Streambank Stabilization: Why, How, and Is It Working?

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Why Mitigate Streambank Erosion?

- Streambank erosion is a:
  - Natural process of streams
  - Essential component of river ecosystems

Accelerated Streambank Erosion

- An effect of ‘channel instability’
- Caused by some change within the watershed and/or stream corridor

Channel Instability

- Examples of Change:
  - Converting Prairie to Ag Land or City
  - Channelization
  - Dams
  - Removal of Riparian Vegetation
  - Sand/Gravel Dredging
  - Many others….

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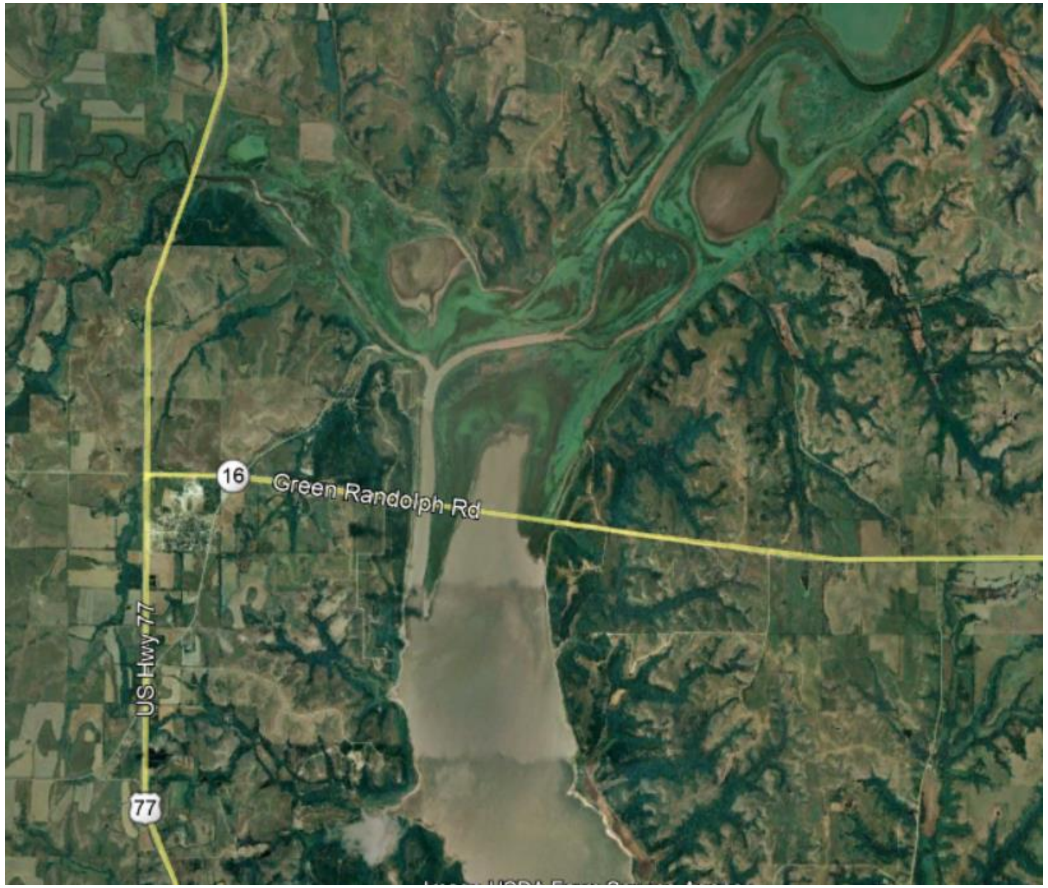
Why We Mitigate Accelerated* Streambank Erosion in Kansas

- Protect reservoirs
- Protect land
- Improve river ecosystems & water quality



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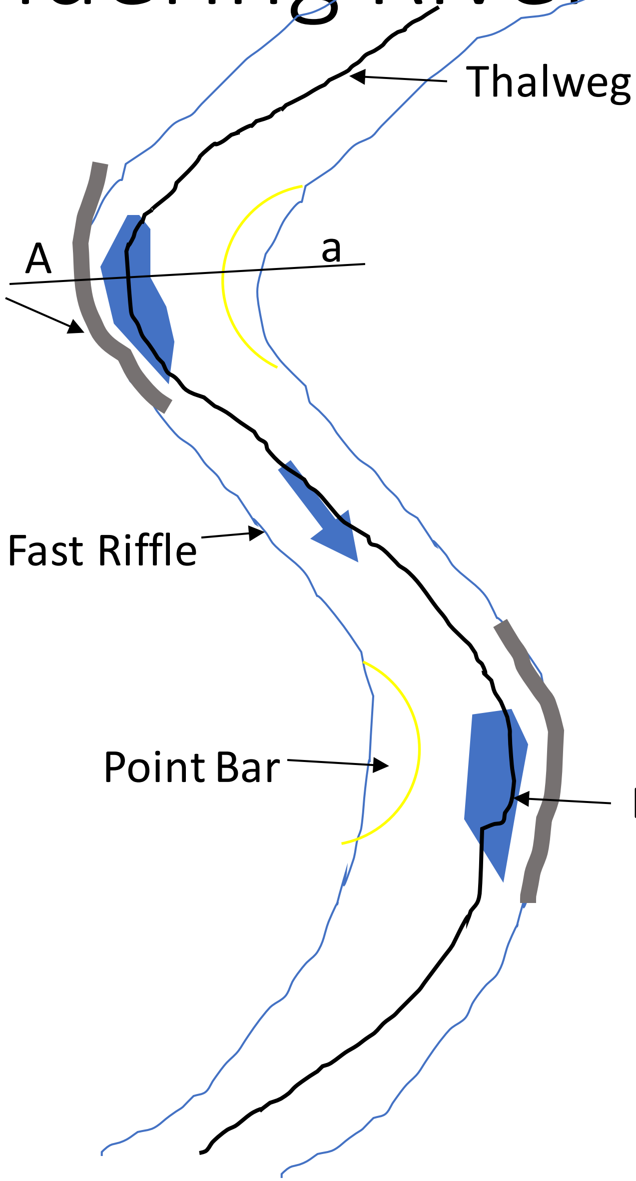
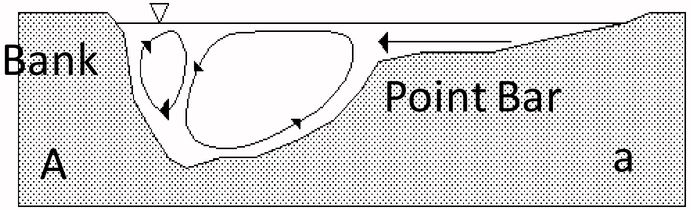
How are we addressing unstable streams?

- Physically changing the stream to more stable form

Basics of a Meandering River





Helical flow through meander bend

Streambank Stabilization Techniques Used in Kansas

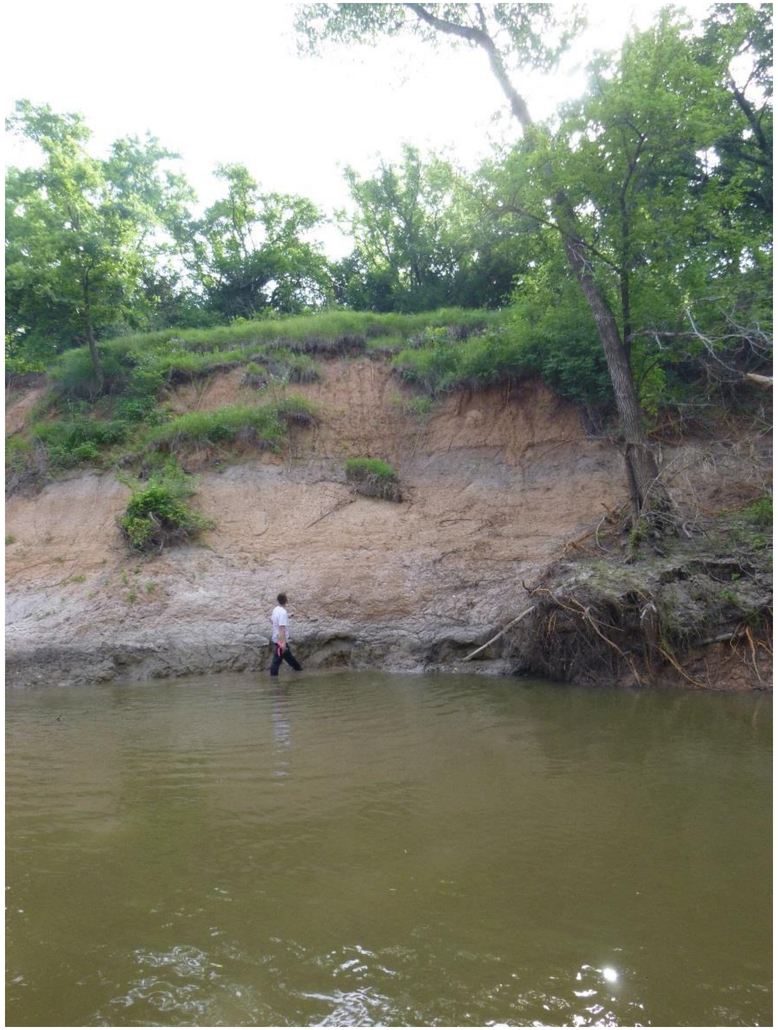
- Flow deflectors
- Additional bank protection
- Vegetation plantings

