Comparison of Estimated Sediment Loads using Continuous Turbidity Measurements and Regression Analysis

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Suspended-sediment load calculations

- Historically, discrete (daily, weekly or monthly) suspended-sediment samples are regressed against discharge
- Computer programs have automated this process but still rely on discharge
- Discrete suspended-sediment concentrations can be regressed against turbidity, leading to more accurate load calculations for some sites

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Approach

- Upgrade USGS stream gaging stations with water-quality monitors
- Collect suspended sediment samples over the range in hydrologic conditions
- Develop regression equations using collected samples and sensor values
- Estimate concentrations from the regression equations and loads from continuous data.

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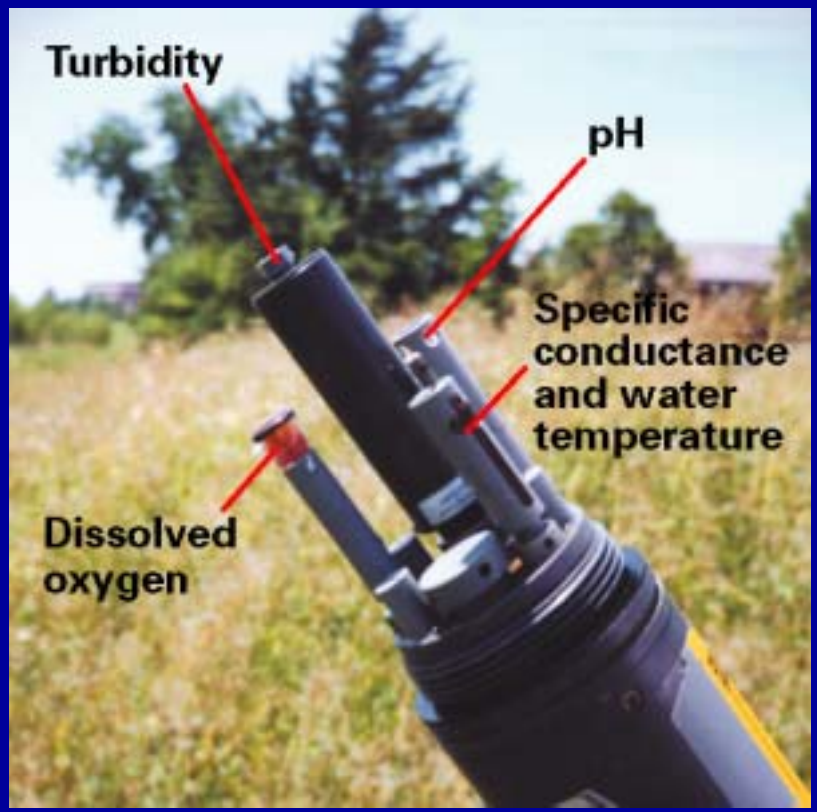
Real-time, Continuous Water-Quality Monitor



- **pH**
- **Water Temperature**
- **Dissolved Oxygen**
- **Specific Conductance**
- **Turbidity**
- **Fluorescence**

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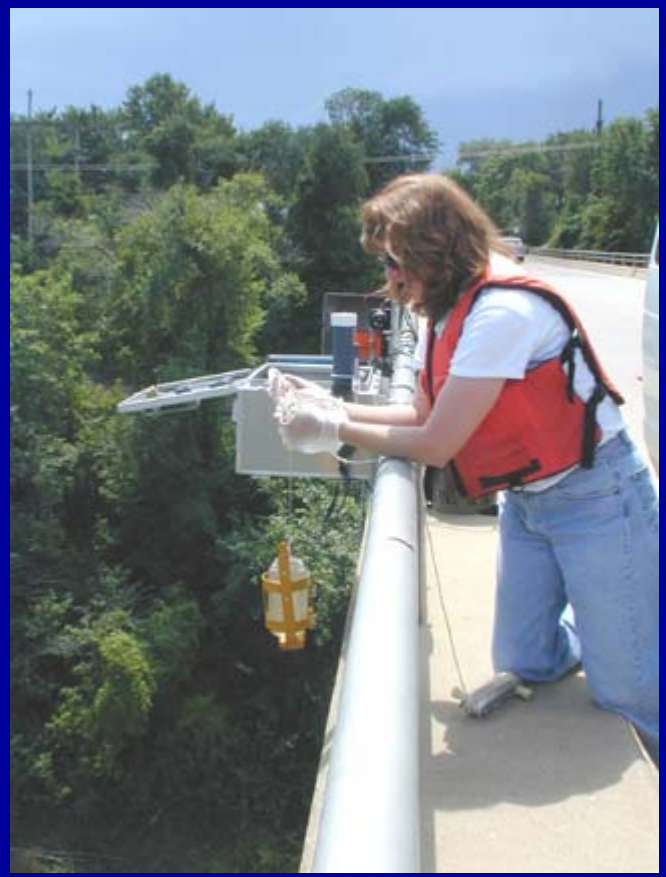
Collection of manual samples

