White River Bank Stabilization Update (ANRC 09-1900)

Reducing Sediment and Nutrient Loadings through River and Streambank Restoration in the Beaver Lake Watershed

Matt Van Eps, Watershed Conservation Resource Center

ANRC 2014 NPS Annual Meeting

September 17 and 18, 2014

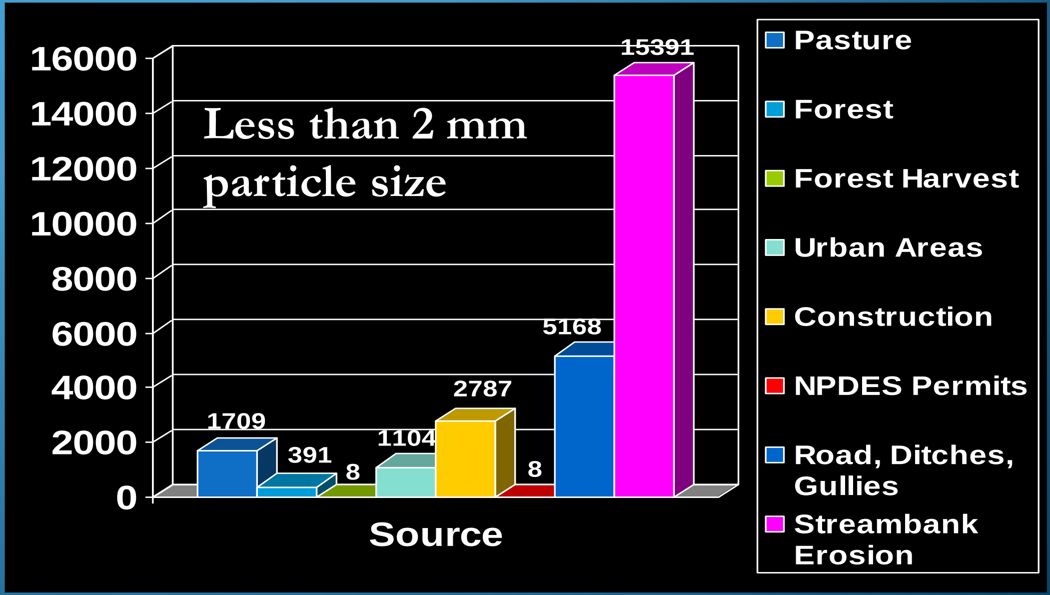
Severe Streambank Erosion
Source of Sediment and Nutrients to Rivers

What does bank erosion look like?

Severe Streambank Erosion is a Source of Sediment and Nutrients to Rivers

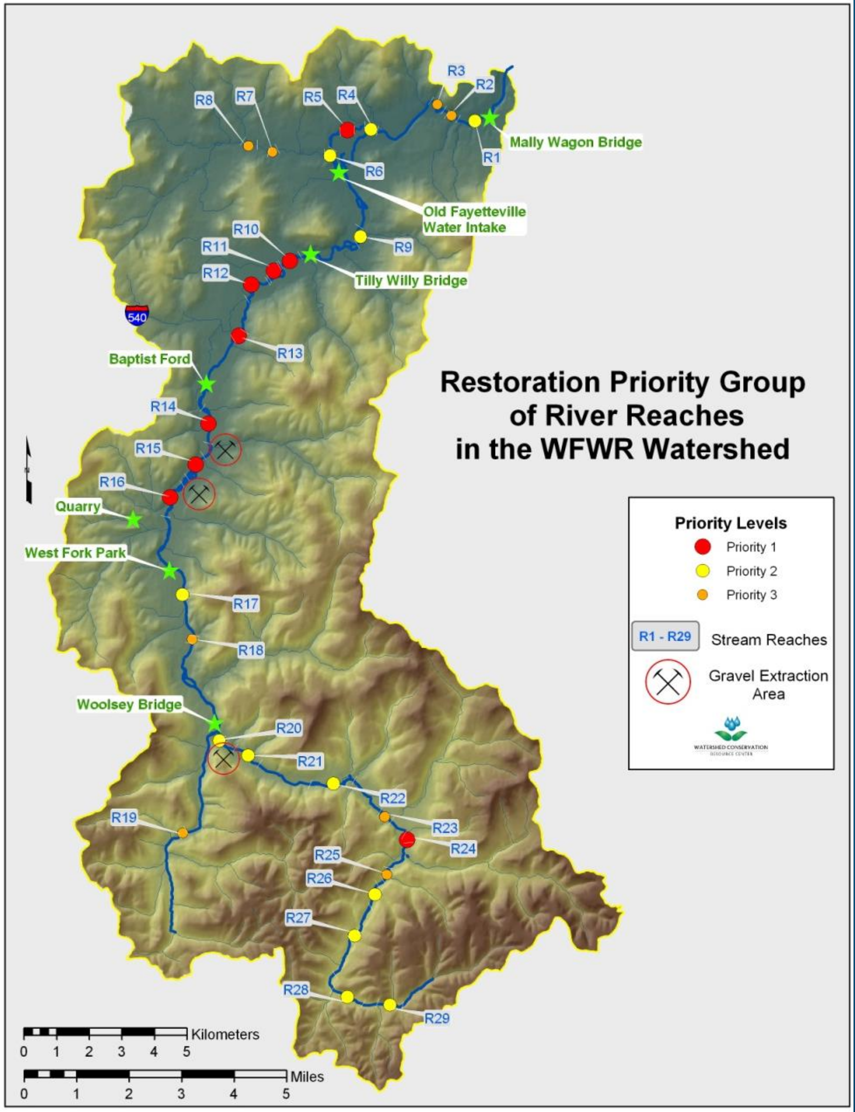
West Fork White River Watershed Assessment (Formica, et, al 2004)

