Stream Function 101 and Clear Creek Stream Restoration Options

HRGreen

AGENDA

- What does a “healthy” stream look like?
- Stream Function 101
- Clear Creek Functional & FGM Assessment
- General Restoration Options
- Q&A

What Does a “Healthy” Stream Look Like?

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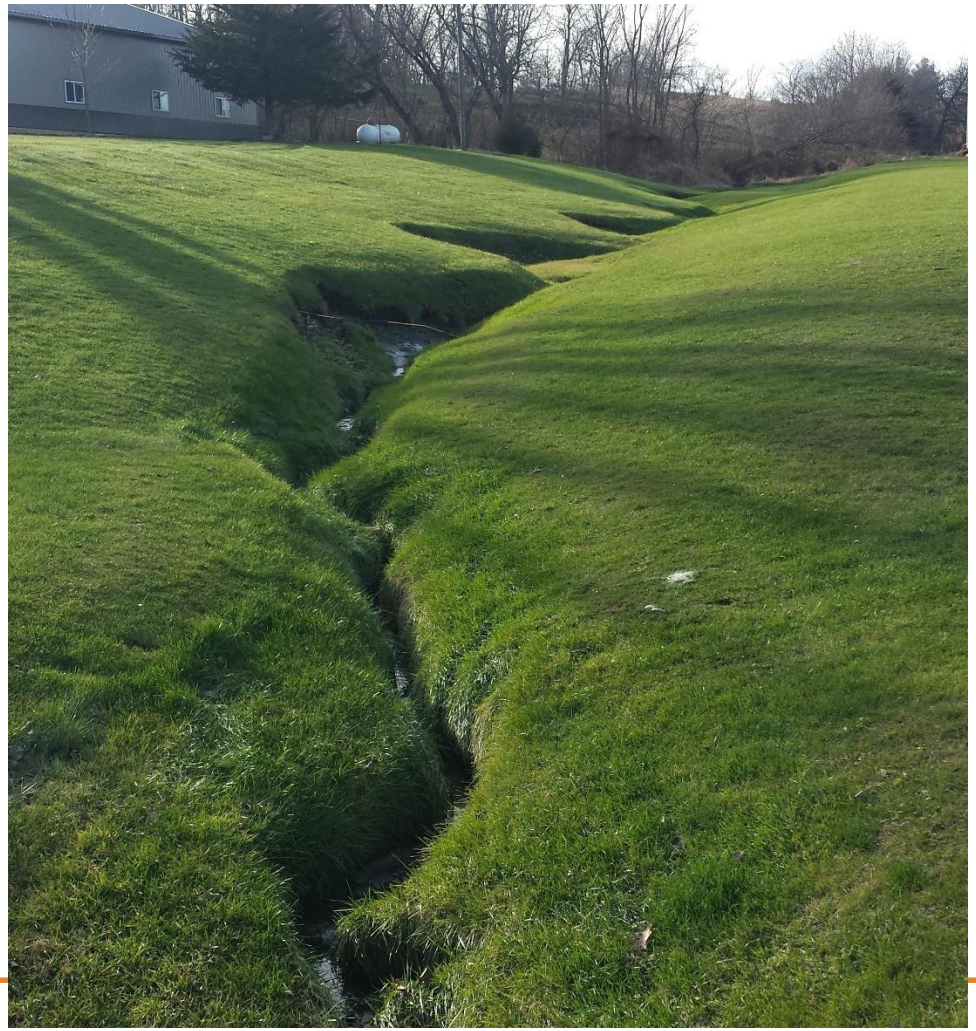

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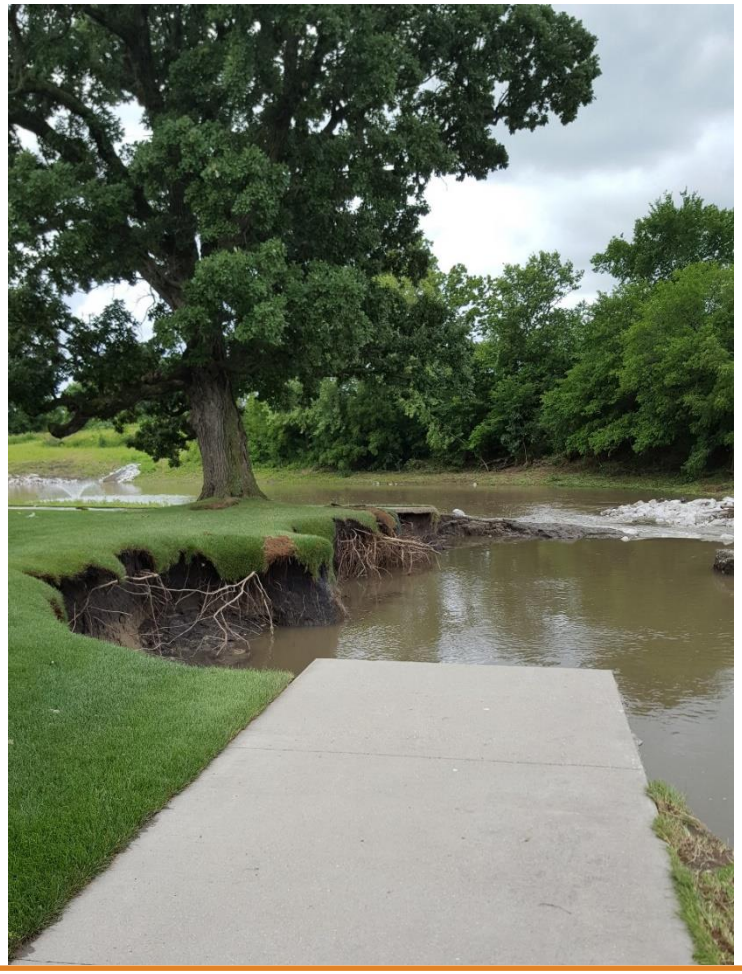


What Does a “Healthy” Stream Look Like?

What Does a “Healthy” Stream Look Like?

What does "Healthy" even mean?

