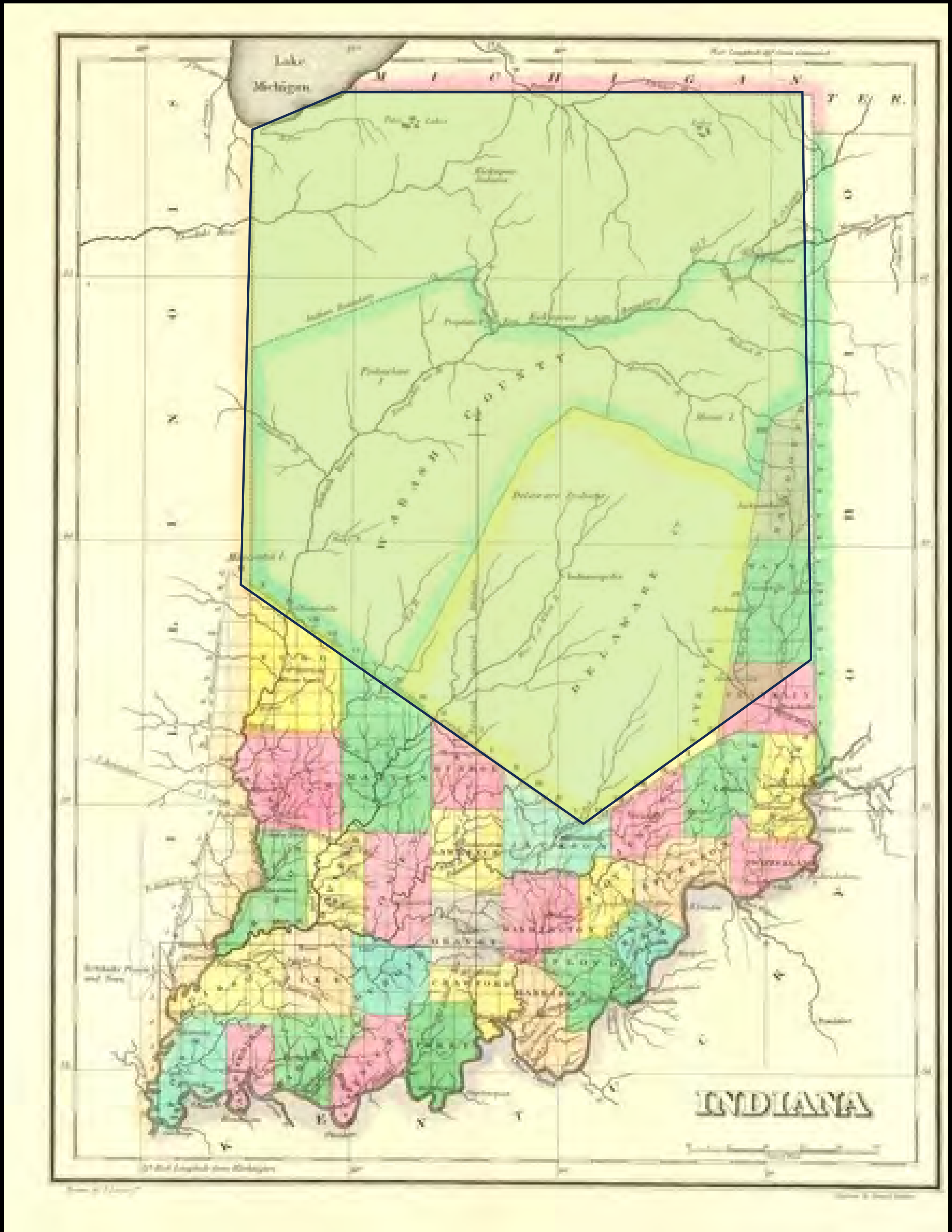
INDIAN CREEK STREAM RESTORATION

FLATLAND
RESOURCES

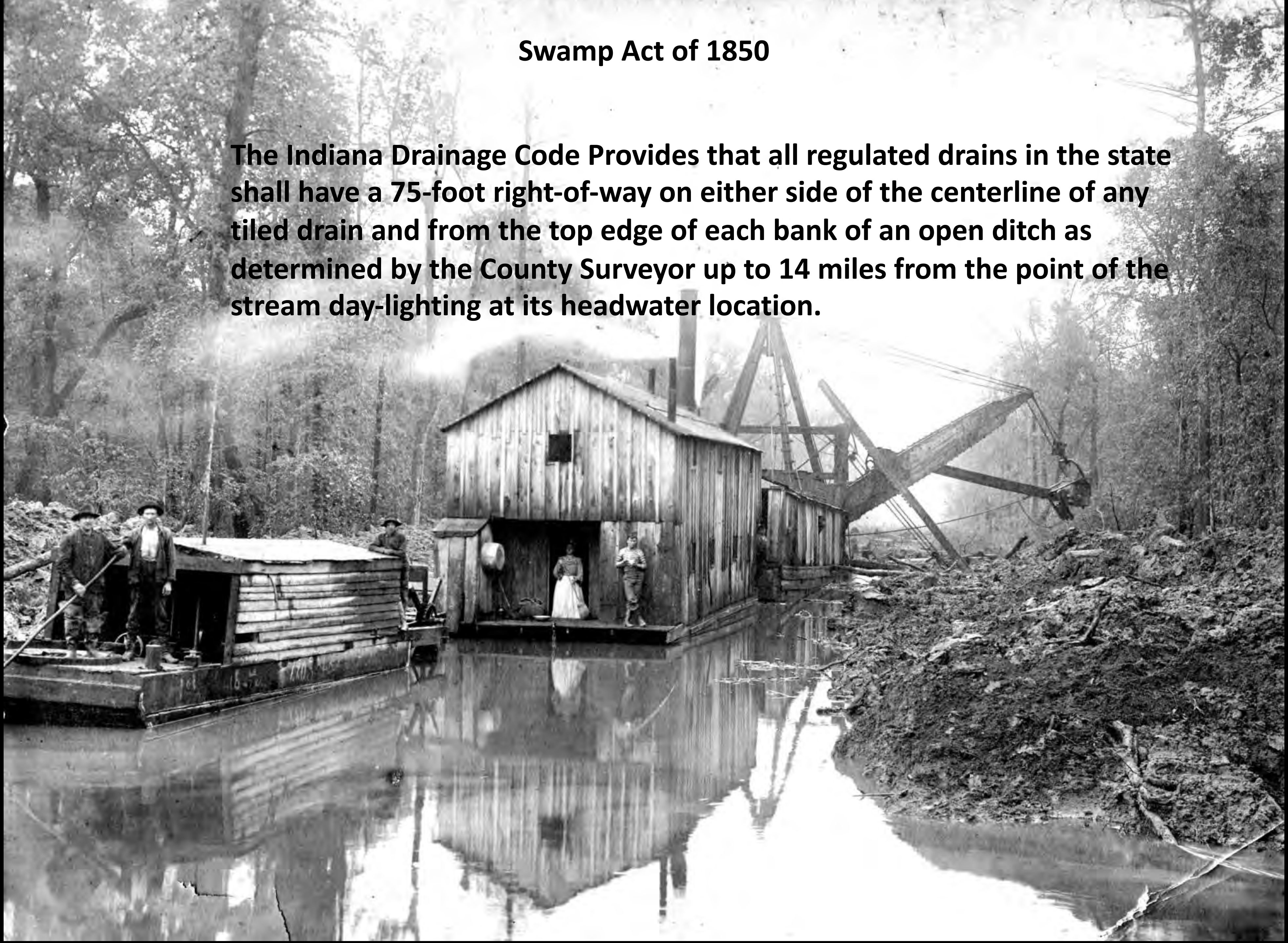
A LITTLE HISTORY…



84% wooded, wooded wetland or wetland

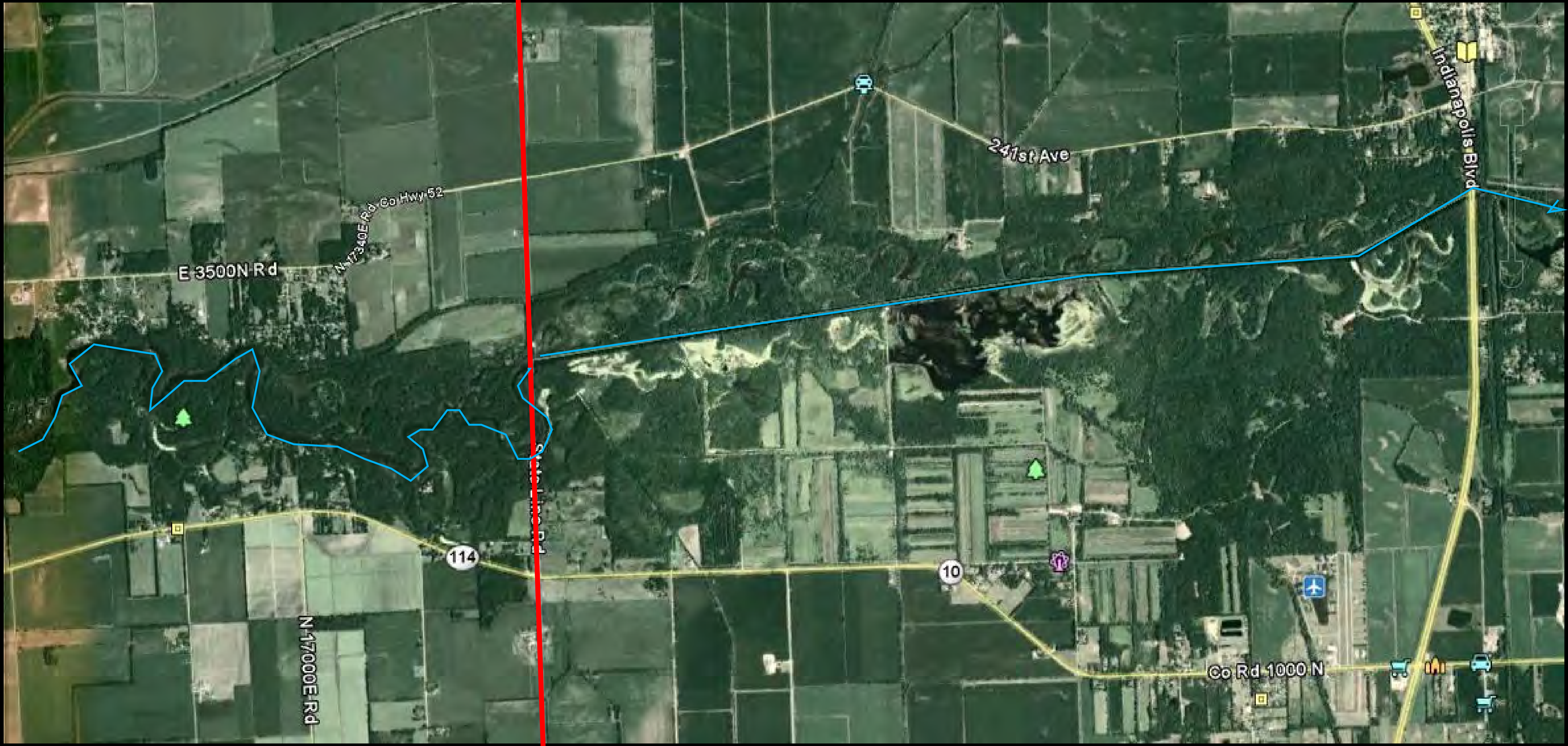
16% prairie

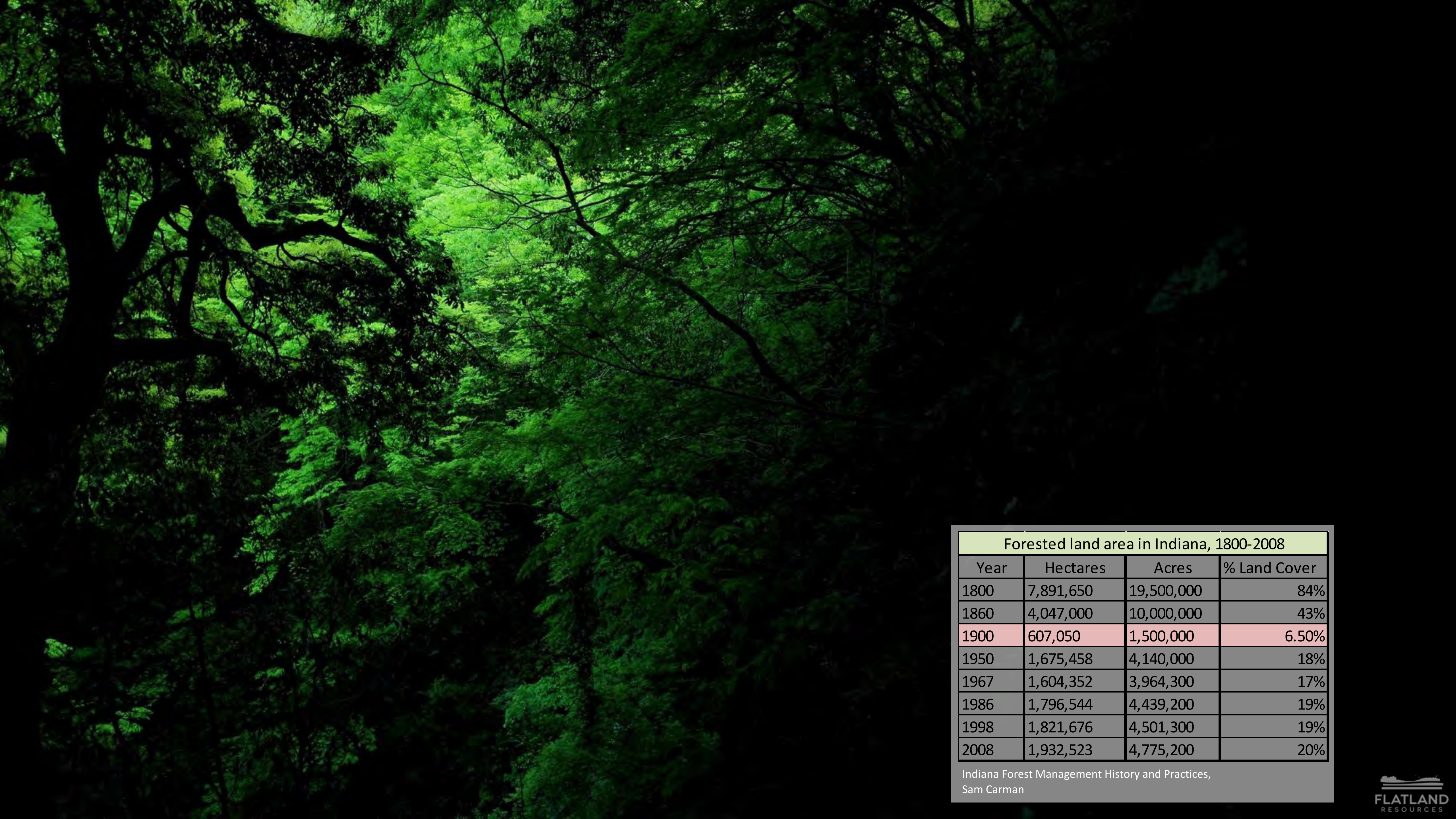
Swamp Act of 1850



The Indiana Drainage Code Provides that all regulated drains in the state shall have a 75-foot right-of-way on either side of the centerline of any tiled drain and from the top edge of each bank of an open ditch as determined by the County Surveyor up to 14 miles from the point of the stream day-lighting at its headwater location.