- Major tributary to Beaver Lake, drinking water source to NWA
- 124 mi^2 rural watershed
- **Estimated annual sediment load – 36,000 tons**
  - **66 % from accelerated streambank erosion**
  - State 303 (d) listed stream since 1998
  - aquatic life use not supported - high turbidity & excessive silt



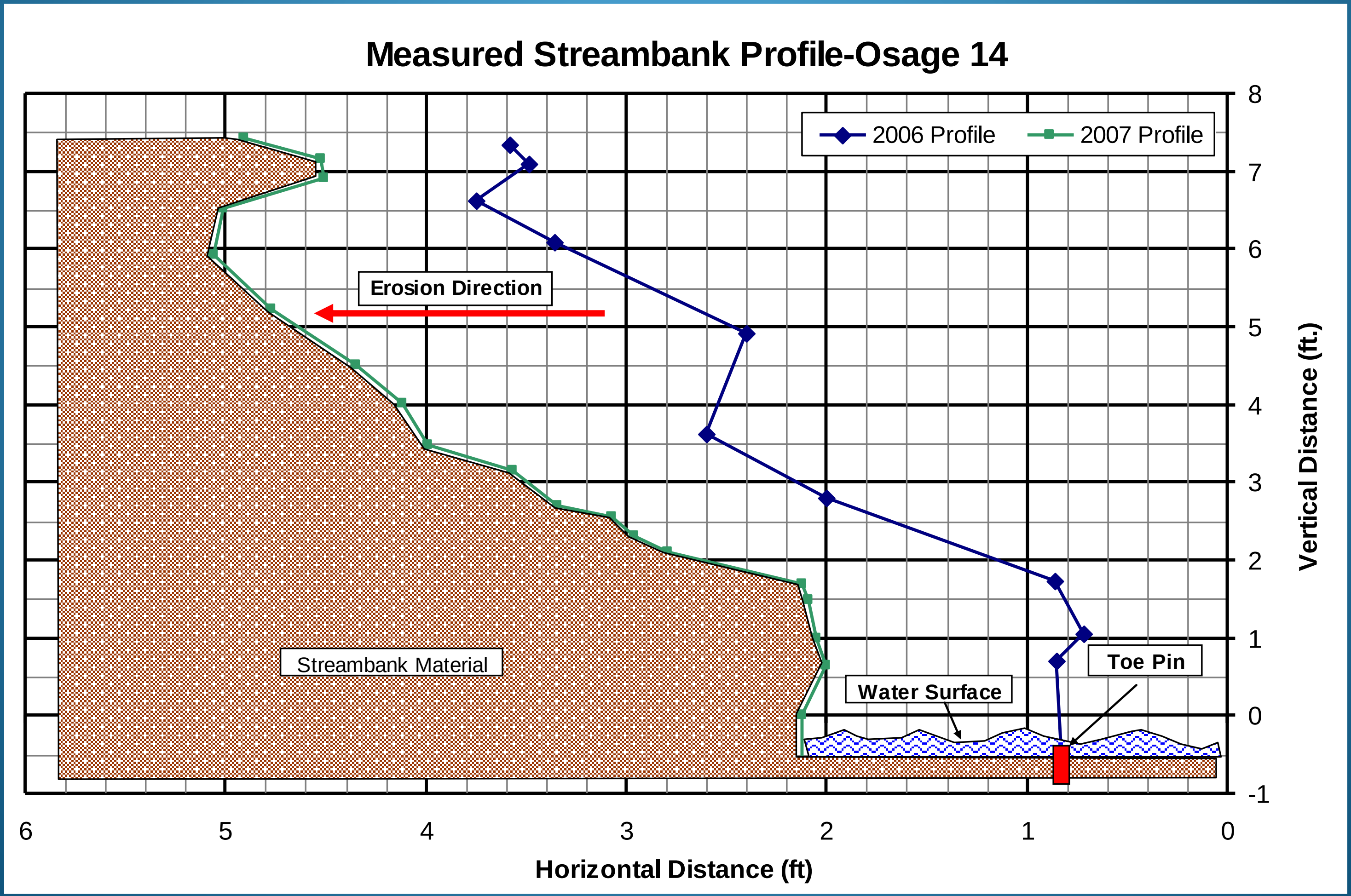
Evaluation of Streambank Erosion and Estimating Sediment and Nutrient loadings

