Sediment Impact Analysis Method (SIAM):

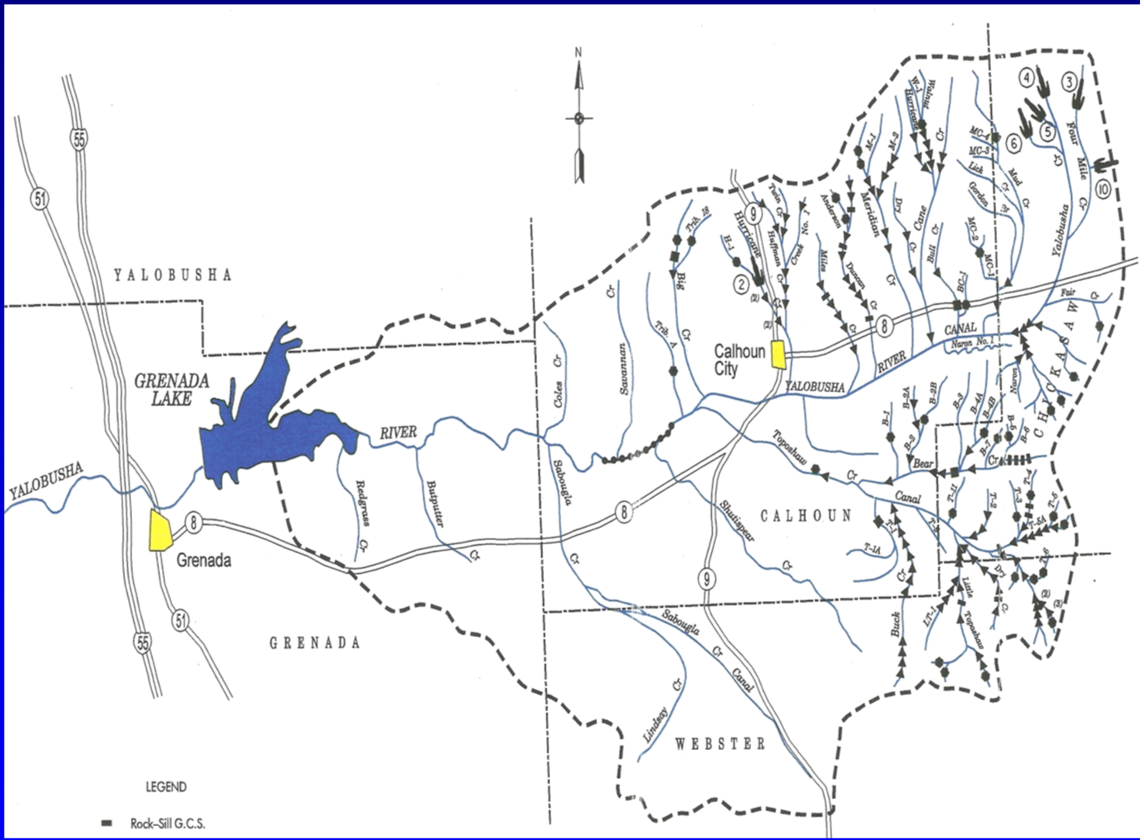
Chris Haring

US Army Corps of Engineers

Engineer Research & Development Center

Sediment Impact Analysis Method (SIAM)

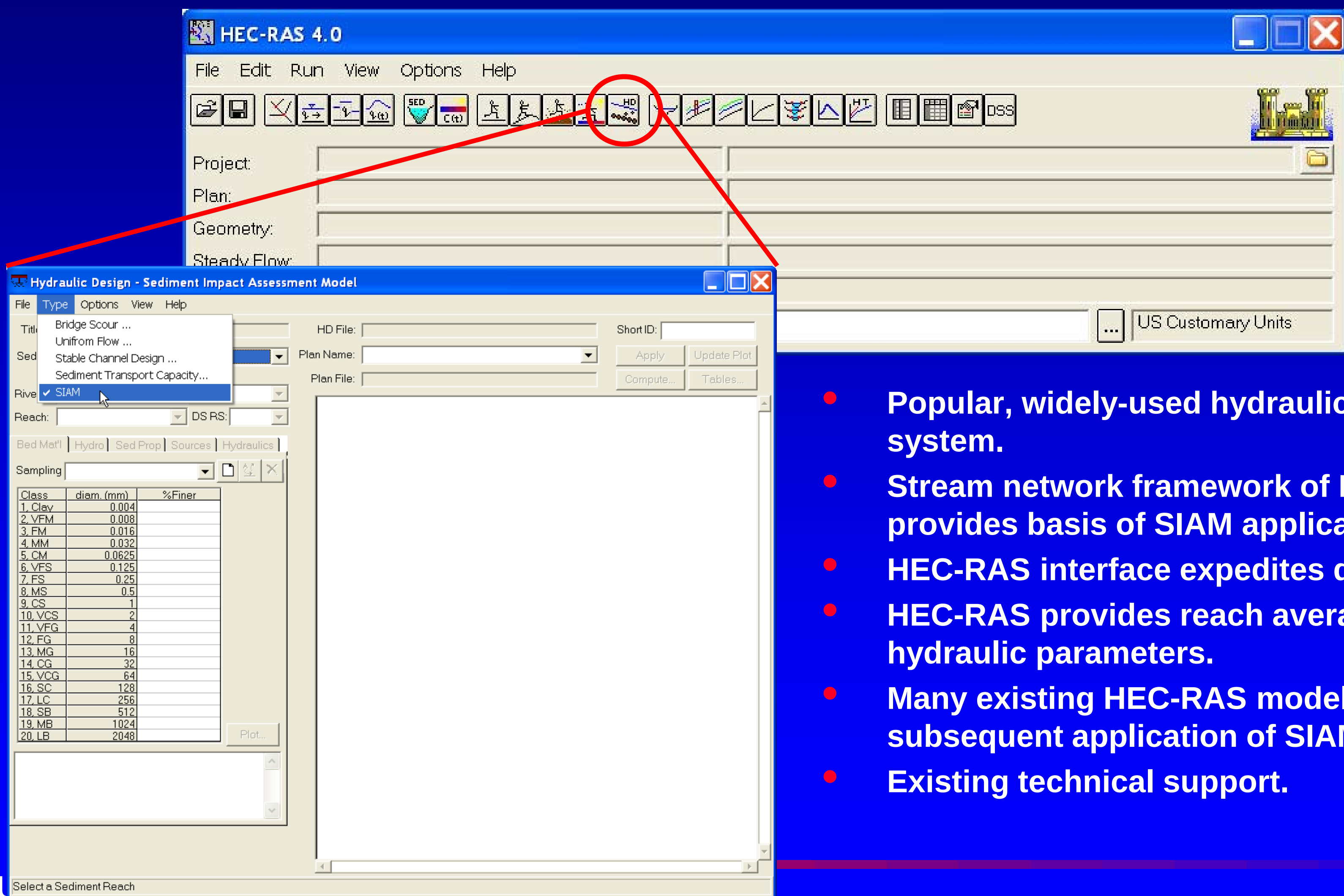
- **Initial development through ERDC/Colorado State University research effort on channel stability as part of Demonstration Erosion Control project. Originally conceived to assist with locating grade control structures.**
- **Original computer programming done by David Mooney (CSU PhD candidate, USBR).**
- **Incorporation into HEC-RAS through ERDC/HEC cooperative effort.**



Question: What is SIAM?

Answer: A reach average sediment continuity assessment tool.

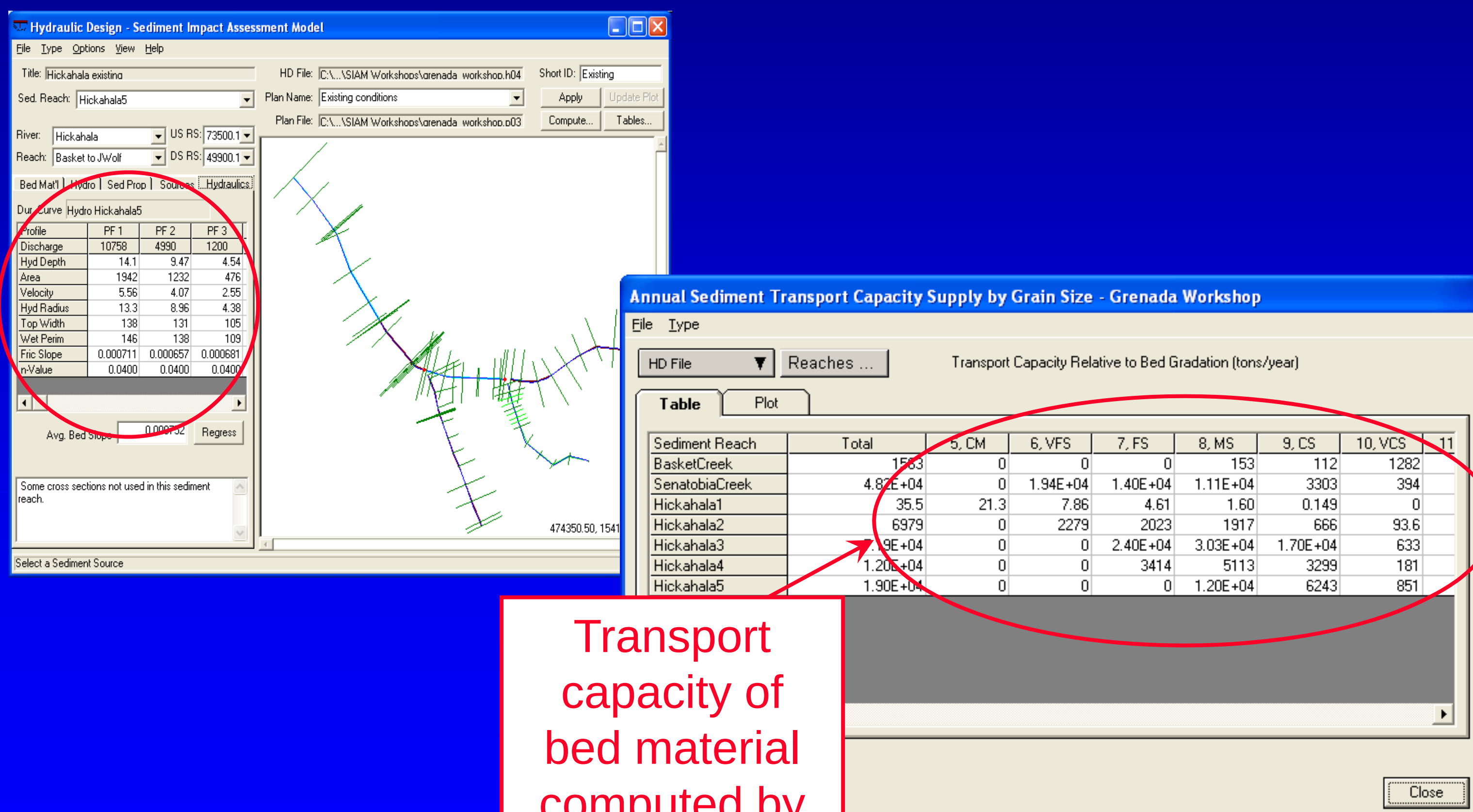
SIAM is incorporated in HEC-RAS Hydraulic Design Module