Illinois **Indiana**





Forested land area in Indiana, 1800-2008			
Year	Hectares	Acres	% Land Cover
1800	7,891,650	19,500,000	84%
1860	4,047,000	10,000,000	43%
1900	607,050	1,500,000	6.50%
1950	1,675,458	4,140,000	18%
1967	1,604,352	3,964,300	17%
1986	1,796,544	4,439,200	19%
1998	1,821,676	4,501,300	19%
2008	1,932,523	4,775,200	20%

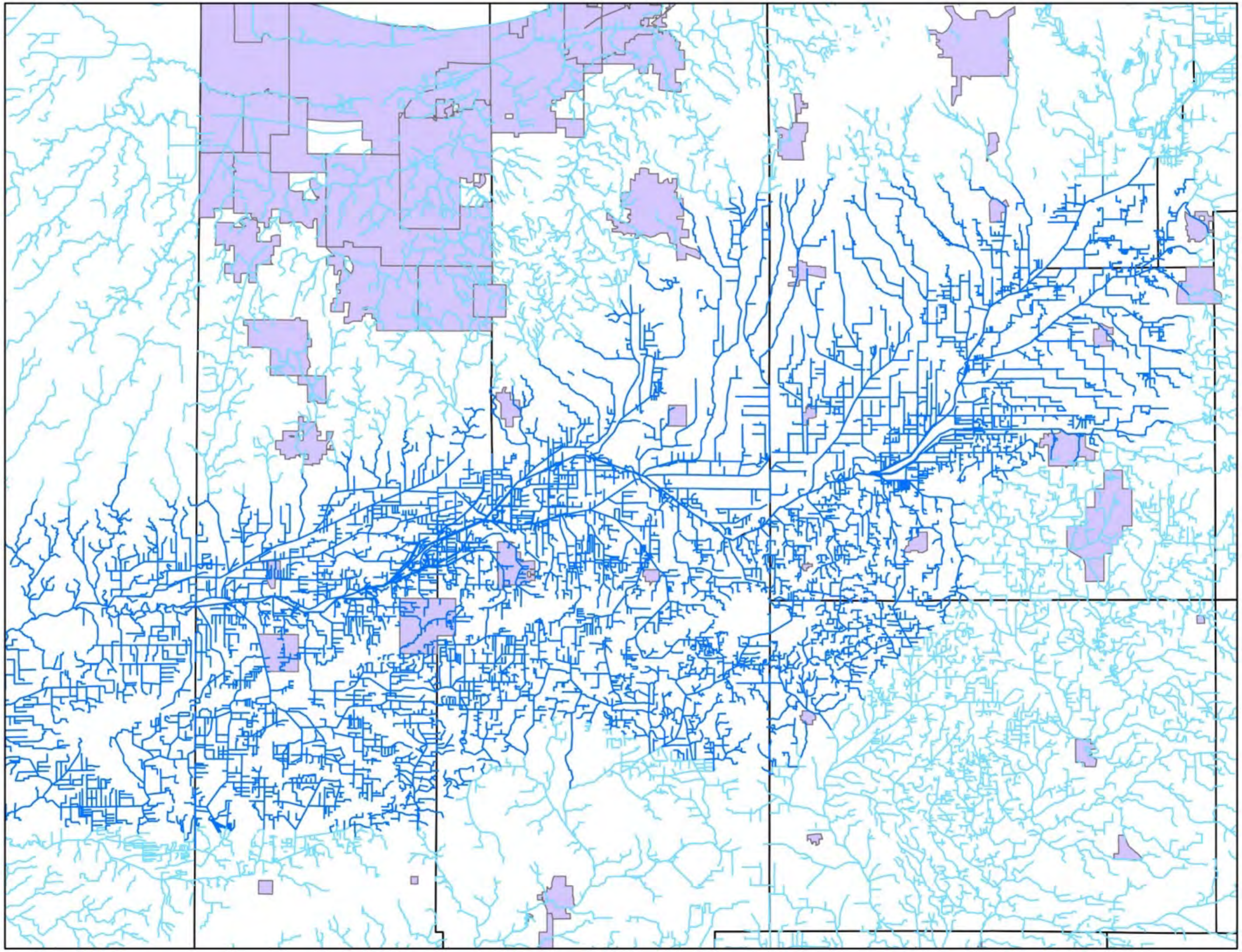
Indiana Forest Management History and Practices,
Sam Carman

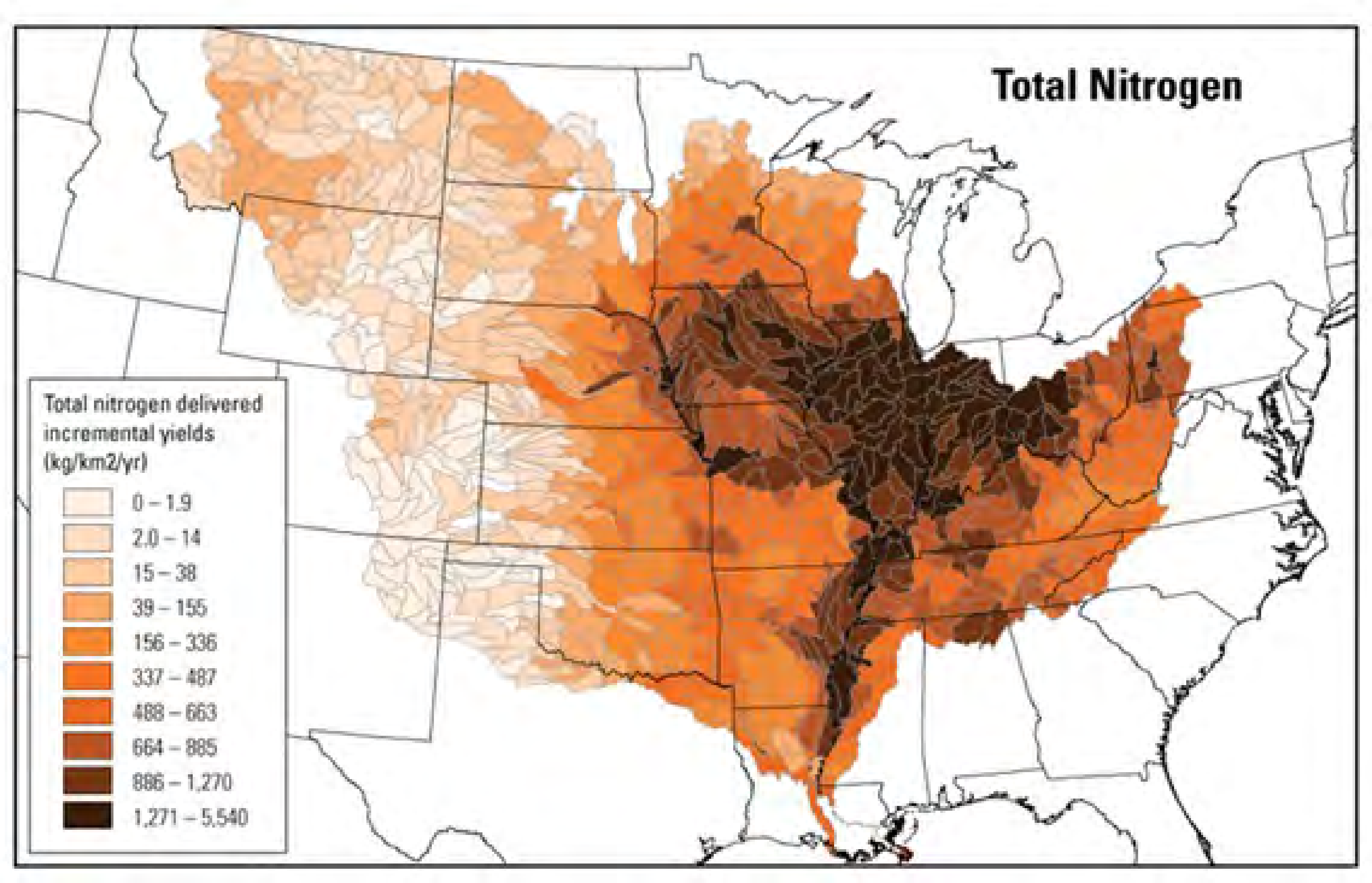
2007

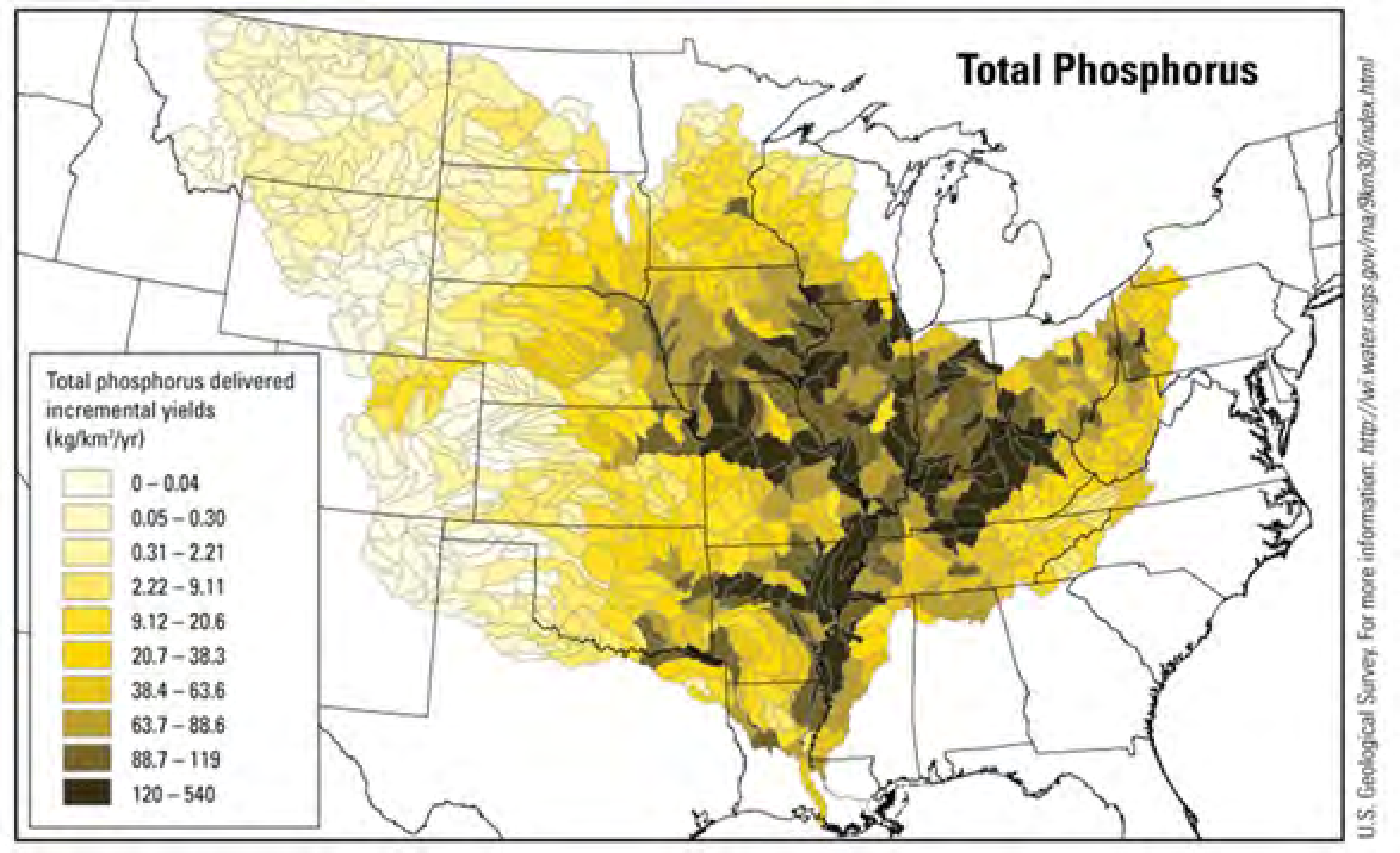
Image USDA Farm Service Agency
© 2011 Google

2005

Image IndianaMap Framework Data
© 2011 Google




Total Nitrogen
Total nitrogen delivered incremental yields (kg/km2/yr)
0 – 1.9
2.0 – 14
15 – 38
39 – 155
156 – 336
337 – 487
488 – 663
664 – 885
886 – 1,270
1,271 – 5,540



U.S. Geological Survey. For more information: http://wi.water.usgs.gov/ma/9km30/index.html


10’


10’


10’


9’

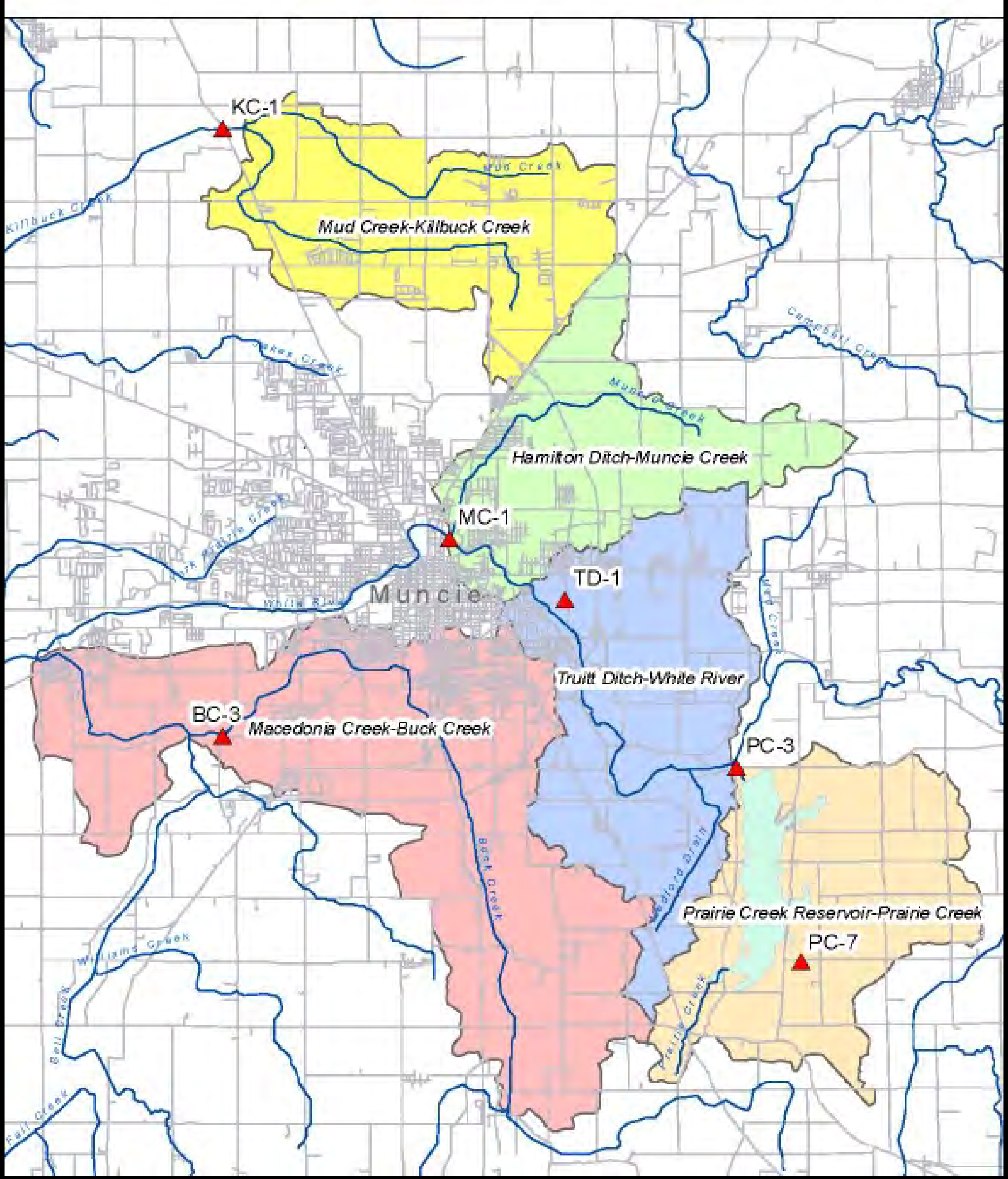
ASSUMPTIONS

1. The biggest pollutant is Nitrogen

2. Agriculture is the major source of Phosphorus.

3. The major source of E.coli is CAFOs.

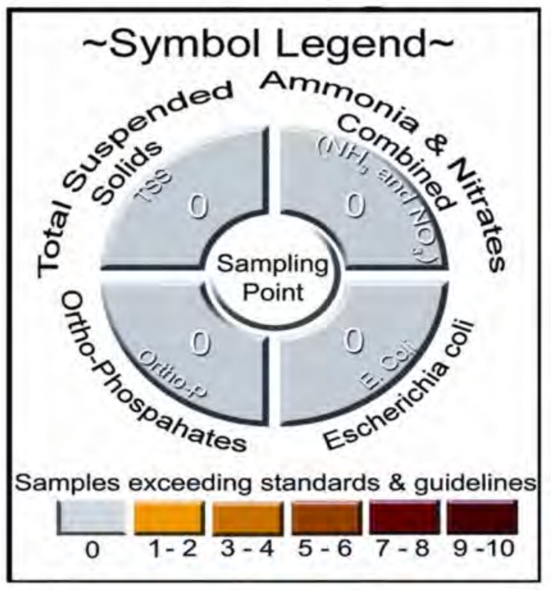
4. Sediment is not an issue & comes mainly from farm fields.