Nerdy Watershed / Stream Terminology

Hydrology = what happens to raindrops after they hit the ground, before they join the stream

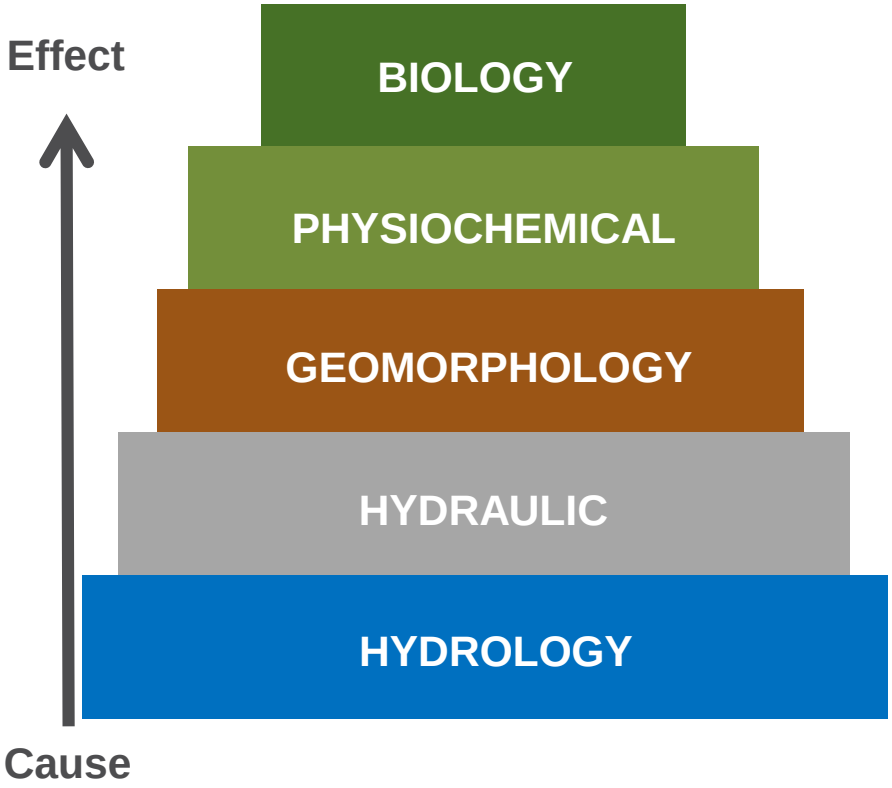
Hydraulics = how fluids behave when moving

Fluvial Geomorphology = Study of the shape of the earth thanks to moving water (and sediment)

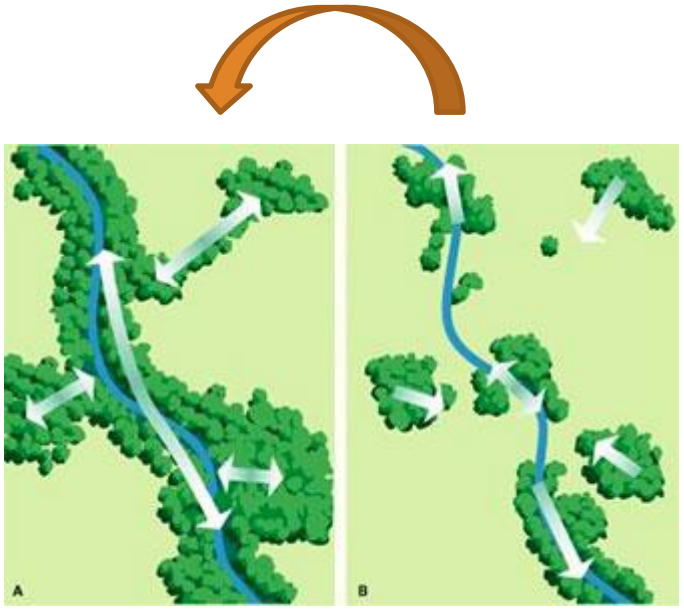
What does “Healthy” even mean?

-> Function-Based Framework

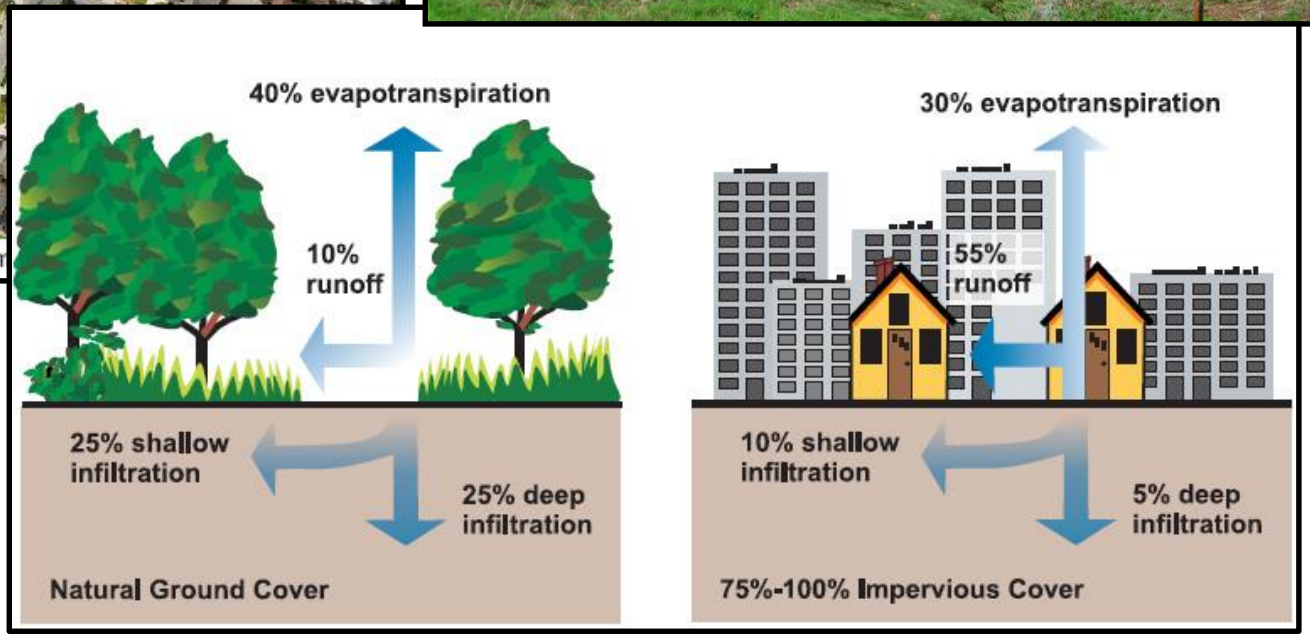
I. Channel Functions



II. Connectivity Functions



HYDROLOGY – THE CHARACTER OF "RUNOFF"