- **Popular, widely-used hydraulic modeling system.**
- **Stream network framework of HEC-RAS provides basis of SIAM application.**
- **HEC-RAS interface expedites data entry.**
- **HEC-RAS provides reach averaged hydraulic parameters.**
- **Many existing HEC-RAS models permit subsequent application of SIAM.**
- **Existing technical support.**

SIAM is reach-based

A reach-based sediment continuity model. Uses reach averaged hydraulic parameters for sediment transport computations by grain size class.

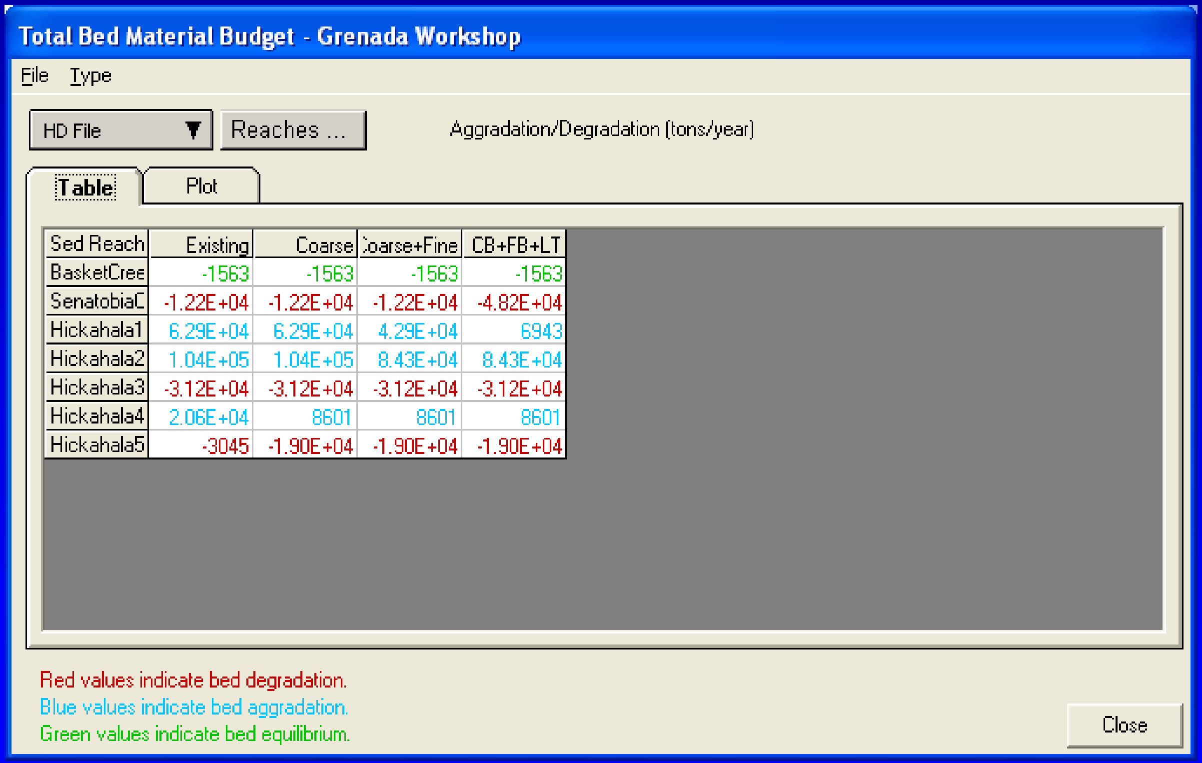


Reach averaged hydraulics from HEC-RAS results

Transport capacity of bed material computed by grain size class

Local Sediment Balance (Continuity)

Local sediment balance by comparing computed annual transport capacity with bed material supply on a reach-by-reach basis.



Sed Reach	Existing	Coarse	:oarse+Fine	CB+FB+LT
BasketCree	-1563	-1563	-1563	-1563
SenatobiaC	-1.22E+04	-1.22E+04	-1.22E+04	-4.82E+04
Hickahala1	6.29E+04	6.29E+04	4.29E+04	6943
Hickahala2	1.04E+05	1.04E+05	8.43E+04	8.43E+04
Hickahala3	-3.12E+04	-3.12E+04	-3.12E+04	-3.12E+04
Hickahala4	2.06E+04	8601	8601	8601
Hickahala5	-3045	-1.90E+04	-1.90E+04	-1.90E+04

SIAM bed/wash material accounting

- Found in significant quantities in the bed
- Function of hydraulic regime
- Interacts with bed - more geomorphic effect (work) on channel development
- Long-term impacts, may take years/decades to see effects.

- Not found in significant quantities in the bed
- Function of supply
- Minimal interaction with bed - more aesthetic or water quality effects
- Generally moves through system quickly

Question: What SIAM is not?

Answer: A sediment routing model or a sediment source/erosion predictor

SIAM is not a routing model….

- Cross section geometry is not adjusted, and sediment transport is not recomputed accordingly.
- Input geometry represents a “snapshot” that is assumed representative of average conditions for determination of sediment transport capacity.
- There is no temporal aspect (i.e., no time stepping through a hydrograph). Results are computed as average annual values.

SIAM is not a sediment source/erosion predictor….

- Sediment source input is user specified, both in quantity and grain size distribution.
- Sediment source loads are assumed uniform over the reach.

Question: What is applicability of SIAM?

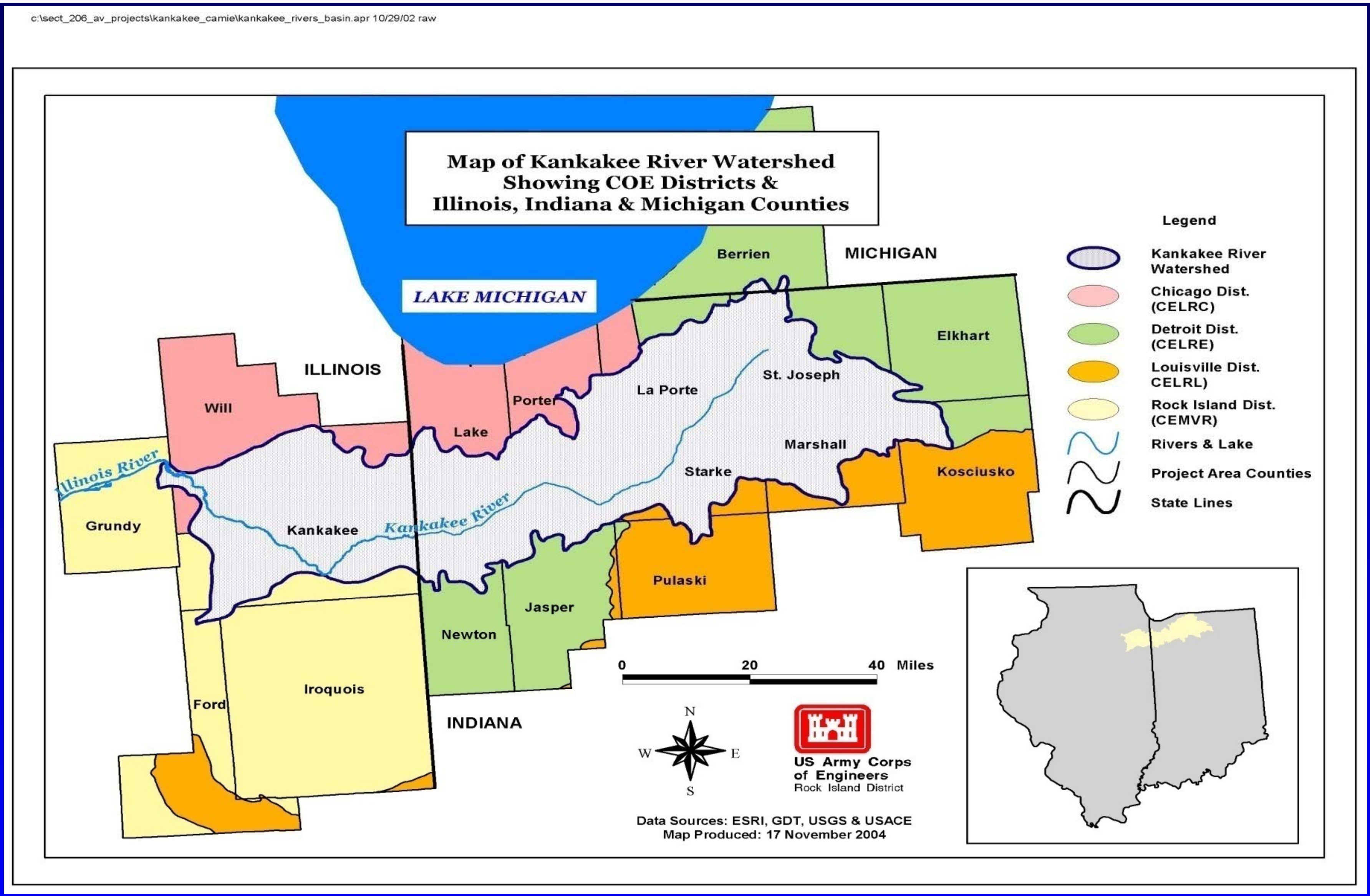
Answer: A screening tool for rapid assessment of the impacts of channel modification or stream rehabilitation measures on sediment continuity.