- Collected throughout the range of expected hydrologic conditions
- Analyzed for sediment and other constituents
- Use EWI or EDI methods



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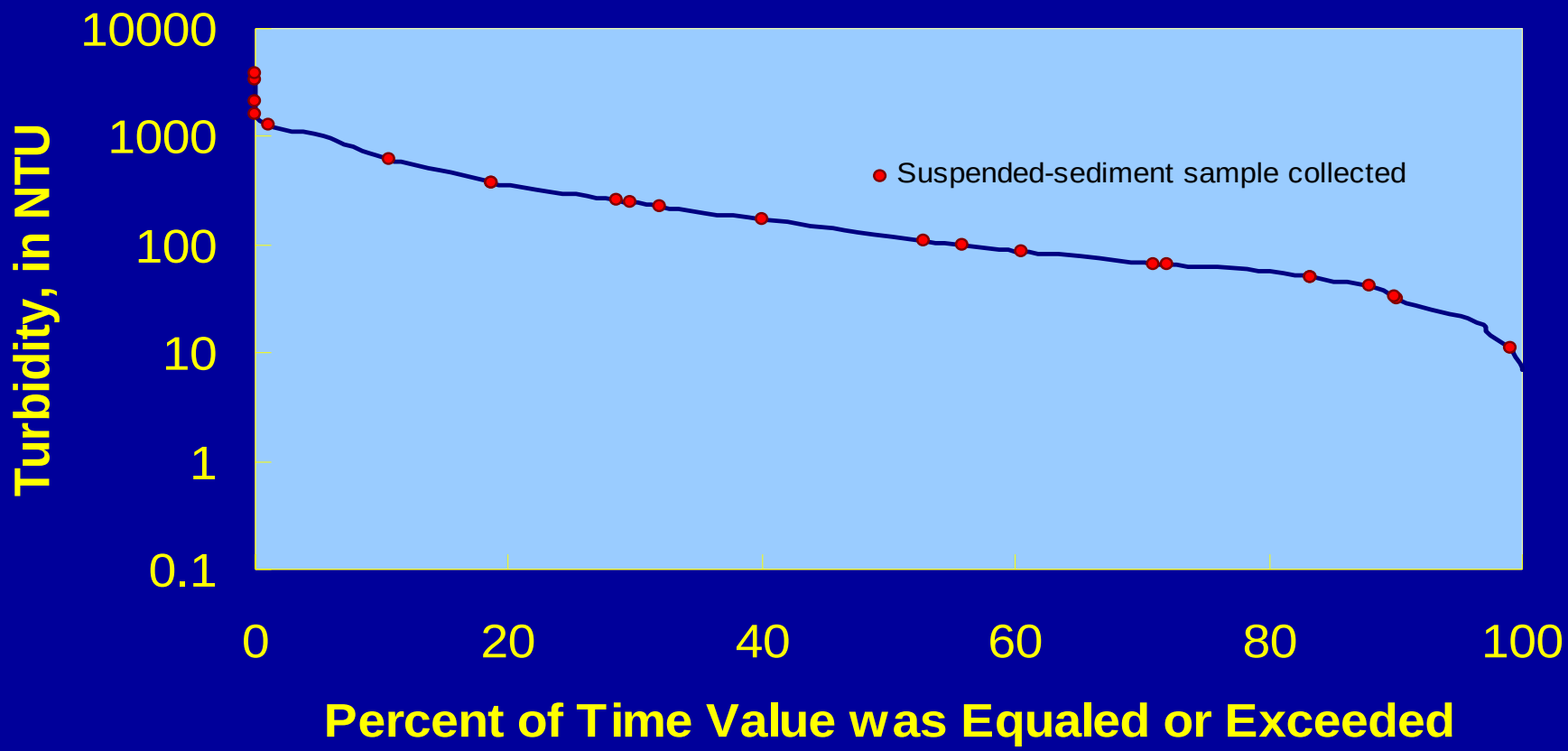
Turbidity Duration Curve



