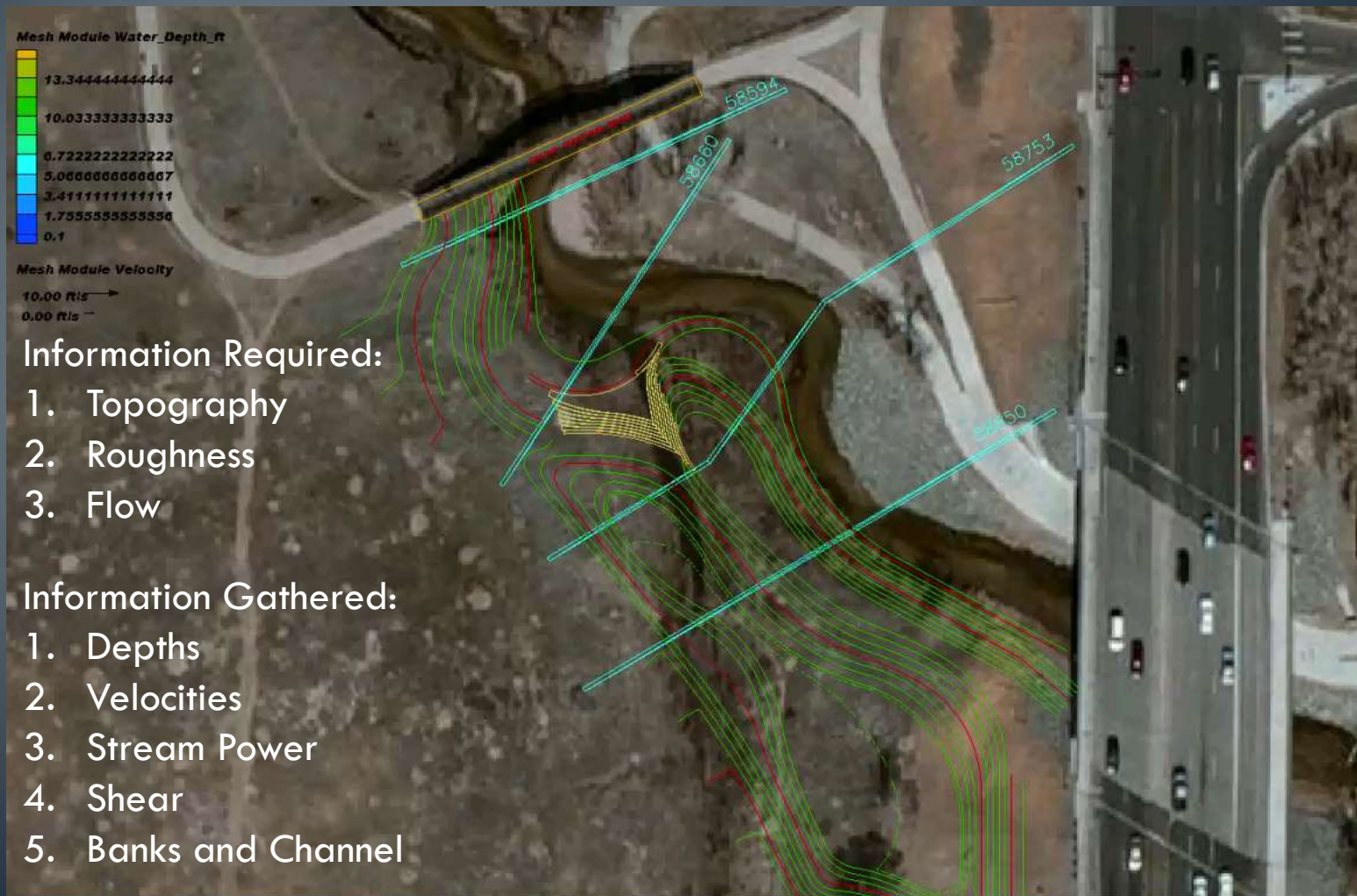


Visual: Erosion / Avulsion



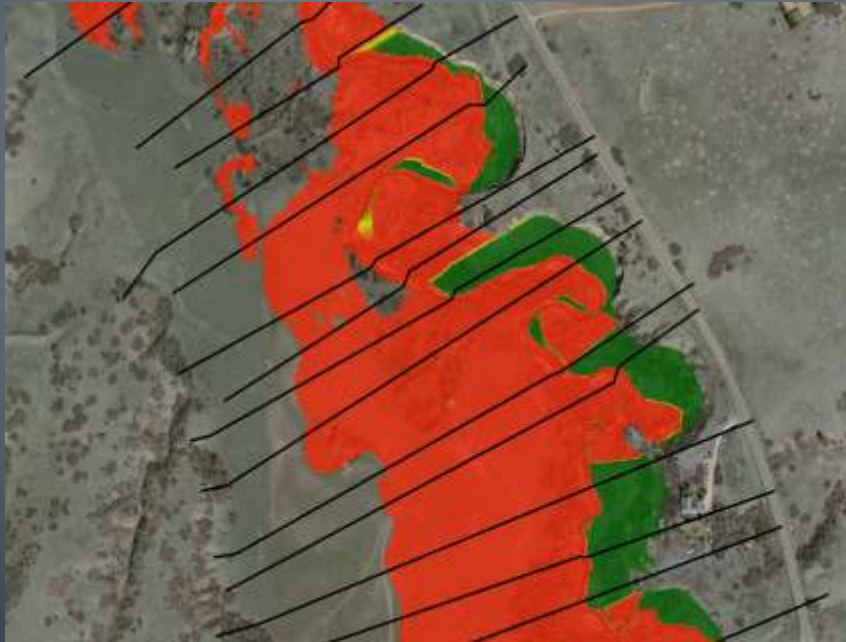
Hydraulic Analysis