SIAM Example Application

Kankakee River, IL

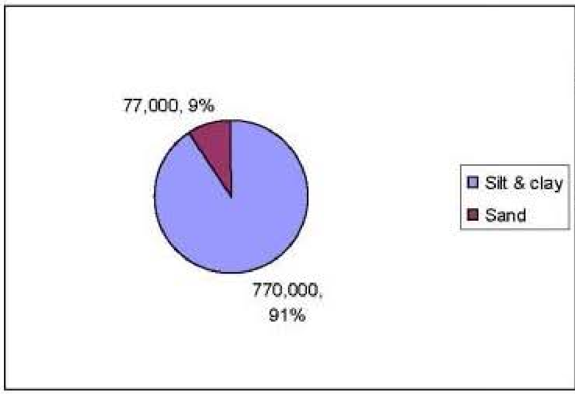
SIAM Modeling for the Kankakee River

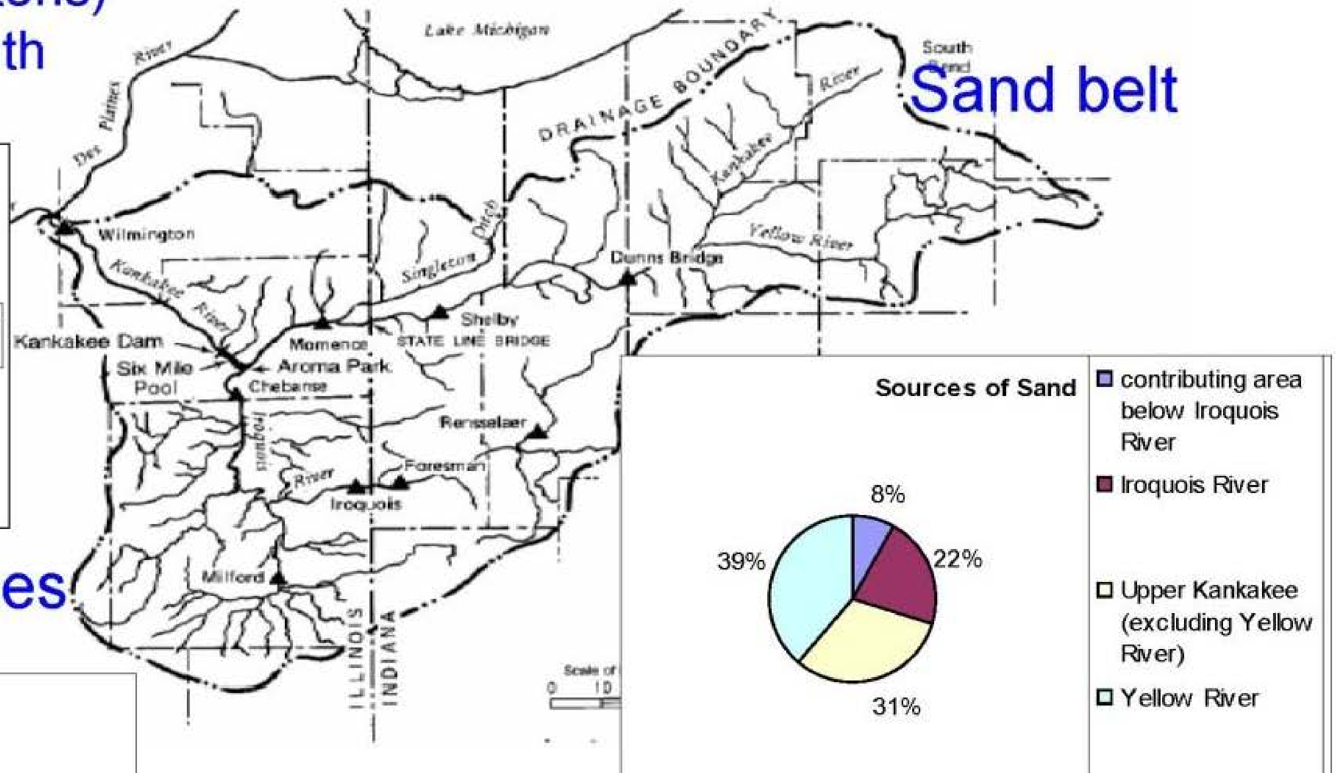
- Hydrologic Engineering Center – River Analysis System (HEC-RAS)
- HEC-RAS model simulates average hydraulic properties of each reach defined in the river.
- SIAM = Sediment Impact Analysis Methods
  - Sediment load data: grain size and bed material gradations determine wash load/bed load division.
  - Sediment transport capacity: Hydraulics and wash load/bed load criteria determine sediment transport capacity.
- Taken together, Hydraulic Model, Sediment Input, and Sediment Model determine wash material / bed material supply and capacity for each reach and local balance.

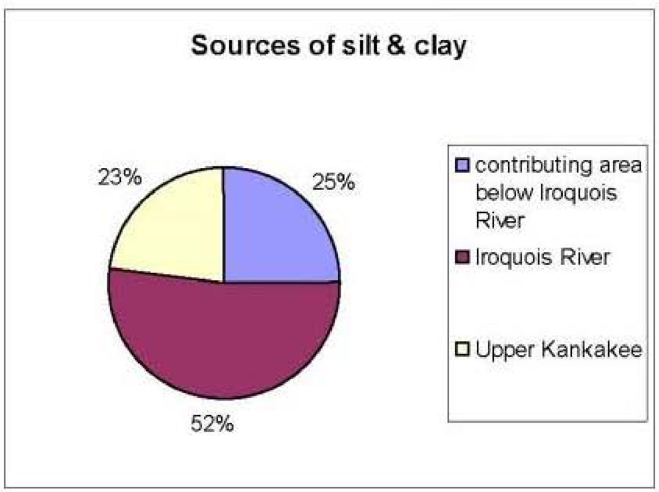

c:\sect_206_av_projects\kankakee_camie\kankakee_rivers_basin.apr 10/29/02 raw
Map of Kankakee River Watershed Showing COE Districts & Illinois, Indiana & Michigan Counties
LAKE MICHIGAN
ILLINOIS
INDIANA
MICHIGAN
Will
Grundy
Kankakee
Iroquois
Ford
Lake
Porter
La Porte
St. Joseph
Elkhart
Berrien
Marshall
Starke
Kosciusko
Pulaski
Jasper
Newton
Illinois River
Kankakee River
Legend
Kankakee River Watershed
Chicago Dist. (CELRC)
Detroit Dist. (CELRE)
Louisville Dist. CELRL)
Rock Island Dist. (CEMVR)
Rivers & Lake
Project Area Counties
State Lines
0 20 40 Miles
N
E
S
W
US Army Corps of Engineers
Rock Island District
Data Sources: ESRI, GDT, USGS & USACE
Map Produced: 17 November 2004