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Hypothesis:

- Turbidity is a better surrogate than streamflow for estimating suspended sediment concentrations and loads

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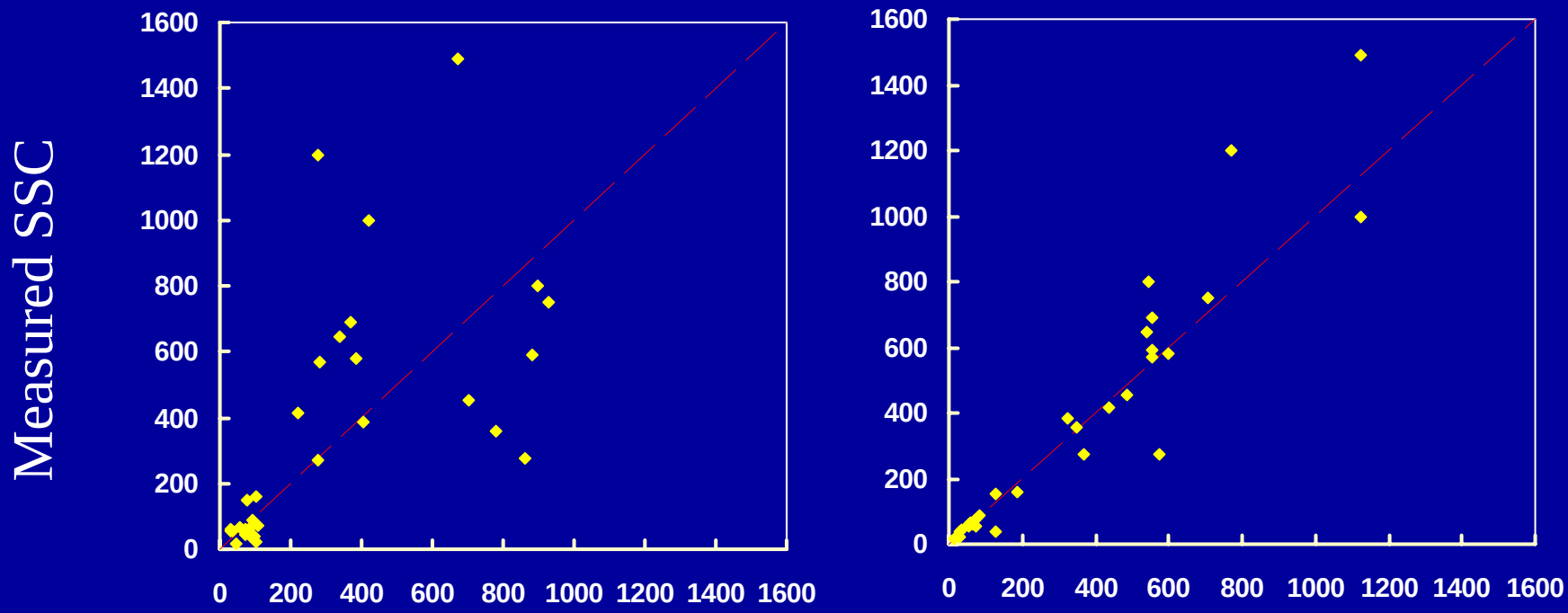
Measured SSC vs Streamflow- and Turbidity-estimated Concentrations