Hydraulic Analysis: 1D vs. 2D

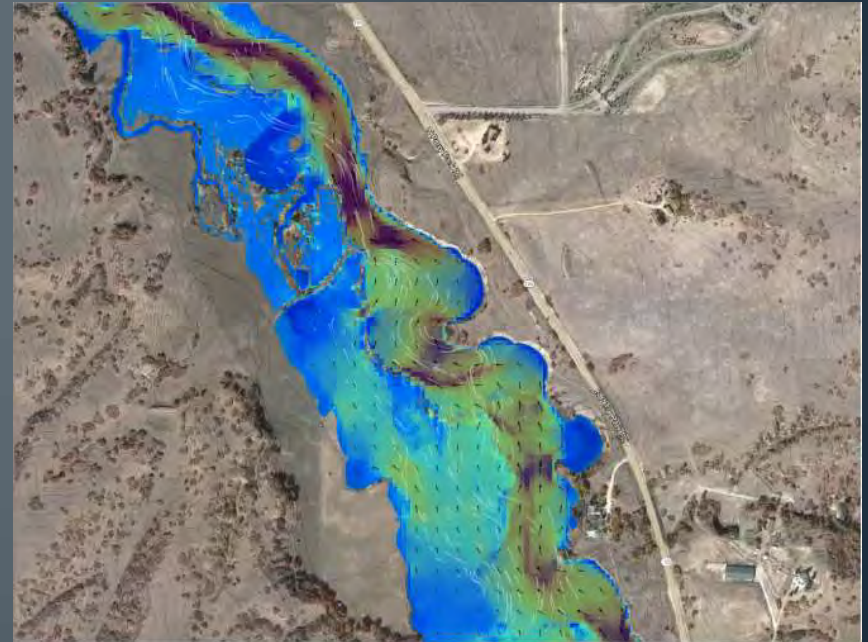


Hydraulic: Hydraulic Models