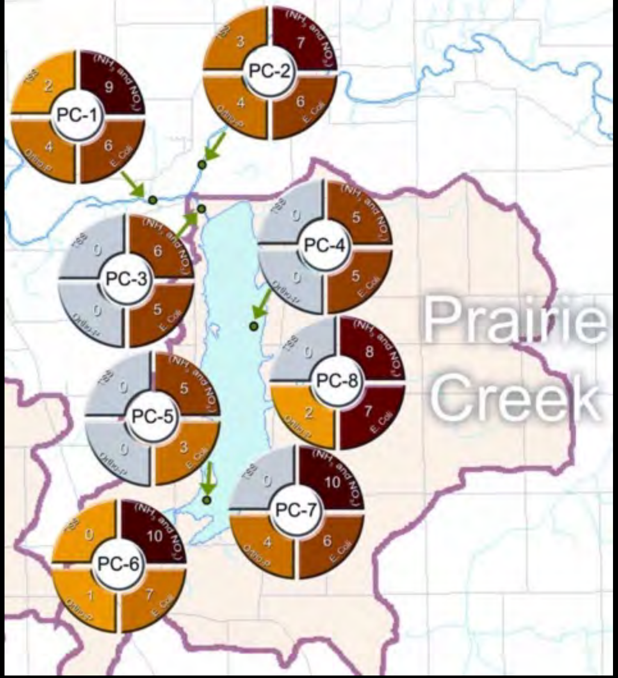


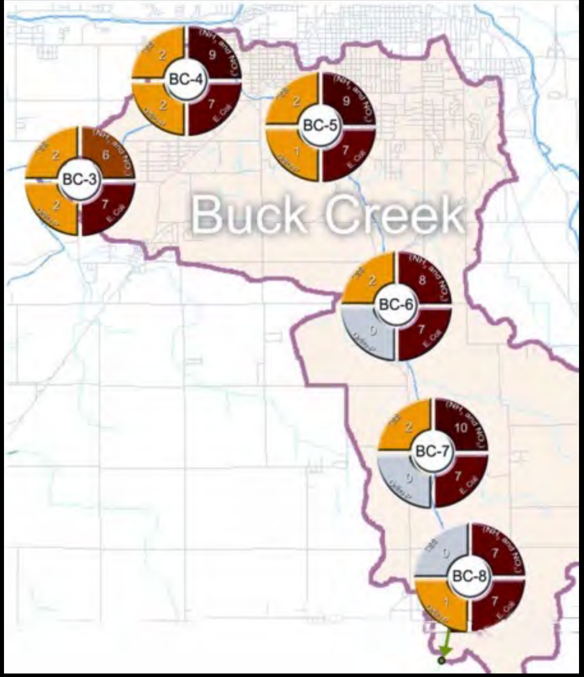
- 2000-2001 Project Origins
  - public meetings lead to formation of WRWP
- Phase 1: 2001-2004
  - Monitoring & Plan Development
- Phase 2: 2005-2008
  - Education and Outreach
  - Demonstration Wetland
  - Master plan for Prairie Creek Reservoir
  - Cost-share program
- Phase 3: 2008-2011
  - Education and Outreach
- - PCR Master plan Implementation
- Phase 4: 2011-2012
- Education and Outreach

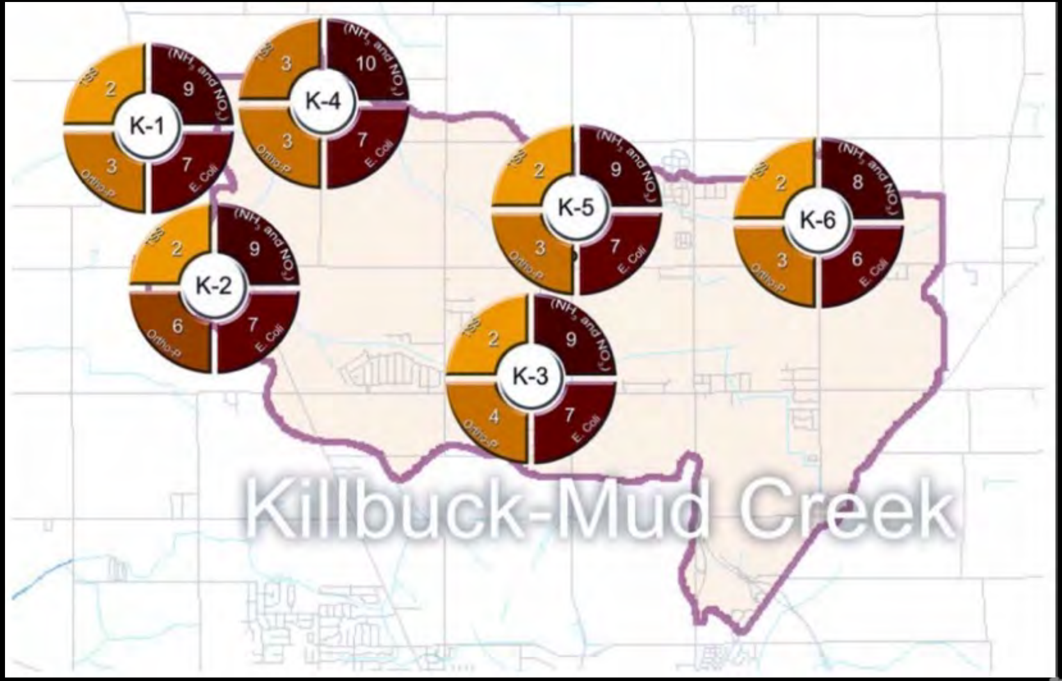
- Phase 1: 2001-2004

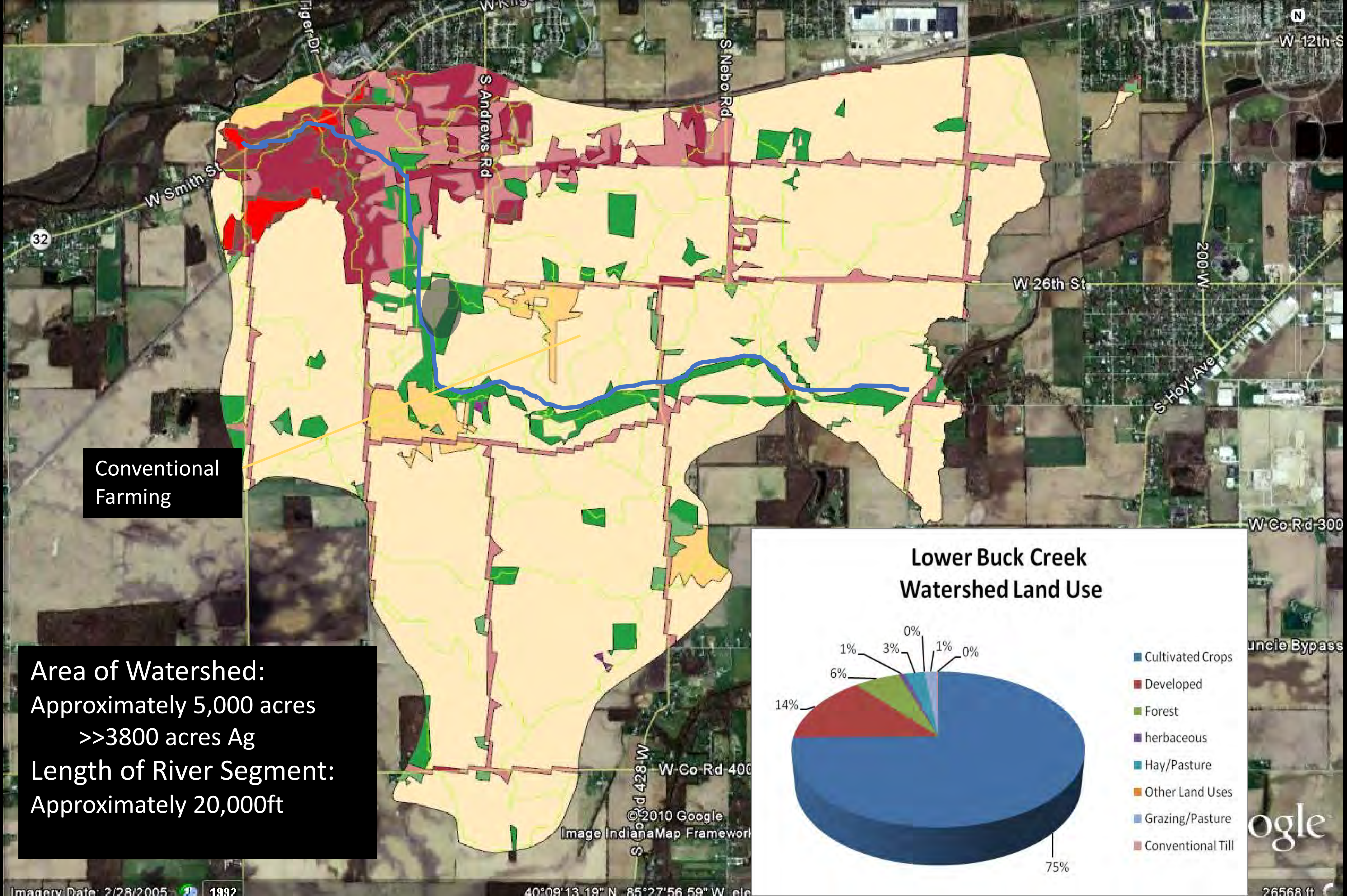
  - Monitoring & Plan Development







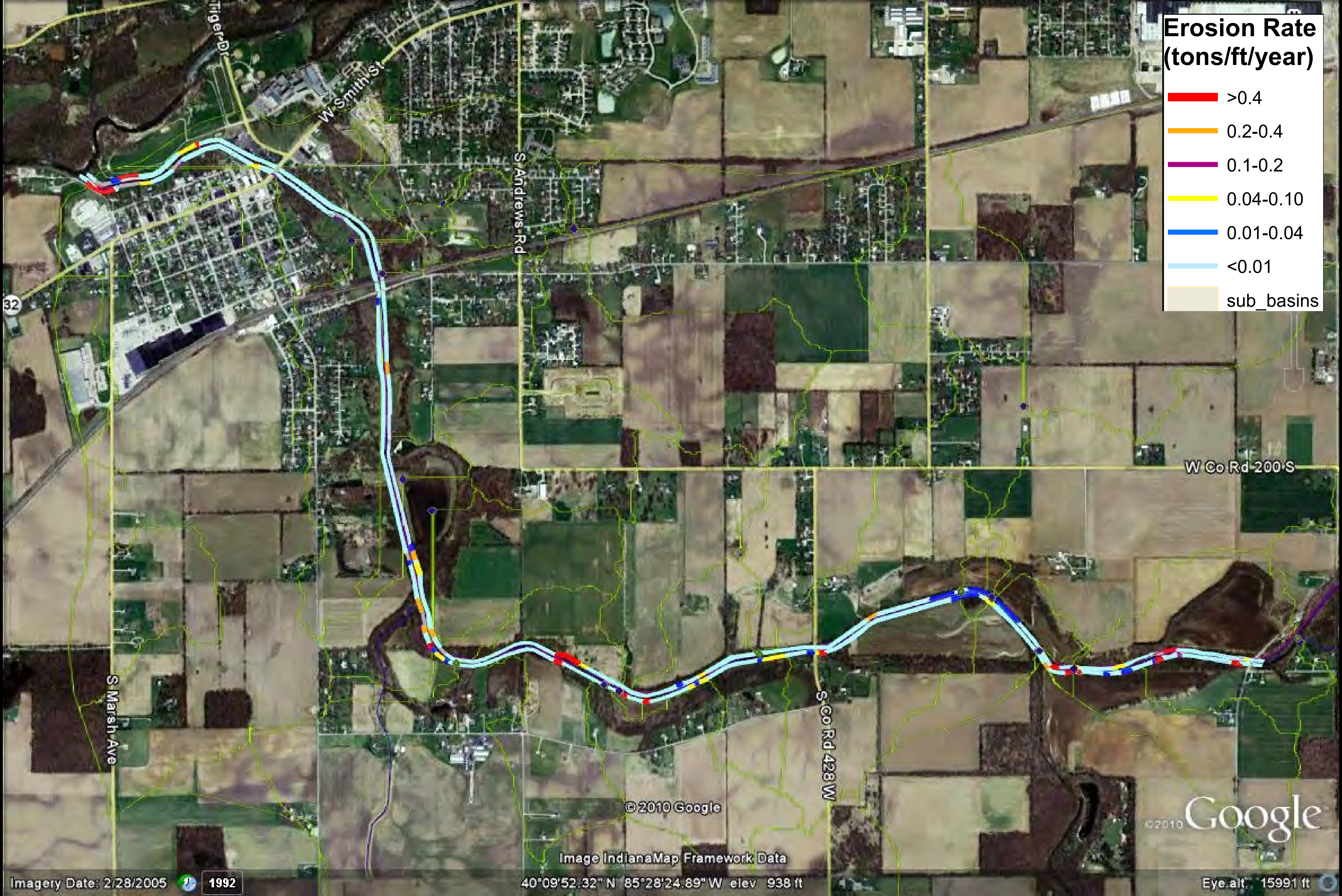


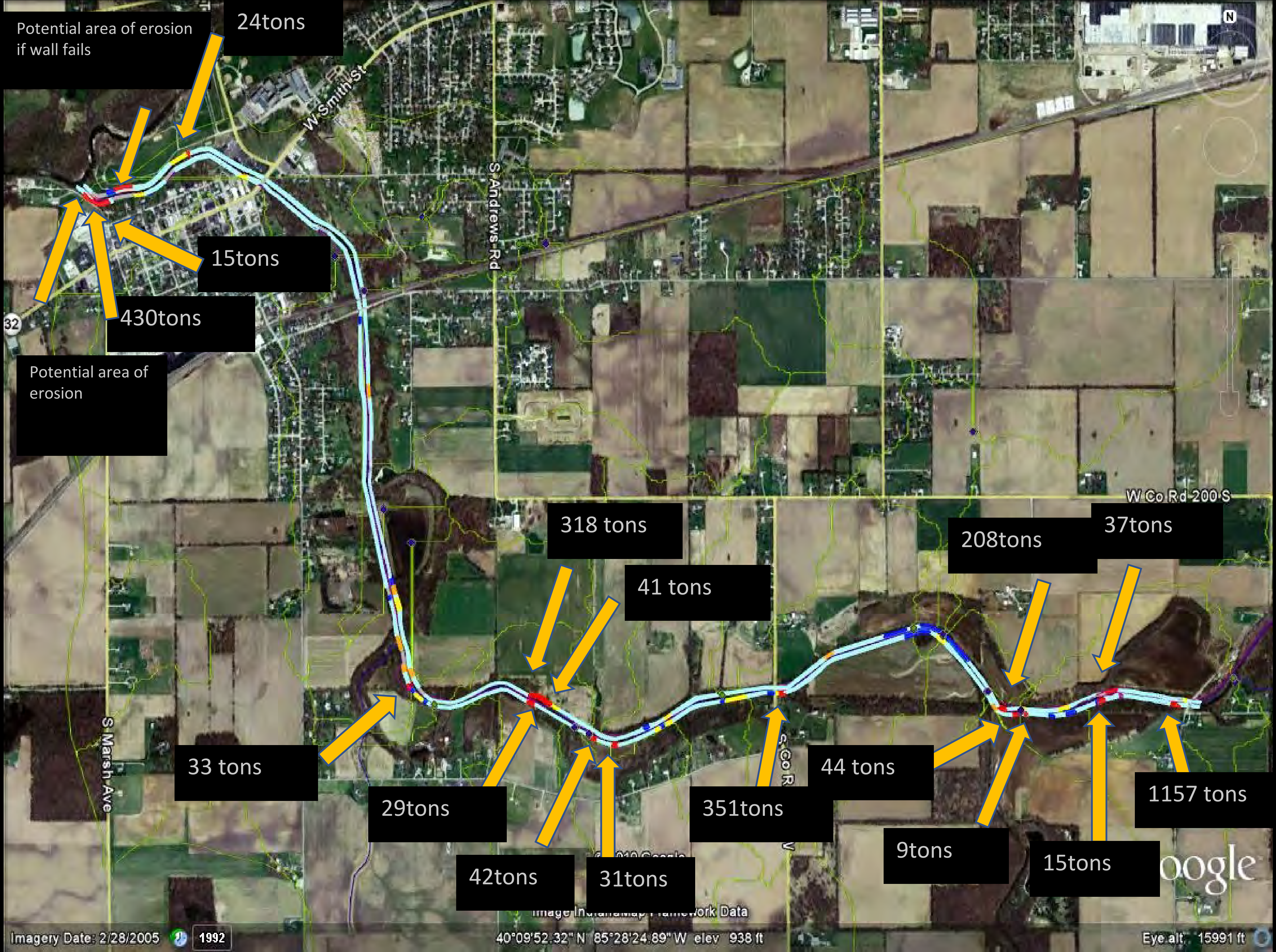


Lower Buck Creek Watershed Land Use

Conventional Farming

Area of Watershed:
Approximately 5,000 acres
>>3800 acres Ag
Length of River Segment:
Approximately 20,000ft