Streambank Stabilization

- A single technique or system of techniques that maximize localized streambank shear strength and/or minimize the forces acting on a streambank with the intent of halting or slowing lateral retreat
- **Make sure streambed is stable or failure likely imminent.**

Streambank Erosion

- Driven by:
  - Streambank characteristics (shear strength)
    - Soil physical properties and layers
    - Streambank height and angle
    - Vegetation cover and root depth
  - Gravitational and hydraulic forces (applied shear stress)
    - Gravitational force – weight of the streambank
    - Hydraulic force – the force applied by the flowing water; dependent on density of water, channel dimensions, and profile



Streambank Stabilization

- Lots of techniques available:
  - Rigid structure
  - Spurs (Impermeable or permeal
  - Bendway weirs
  - Rock vanes
  - Iowa vanes
  - Tree revetments
  - Toe rock
  - Bank shaping
  - Bankfull bench
  - Vegetation/Bioengineering

How do you select technique(s)?

Streambank Stabilization Approach	Shear Strength Addition	Gravitational Force Reduction	Hydraulic Force Reduction	Habitat Improvement	Cost
Spurs			X	X	$$$
Bendway Weir			X	X	$$
Rock Vane			X	X	$$
Iowa Vane			X		$$
Tree Revetment	X		X	X	$
Toe Protection	X	X			$$
Rigid Structure	X	X			$$$$
Bank Shaping	X	X			$$
Bankfull Bench		X	X	X	$$
Vegetation	X		X	X	$

Techniques Used in Kansas Today

Streambank Stabilization Approach	Shear Strength Addition	Gravitational Force Reduction	Hydraulic Force Reduction	Habitat Improvement	Cost
Spurs			X	X	$$$
Bendway Weir			X	X	$$
Rock Vane			X	X	$$
Iowa Vane			X		$$
Tree Revetment	X		X	X	$
Toe Protection	X	X			$$
Rigid Structure	X	X			$$$$
Bank Shaping	X	X			$$
Bankfull Bench		X	X	X	$$
Vegetation	X		X	X	$

Methods employed depend on site conditions and project objectives.

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Techniques Used in Kansas Today

Monitoring…

Assessing the Effectiveness of Streambank Stabilization Projects

Tony Layzell, Kansas Geological Survey

Kansas Water Office, Aug 25th, 2020

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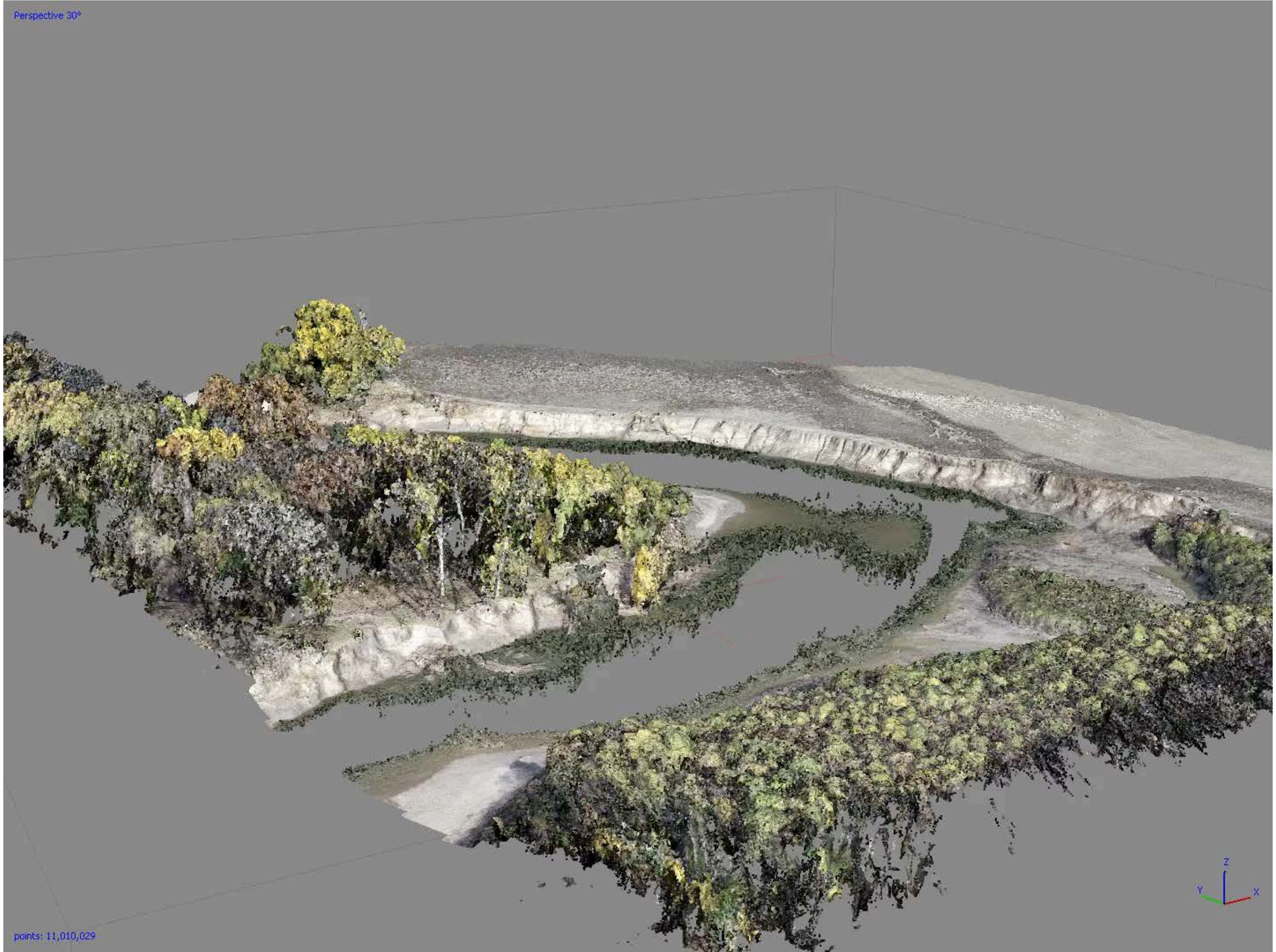
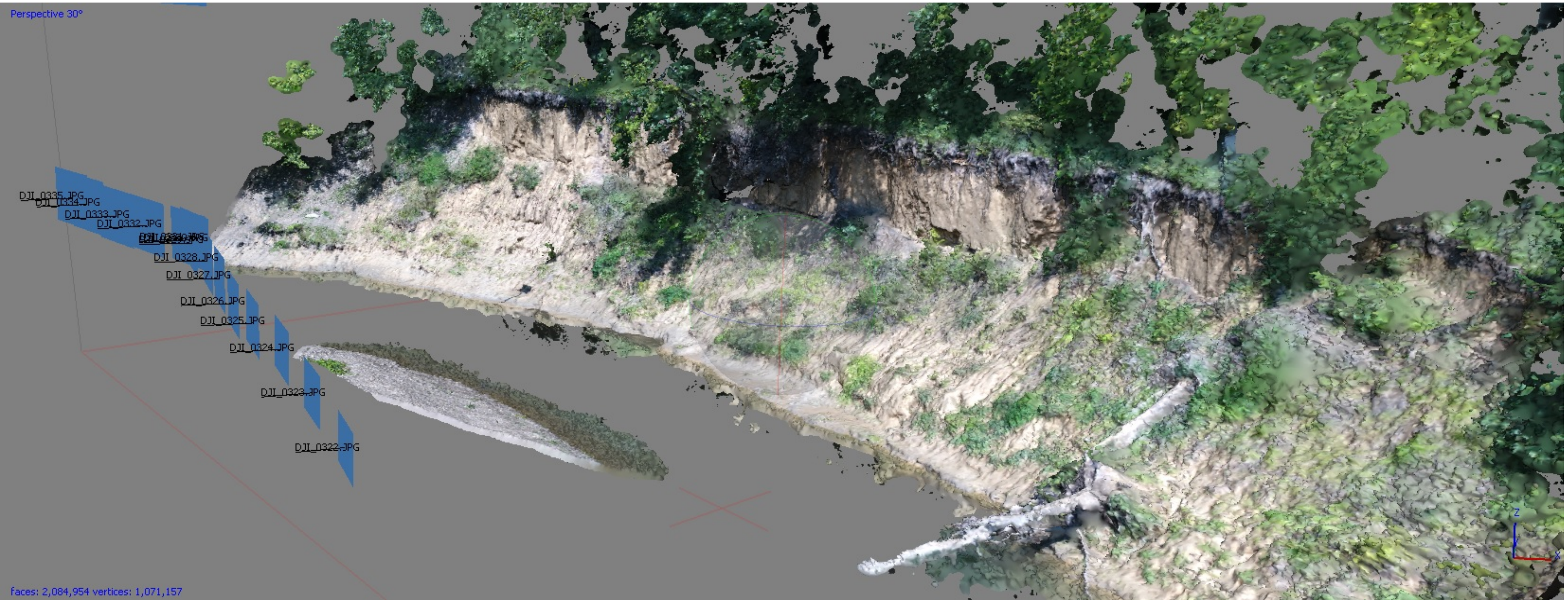
Unmanned Aircraft Systems (UAS)