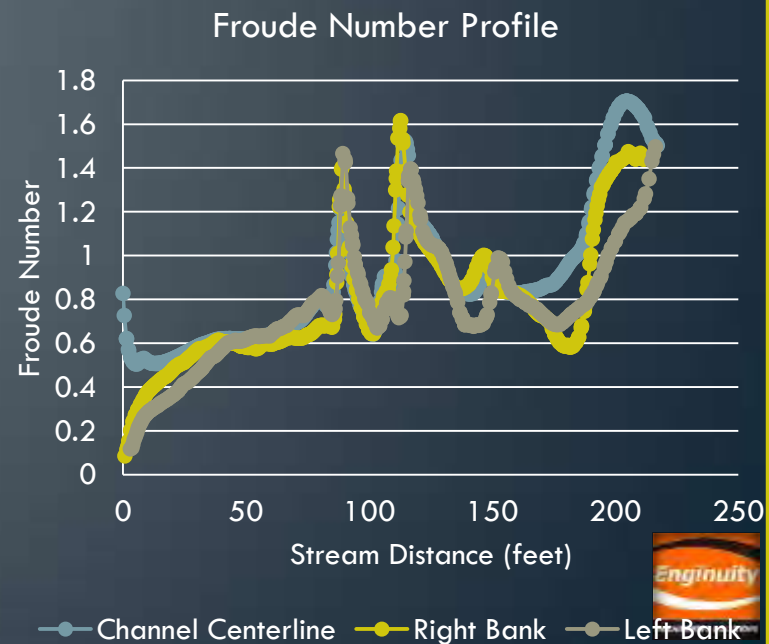
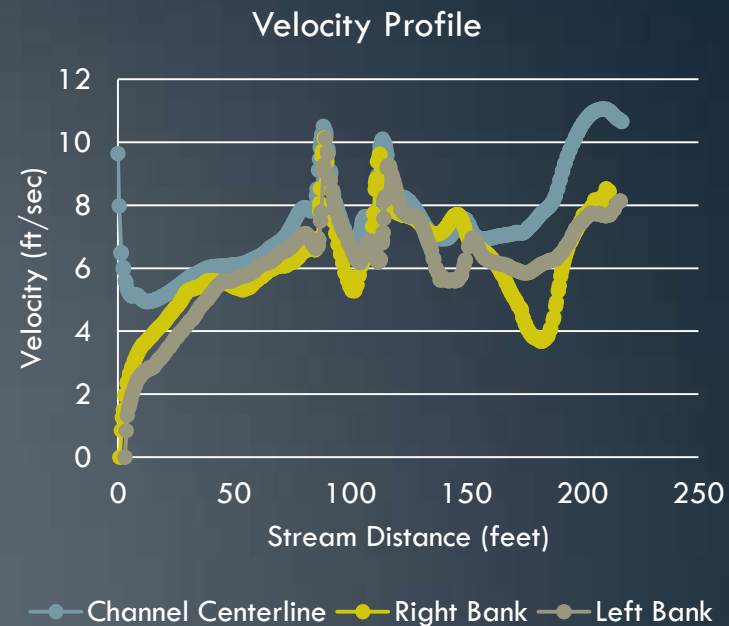
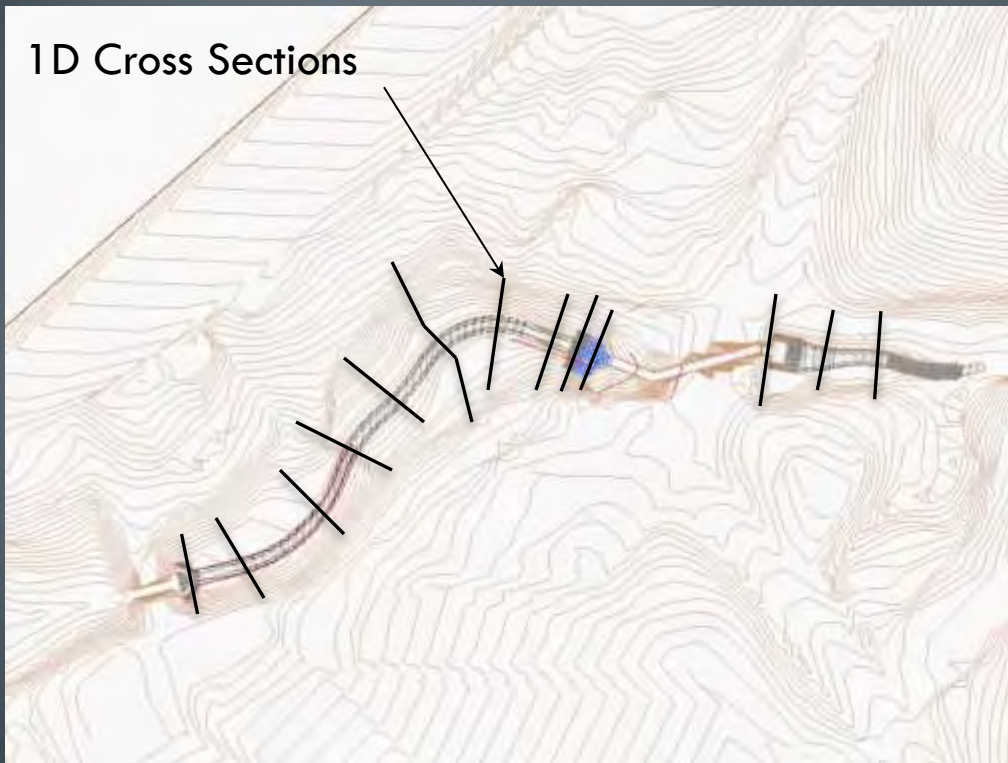
1D - Velocity