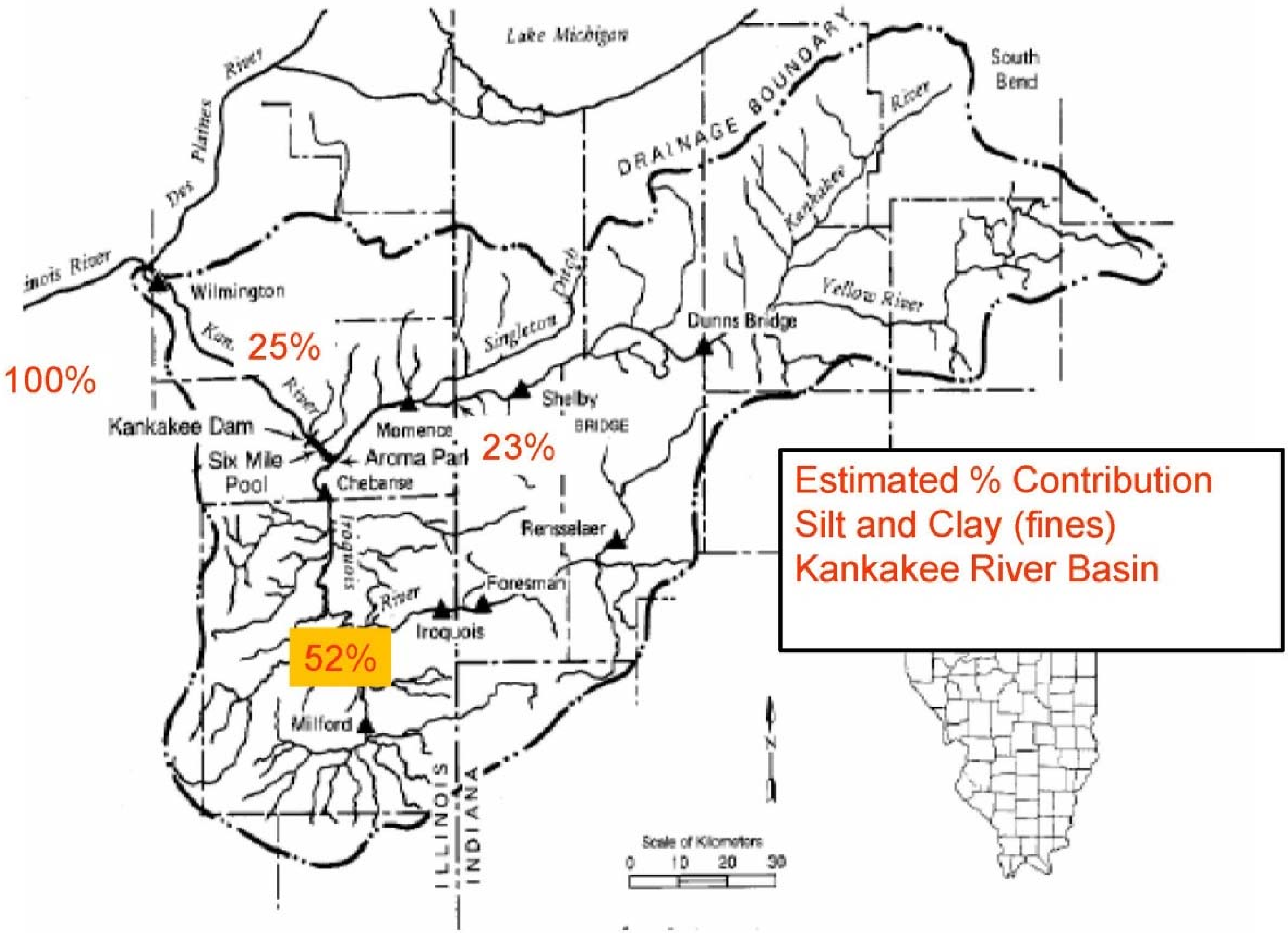
Kankakee River Basin
Sources of Fine and Coarse Sediment

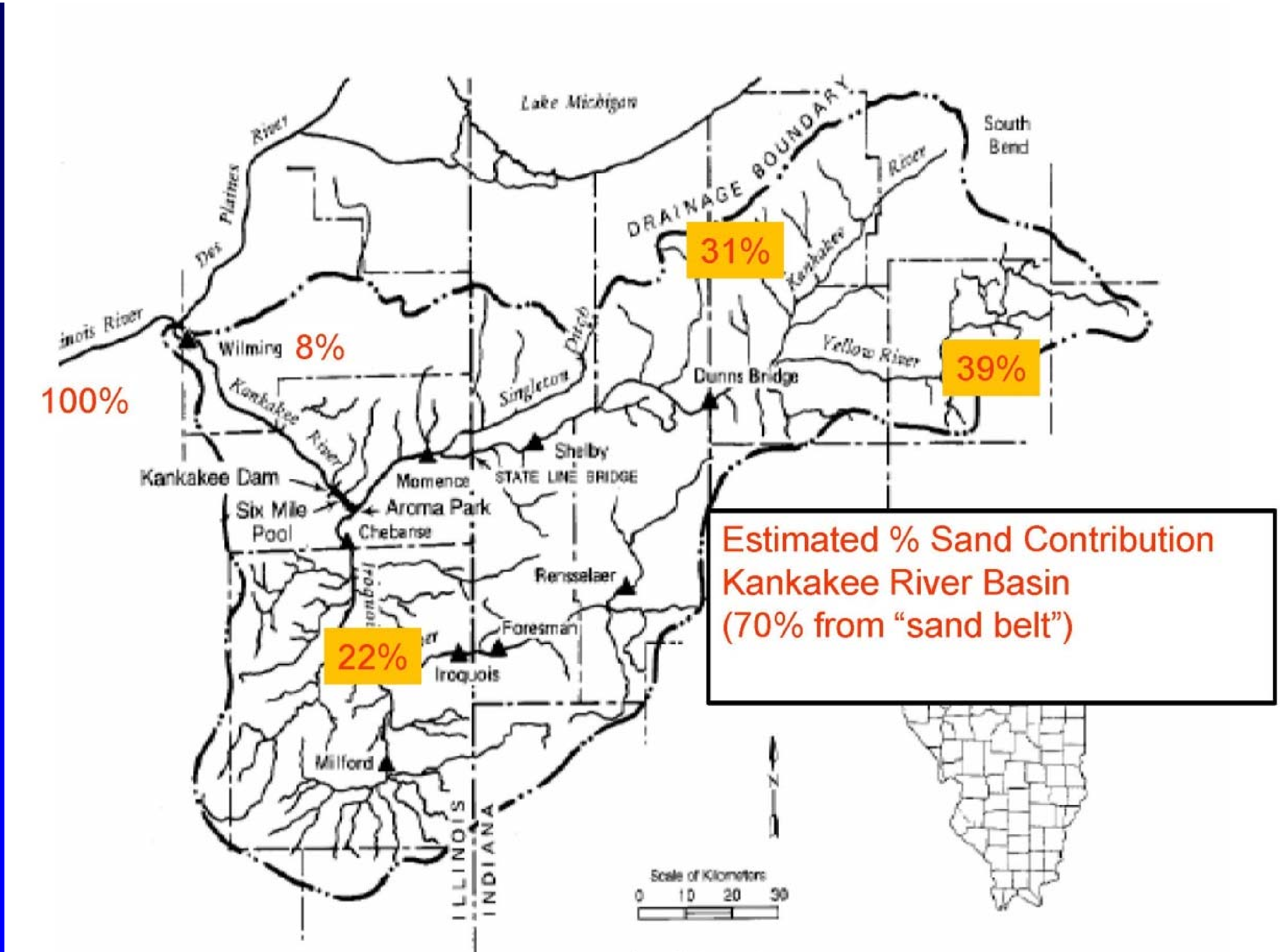
Average Annual Load (tons)
Kankakee River at mouth



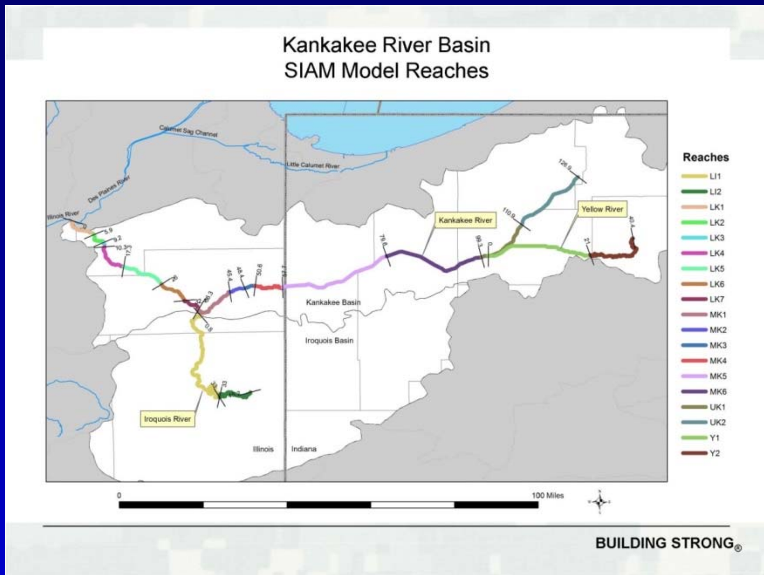





Lake Michigan
South Bend
DRAINAGE BOUNDARY
Des Plaines River
Illinois River
Wilmington
Kan. River
25%
100%
Kankakee Dam
Six Mile Pool
Momence
Aroma Park
23%
Chebanse
Shelby BRIDGE
Singleton Ditch
Dunns Bridge
Yellow River
Kankakee River
Rensselaer
Foresman
Iroquois River
Iroquois
52%
Milford
ILLINOIS
INDIANA
Scale of Kilometers
0 10 20 30
N
Estimated % Contribution
Silt and Clay (fines)
Kankakee River Basin


Estimated % Sand Contribution
Kankakee River Basin
(70% from "sand belt")
Lake Michigan
South Bend
DRAINAGE BOUNDARY
Des Plaines River
River
Kankakee
Yellow River
31%
39%
8%
100%
22%
Wilming
Kankakee River
Singleton Ditch
Dunns Bridge
Shelby
STATE LINE BRIDGE
Momence
Kankakee Dam
Aroma Park
Six Mile Pool
Chebanse
Rensselaer
Foresman
Iroquois
Milford
ILLINOIS
INDIANA
Scale of Kilometers
0 10 20 30
N