Cottonwood River

Cottonwood/Neosho flooding – Oct 10th 2018

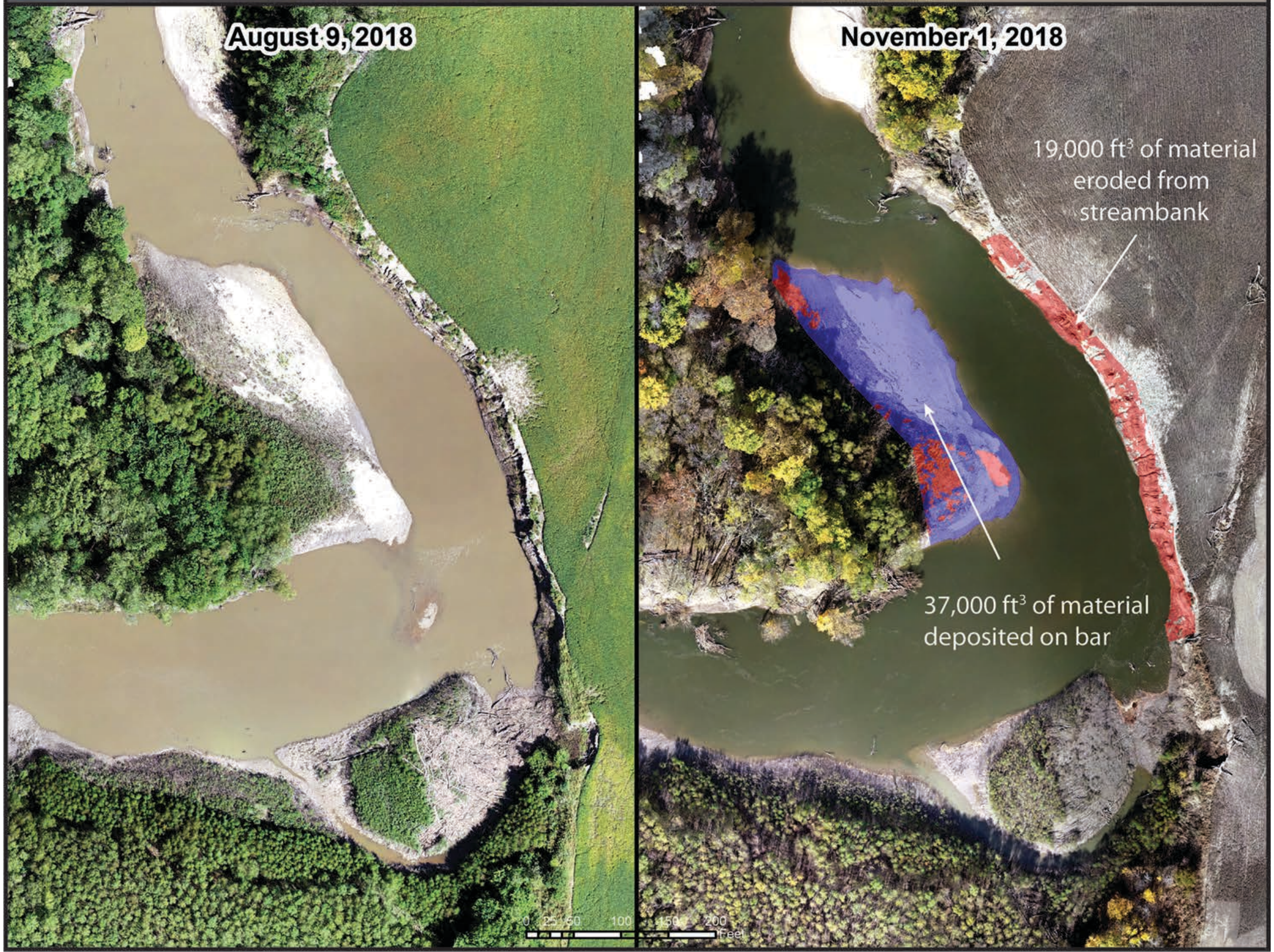
3D model of streambanks





Photogrammetry

- Structure from motion
- Ground control points

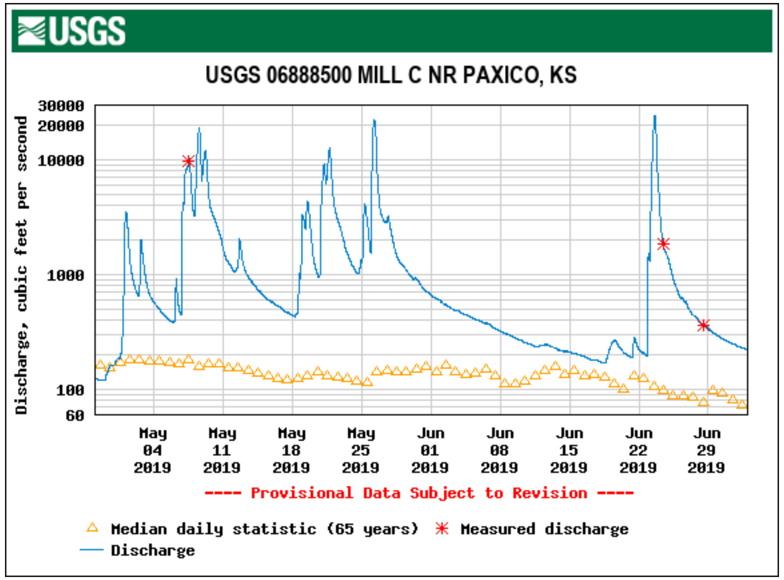

August 9, 2018
November 1, 2018
19,000 ft³ of material eroded from streambank
37,000 ft³ of material deposited on bar
0
25
50
100
150
200
Feet