STREAM GEOMORPHOLOGY 101

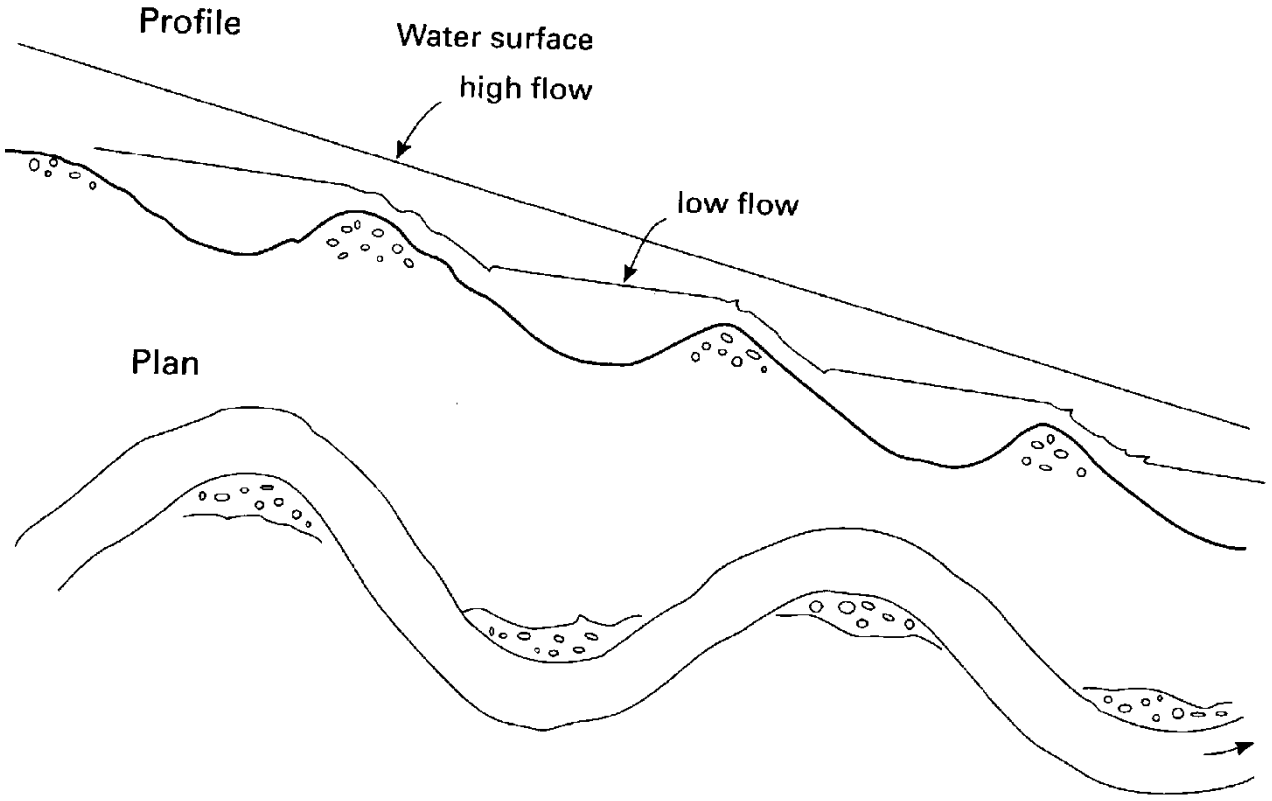
Energy dissipation

- Streams start with potential energy (water up high)
- Potential becomes kinetic when it falls
- Streams dissipate this energy in the form of work (moving water and sediment)
- Linear systems dissipate energy in two principle ways:
    - Sinuosity (meandering)
    - Gradient (riffles, steps, waterfalls, headcuts)