- Projects include a streambank monitoring component
  - Measure erosion rates before and after restoration
  - Sample bank materials
- Quantifying the amount sediment & nutrients unstable streambanks contribute provides information:
  - Urban & watershed planning
    - Prioritize sites for restoration
    - Demonstrates project effectiveness
    - Determine best use of funding
    - Address TMDLs or other water quality issues



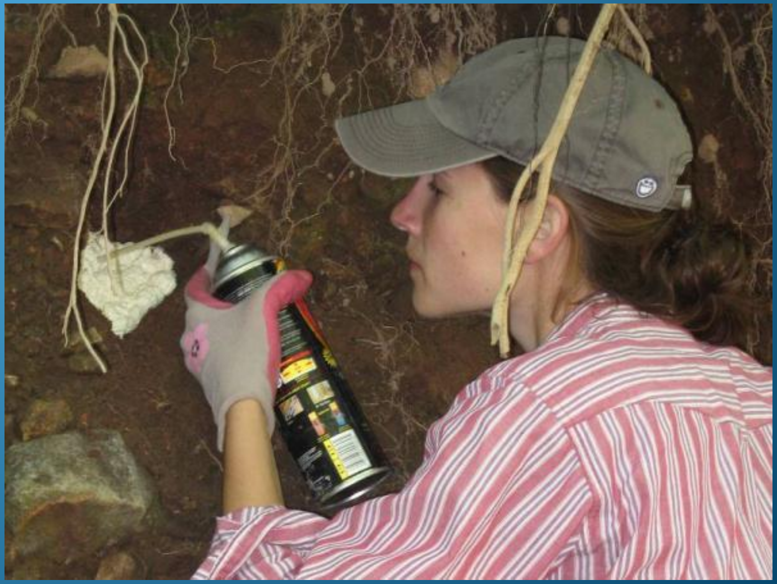
Evaluation of Streambank Erosion and Estimating Sediment and Nutrient Loadings

Streambank erosion rates are measured before and after stream restoration is implemented



Evaluation of Streambank Erosion and Estimating Sediment and Nutrient Loadings

- Samples collected from streambank horizons
  - Measured
    - Bulk Density
    - Particle Size Distribution
  - Analyzed Samples
    - Total Phosphorus
    - Total Nitrogen



Streambank Material Sampling Results*
Summary of Average Values

Bulk Density: 71 to 148 lb/ft^3

Total Phosphorus: 0.2 – 1.0 lb/ton of sediment
Total Nitrogen: 0.6 – 2.4 lb/ton of sediment