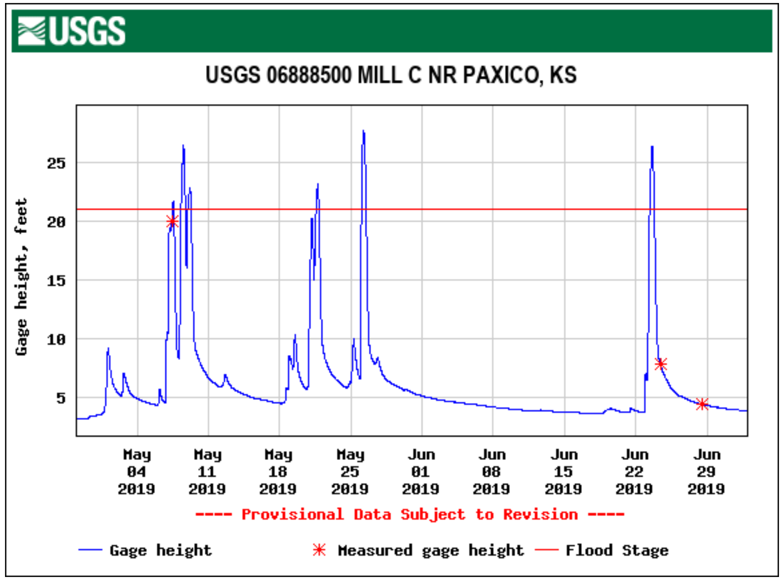
April 24, 2019

July 2, 2019

129,319 ft^3 eroded

26,551 ft^3 stored on bank toe





Cottonwood River

- 14 SBS sites
- 8 unmodified sites


As built – April 2015
Post flood – October 2015
Photos courtesy of Brock Emmert

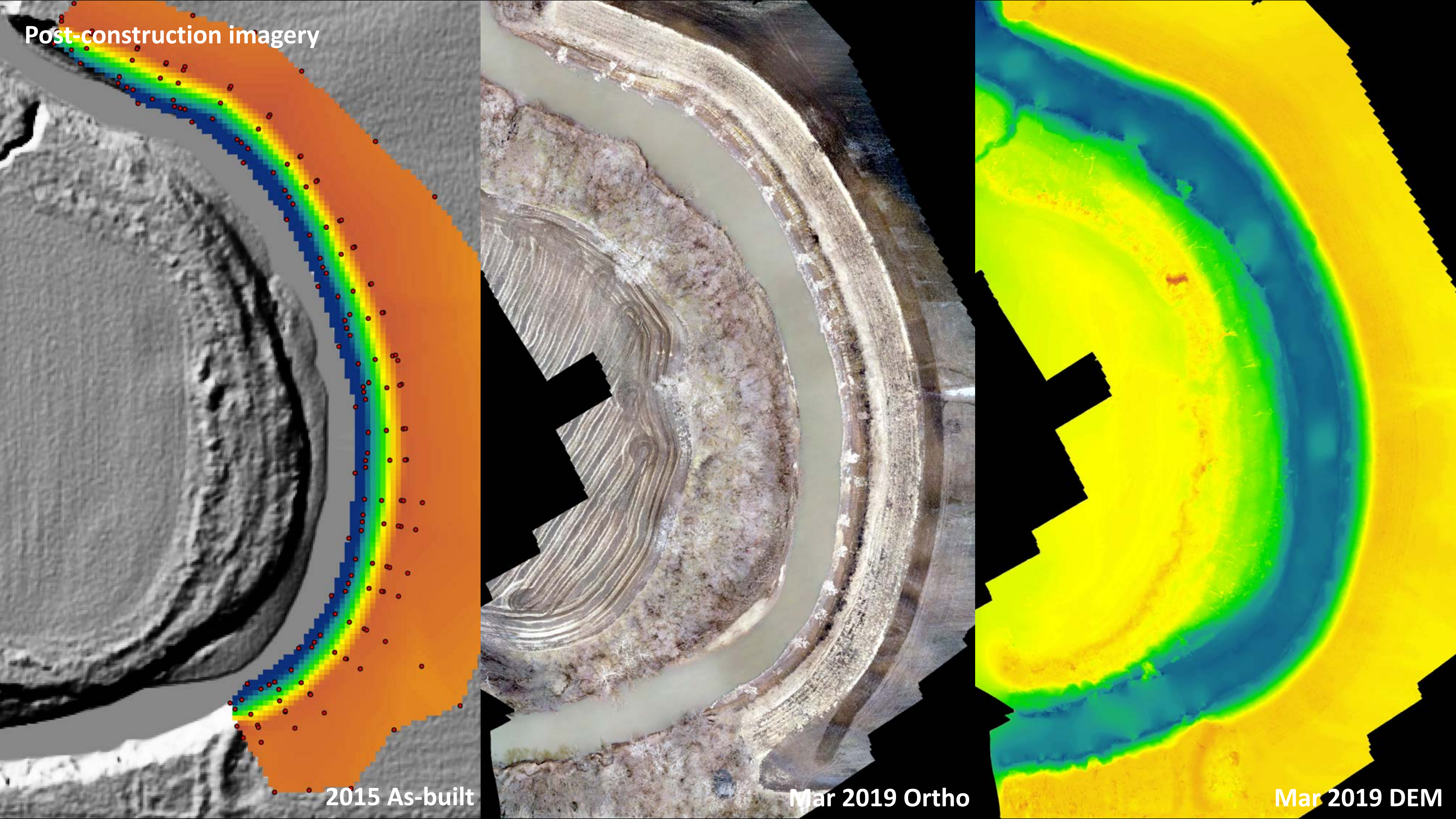

As built – April 2015

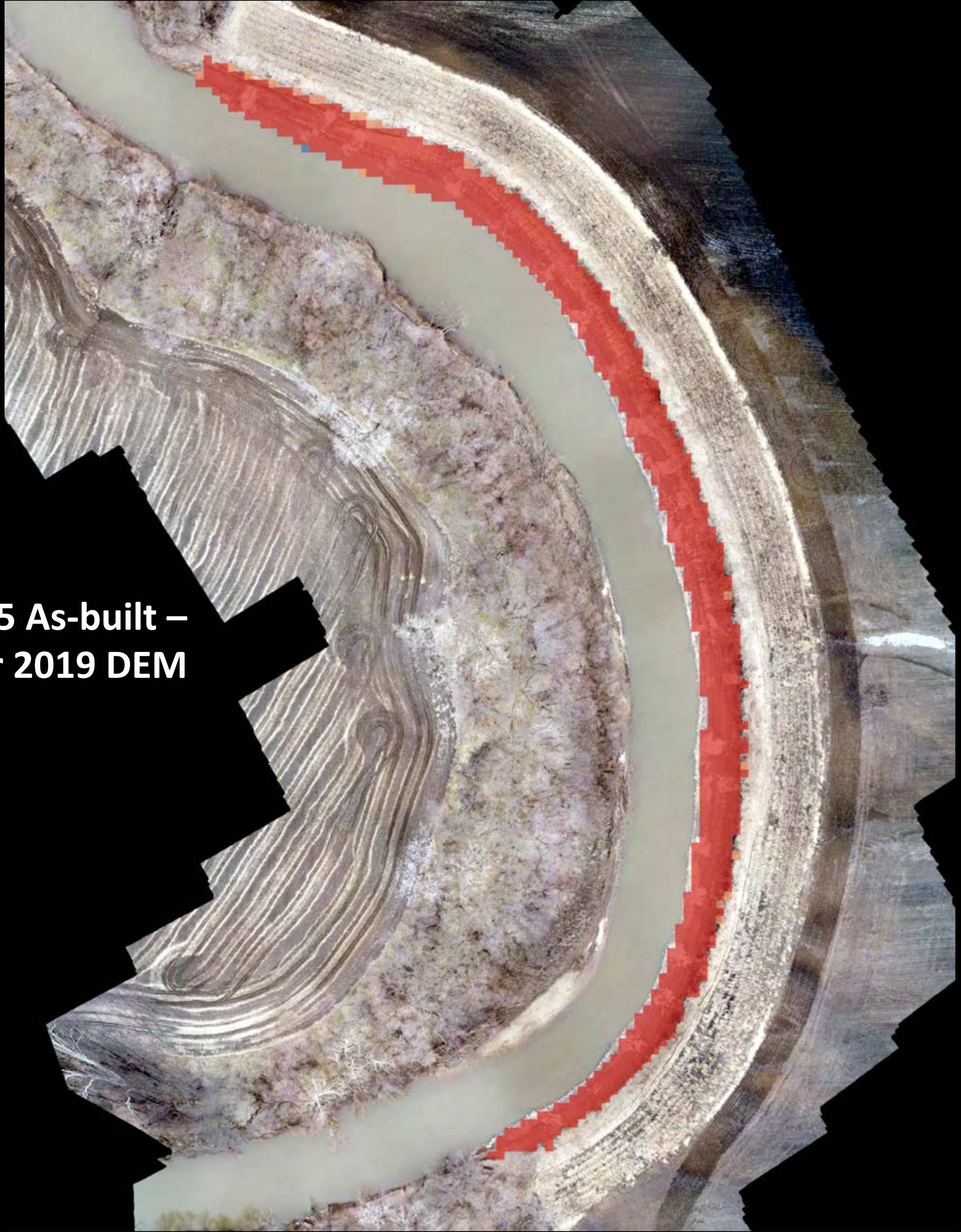

Post flood – October 2015