NATURAL SINUOSITY

Vertical Sinuosity

Horizontal Sinuosity

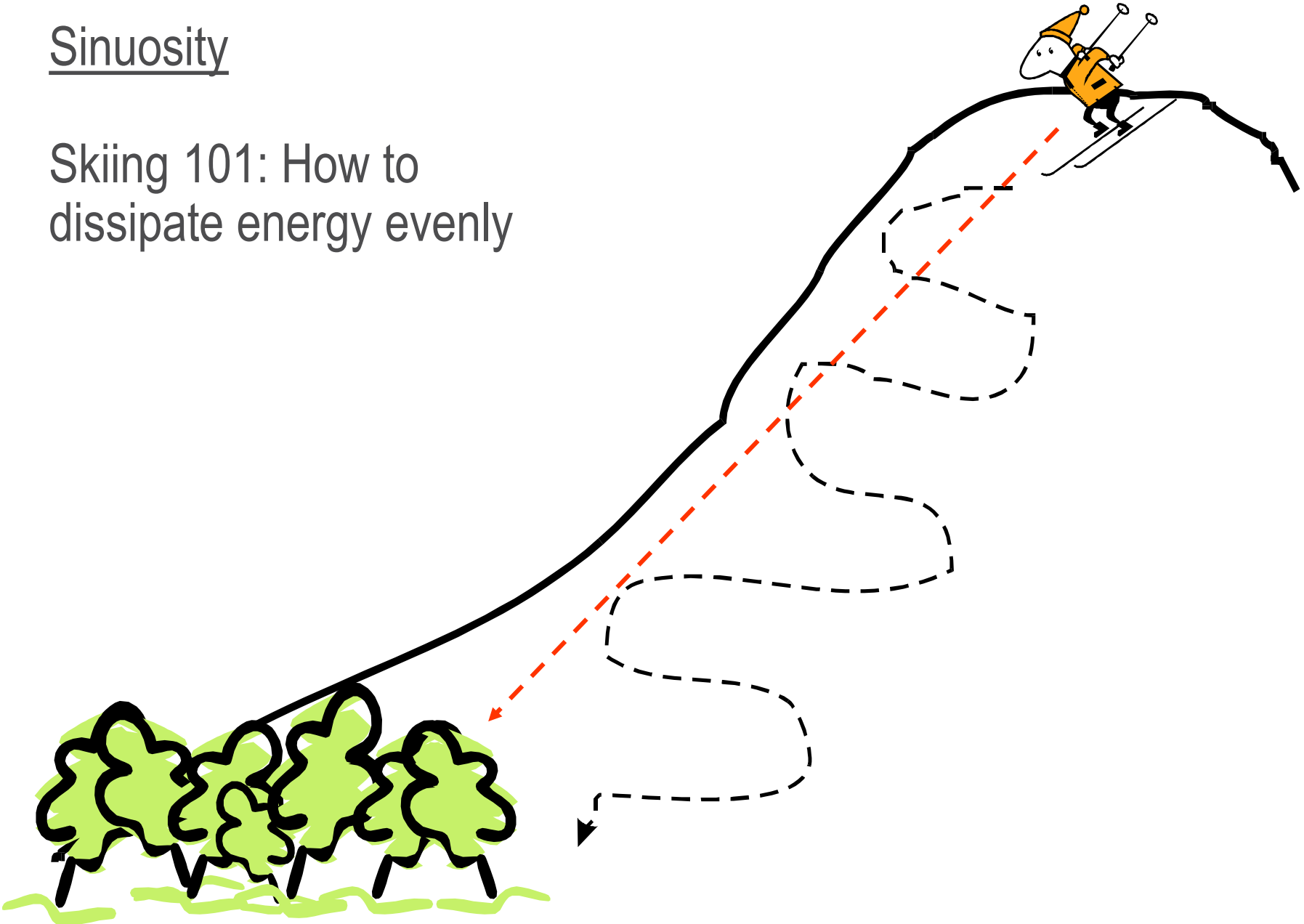


The same patterns appear in water moving through

- Soil (streams)
- Ice (glaciers)
- Water (gulf stream)

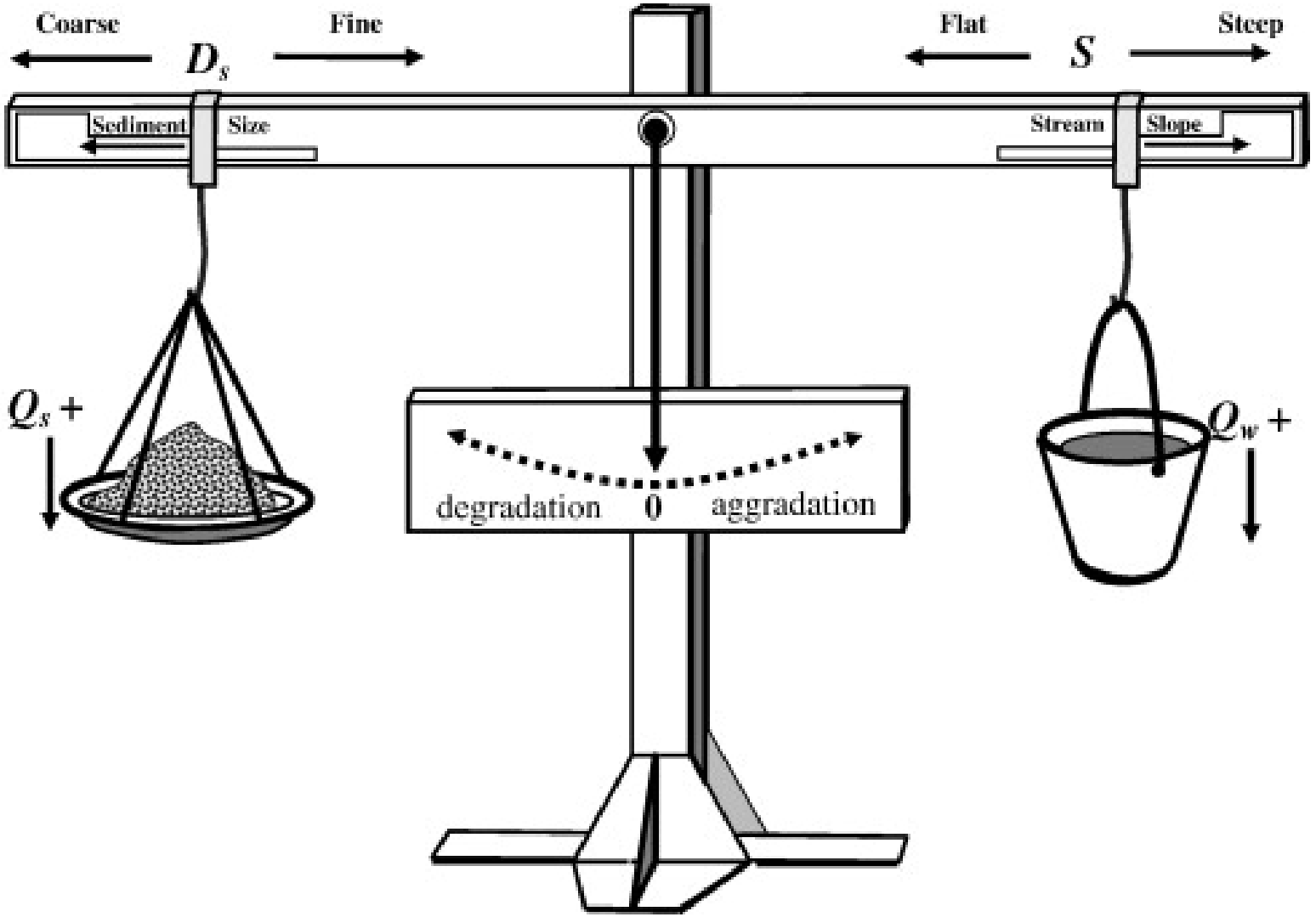
Sinuosity

Skiing 101: How to dissipate energy evenly



Lane's Balance

Streams respond to changes in hydrology, slope or sediment load



Stream Responses to Disturbance

- Vertical (aka “profile”) Responses
  - Aggradation – depositing sediment in channel or on banks
  - Degradation – removing channel material (“incision”)

- Horizontal (aka “planform”) Responses
  - Stream Bank Erosion – failure of one or both banks
  - Bar Formation / Erosion – (think sand bars)
  - Avulsion – short circuiting that cuts off meanders / oxbows

Stream Evolution without Anthropogenic Disturbance?