Kankakee River
Conceptual Sediment Budget



SIAM Modeling Reaches for the Kankakee River Basin

Lower RM	Upper RM	Reach	Description	Reach Dist. (mi.)
0.0	5.9	LK1	Kankakee R. mouth to Wilmington gage	5.9
5.9	9.2	LK2	Kankakee R. flat gradient u/s of Wilmington gage	3.1
9.2	10.3	LK3	Kankakee R. steep reach d/s of Wilmington dam	0.9
10.3	17.3	LK4	Pool of Wilmington dam	7.0
17.3	26.0	LK5	Kankakee R. u/s of Wilmington pool to near Davis Creek	4.7
26.0	32.4	LK6	Kankakee R. near Davis Creek to Kankakee dam	5.7
32.4	36.3	LK7	Six Mile Pool to Iroquois R.	3.9
36.3	45.4	MK1	Kankakee R. from Iroquois R. to Momence sill	8.5
45.4	48.5	MK2	Momence sill to Momence	2.0
48.5	50.6	MK3	Momence to Singleton Ditch	1.9
50.6	57.7	MK4	Singleton Ditch to IL/IN state line	6.5
57.7	79.6	MK5	IL/IN state line to halfway to Yellow R.	21.8
79.6	99.3	MK6	To confluence of Yellow R.	18.7
99.3	110.9	UK1	Kankakee R. u/s of Yellow R, lower	11.6
110.9	126.9	UK2	Kankakee R. u/s of Yellow R, upper	16.0
126.9	13.8	LI1	Mouth to Sugar Creek	13.0
13.8	27.1	LI2	U/S of Sugar Creek	12.2
27.1	21.1	Y1	Lower Yellow R.	21.0
21.1	40.4	Y2	Upper Yellow R.	19.4

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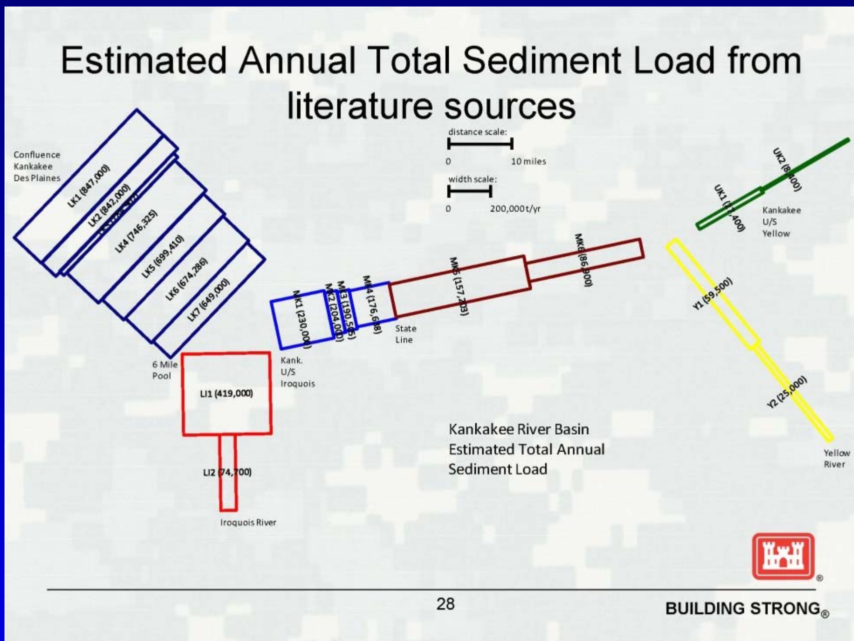
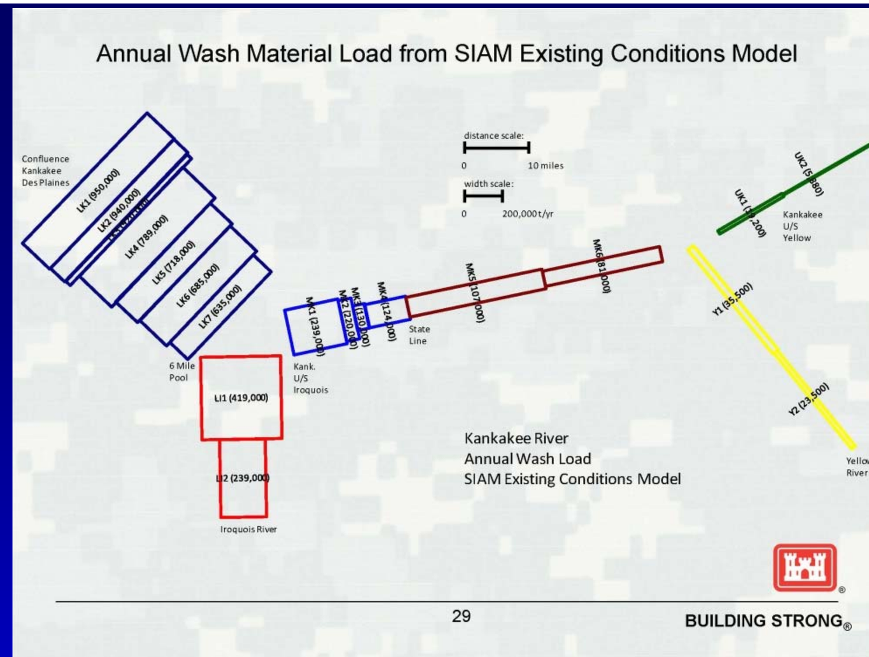
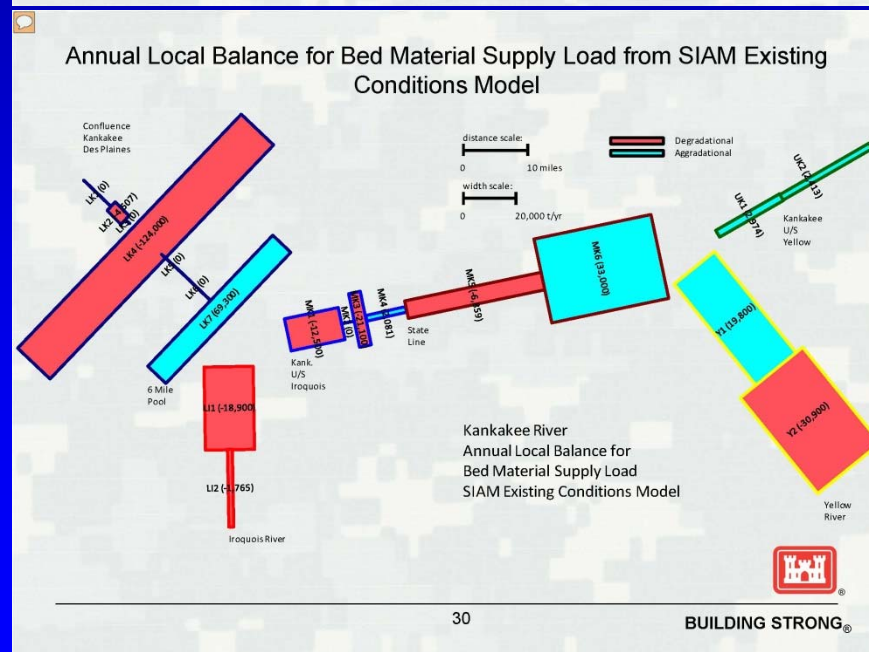
BUILDING STRONG®







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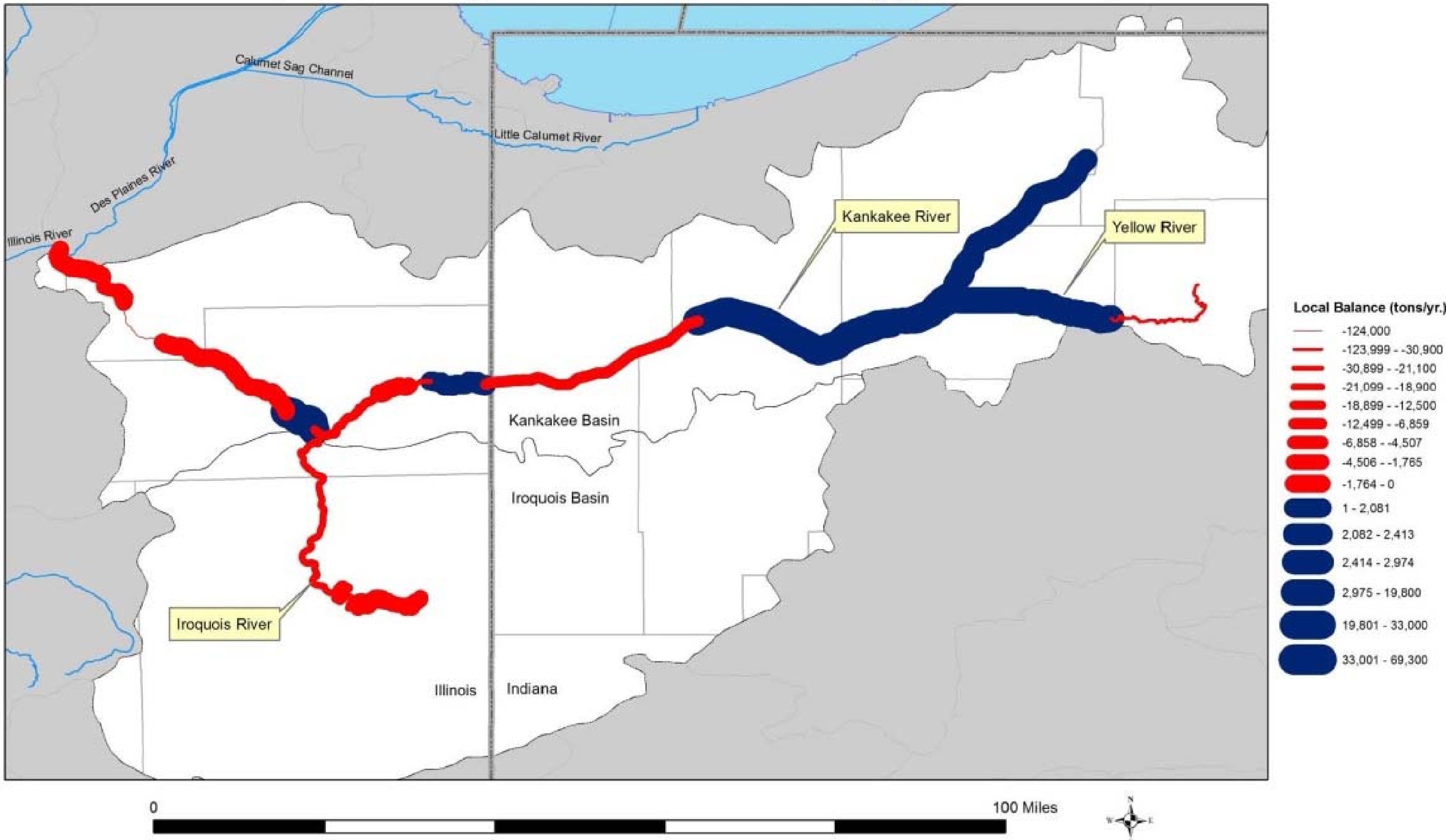
Kankakee River Basin