Photos courtesy of Brock Emmert


October 2019

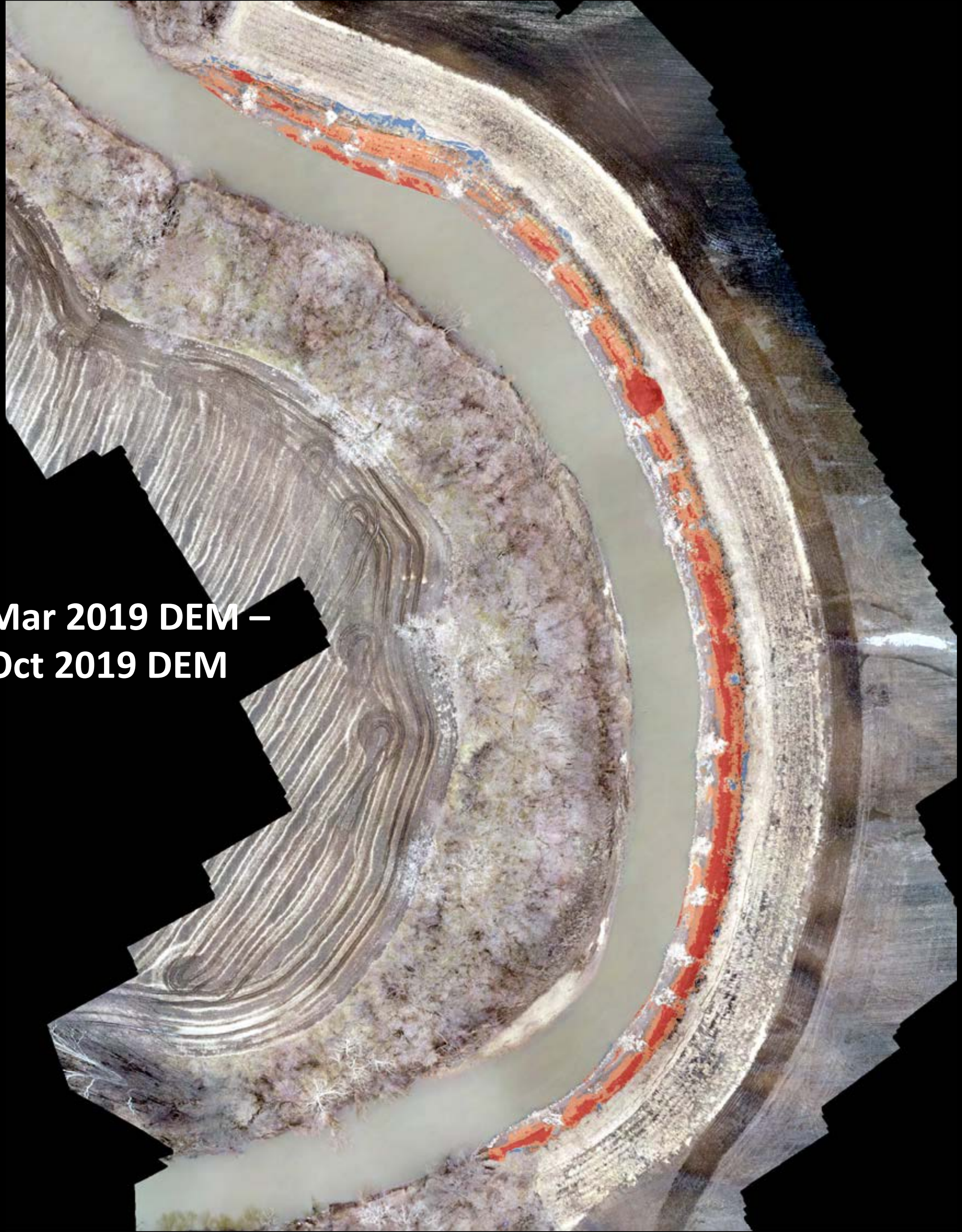

Pre-construction imagery
2006 NAIP
2010 Lidar
2015 NG911

Site C62			Volume eroded				
	Time period	No. days	No. years	Total (ft^3)	per year (ft^3/yr)	per year (tons/yr)	per year/bank length (tons/yr/ft)
Pre	7/7/06-12/15/10	1622	4.4	**790,978**	177,994	7921	5.0
	12/15/10-4/7/15	1562	4.3	**50,959**	11,908	530	0.3