Erosion Rate (tons/ft/year)
🟥 >0.4
🟧 0.2-0.4
🟪 0.1-0.2
🟨 0.04-0.10
🟦 0.01-0.04
<0.01
sub_basins
Tiger Dr
W Smith St
S Andrews Rd
32
W Co Rd 200 S
S Marsh Ave
S Co Rd 428 W
© 2010 Google
Image IndianaMap Framework Data
©2010 Google
Imagery Date: 2/28/2005
1992
40°09'52.32" N 85°28'24.89" W elev 938 ft
Eye alt 15991 ft



Potential area of erosion if wall fails

24tons

15tons

430tons

Potential area of erosion

318 tons

41 tons

208tons

37tons

33 tons

29tons

42tons

31tons

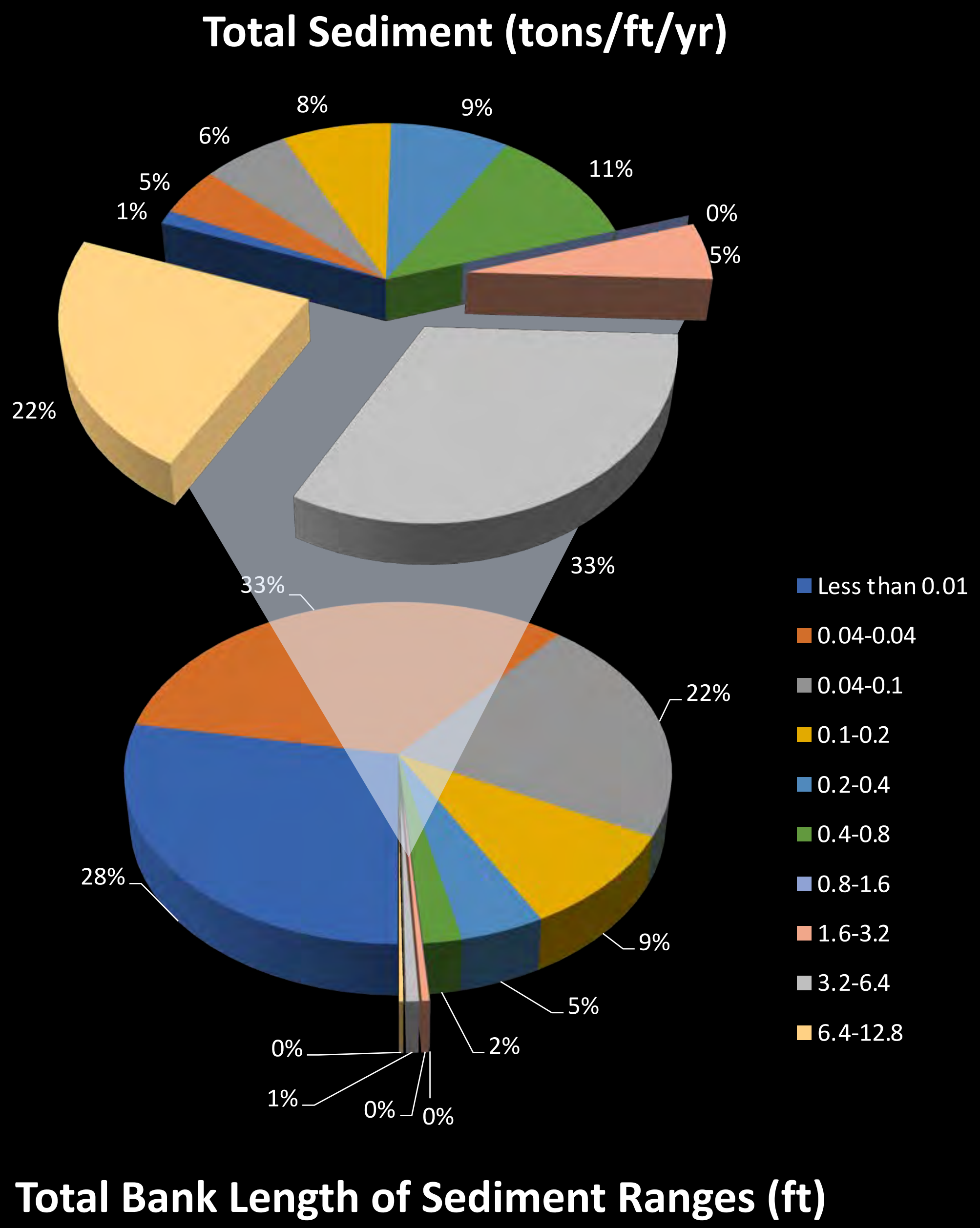
351tons

44 tons

9tons

15tons

1157 tons



*5204 tons being discharged from the banks annually

*62% coming from <3% of the banks

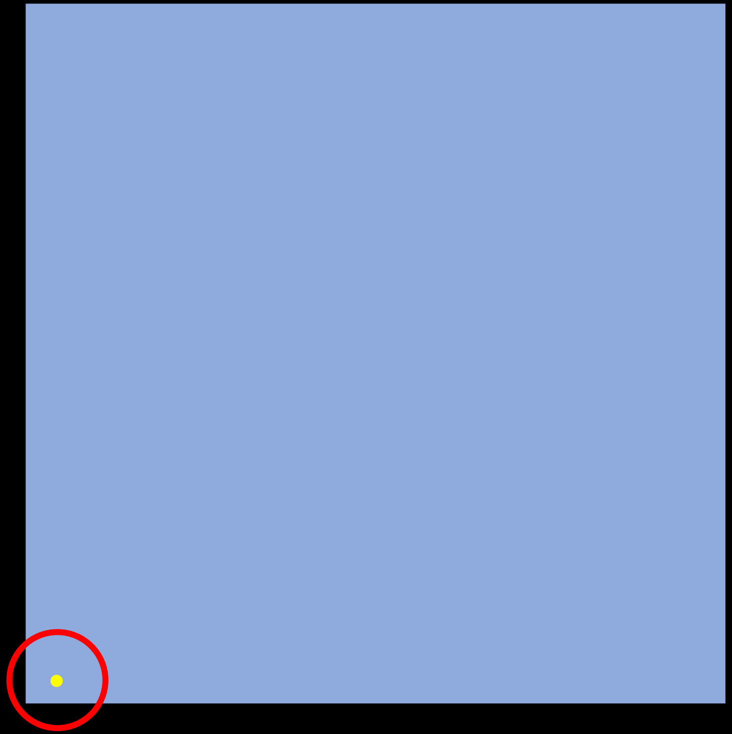
*54% of the Sediment coming from 659’ of the 20,000’ banks

*Equates to an NFL football field almost 2’ deep in the sediment- coming from 659’ of the bank

Cultivated Crop - Sample Analysis
Lower Buck Creek

The sediment coming from Buck Creek is almost 37,763 times greater than the sediment being discharged from the entire acreage of farmland.

- Buck Creek: 4.59 acres
- BEHI Model: 5,200 tons/yr
    - 1132.9 tons/acre



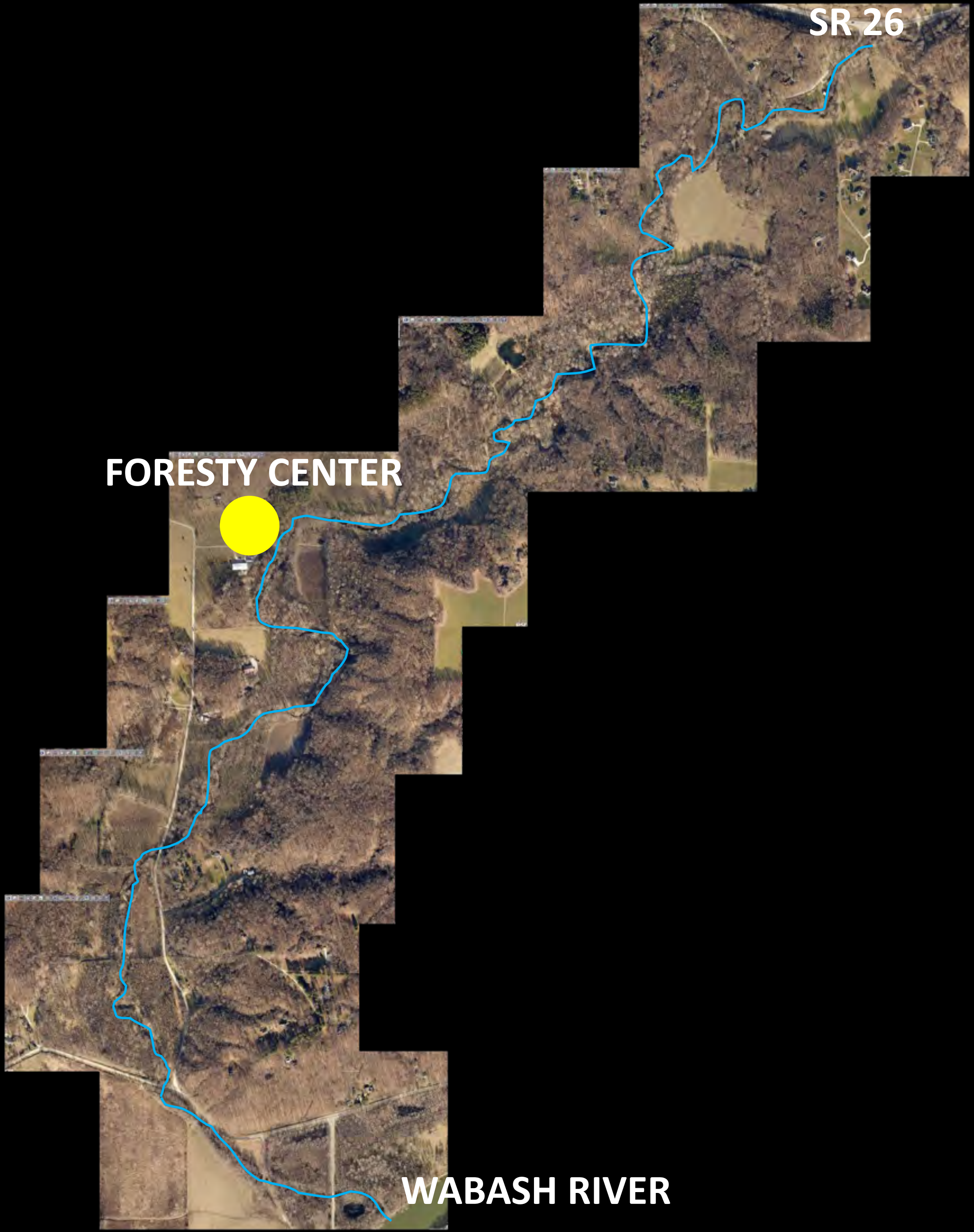
INDIAN CREEK

PROJECT SITE WATERSHED

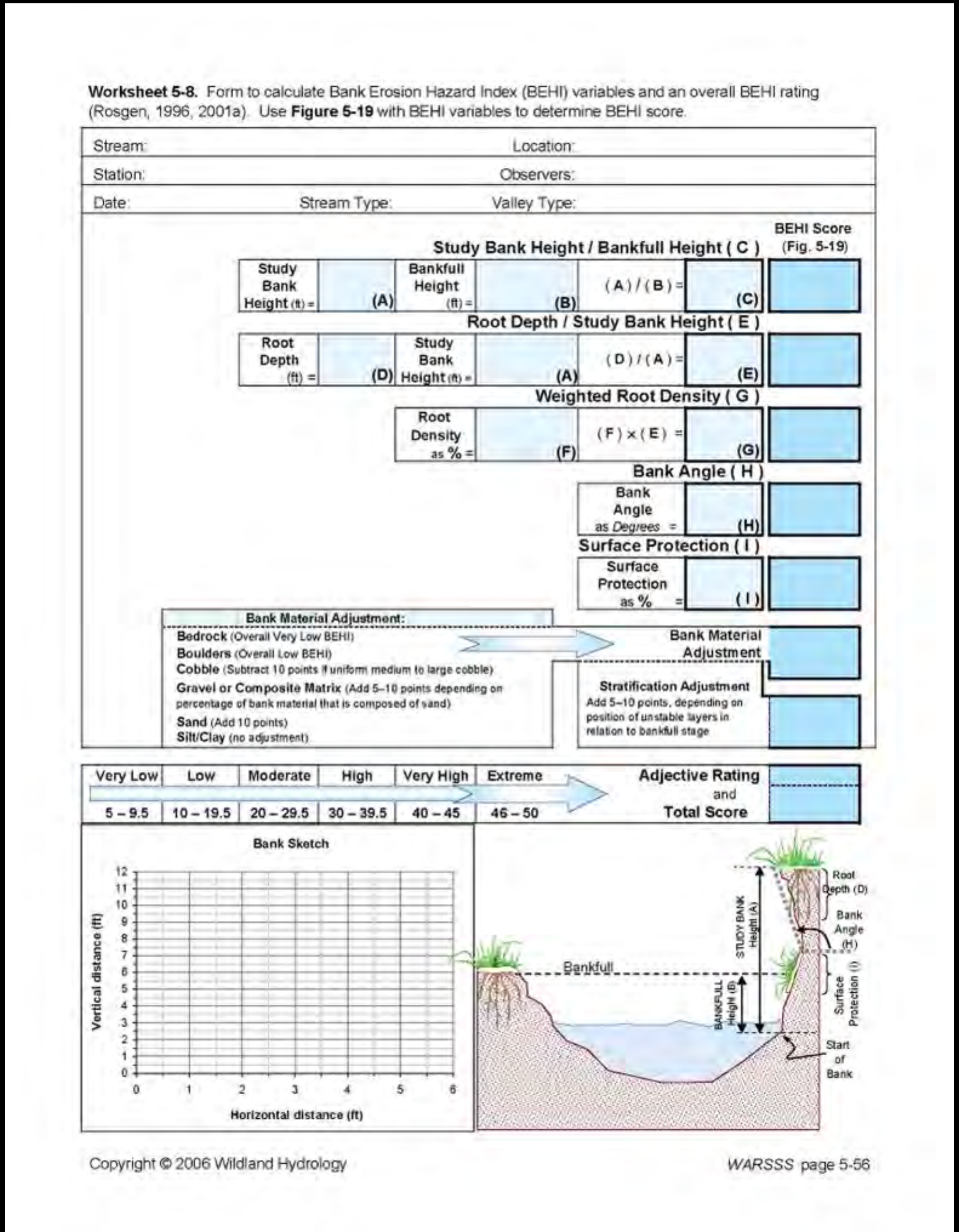
SITES 1 & 2 – 27.81 SQ MILES

SITES 3 – 28.2 SQ MILES

5/2012
Division Rd
Base Line Rd
Division Rd
S 700 W
Indian Creek
Granville Boat Ramp Acc
S 700 W
Wabash River
Google Earth
HEARTLAND RESOURCES