Local Balance for Bed Material Supply Load (SIAM Model, tons/year)

(Red = Degradational; Blue = Aggradational)



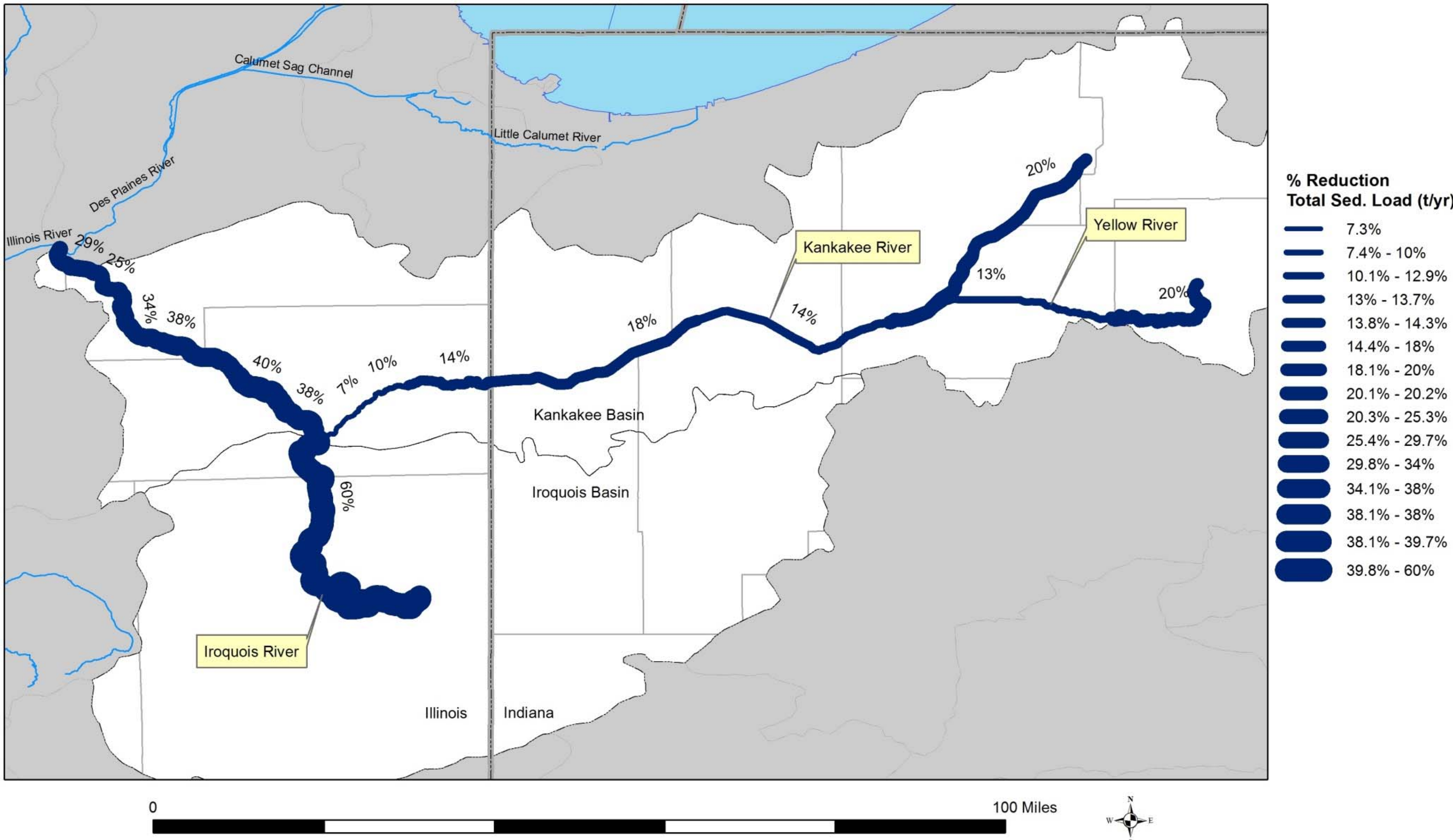
3 Alternative Options Modeled with SIAM

1. Reduction in total sediment source load by 20 percent from existing condition levels for specified reaches
2. Channel re-meandering and flood plain reconnection in sediment reaches MK5 and MK6
3. Dredging in Six Mile Pool

Combinations of these 3 options created 35 different alternatives.

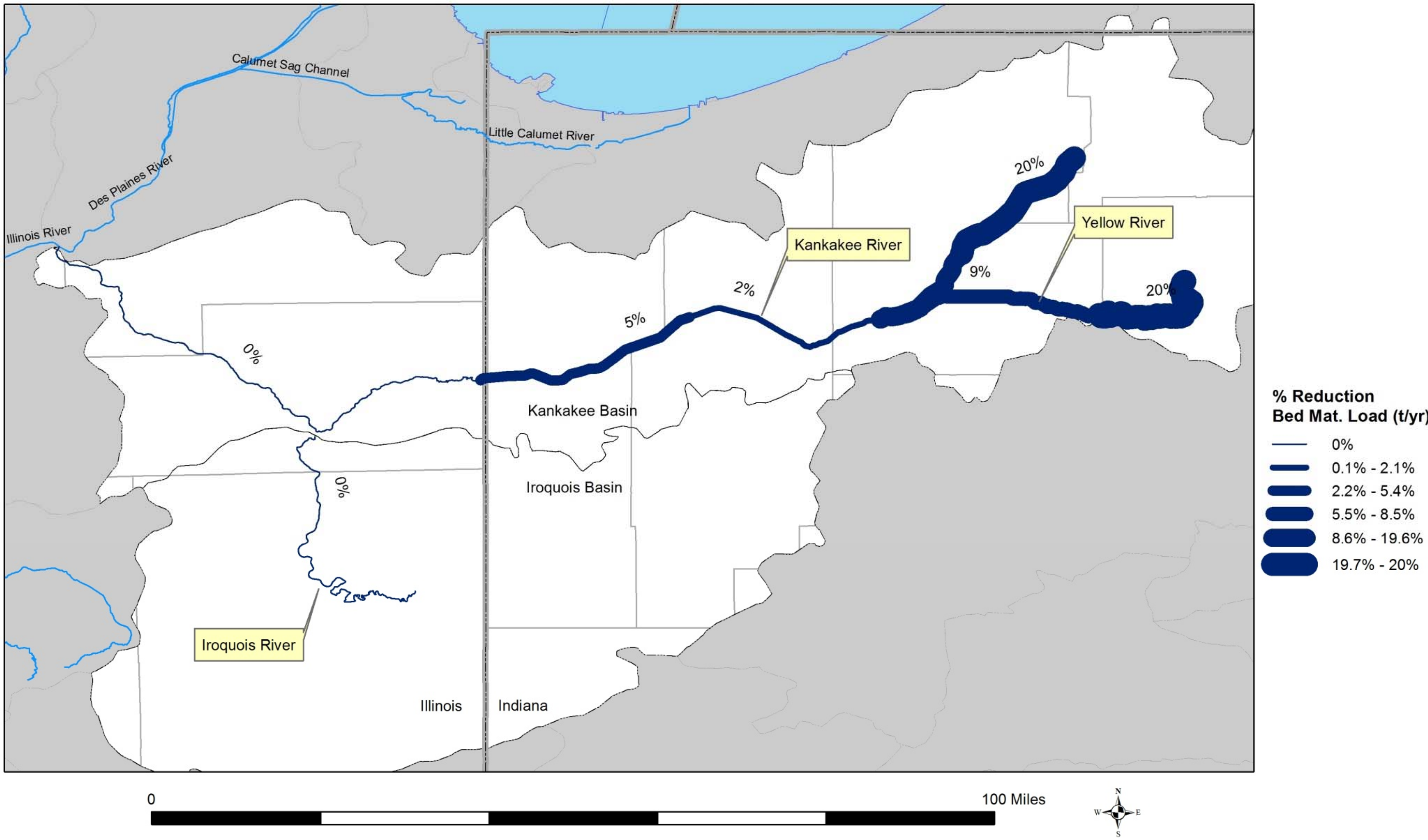
Following 6 slides illustrate the kinds of outputs and indicate types of findings.