Post-construction imagery
2015 As-built
Mar 2019 Ortho
Mar 2019 DEM



2015 As-built –
Mar 2019 DEM



Mar 2019 DEM –
Oct 2019 DEM

Site C62					Volume eroded		
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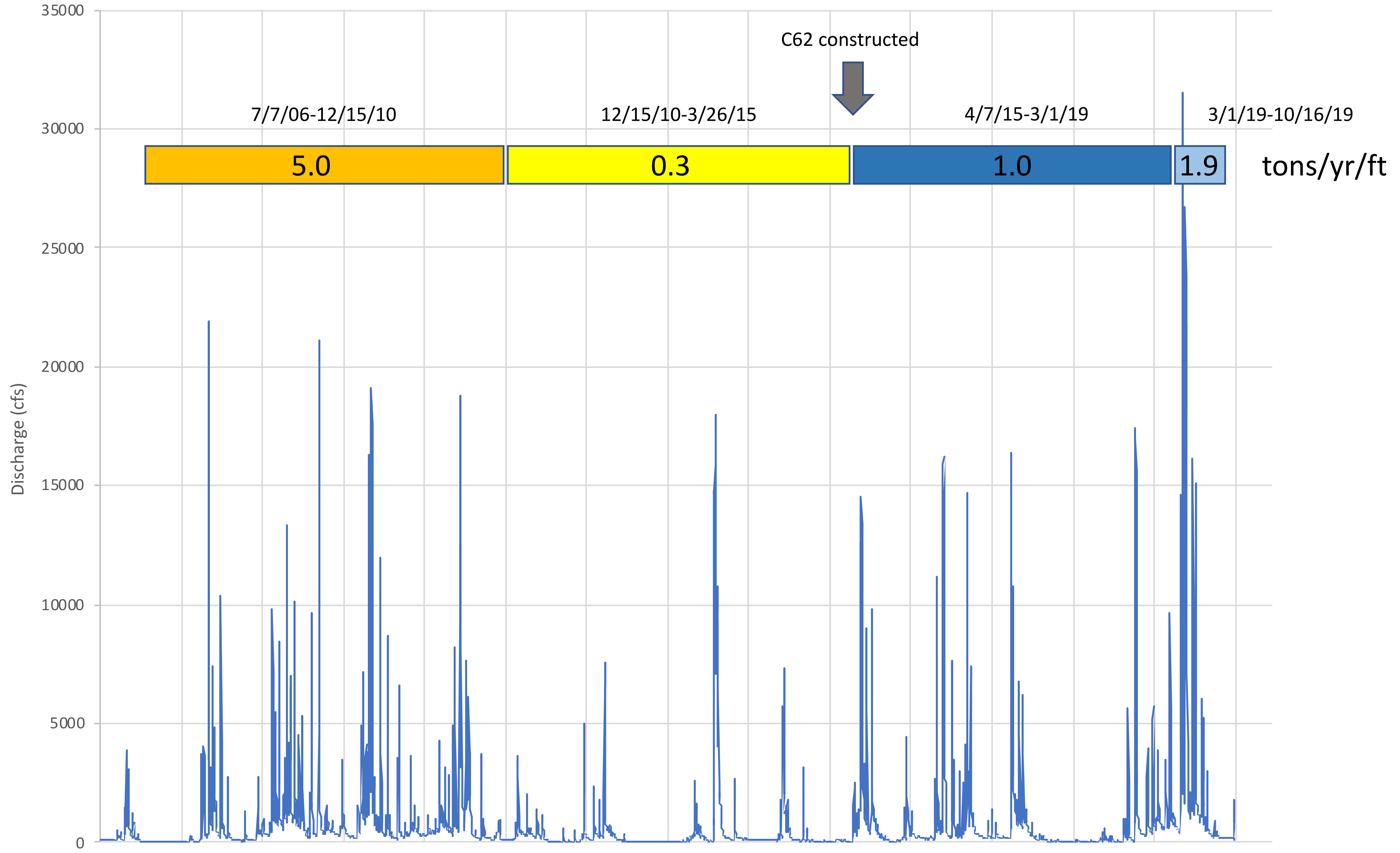
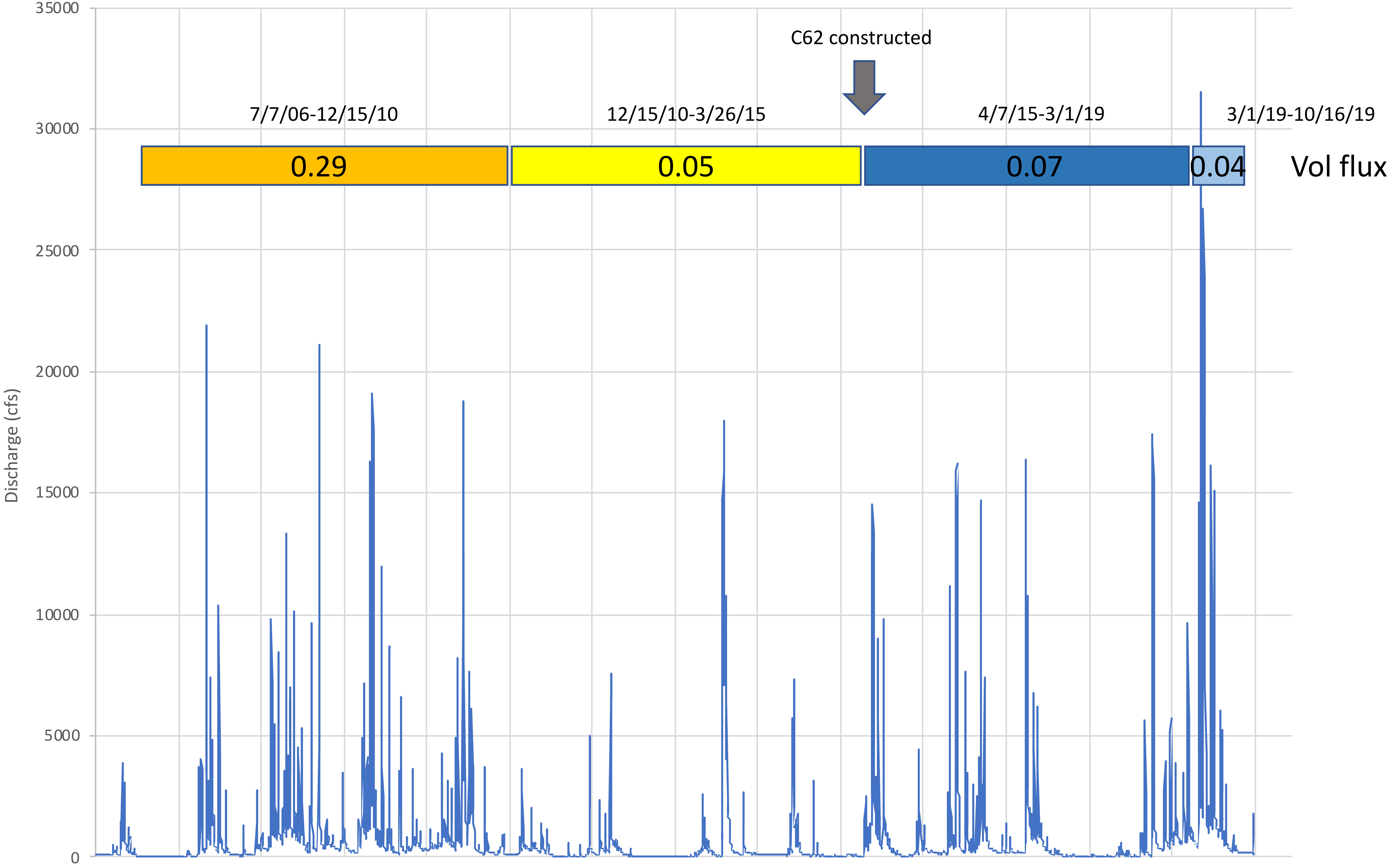
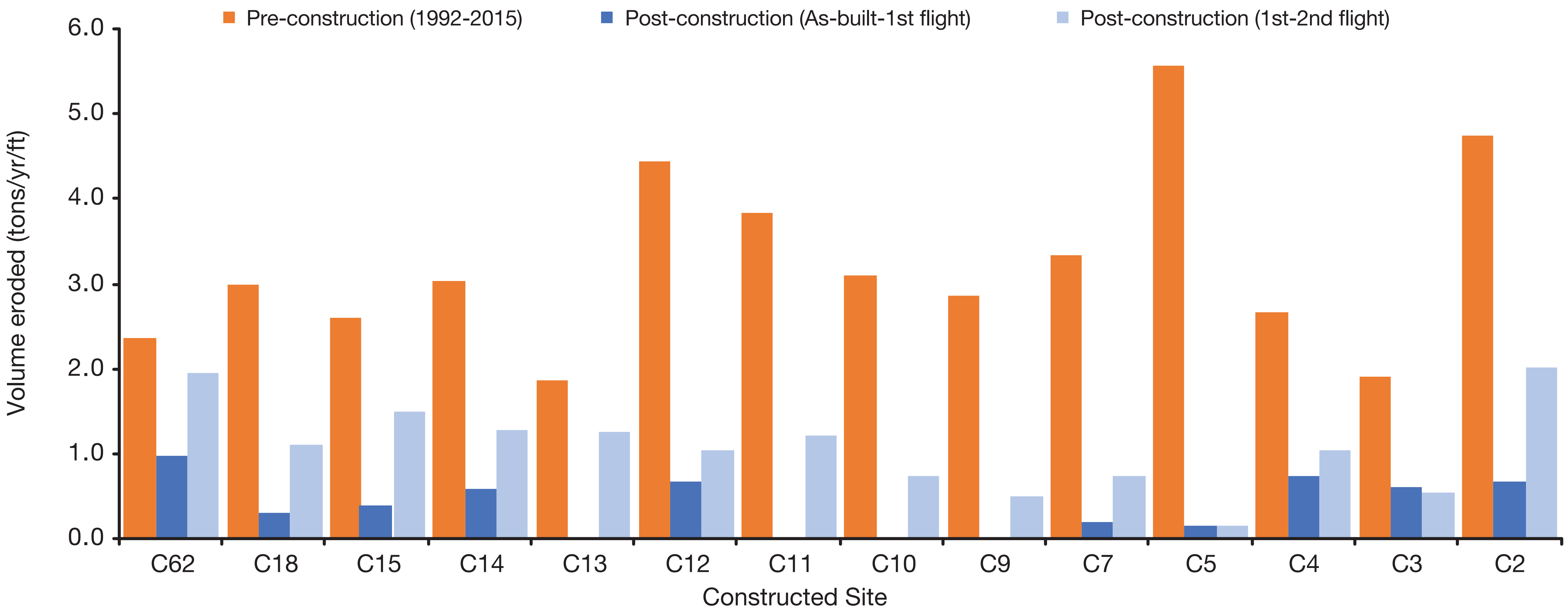
	12/15/10-4/7/15	1562	4.3	**50,959**	11,908	530	0.3
Post	4/7/15-3/1/19	1424	3.9	**142,142**	36,434	1621	1.0
	3/1/19-10/16/19	229	0.6	**45,838**	73,061	3251	1.9

Is this SBS project effective?