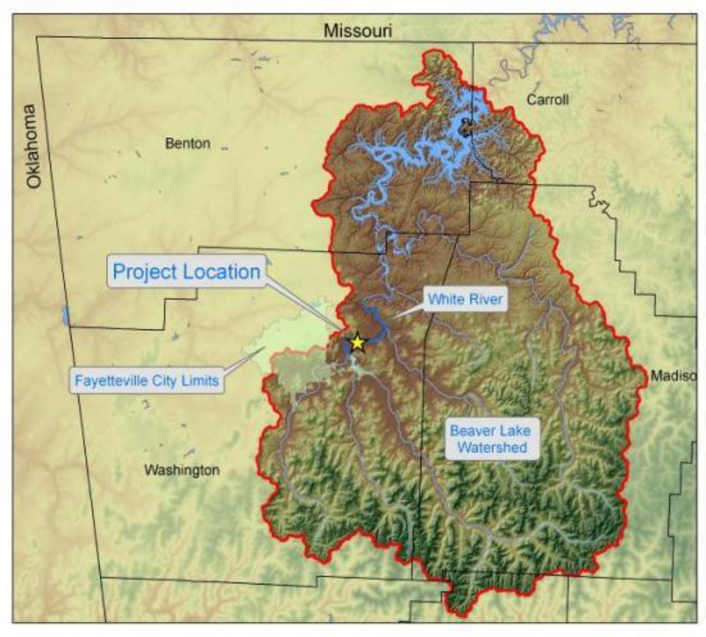
Location	Material Class	Bulk Density (lb/ft^3)	TP (lb/ton)	TN (lb/ton)
Niokaska - Gulley	Fine	80	0.6	2.3
	Coarse	148	0.2	0.6
Niokaska - Sweetbriar	Fine	102	0.6	1.6
	Coarse	135	0.3	0.6
White River	Fine	99	1.0	1.9
Mullins Branch	Fine	96	0.4	2.3
West Fork White River	Fine	93	0.6	2.0
	Coarse	97	0.3	0.6
Osage Creek	Fine	71	0.9	2.4
	Coarse	112	0.3	0.6

* Results of the materials analysis is preliminary and under review

White River Streambank Restoration

Objectives

- **Improve Water Quality and Local Ecology**
  - Restore 1,000 feet of streambank and riparian using natural channel design principles
  - Reduce sediment and nutrients loadings from severe streambank erosion
  - Improve aquatic and terrestrial habitats
- **Conduct Restoration in Priority Watershed**
  - Beaver Lake provides drinking water for over 420,000 people in NWA
  - Section of White River on the State 303(d) list
  - State NPS priority for reducing nutrients



Project Partners

- **Watershed Conservation Resource Center**
- **City of Fayetteville**
- **Arkansas Natural Resources Commission**
- **US Environmental Protection Agency**
- **CH2M Hill**

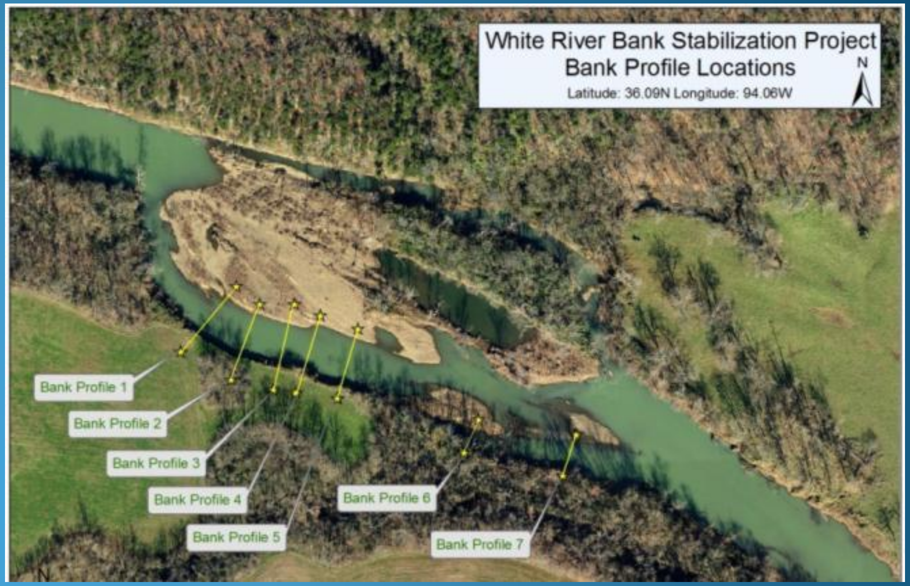
White River Streambank Restoration General Conditions