Storm Related Sediment Flux

Geomorphic Design in Summary

Appropriate stream design is mostly about managing sediment, not water

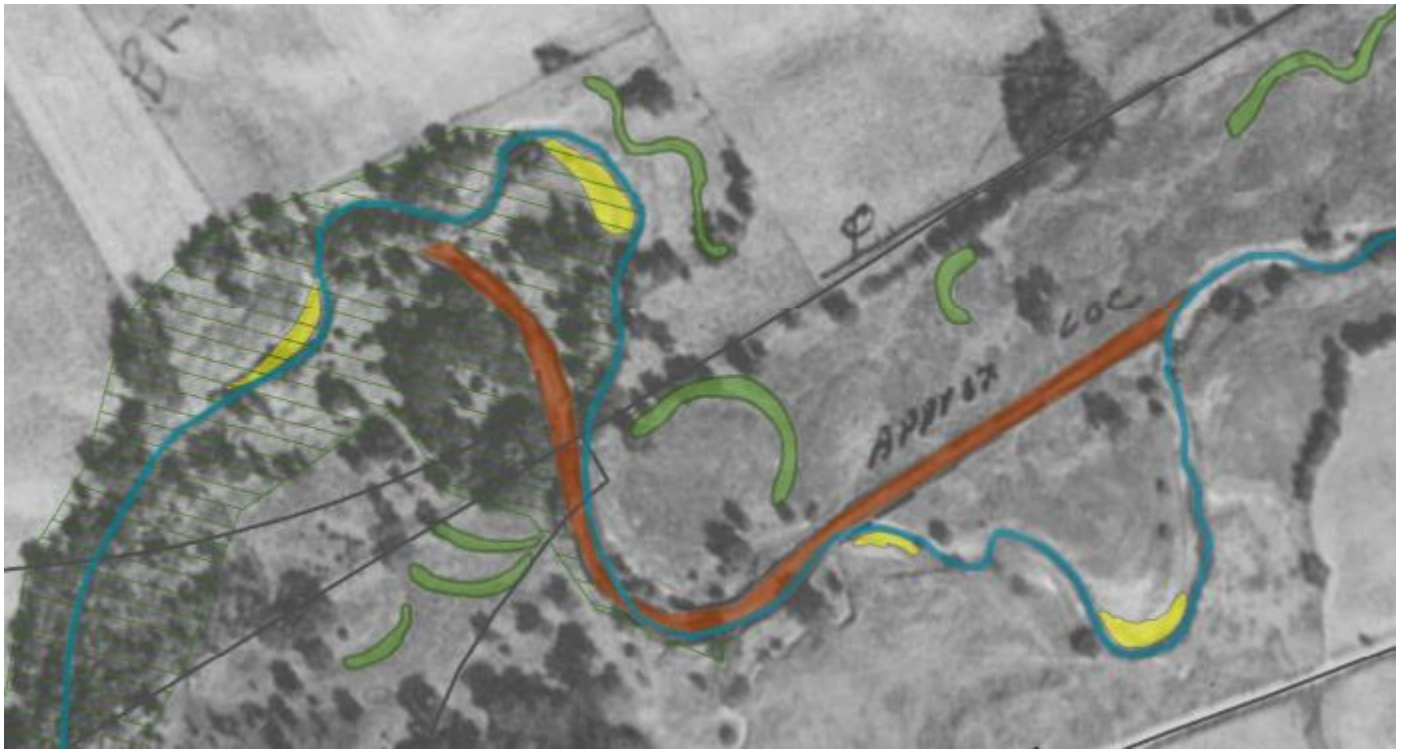
(There's a bunch of other variables too)

Clear Creek Assessment

- Current “Area of Interest” =
  - I-380 to Iowa River (~6 stream miles)
- Historical Context and Evolution
- FGM Assessment - Current State of the Stream

Clear Creek History

1930's Aerial Photography with Proposed Straightening



Clear Creek History

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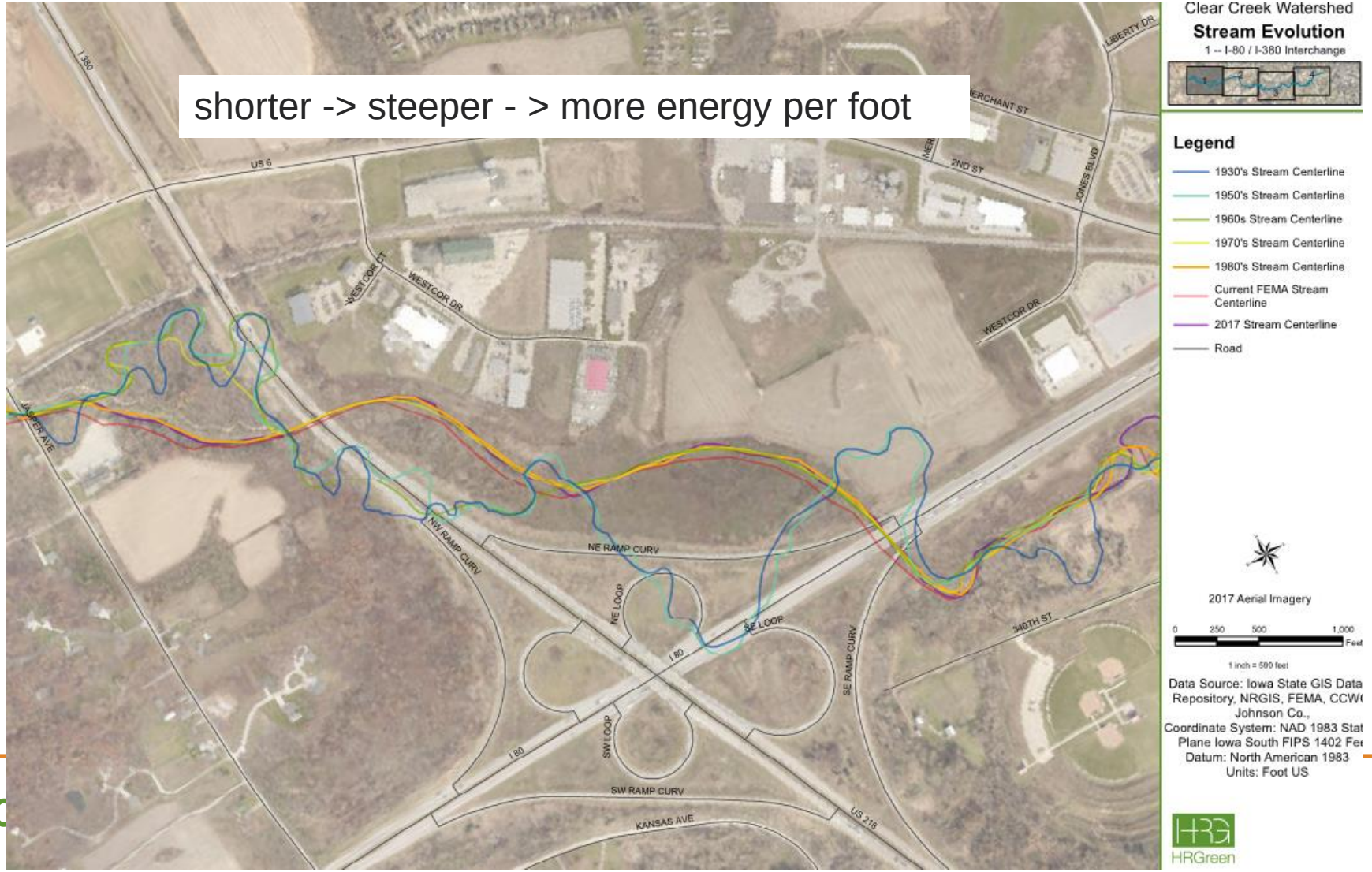