C62 constructed
7/7/06-12/15/10
12/15/10-3/26/15
4/7/15-3/1/19
3/1/19-10/16/19
5.0
0.3
1.0
1.9
tons/yr/ft
Discharge (cfs)
35000
30000
25000
20000
15000
10000
5000
0

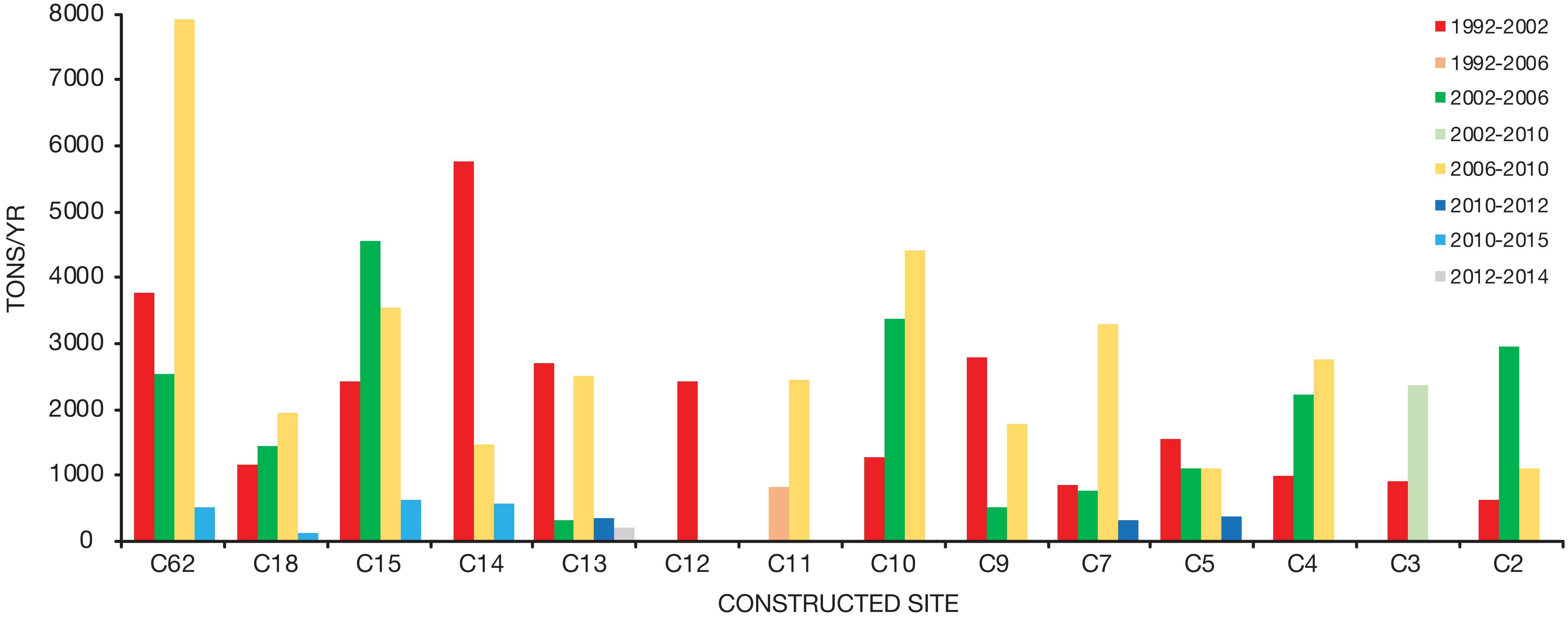


C62 constructed
7/7/06-12/15/10
12/15/10-3/26/15
4/7/15-3/1/19
3/1/19-10/16/19
0.29
0.05
0.07
0.04
Vol flux
Discharge (cfs)
35000
30000
25000
20000
15000
10000
5000
0

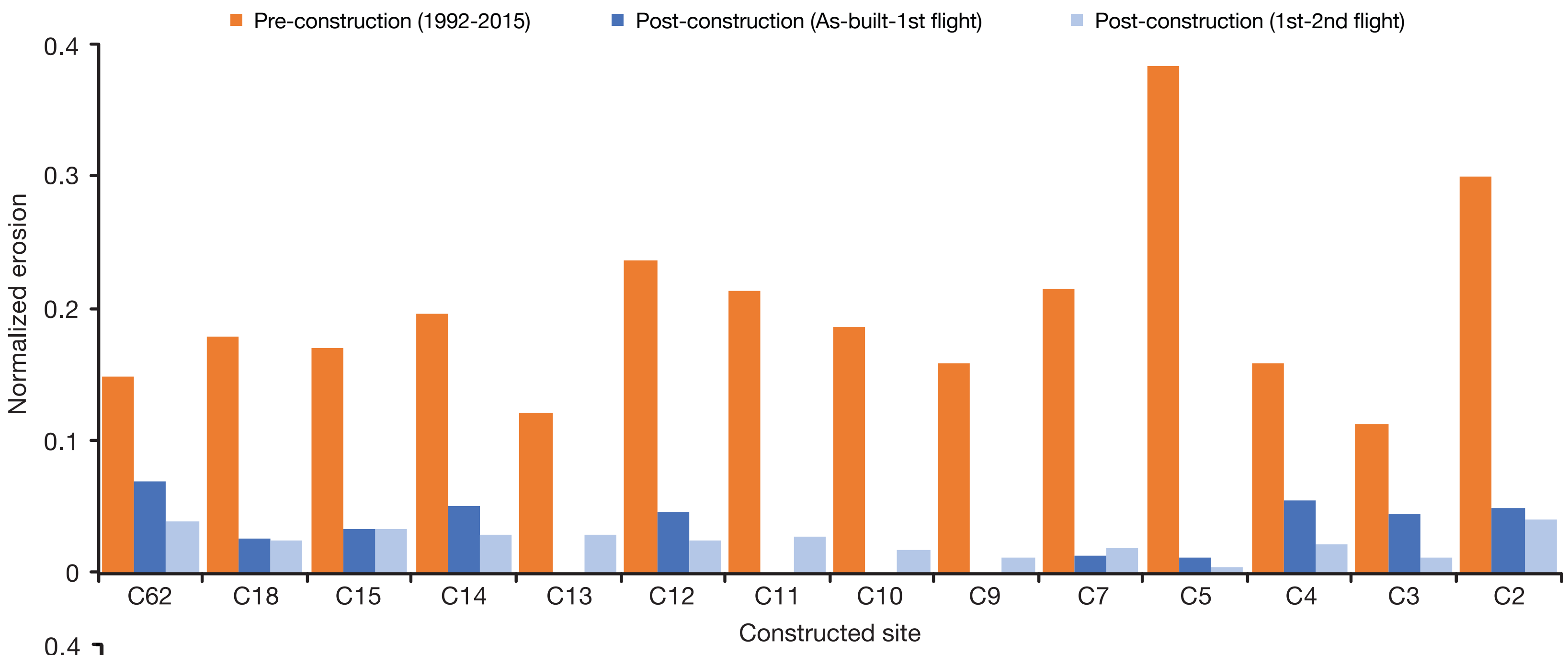


Concerns with accuracy of pre-construction imagery

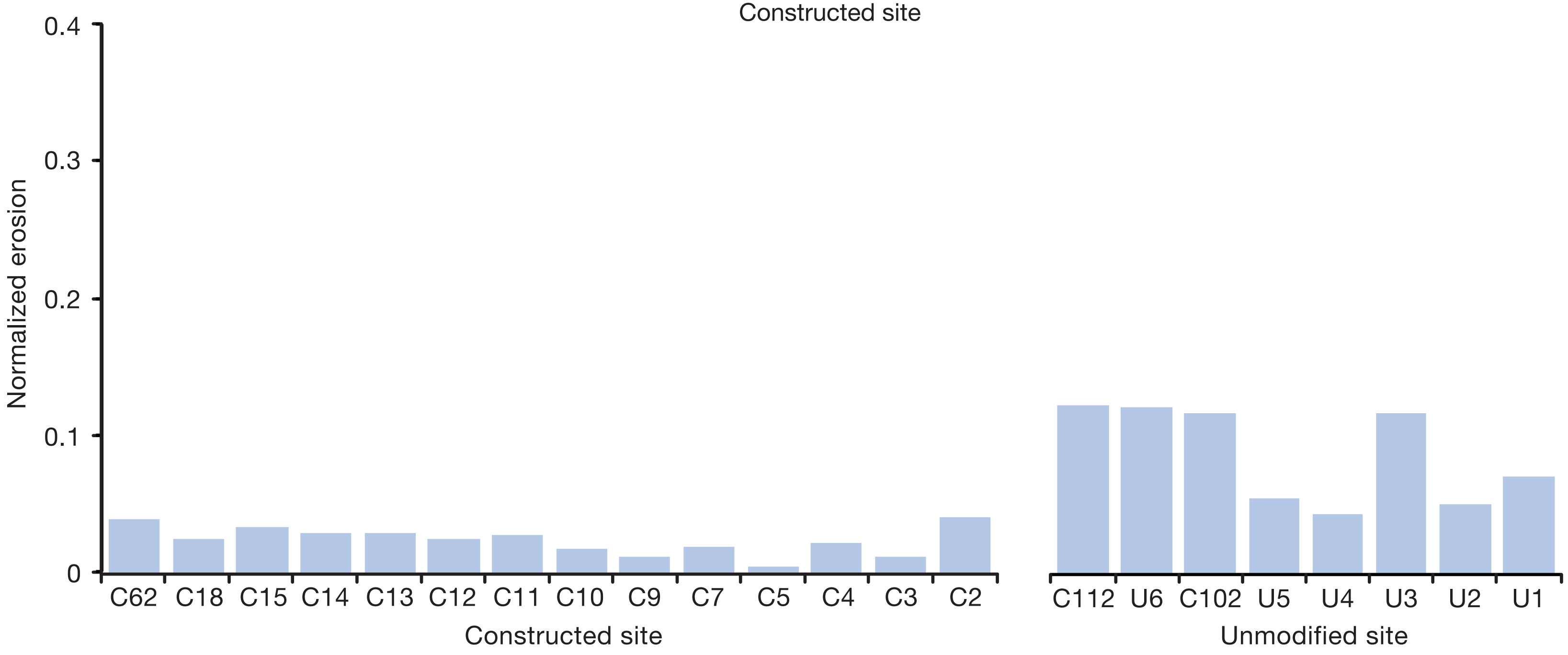
Are **average** pre-construction values representative?