FLATLAND RESOURCES



Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream: Location:

Station: Observers:

Date: Stream Type: Valley Type:

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) = (A) Bankfull Height (ft) = (B) (A) / (B) = (C)

Root Depth / Study Bank Height (E)

Root Depth (ft) = (D) Study Bank Height (ft) = (A) (D) / (A) = (E)

Weighted Root Density (G)

Root Density as % = (F) (F) × (E) = (G)

Bank Angle (H)

Bank Angle as *Degrees* = (H)

Surface Protection (I)

Surface Protection as % = (I)

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and Total Score

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WARSSS page 5-56

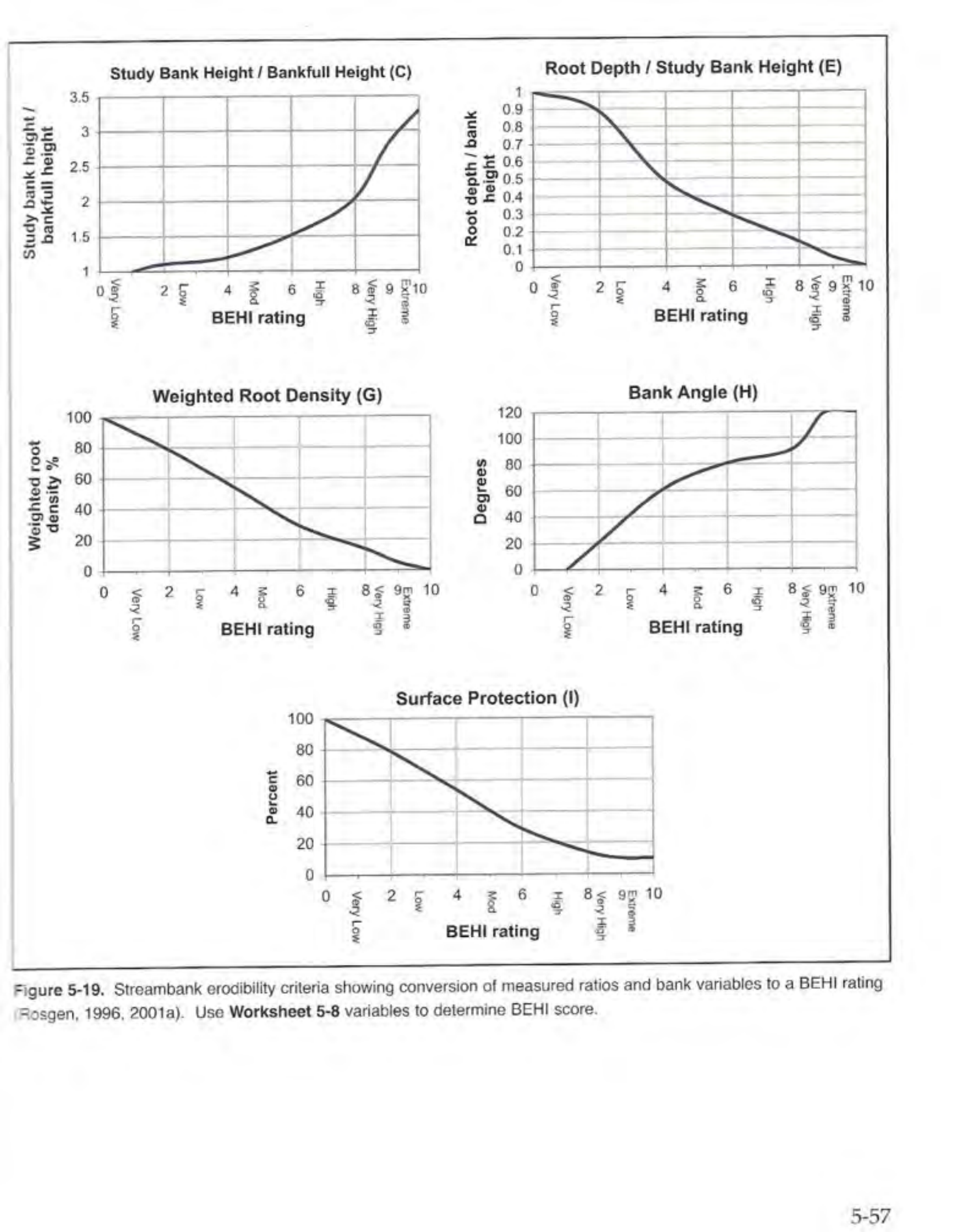
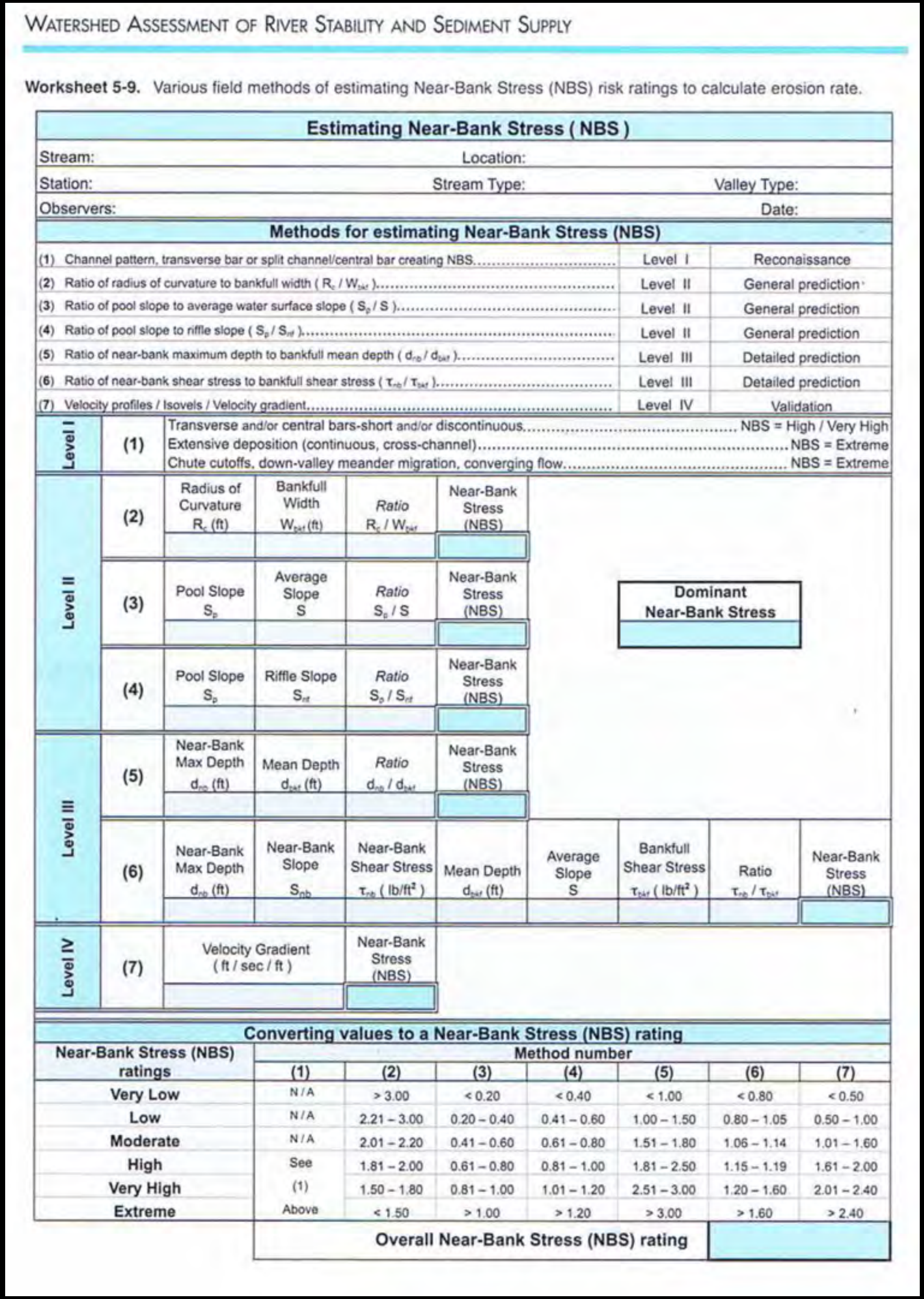


Figure 5-19. Streambank erodibility criteria showing conversion of measured ratios and bank variables to a BEHI rating (Rosgen, 1996, 2001a). Use **Worksheet 5-8** variables to determine BEHI score.

5-57



Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS.	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous .... NBS = High / Very High

Extensive deposition (continuous, cross-channel) .... NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow .... NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)				

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting values to a Near-Bank Stress (NBS) rating

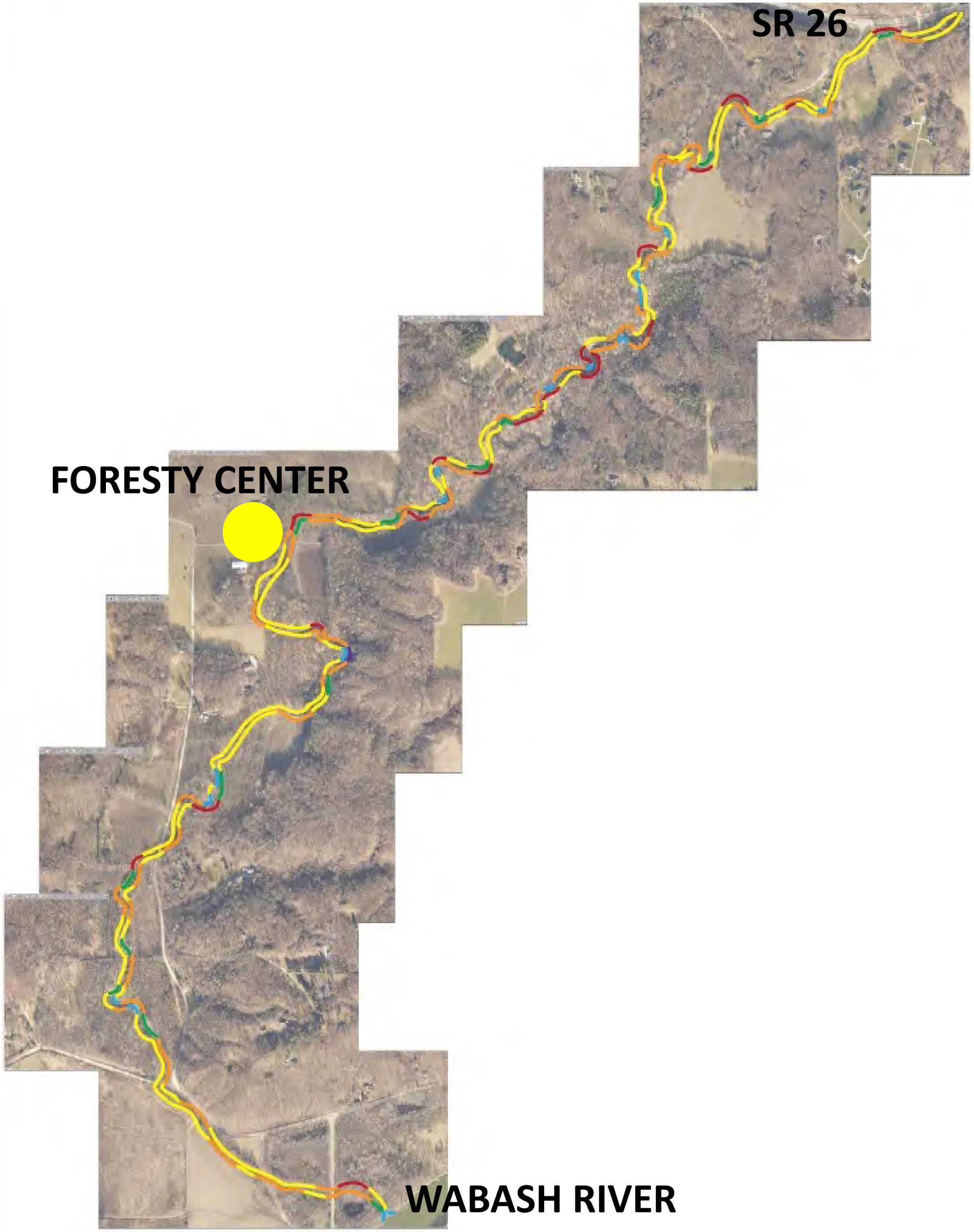
Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating


10’


10’


9’