Clear Creek Evolution – Re-Meandering

Clear Creek Assessment – Major Facets

- Hydrology (watershed) – Effort underway
- Hydraulics and Stability - Varies
- Ecology and Habitat – Effort underway

Not Covered Today

- Recreational Elements – Effort underway
- Infrastructure Protection - Varies

Hydrology

- The first step in stabilizing a stream

  -> Stabilize the watershed

  -> Water and Sediment

- Watershed work is underway to this end
  - Agricultural BMPs
  - Urban BMPs
  - Riparian restoration
  - Distributed conservation work

Hydraulics – Profile (Vertical) Stability

- Clear Creek (@ AOI) is a classic “sand bed” stream
  - Not much traditional Riffle-Run-Pool morphology
  - Flat and transient sandy streambed
  - Most vertical “character” (also habitat) is centered around woody debris, also at outside bends
  - A few grade controls exist (natural and man-made)

  - OVERALL – Profile is fairly stable

Wood is extremely important in Clear Creek

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Hydraulics – Planform (Horizontal) Stability

- Some reaches are in extreme transition
  - Typically seen below straightened reaches
  - Eg. the “death bends”
- Some are naturally stable
- Some are artificially stable
- Most are in “dynamic equilibrium”

Sandy-Bank Block Failures are Common

Bank Aggradation or Degradation?
-> Planform Adjustment in Progress

Clear Creek Evolution – Natural Meandering

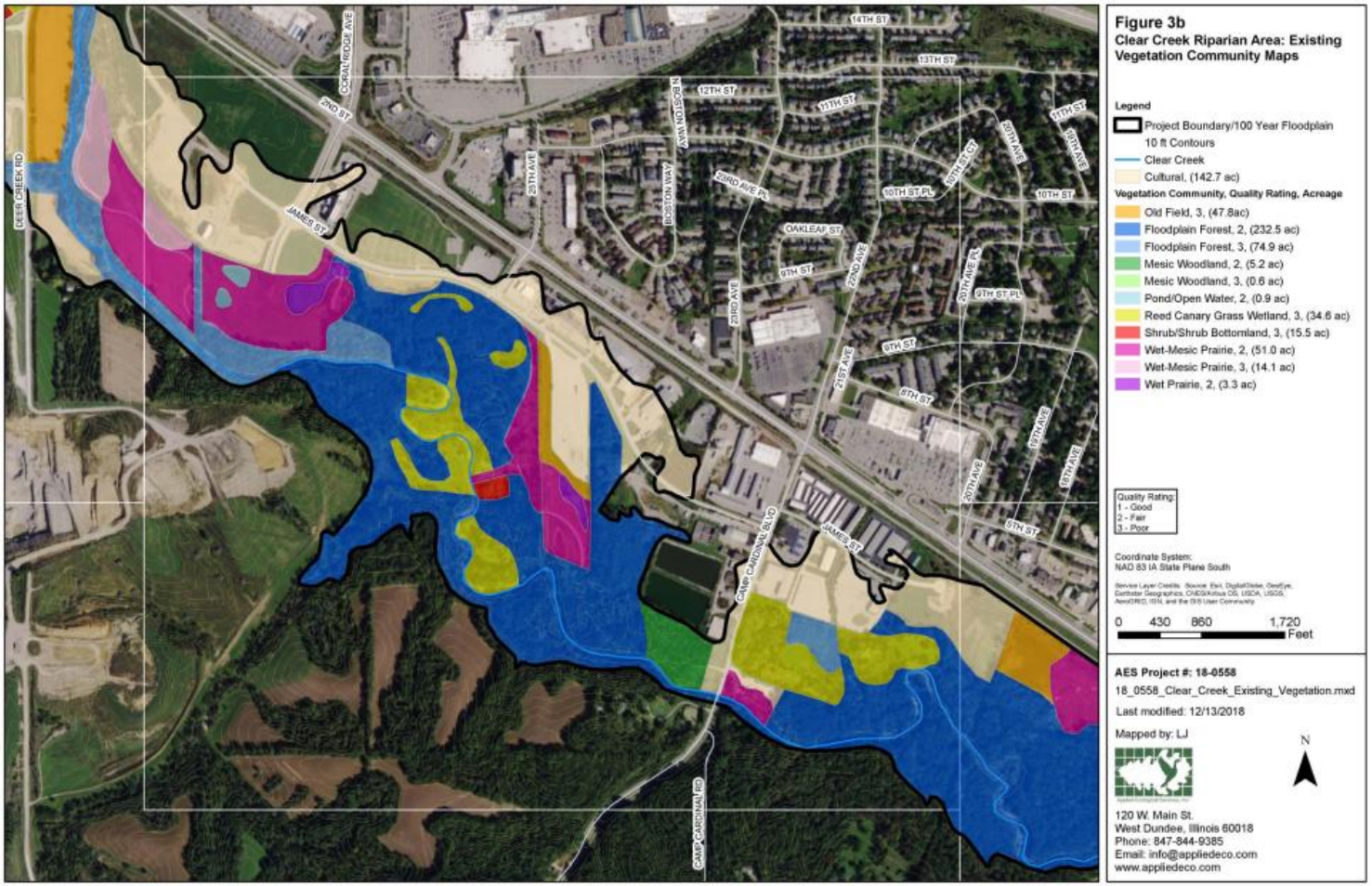
Clear Creek Evolution

Clear Creek Evolution

Clear Creek Evolution - Avulsion

Habitat

Habitat



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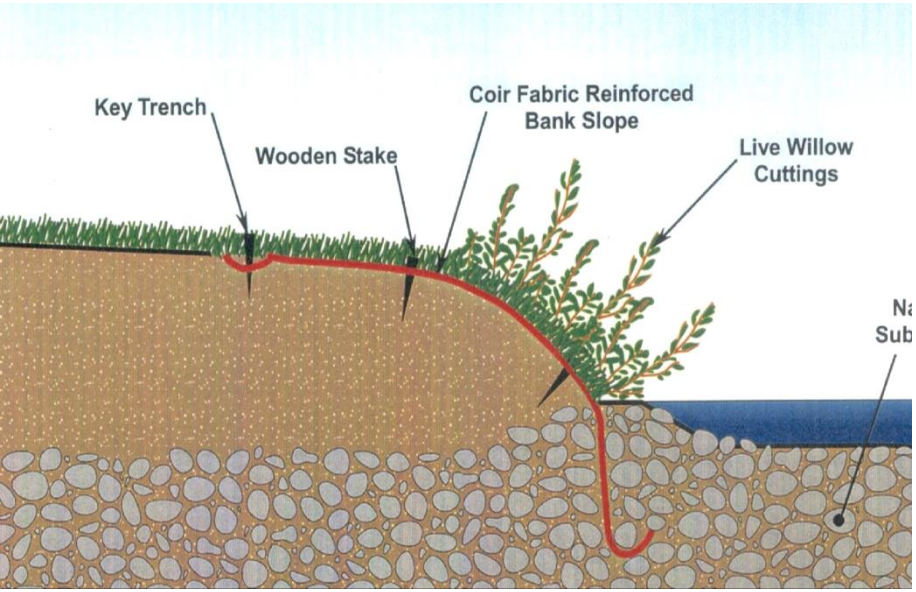
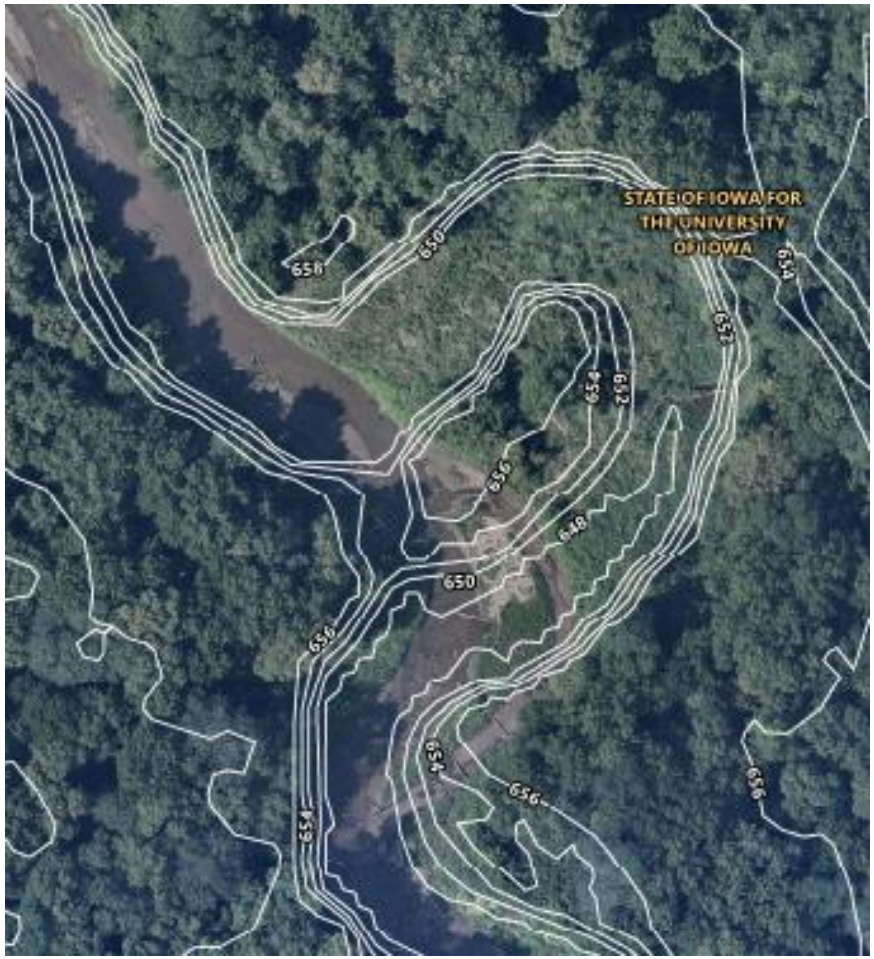
Restoration Vision