Highlights importance of obtaining accurate and representative baseline data



Normalized for total volume of water (kcfs) for each time period.



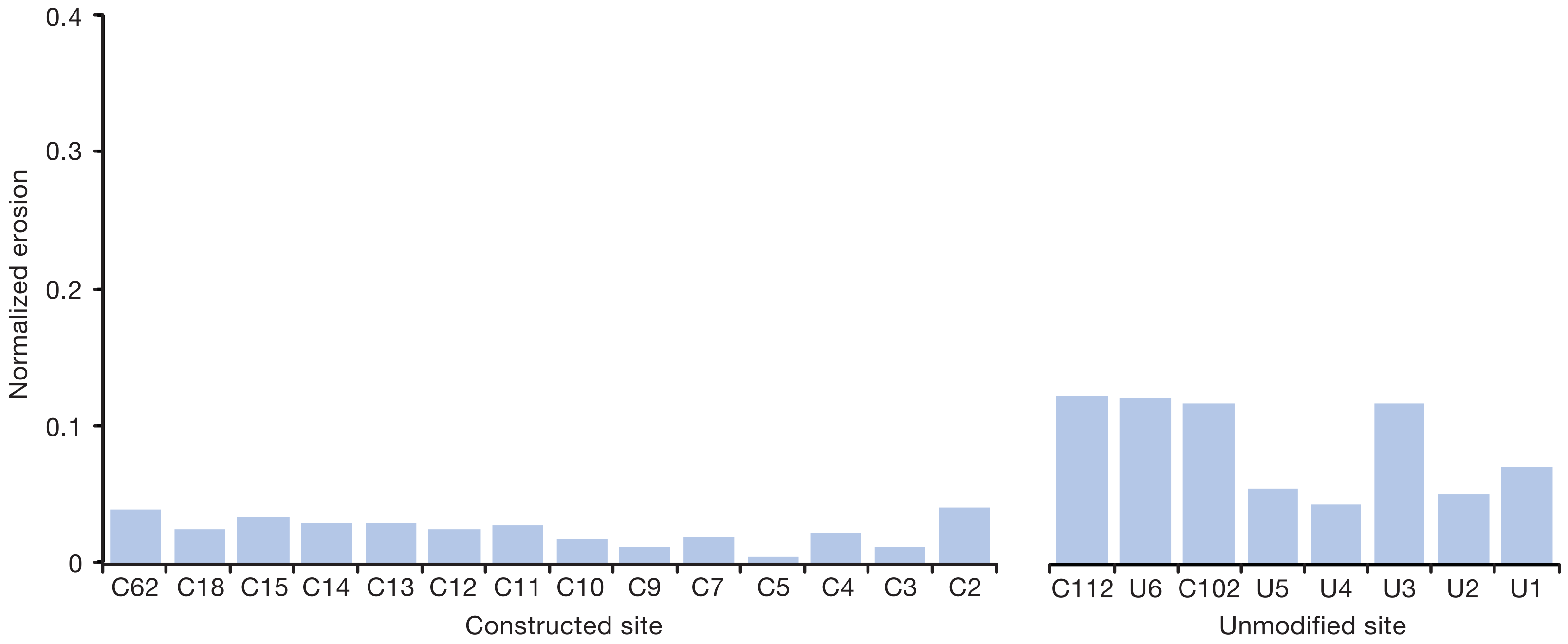
Average 75% efficiency in reducing sediment

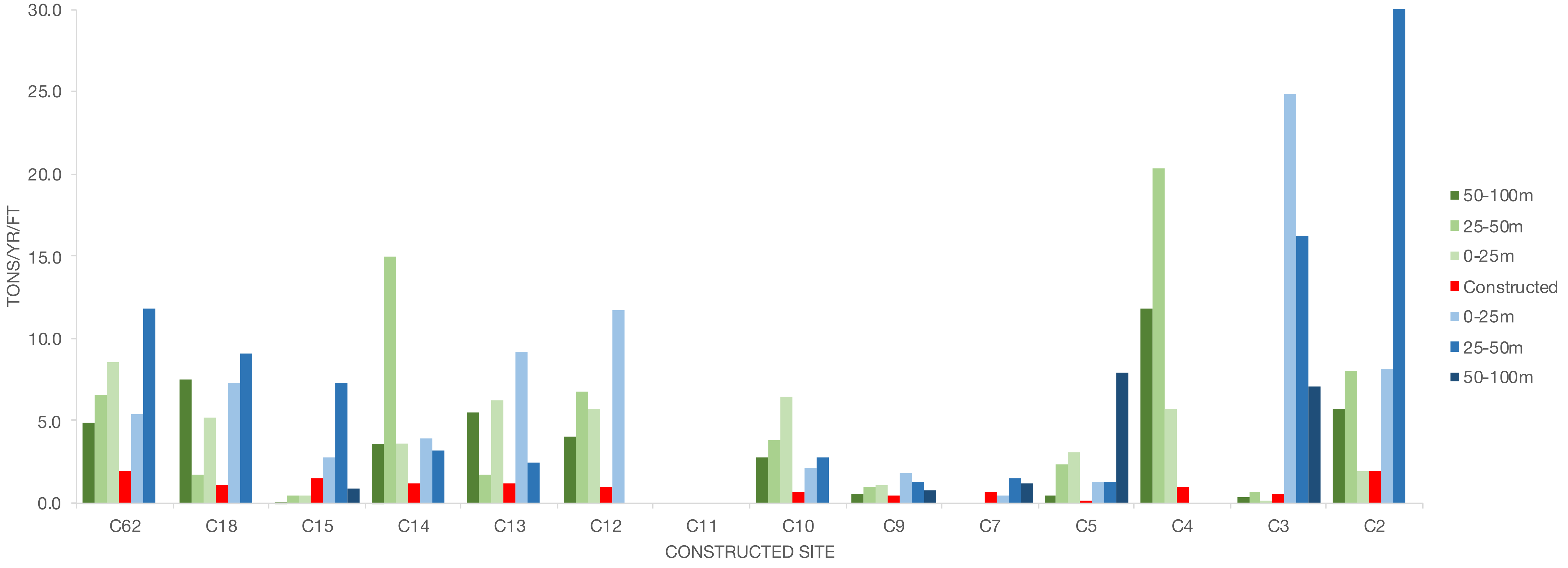
Worst case scenario - Max erosion

Length (ft)		Total eroded (ton/yr)				
21549	Total (from C2-C15)	**61765**	Assuming no SBS (using av. natural rate)			
8281	Stabilized	6795	At SBS sites (using av. stabilized rate)	Price / ft	71.5	$/ft SBS cost
13268	Natural/Unmodified	38030	Natural reaches (using av. natural rate)	Total ($)	592,080	$ (est. cost for C15-C2)
		44824			34.95	$/ton/yr

16941 Total saved (ton/yr)

27.4%




30.0
25.0
20.0
15.0
10.0
5.0
0.0
TONS/YR/FT
C62
C18
C15
C14
C13
C12
C11
C10
C9
C7
C5
C4
C3
C2
CONSTRUCTED SITE
50-100m
25-50m
0-25m
Constructed
0-25m
25-50m
50-100m

Take home points

- Utility of using UAS to monitor streambank erosion
- Stabilized streambanks are effective in reducing streambank erosion
- Importance of accurate baseline data (C102 & C112)
- Site to site variability
- Upstream/downstream effects being investigated