SR 26
FORESTY CENTER
WABASH RIVER

BEHI/NBS

TASK 2

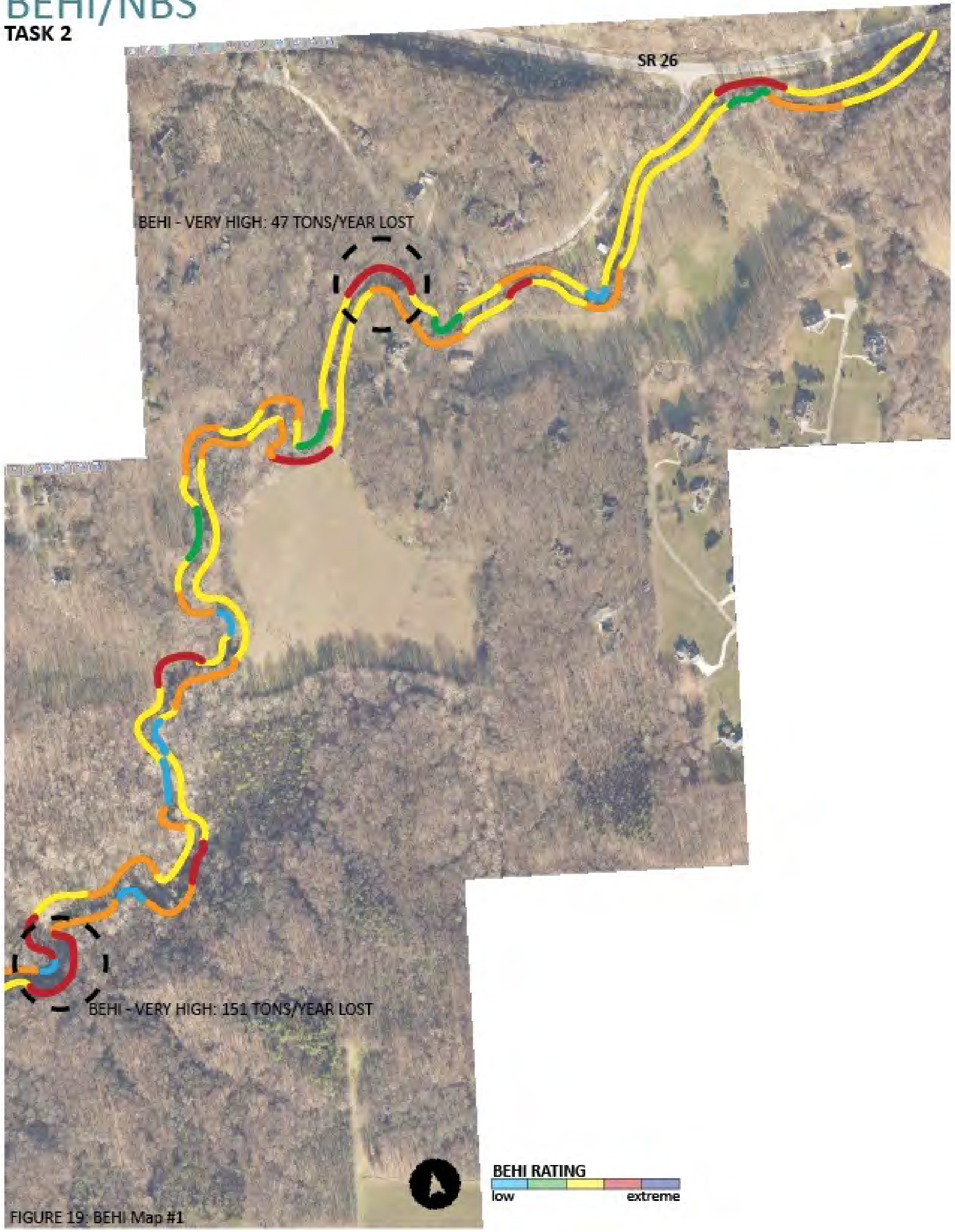


FIGURE 19: BEHI Map #1

BEHI/NBS

TASK 2

FIGURE 20: BEHI Map #2

FLATLAND
RESOURCES

BEHI/NBS

TASK 2

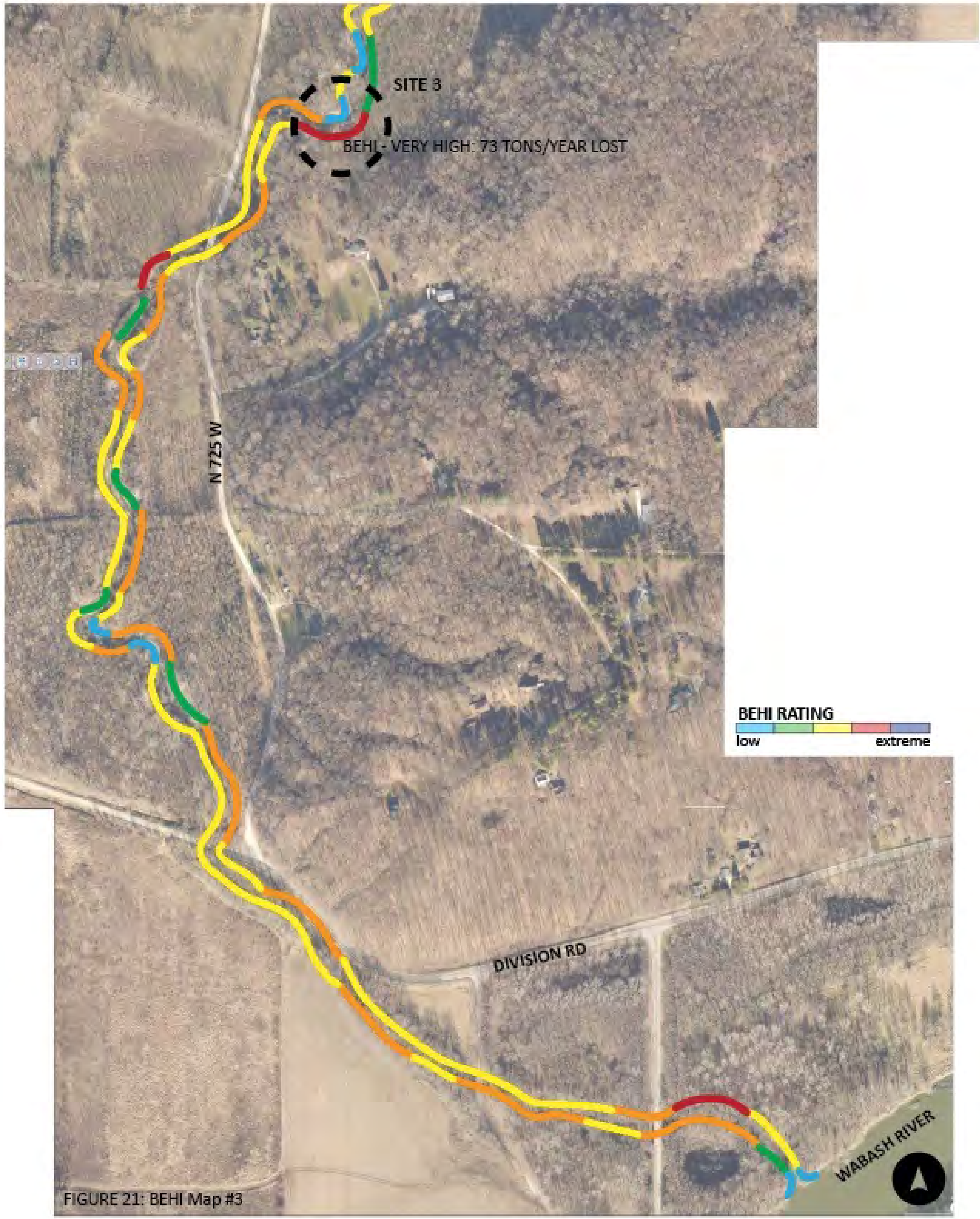
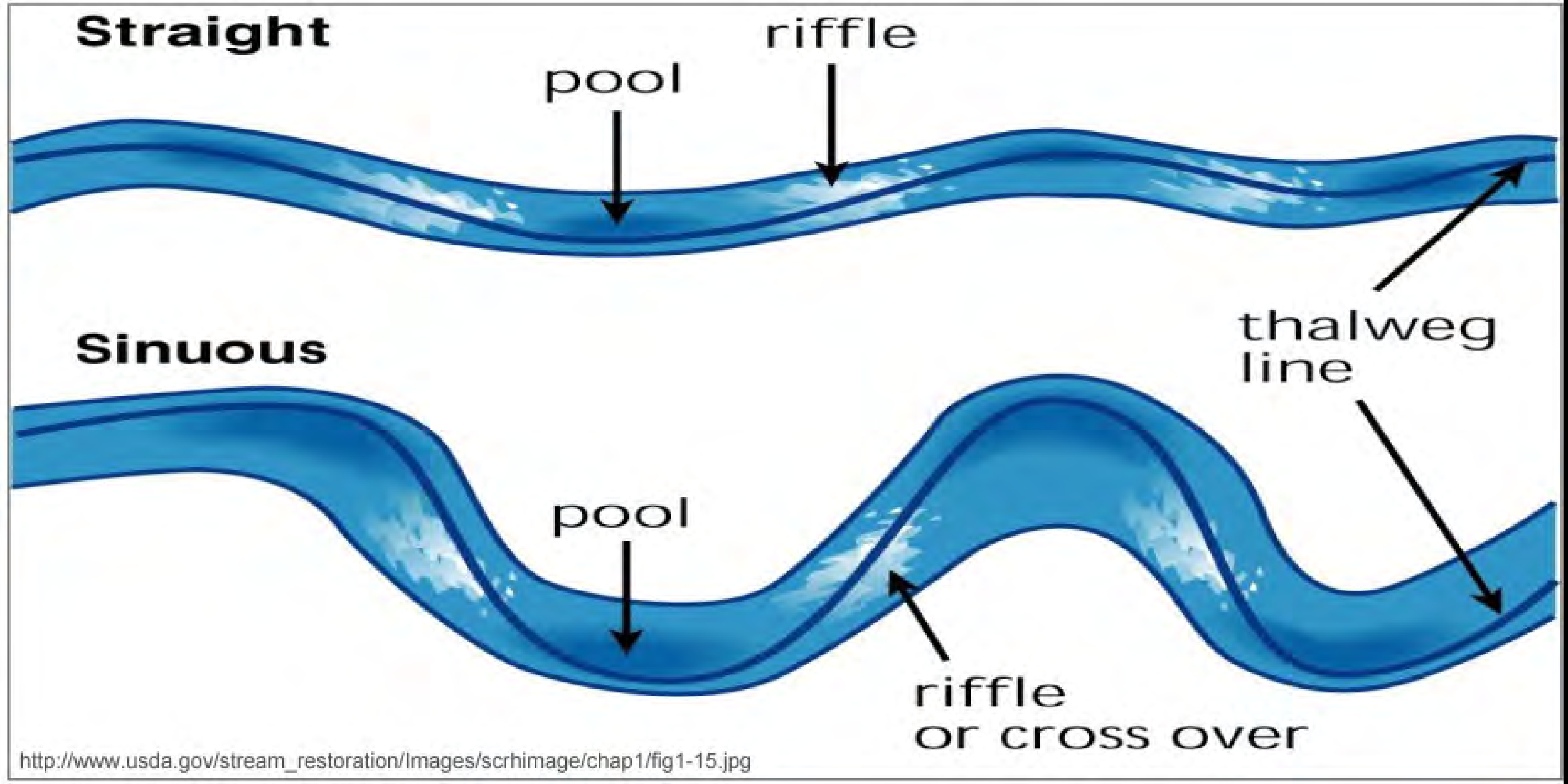
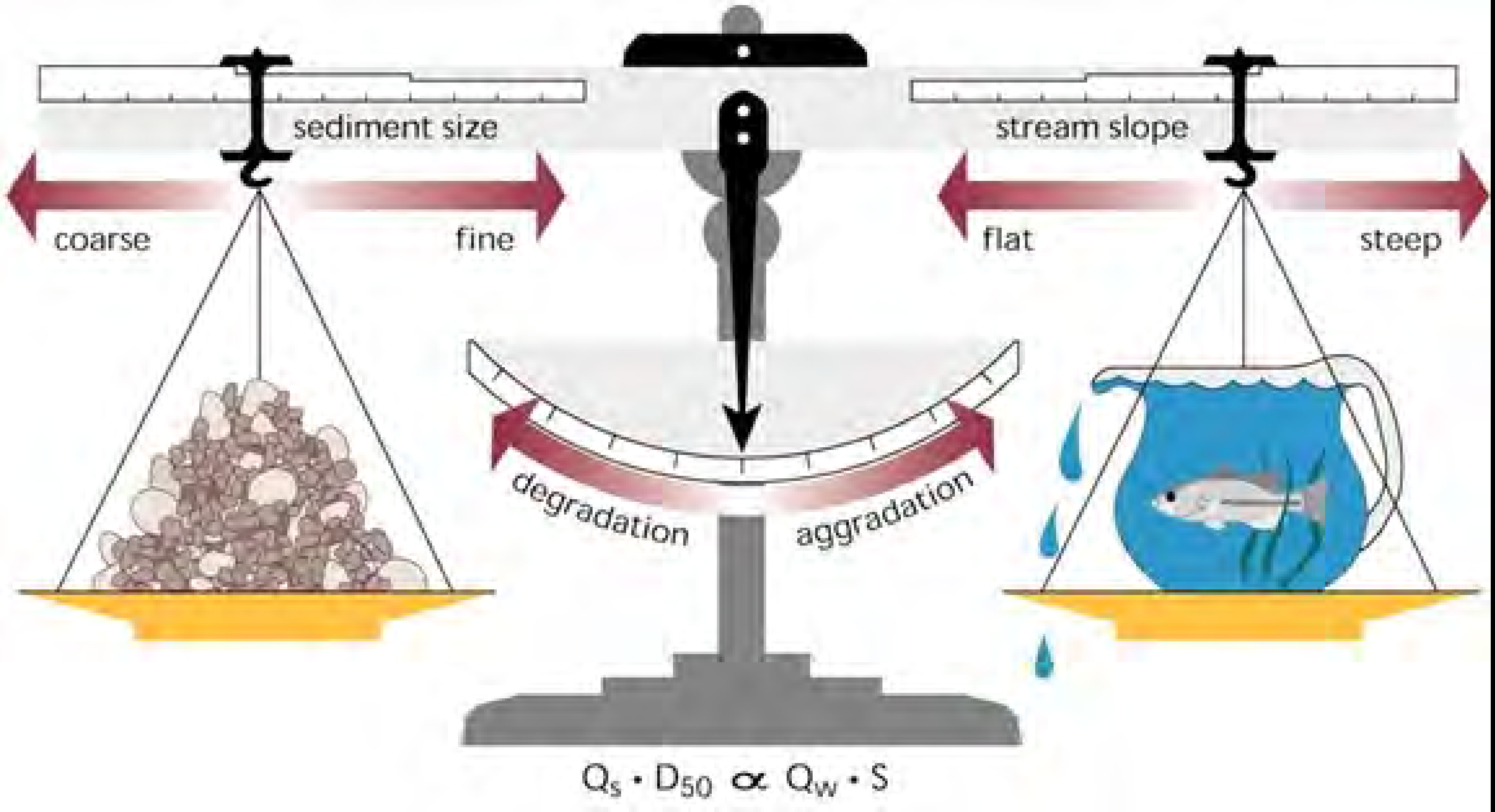