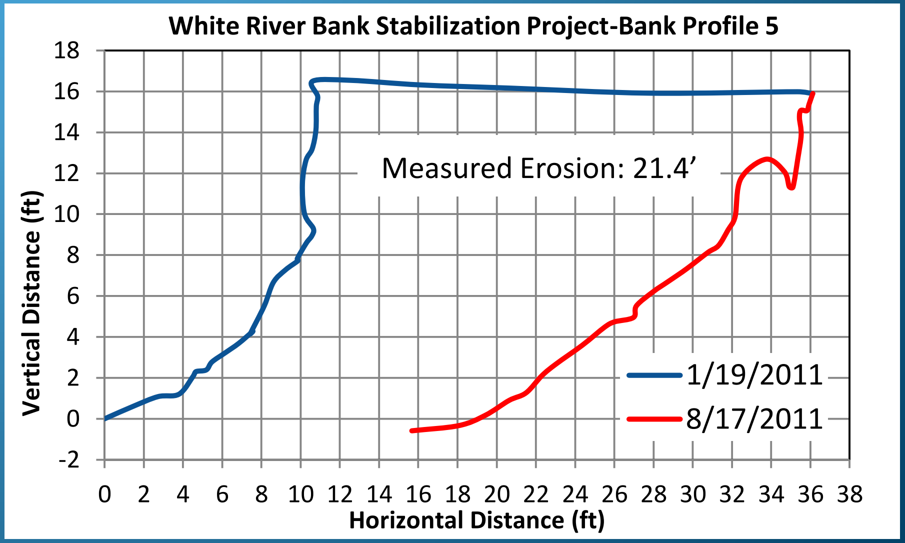
Project Site

- Bank Height
  - 16 ft
- Watershed Area
  - 400 mi^2
- Bankfull Flow
  - 11,500 cfs

Pre-Restoration Site Monitoring

- Bank Erosion Monitoring Results
  - Ranged from 3.1 to 21.7 feet over a 7 month period
  - Included two major flood events - April and May 2011
- Air Photo Evaluation of Lateral Bank Erosion - 2009 - 2011
  - **Average rate over three years was 14 ft/year**