Alternative 1E
% Reduction in SIAM Total Sediment Load



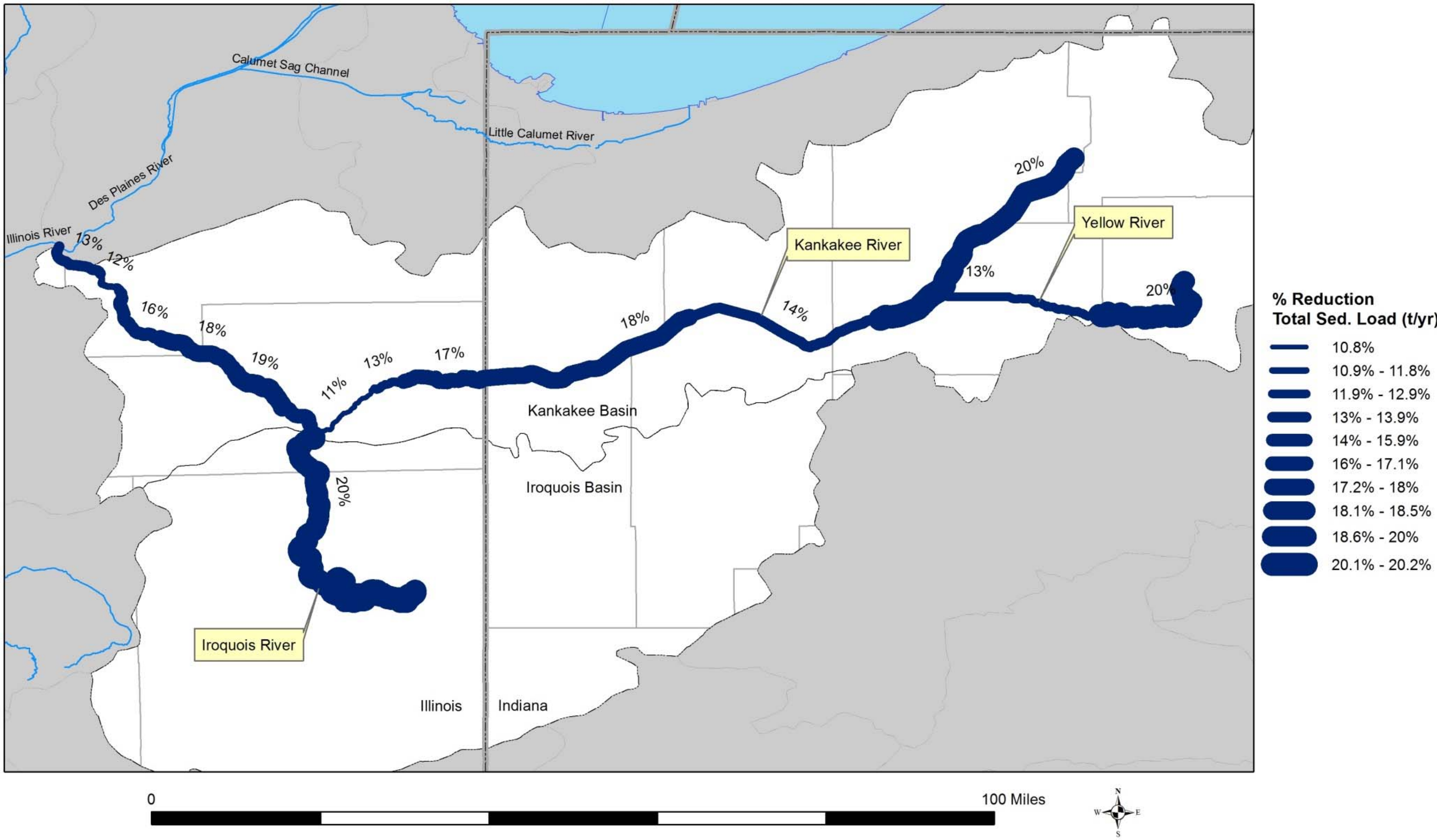
	Kank. River Below Kank. Dam						6MP	Kank. U/S Ir. Riv. to SL				U/S stateline		U/S Yellow		Ir. Riv.		Yellow River		
Reach	LK1	LK2	LK3	LK4	LK5	LK6	LK7	MK1	MK2	MK3	MK4	MK5	MK6	UK1	UK2	LI1	LI2	Y1	Y2	Reach
1E												20	20	20	20	60	60	20	20	1E

Alternative 1E
% Reduction in SIAM Bed Material Supply Load



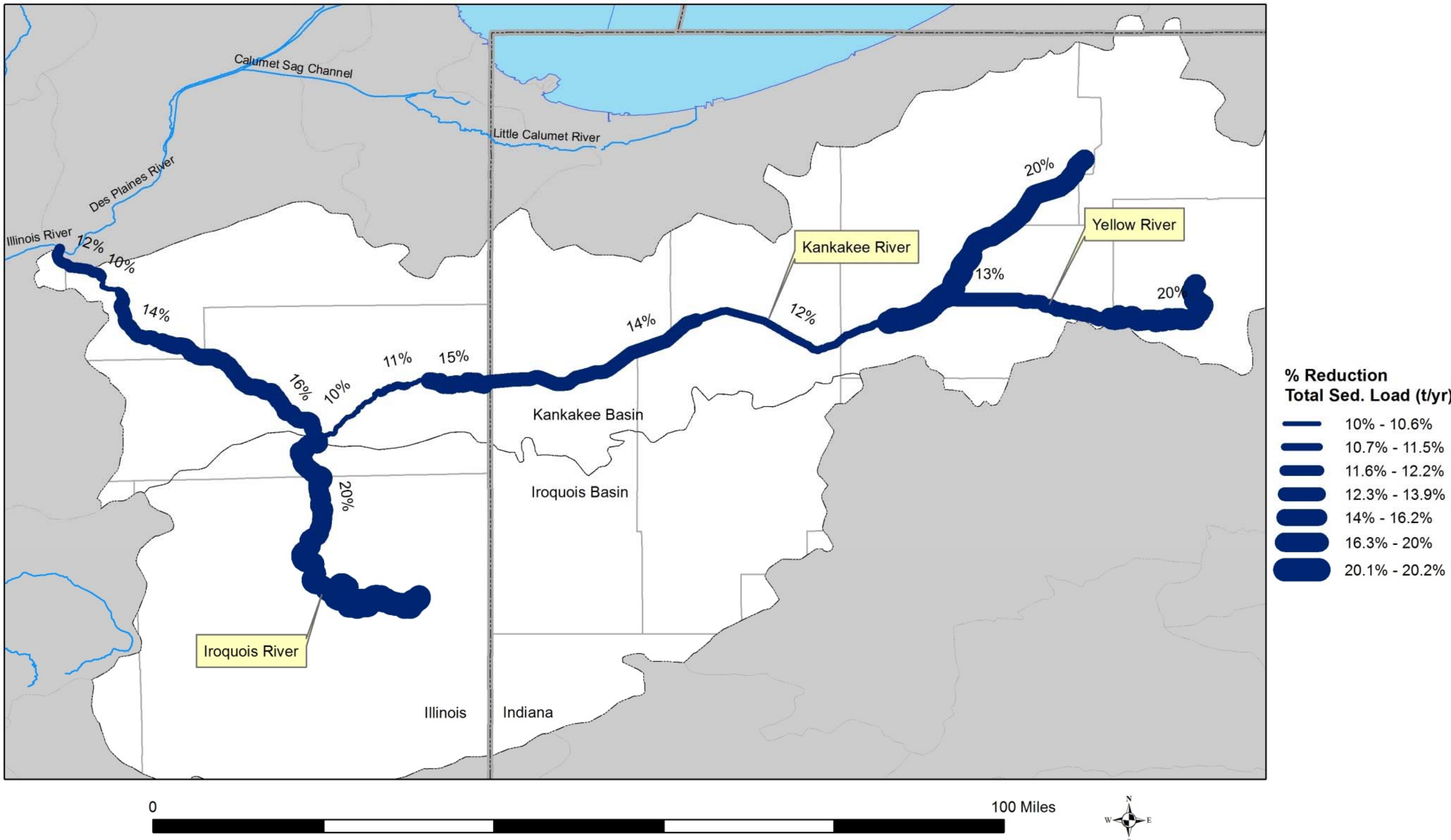
	Kank. River Below Kank. Dam						6MP	Kank. U/S Ir. Riv. to SL				U/S stateline		U/S Yellow		Ir. Riv.		Yellow River		
Reach	LK1	LK2	LK3	LK4	LK5	LK6	LK7	MK1	MK2	MK3	MK4	MK5	MK6	UK1	UK2	LI1	LI2	Y1	Y2	Reach
1E												20	20	20	20	60	60	20	20	1E