FIGURE 21: BEHI Map #3

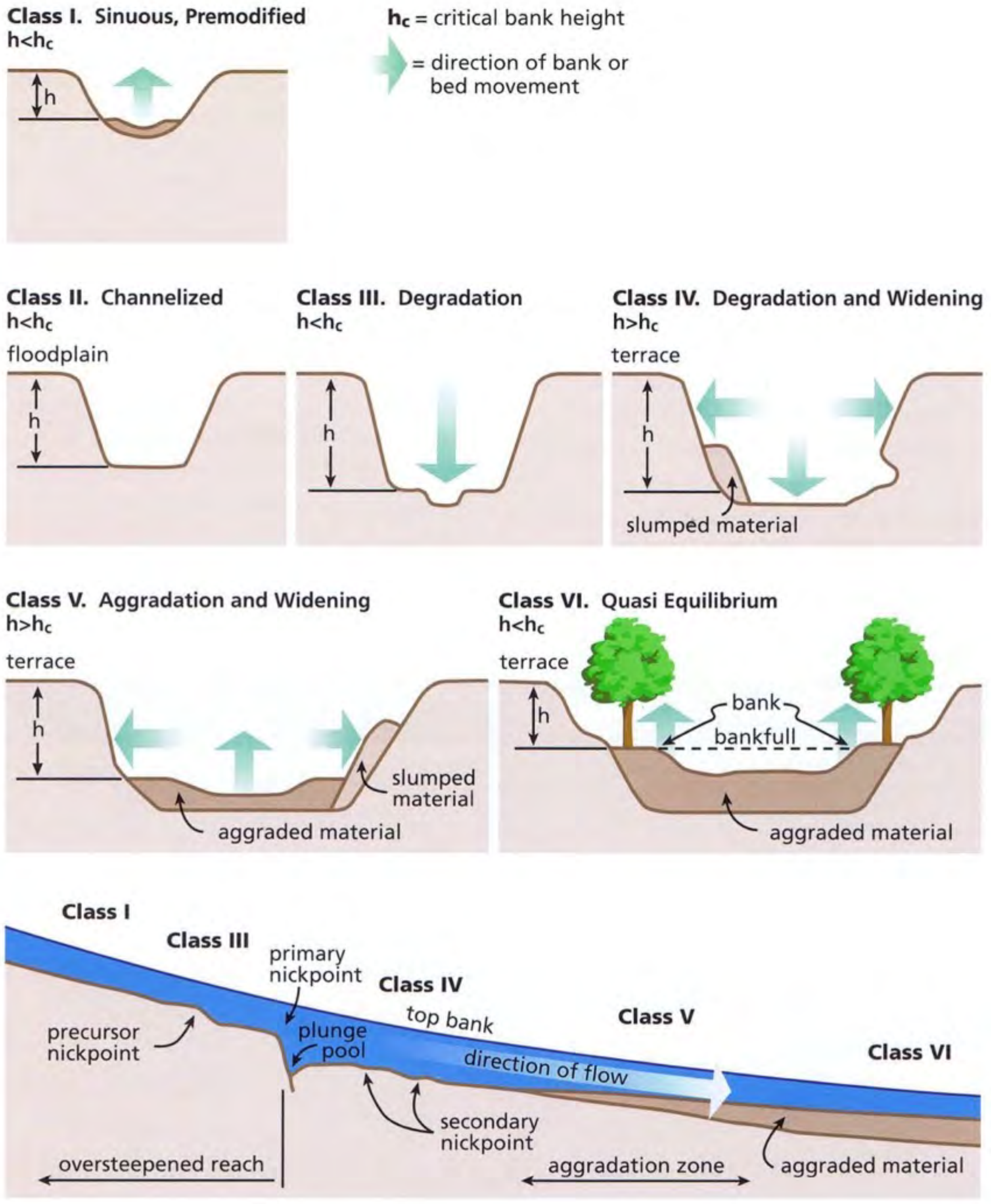


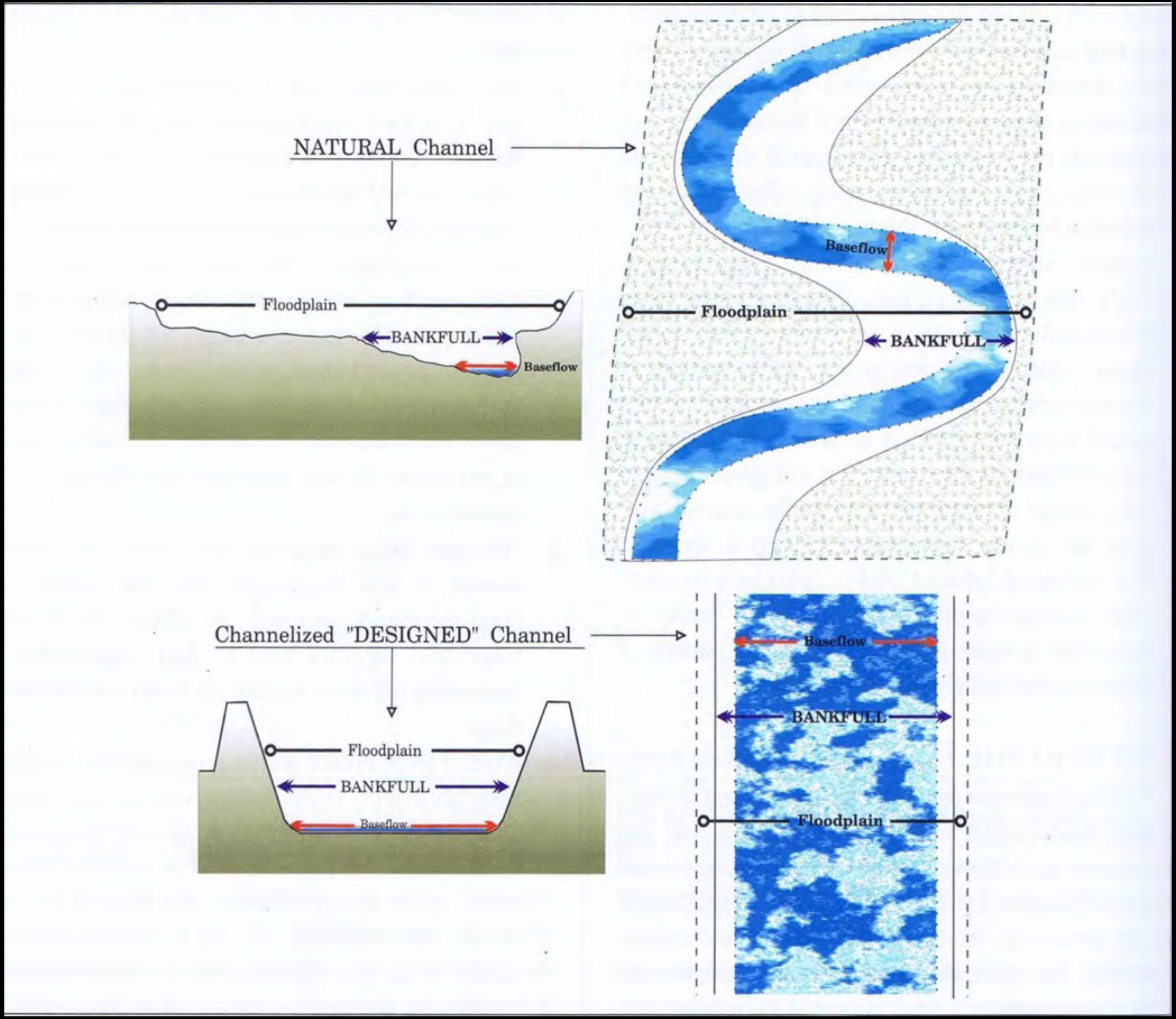
http://www.usda.gov/stream_restoration/Images/scrhimage/chap1/fig1-15.jpg

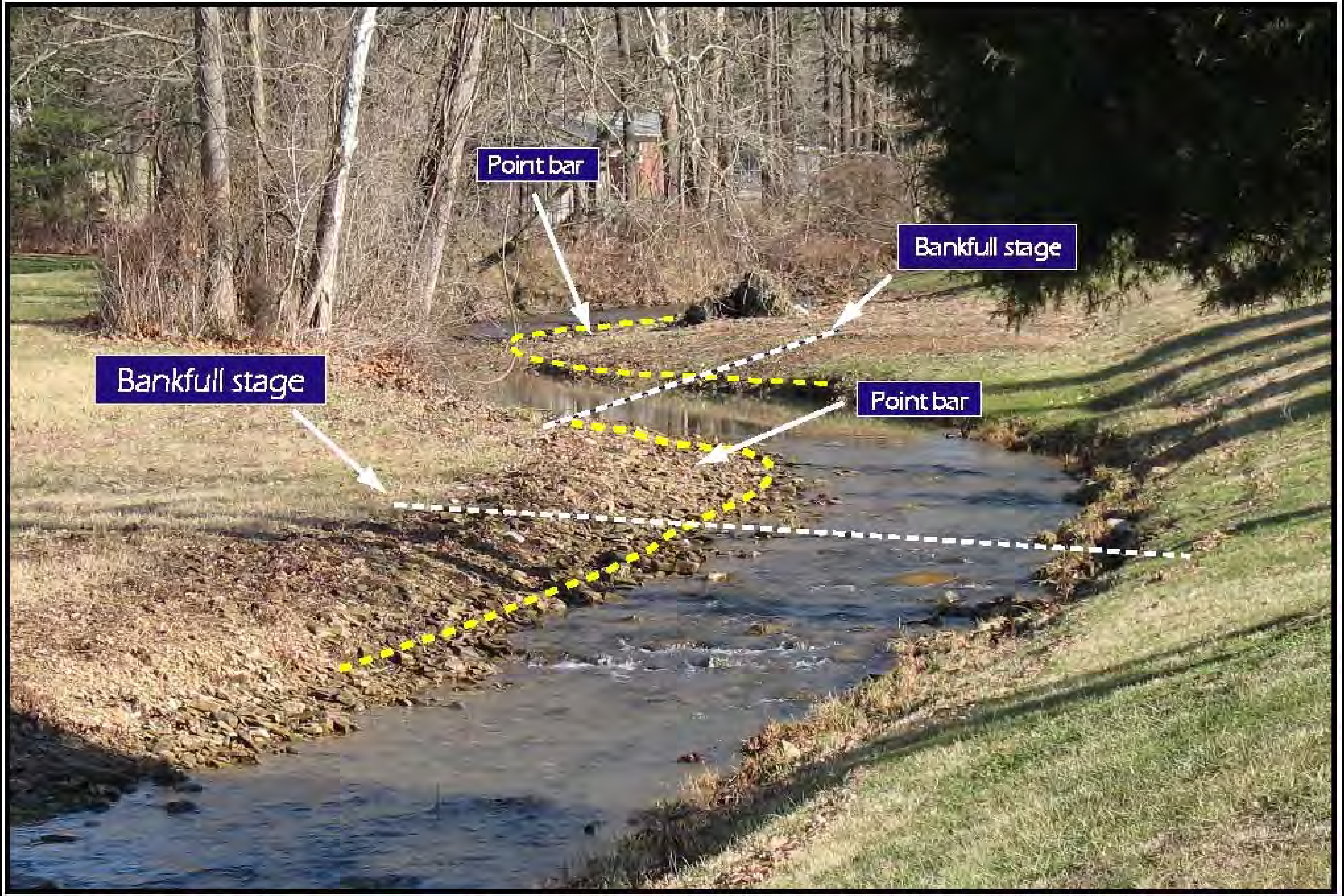


Lane’s Principle:

Streams progress toward a state of dynamic equilibrium, where they balance discharge, sediment transport, and slope




NATURAL Channel
Floodplain
BANKFULL
Baseflow
Baseflow
Floodplain
BANKFULL
Channelized "DESIGNED" Channel
Floodplain
BANKFULL
Baseflow
Baseflow
BANKFULL
Floodplain


Point bar
Bankfull stage
Bankfull stage
Point bar

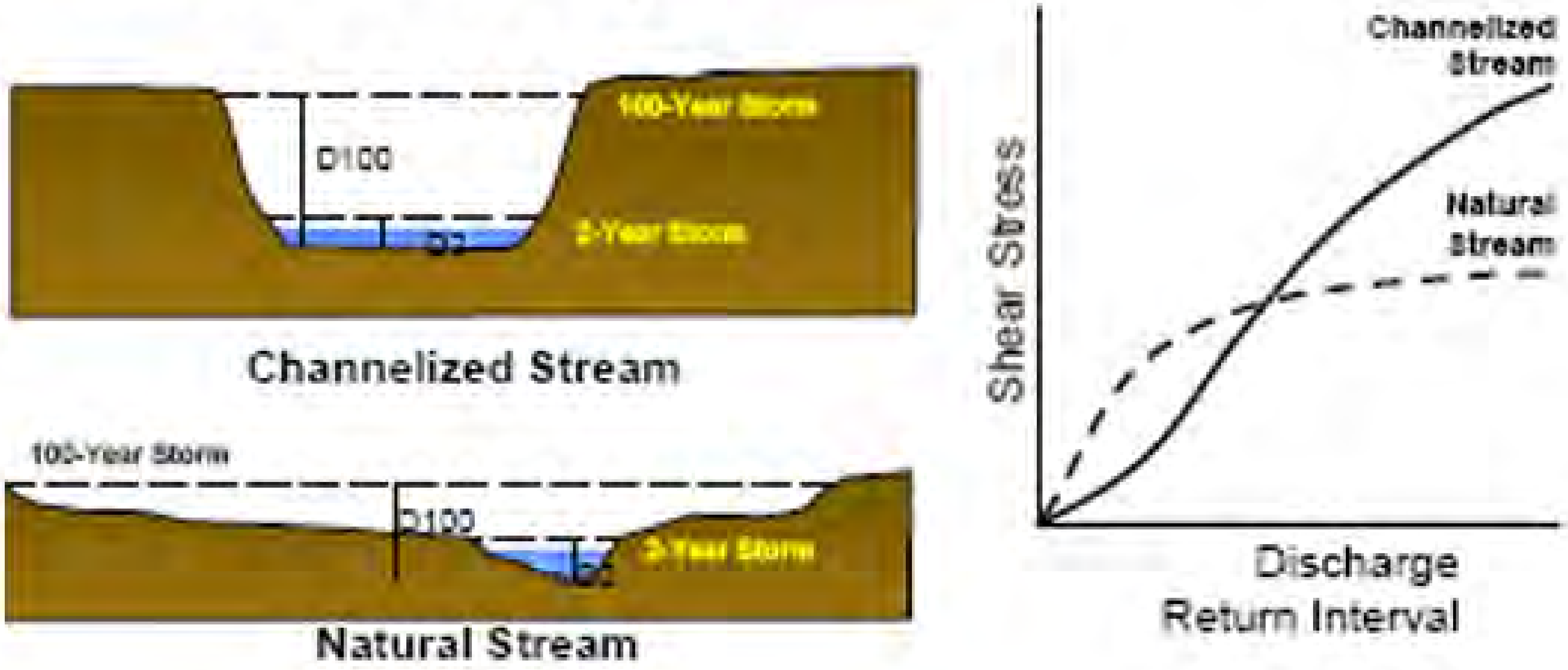
Calculating Sinuosity

Stream Length
= Sinuosity
Valley Length

The closer the sinuosity it to 1, the straighter the stream/river is

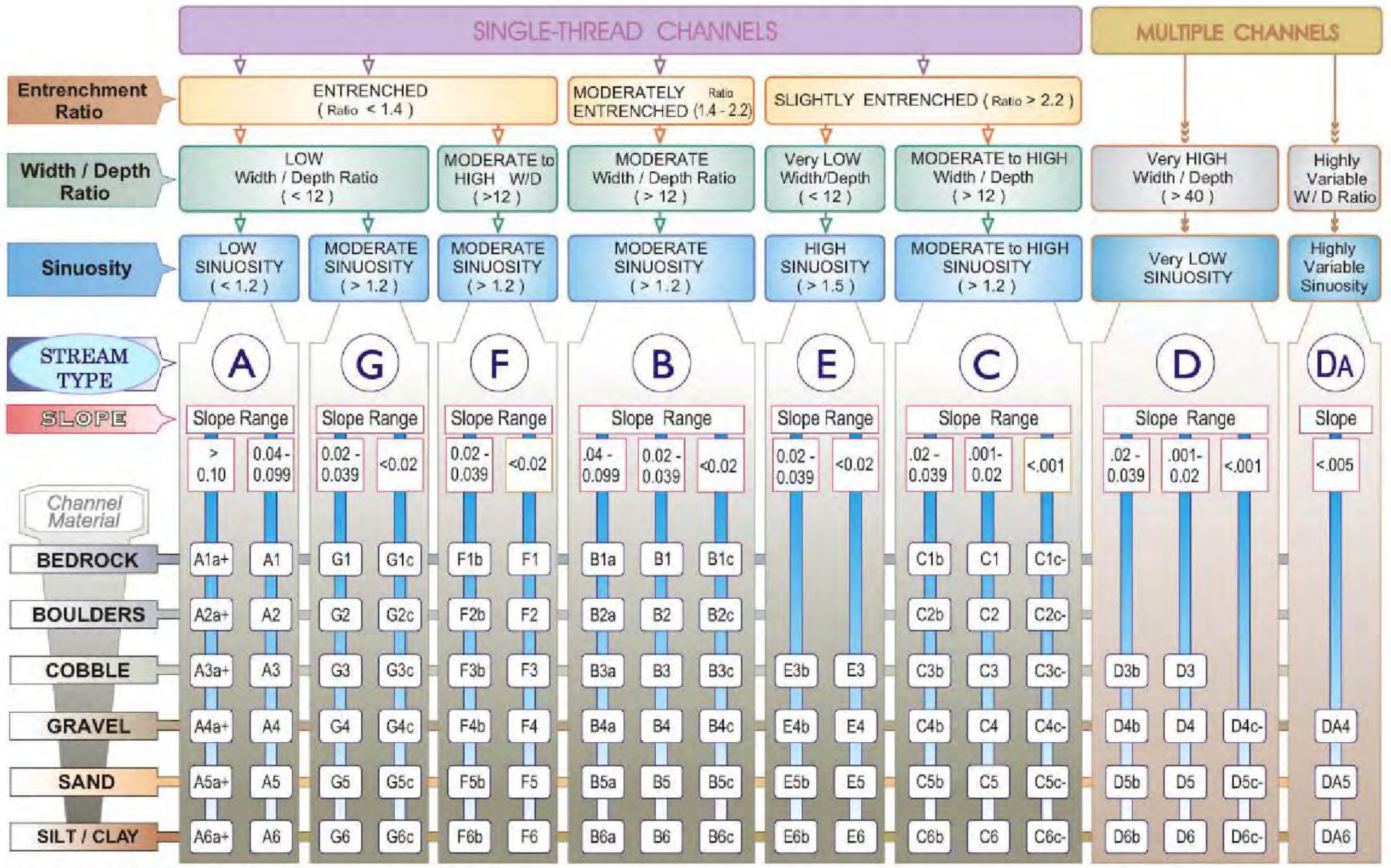
Grassy Branch is classified as a F4 or Entrenched E4 stream (ROSGEN), therefore the Sinuosity should range from >1.2 for an F and >1.5 for and E.