Pre-Restoration Site Monitoring

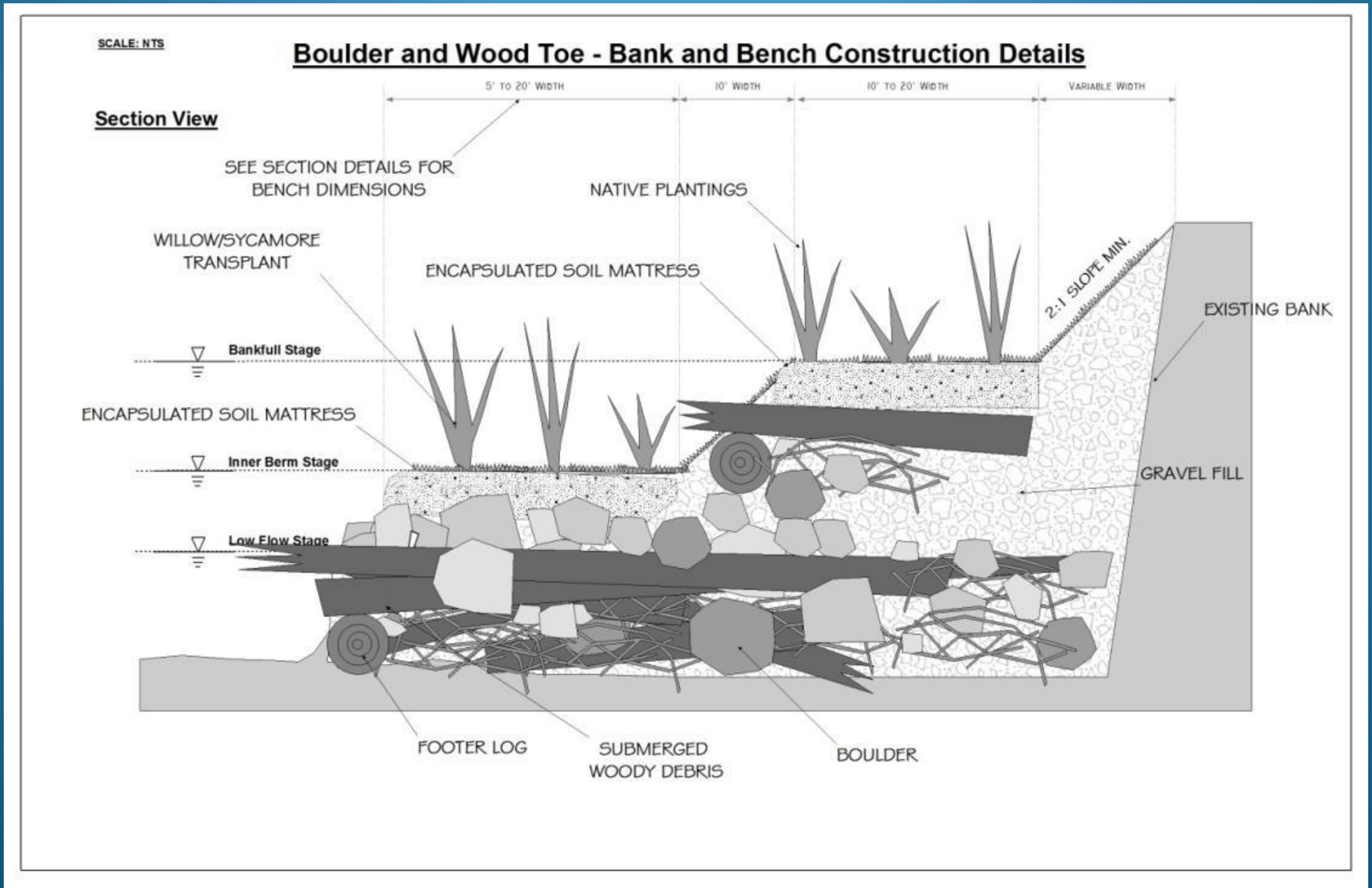
- Results of Bank Material Sampling

Soil Type	Bulk Density (lb/ft3)	TP (lb/ton)	TN (lb/ton)
Silt Loam	104.9	1.0	1.7
Clay Loam	88.0	1.0	2.3

- Pre-Restoration Estimated Loadings
  - Calculated over 7 month monitoring period
    - Sediment: 4,800 tons
    - T Phosphorus: 4,700 lbs
    - T Nitrogen: 8,700 lbs
  - **Estimated for average flow year**
    - **Sediment: 3,600 tons/year**
    - **T Phosphorus: 3,500 lbs/year**
    - **T Nitrogen: 6,500 lbs/year**

Restoration Design

The primary component of the stabilization design was the construction of a multi-level bench composed of boulders, trees, and gravel with a layer of topsoil encapsulated in coconut fiber fabric on top.



Implementation of Restoration

Pre-Construction – 2011 through 2012

- 200 trees were salvaged and brought to the site
  - City of Fayetteville and CH2M Hill delivered downed trees
  - Nabholz Construction donated trees from Highway 265 project
- 30 footer logs were compromised tree harvested on site
- 900 tons of rock delivered
- Gravel road was constructed across the pasture to handle the heavy trucks and equipment during wet weather

Implementation of Restoration

Heavy Equipment Construction – Feb & Mar 2012

- Inner-berm Bench Construction
  - **Built out from 16 ft high cutbank**
  - Widest point 40 feet
  - Gravel from point bar on opposite side was removed to maintain design cross-sectional area

Implementation of Restoration

Heavy Equipment Construction – Feb & Mar 2012

- Bankfull Bench Construction
  - Built on top of inner-berm bench
  - Widest point 20 feet
- Soil Mattresses Constructed on both Benches
  - Coconut fiber erosion control fabric filled with soil
  - Hardwood stakes were used to secure mattresses

Implementation of Restoration

Site Finishing, Re-vegetation, & Irrigation
Mar - Apr 2012

- Seeded with native grasses and wildflowers
- Site was planted with native trees, shrubs, and grasses
  - Purchased potted plants, such as, sycamore, button bush, alders, river birch, witch hazel, wild hydrangea, indigo bush, blackhaw viburnum, and more
  - Harvested local river oats, button bush, willow, sycamore, switch grass, river cane, gamma grass
  - Sod mats of native plants harvested along the fringe of the pasture
- 1 acre of riparian that was previously pasture was tilled and planted with natives
- Leftover rocks were used to create a boundary between the pasture land and the newly established riparian planted with natives
- Irrigation system was designed and assembled for the site