Alternative 2J
% Reduction in SIAM Total Sediment Load



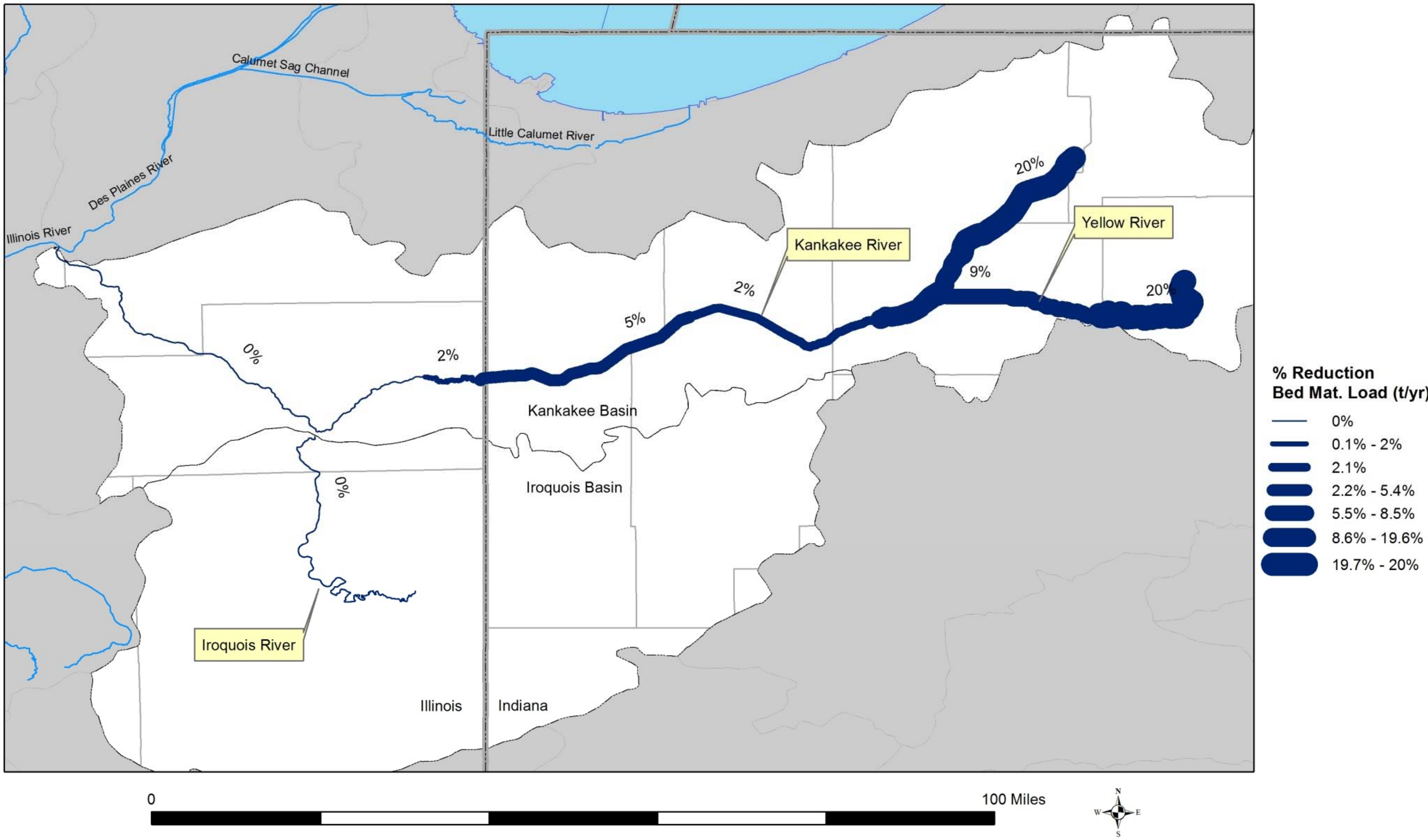
	Kank. River Below Kank. Dam						6MP	Kank. U/S Ir. Riv. to SL				U/S stateline		U/S Yellow		Ir. Riv.		Yellow River		
Reach	LK1	LK2	LK3	LK4	LK5	LK6	LK7	MK1	MK2	MK3	MK4	MK5	MK6	UK1	UK2	LI1	LI2	Y1	Y2	Reach
2J						20	20	20	20	20	20	20	20	20	20	20	20	20	20	2J

Alternative 3B
% Reduction in Total Sediment Load (downstream from Alternative 3B)



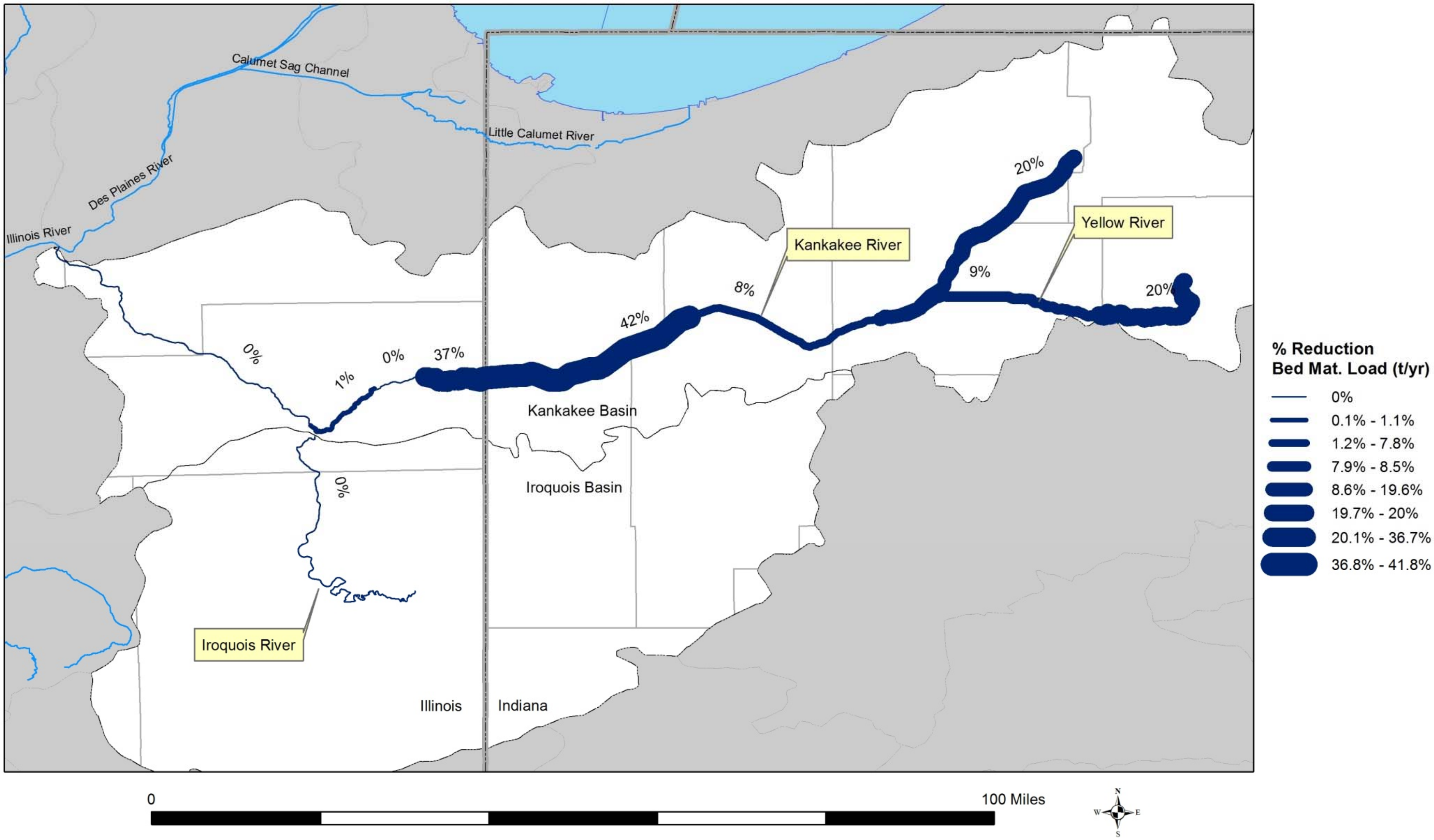
	Kank. River Below Kank. Dam						6MP	Kank. U/S Ir. Riv. to SL				U/S stateline		U/S Yellow		Ir. Riv.		Yellow River		
Reach	LK1	LK2	LK3	LK4	LK5	LK6	LK7	MK1	MK2	MK3	MK4	MK5	MK6	UK1	UK2	LI1	LI2	Y1	Y2	Reach
3B								20	20	20, S	20	re.	re.	20	20	20	20	20	20	3B

Alternative 2J
% Reduction in SIAM Total Bed Material Supply Load



	Kank. River Below Kank. Dam						6MP	Kank. U/S Ir. Riv. to SL				U/S stateline		U/S Yellow		Ir. Riv.		Yellow River		
Reach	LK1	LK2	LK3	LK4	LK5	LK6	LK7	MK1	MK2	MK3	MK4	MK5	MK6	UK1	UK2	LI1	LI2	Y1	Y2	Reach
2J						20	20	20	20	20	20	20	20	20	20	20	20	20	20	2J

Alternative 3B
% Reduction in SIAM Total Bed Material Supply Load



	Kank. River Below Kank. Dam						6MP	Kank. U/S Ir. Riv. to SL				U/S stateline		U/S Yellow		Ir. Riv.		Yellow River		
Reach	LK1	LK2	LK3	LK4	LK5	LK6	LK7	MK1	MK2	MK3	MK4	MK5	MK6	UK1	UK2	LI1	LI2	Y1	Y2	Reach
3B								20	20	20, S	20	re.	re.	20	20	20	20	20	20	3B

SIAM Results
General Observations

- Reduction in watershed suspended loads (silt and clay) persisted downstream to the Illinois River
- Reduction in incoming sand loads shifted the local balance towards degradation, but the shift did not persist significantly downstream
- Reducing bank erosion shifted river to eroding the sand bed locally and no net change downstream
- Re-meandering river caused increased deposition locally and reduced deposition just downstream
- The outcomes above reflect short-term effects of modified conditions

Kankakee River Basin Projects
Potential Next Steps

- Develop and assess additional alternatives
- Examine longer time periods of change
- Evaluate management actions that best achieve alternatives
- Develop a recommended plan that most effectively accomplishes the goal of Kankakee River sediment reduction and habitat restoration
- Implement the management actions in the recommended plan