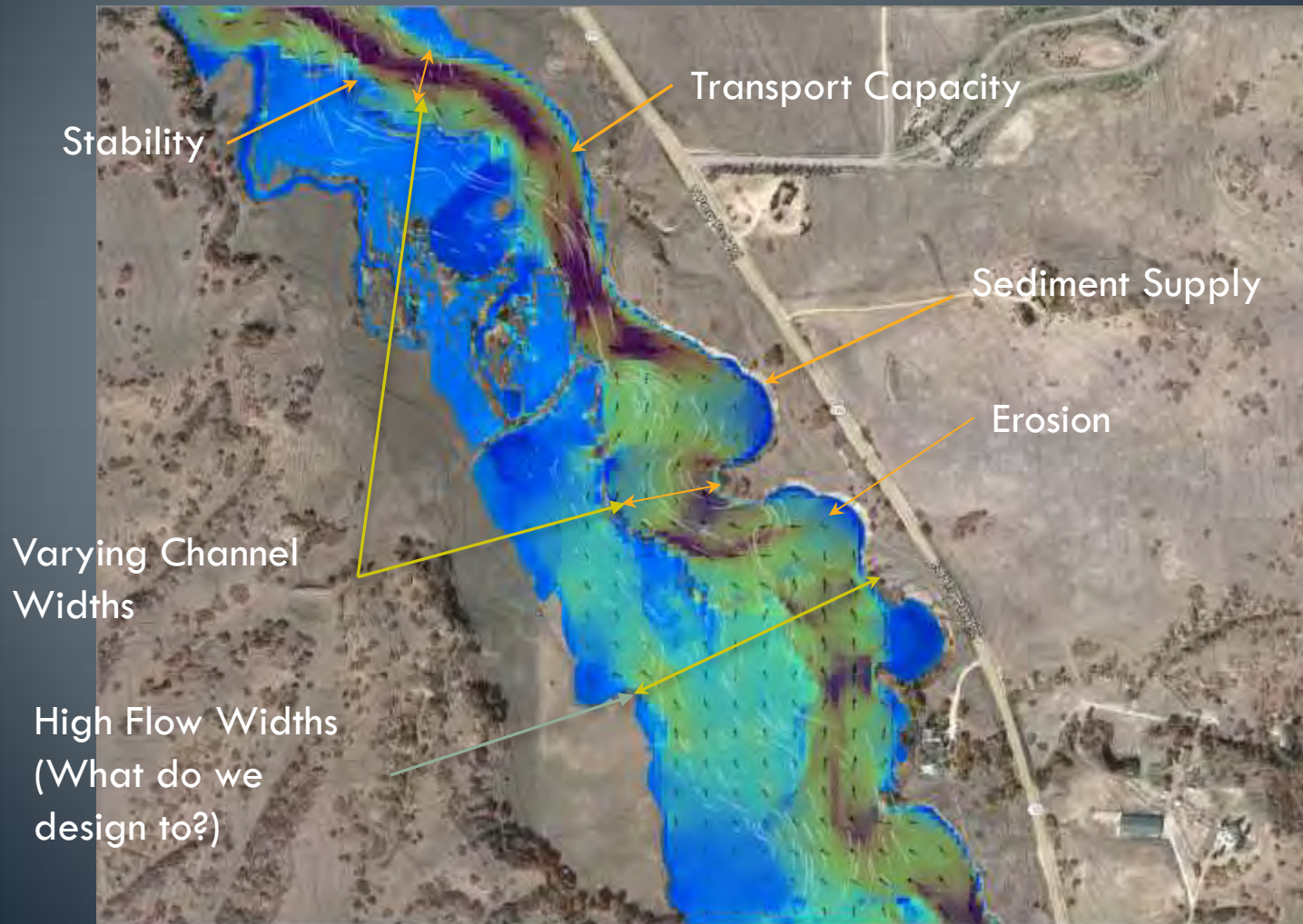
2D - Velocity



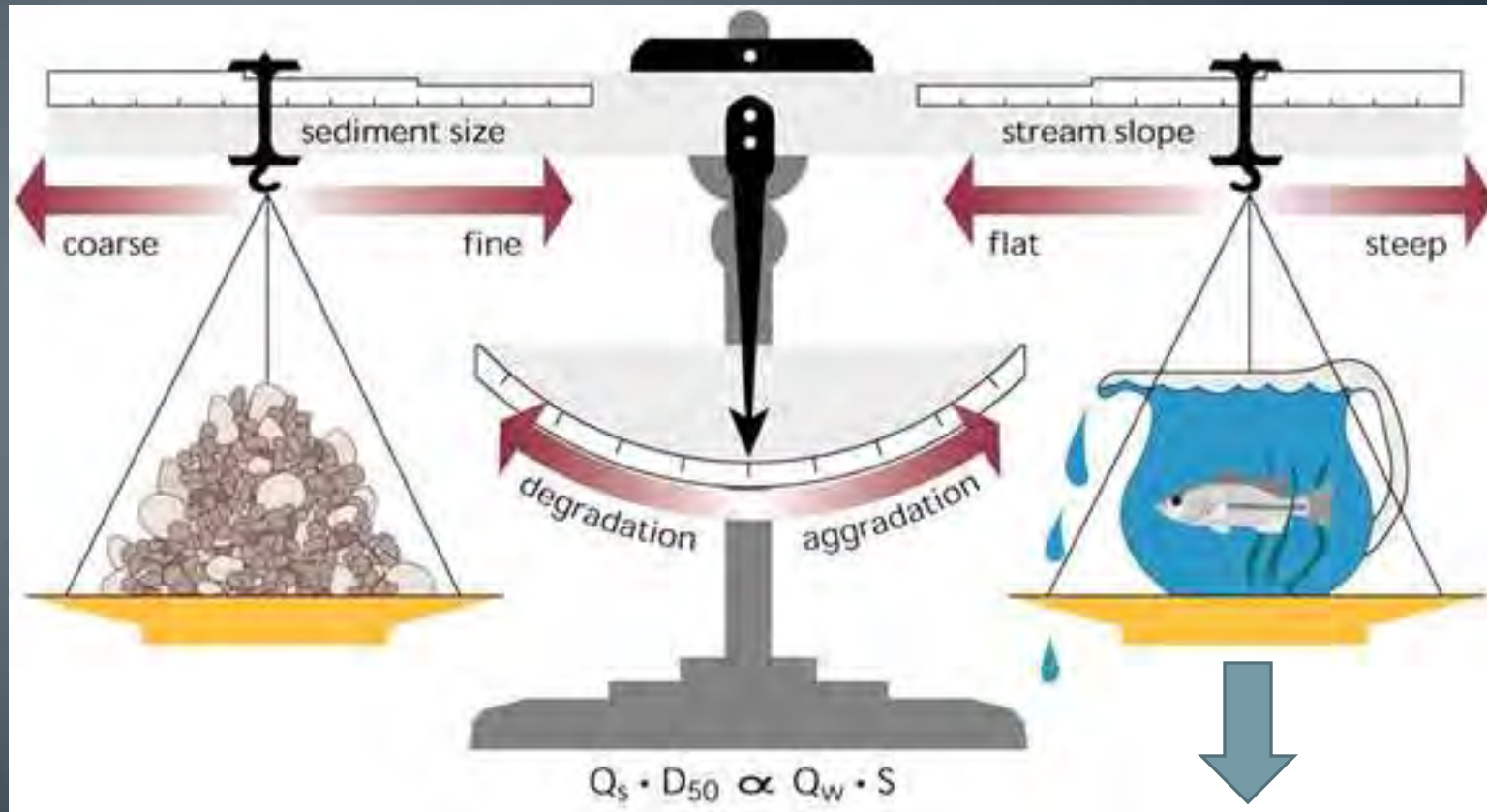
Froude No, Velocity, Power



Hydraulic Analysis

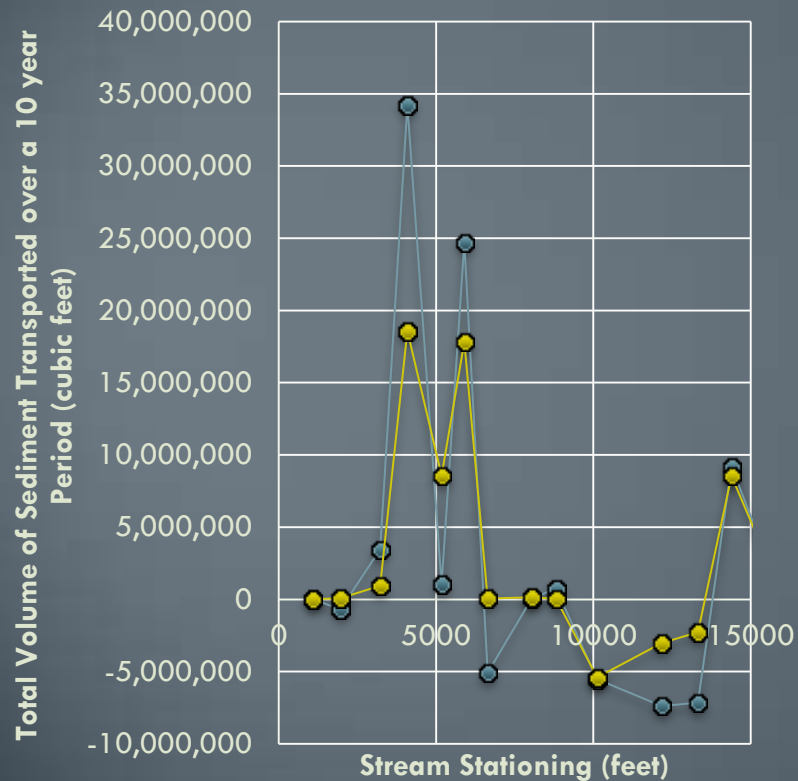


Hydraulics Analysis – Sediment Balance



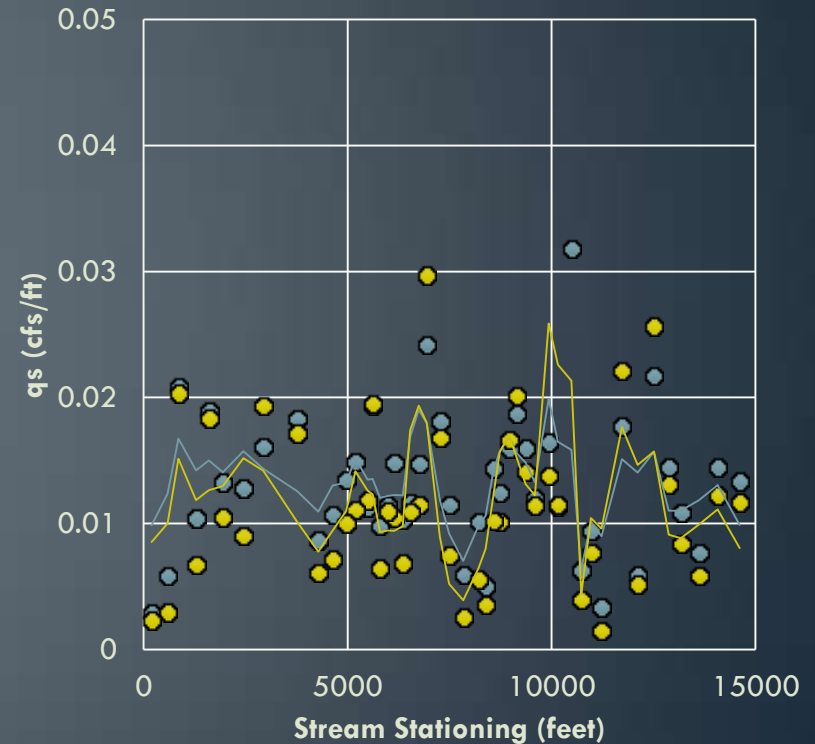
Stable Hydraulics = Stable Transport Rate

GSSHA Total Volume Results



Existing Future

Sediment Transport Rate
Q = 100 cfs