Site Transformation

28 Months After Construction

Site Transformation

28 Months After Construction

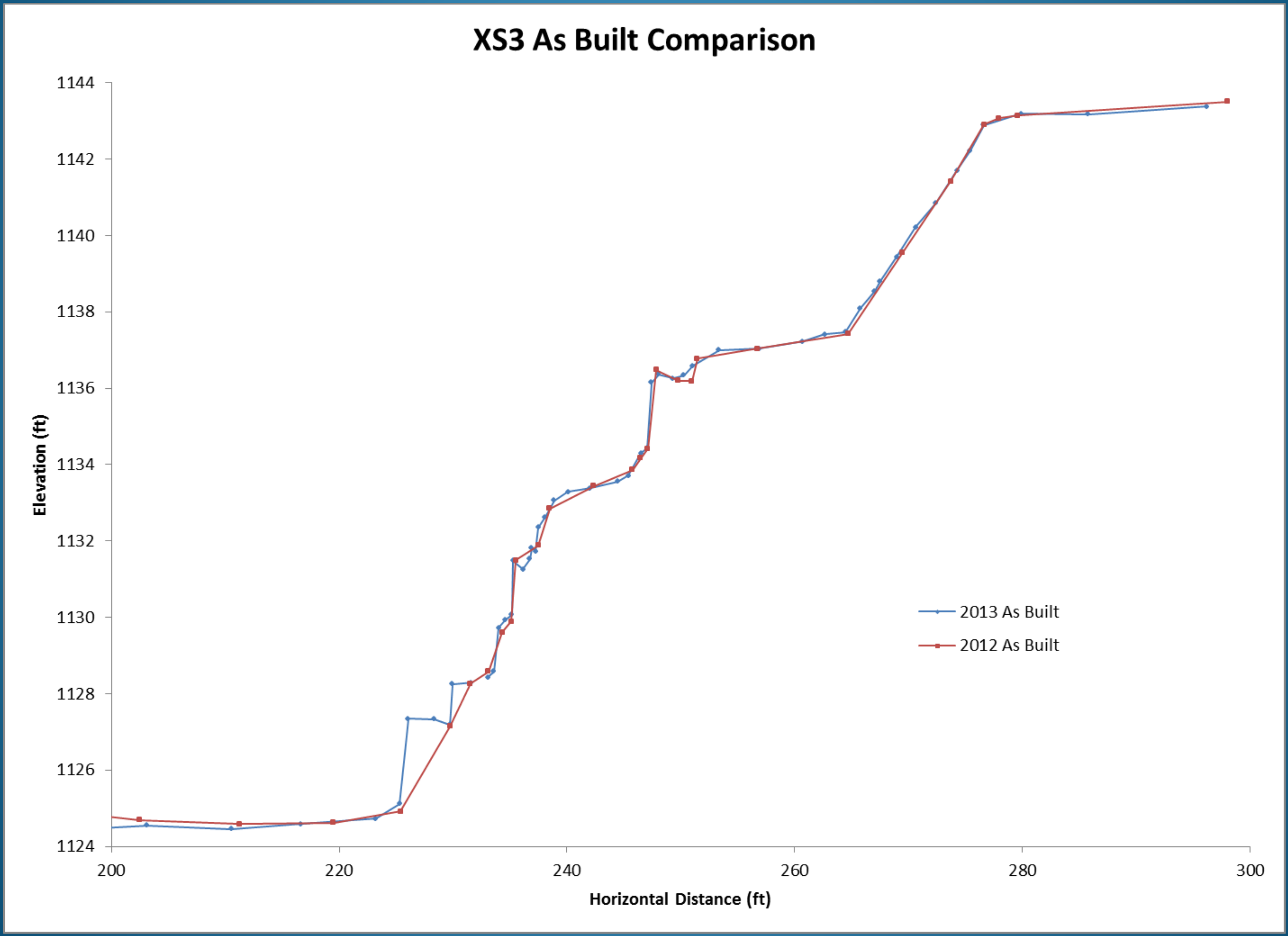
Post Restoration

- If you need rain, build a stream restoration
- Two weeks following construction, 13,000 cfs peak flow (bankfull Q is 11,500 cfs)