Riparian Vegetation Restoration

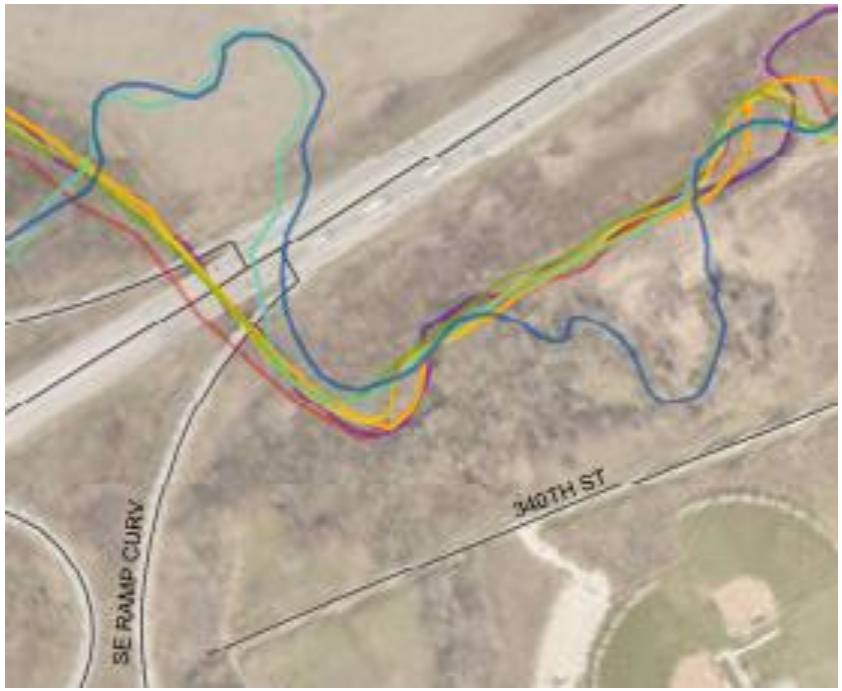
Simple grade and shape

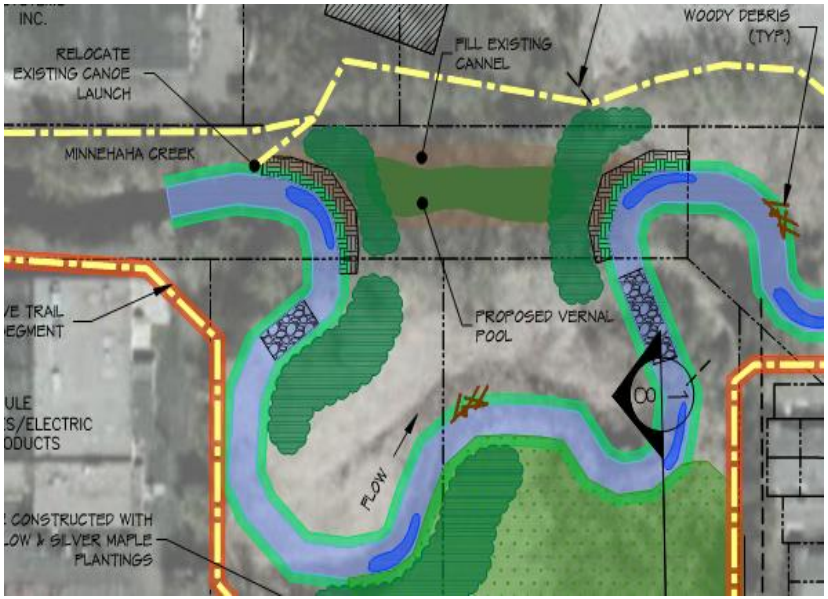


Floodplain Connections and Oxbow Restoration



Re-meander where Feasible





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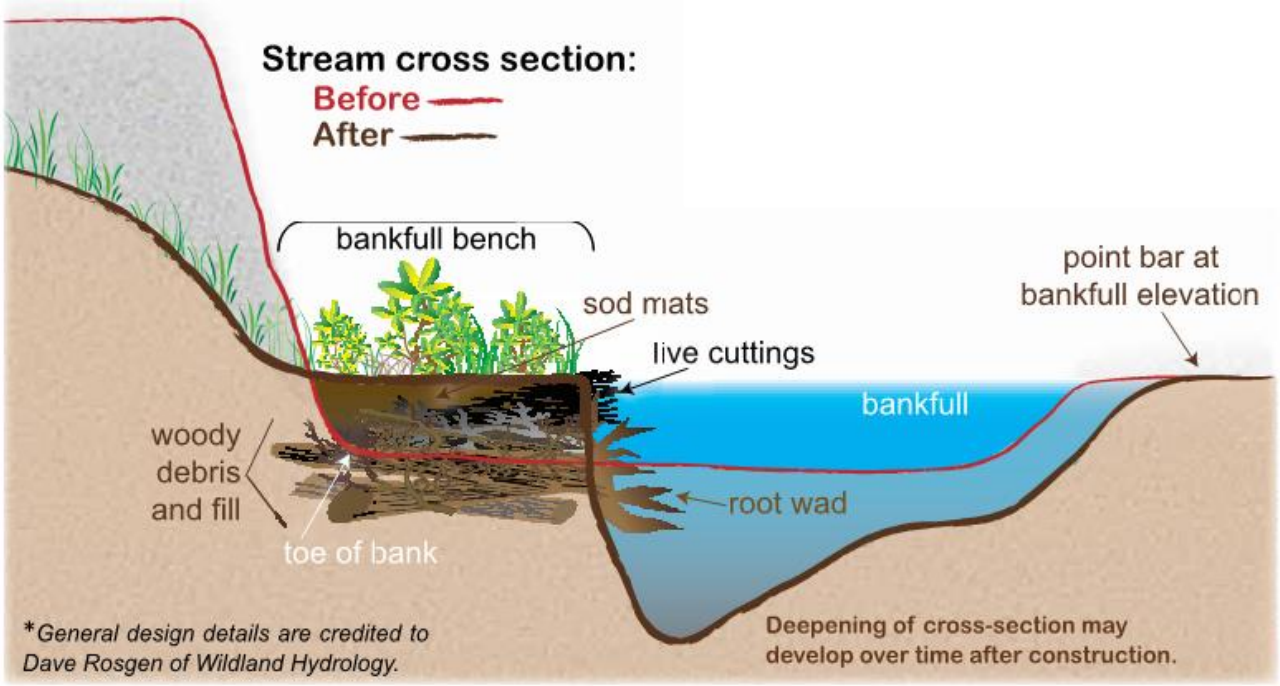
Toe-wood

- Restores width-depth dimension
- Protects vulnerable banks – especially at outside bends
- Habitat

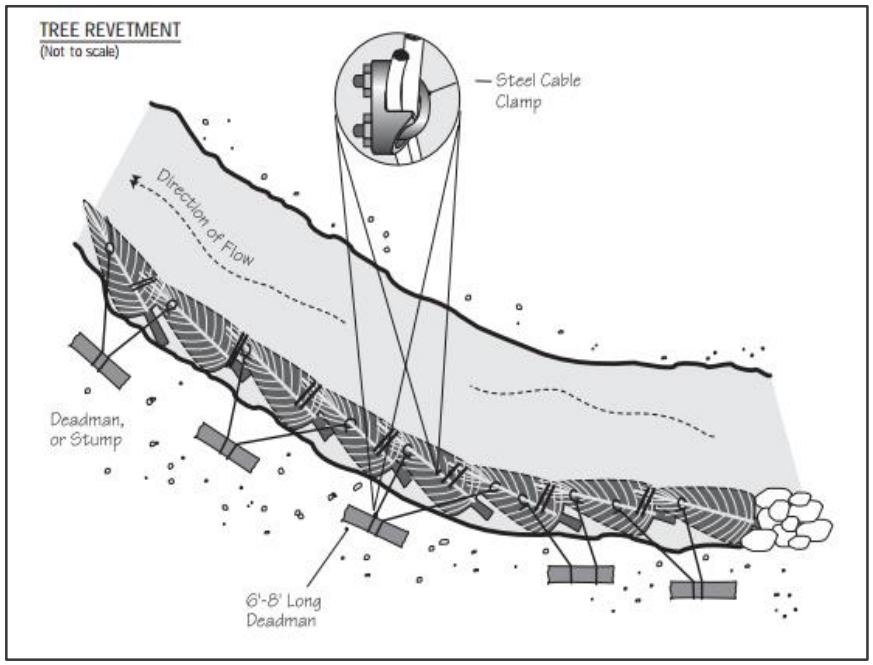


Toe Wood Sod Mat – Rosgen Type 3

Before

After

Bioengineering – Cedar Tree Revetment



Cedar Tree Revetments

- Passive siltation of channel sediment load
- Reforms cut banks without grading
- Silt behind revetments was deposited immediately after installation
- Easy, inexpensive, biologically friendly

Questions?

Aaron Gwinnup, PE

agwinnup@hrgreen.com

319-841-4357

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