qs (Meyer, Peter, Muller) qs (Simons and Li)

In Summary

- Both are Necessary
 1. Visual
 2. Hydraulic



- Visual

- Channel Movement
- Pre and Post Assessment
- Historic

- Hydraulics

- 2D –
 - Requires Same Information as 1D
 - More information for analysis
- 1D –
 - Meets Regulatory Requirements (FEMA)
 - Less Distributed Results

Designing for Sediment, Erosion, and Hydraulics— New(ish) Tools

- Public 2D Sediment and Hydraulic Models
 - Gridded Surface and Sub-Surface Analysis (GSSHA)
 - (US Army Corps)
 - <https://en.wikipedia.org/wiki/GSSHA>
 - Sediment and River Hydraulic 2D (SRH-2D)
 - US Bureau of Reclamation
 - <http://xmswiki.com/wiki/SMS:SRH-2D>
 - HEC-RAS 2D
 - (US Army Corps) (Beta)
- Visual Assessment
 - GIS
- Erosion and Hazard Analysis
 - **Vermont Geomorphic Assessment Protocols:**
http://www.vtwaterquality.org/rivers/htm/rv_geoassesspro.htm
 - **Watershed Assessment of River Stability and Sediment Supply:**
http://water.epa.gov/scitech/datatit/tools/warsss/http://www.wildlandhydrology.com/assets/CHANNEL_STABILITY.pdf
 - **Framework for delineating channel migration zones: Washington State:**
<https://fortress.wa.gov/ecy/publications/summarypages/0306027.html>

Thank you!



Rare Geomorphic “Stacking”