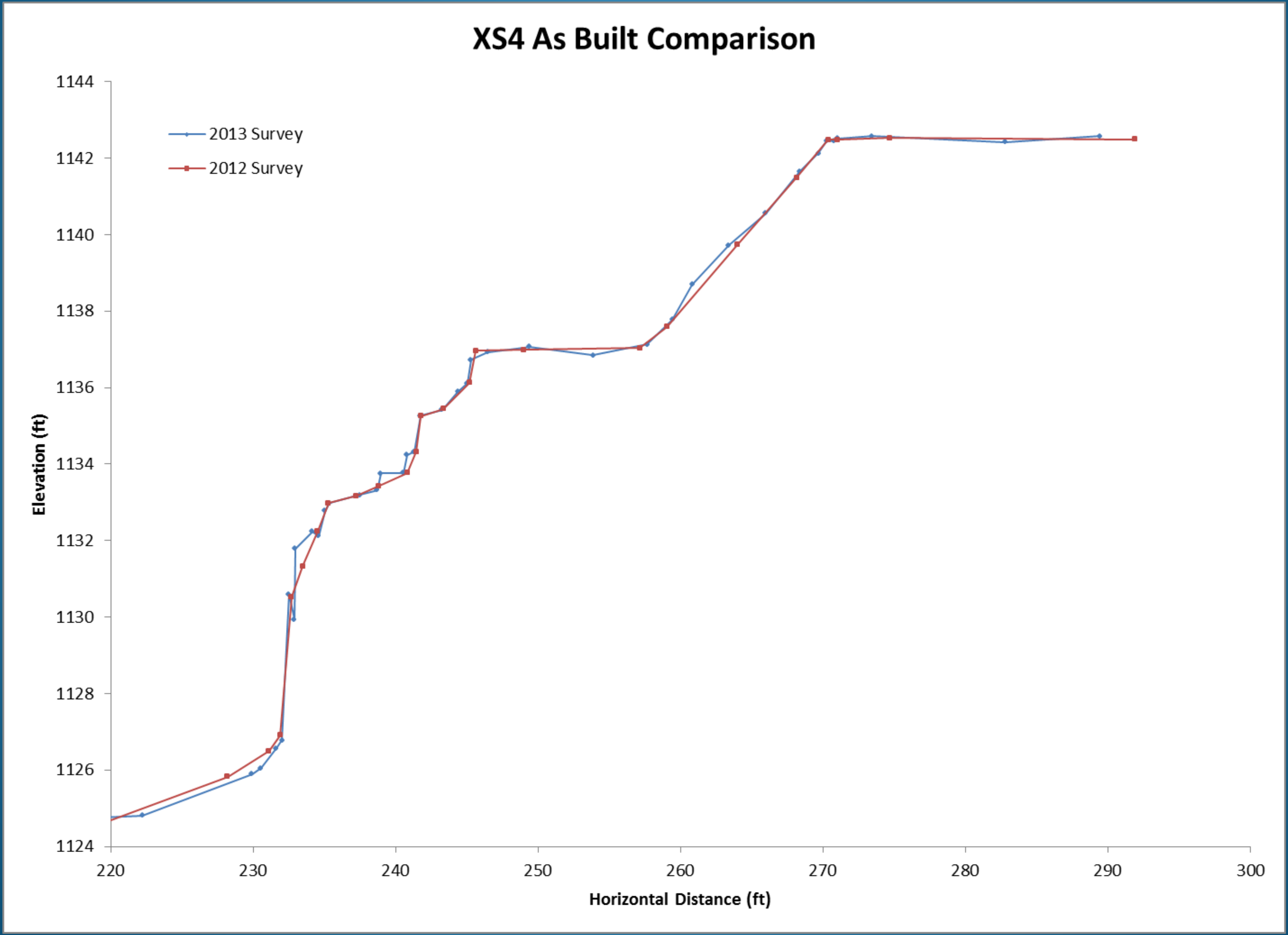
Post Restoration

Post Restoration

Post Restoration (monitoring)



Post Restoration (monitoring)



White River Post Restoration

Load Reductions

- Achieving near 100% reduction in annual sediment and nutrient loads
    - 3,600 tons/year of sediment
    - 3,500 lbs/year of total phosphorus
    - 6,500 lbs/year of total nitrogen

Total Cost - $352,000

- Survey & Design
- Construction and Materials
- Extensive Re-vegetation
- Public Outreach
- Monitoring and grant administration

Ongoing Inspection, Maintenance and Flood Repairs

If You Need Rain,

Build a Stream Restoration!

- Inspection following flood events
- Ongoing Maintenance
  - Vegetation management
  - Hand repairs of structures
- Flood Repairs
- Minimum time - five years following construction
- Cost have been covered:
  - Original grant
  - Partners
  - 2011 Flood Disaster – FEMA
- Funding should be established when project is initiated

River and Streambank Restoration
Conclusion and Recommendations

- Streambank erosion is a source of sediment and nutrients
- Tons of sediment and nutrients can be reduced annually through river restoration projects
  - Example: White River Project estimated minimum sediment & total phosphorus reductions over 10 years:
    - 10X3,600 tons = 36,000 tons sediment
    - 10X3,500 lbs = 35,000 lbs total phosphorus
- Recommend source of funding be developed for ongoing inspection and maintenance for five years