Shear Stress = γ R S



STREAM CLASSIFICATION

The Key to the Rosgen Classification of Natural Rivers



	SINGLE-THREAD CHANNELS														MULTIPLE CHANNELS			
Entrenchment Ratio	ENTRENCHED (Ratio < 1.4)						MODERATELY ENTRENCHED (Ratio 1.4 - 2.2)			SLIGHTLY ENTRENCHED (Ratio > 2.2)								
Width / Depth Ratio	LOW Width / Depth Ratio (< 12)				MODERATE to HIGH W/D (>12)		MODERATE Width / Depth Ratio (> 12)			Very LOW Width/Depth (< 12)		MODERATE to HIGH Width / Depth (> 12)			Very HIGH Width / Depth (> 40)			Highly Variable W/ D Ratio
Sinuosity	LOW SINUOSITY (< 1.2)		MODERATE SINUOSITY (> 1.2)		MODERATE SINUOSITY (> 1.2)		MODERATE SINUOSITY (> 1.2)			HIGH SINUOSITY (> 1.5)		MODERATE to HIGH SINUOSITY (> 1.2)			Very LOW SINUOSITY			Highly Variable Sinuosity
STREAM TYPE	A		G		F		B			E		C			D			DA
SLOPE	Slope Range		Slope Range		Slope Range		Slope Range			Slope Range		Slope Range			Slope Range			Slope
	> 0.10	0.04 - 0.099	0.02 - 0.039	<0.02	0.02 - 0.039	<0.02	.04 - 0.099	0.02 - 0.039	<0.02	0.02 - 0.039	<0.02	.02 - 0.039	.001- 0.02	<.001	.02 - 0.039	.001- 0.02	<.001	<.005
Channel Material																		
BEDROCK	A1a+	A1	G1	G1c	F1b	F1	B1a	B1	B1c			C1b	C1	C1c-				
BOULDERS	A2a+	A2	G2	G2c	F2b	F2	B2a	B2	B2c			C2b	C2	C2c-				
COBBLE	A3a+	A3	G3	G3c	F3b	F3	B3a	B3	B3c	E3b	E3	C3b	C3	C3c-	D3b	D3		
GRAVEL	A4a+	A4	G4	G4c	F4b	F4	B4a	B4	B4c	E4b	E4	C4b	C4	C4c-	D4b	D4	D4c-	DA4
SAND	A5a+	A5	G5	G5c	F5b	F5	B5a	B5	B5c	E5b	E5	C5b	C5	C5c-	D5b	D5	D5c-	DA5
SILT / CLAY	A6a+	A6	G6	G6c	F6b	F6	B6a	B6	B6c	E6b	E6	C6b	C6	C6c-	D6b	D6	D6c-	DA6

KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

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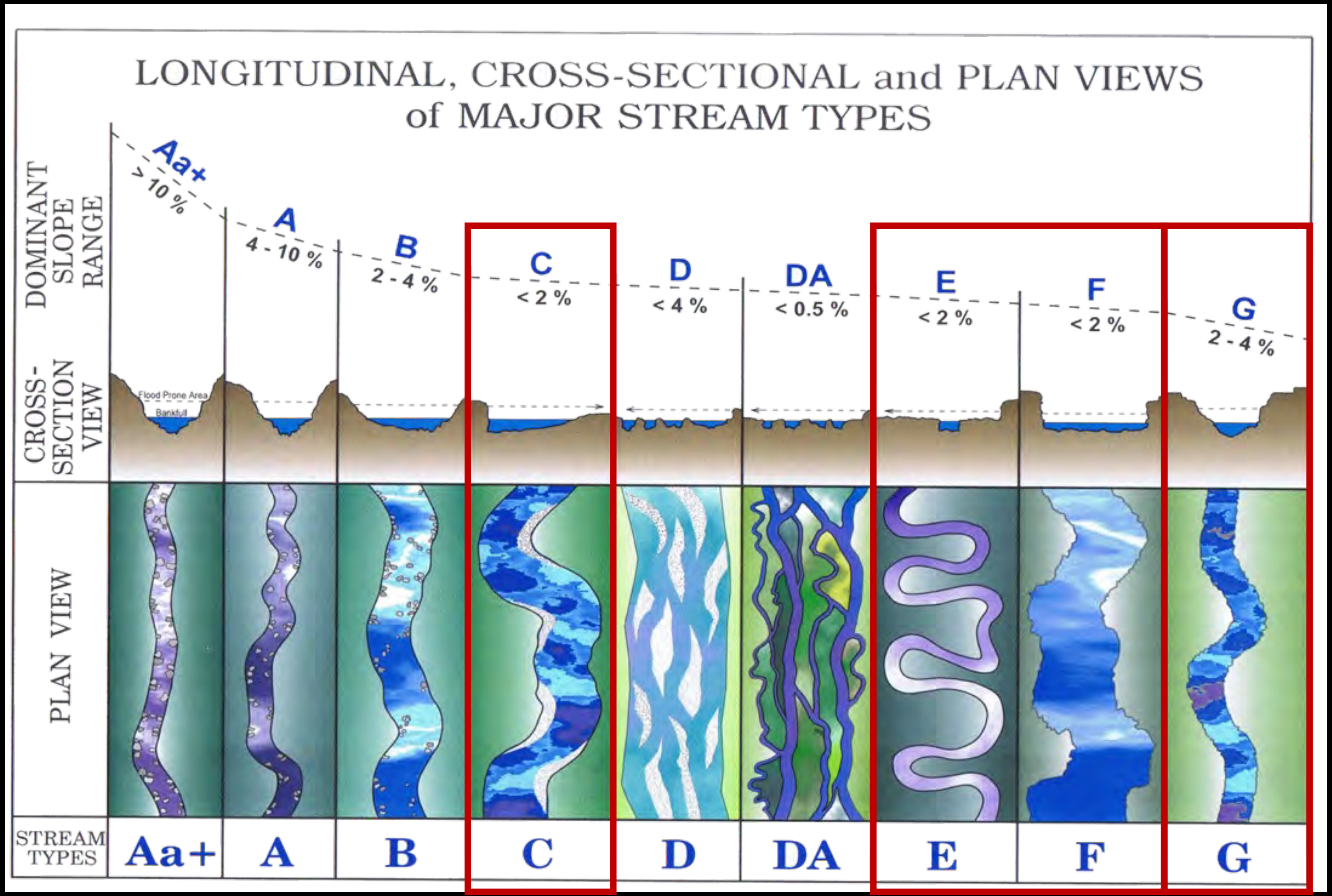
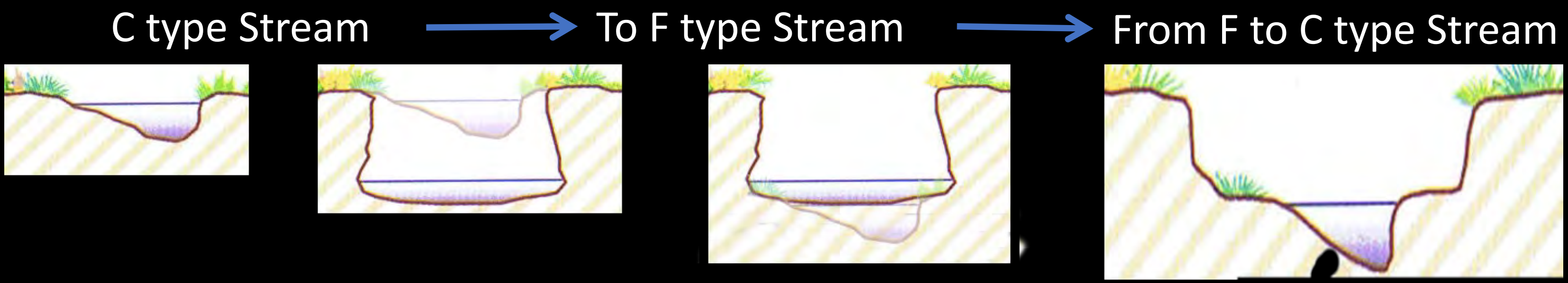


Most common types in the Midwest



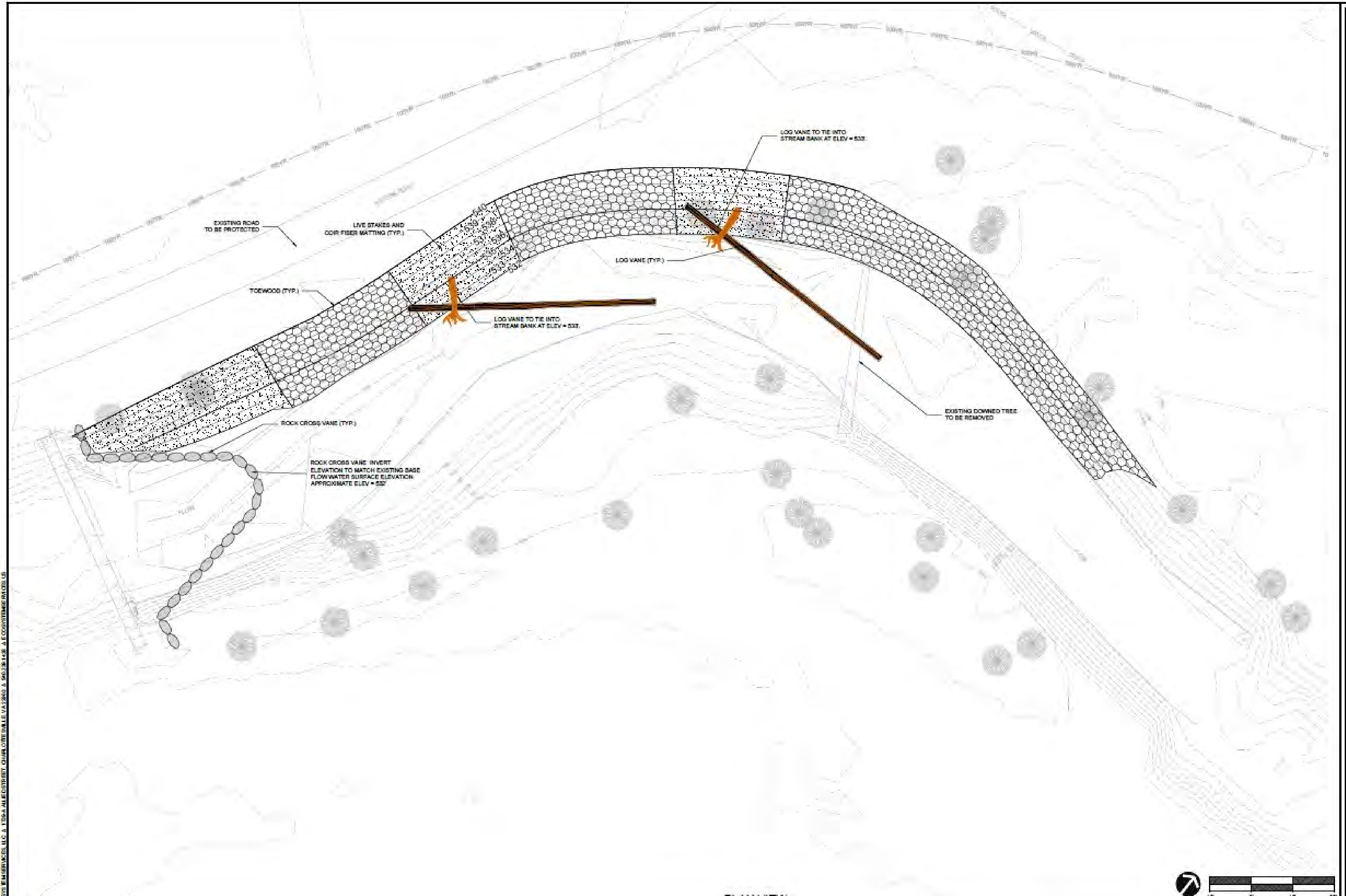
C type Stream → To F type Stream → From F to C type Stream

FIGURE 7:
Vegetated geolifts designed and installed (Oct 31, 2015) on Eagle Creek by FLR

FIGURE 8:
Root wads designed and installed (Dec 2, 2011) on Payne Branch of Crooked Creek by FLR

FIGURE 9:
J-hook og vane designed and installed (May 1, 2019) on Eagle Creek by FLR & ESE

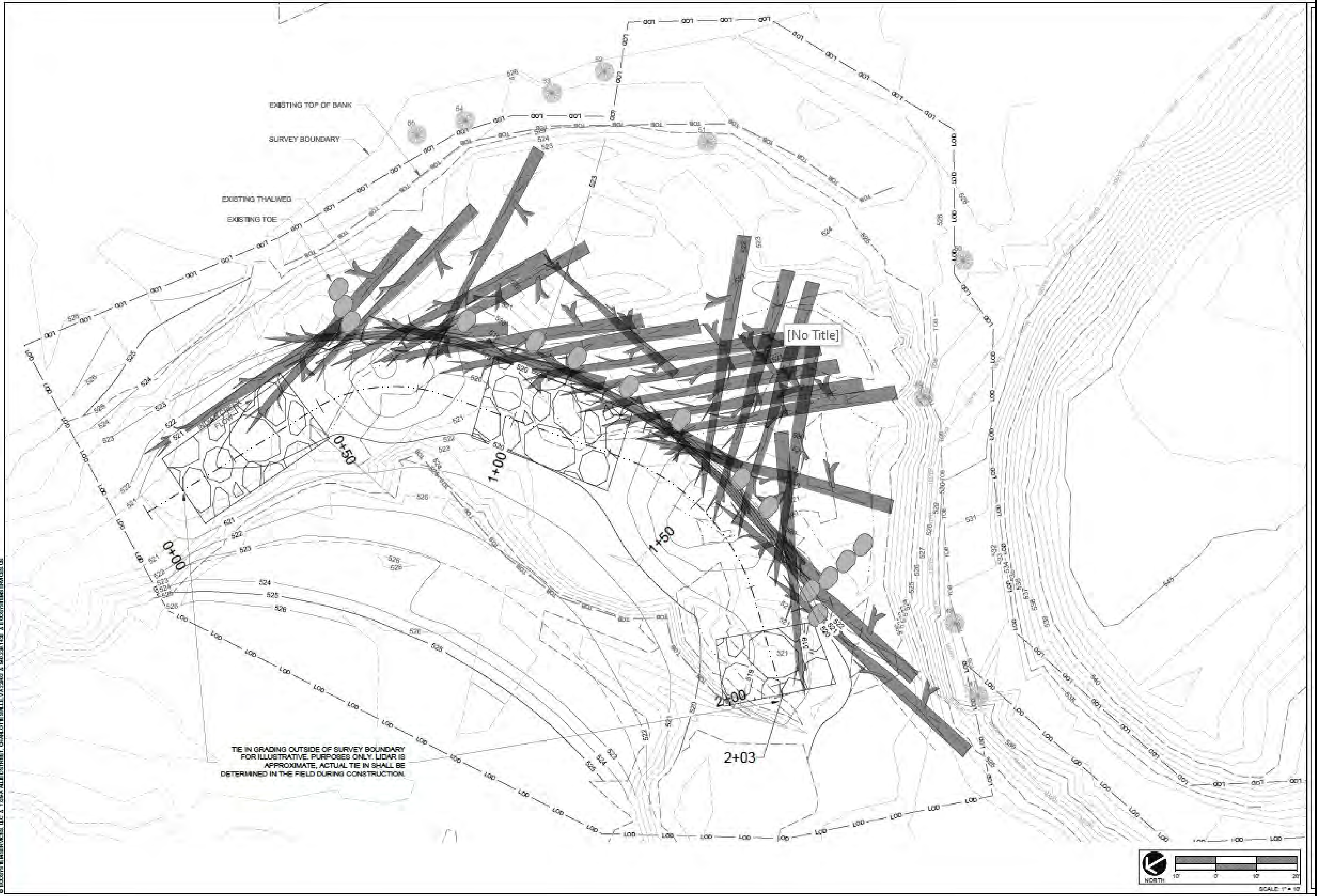
FIGURE 10:
Cross vane designed and installed (Nov 23, 2011) on Payne Branch of Crooked Creek by FLR



PLAN VIEW

FLATLAND
RESOURCES

SITE 1



TIE IN GRADING OUTSIDE OF SURVEY BOUNDARY FOR ILLUSTRATIVE PURPOSES ONLY. LIDAR IS APPROXIMATE, ACTUAL TIE IN SHALL BE DETERMINED IN THE FIELD DURING CONSTRUCTION.

SITE 2

FLATLAND
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