Little Arkansas River near Halstead



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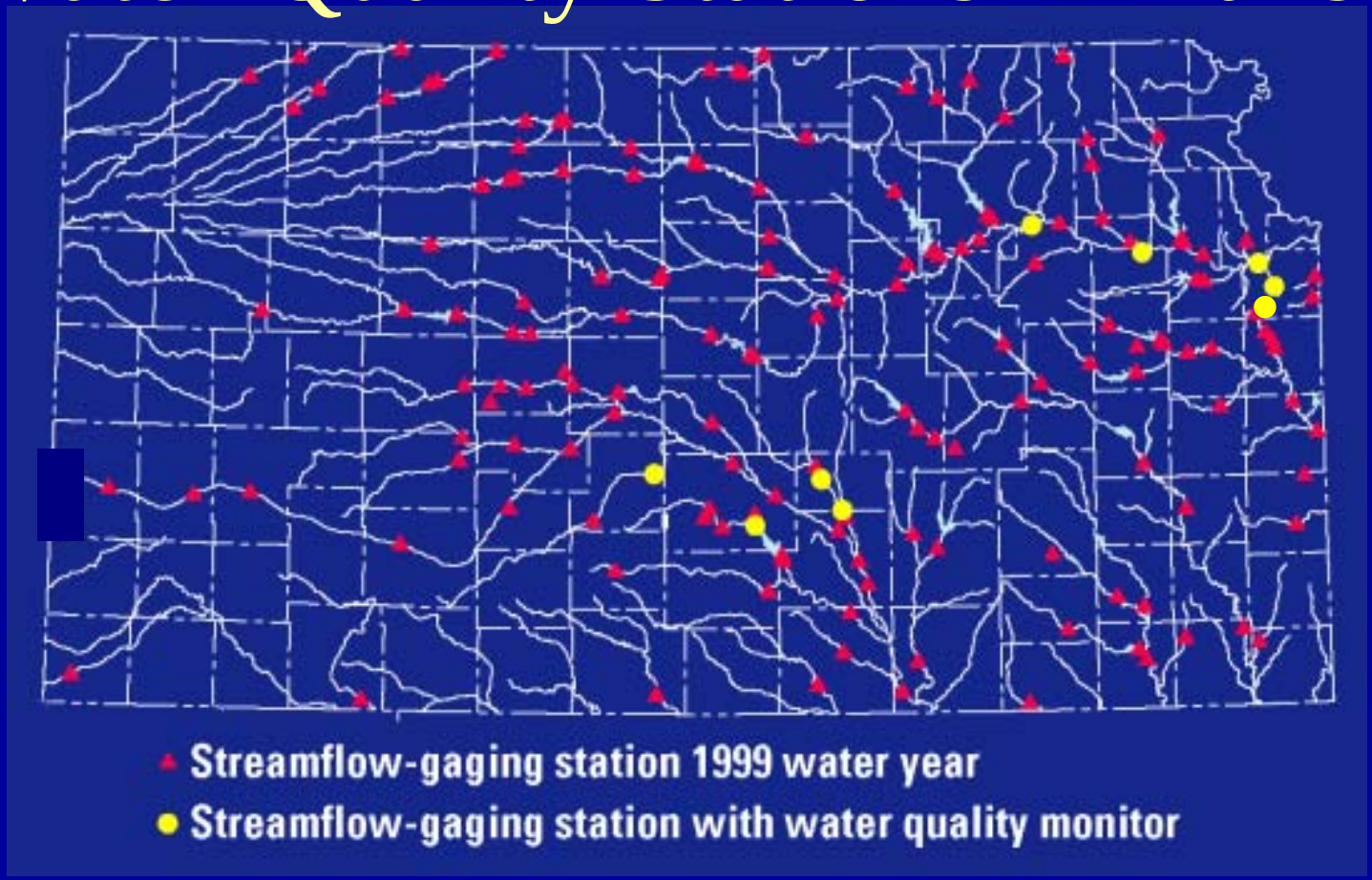
SSC vs Streamflow or Turbidity

Comparison of R^2 for Simple Regression

	Station	R^2 streamflow equation	R^2 turbidity equation
*	06887500	0.53	0.81
*	06889000	0.81	0.97
*	06892350	0.79	0.99
*	06892440	0.82	0.77
*	06892450	--	0.83
*	07142575	0.41	0.93
*	07143672	0.71	0.94
*	07144100	0.71	0.86
	07144601	0.33	0.74
	07144660	0.65	0.70
	07144680	0.55	0.94
	07144730	0.33	0.97
*	07144780	0.80	0.81
	07144790	--	0.68
	07144795	0.04	0.36

Streamflow-Gaging and Real-Time Water-Quality Stations in Kansas



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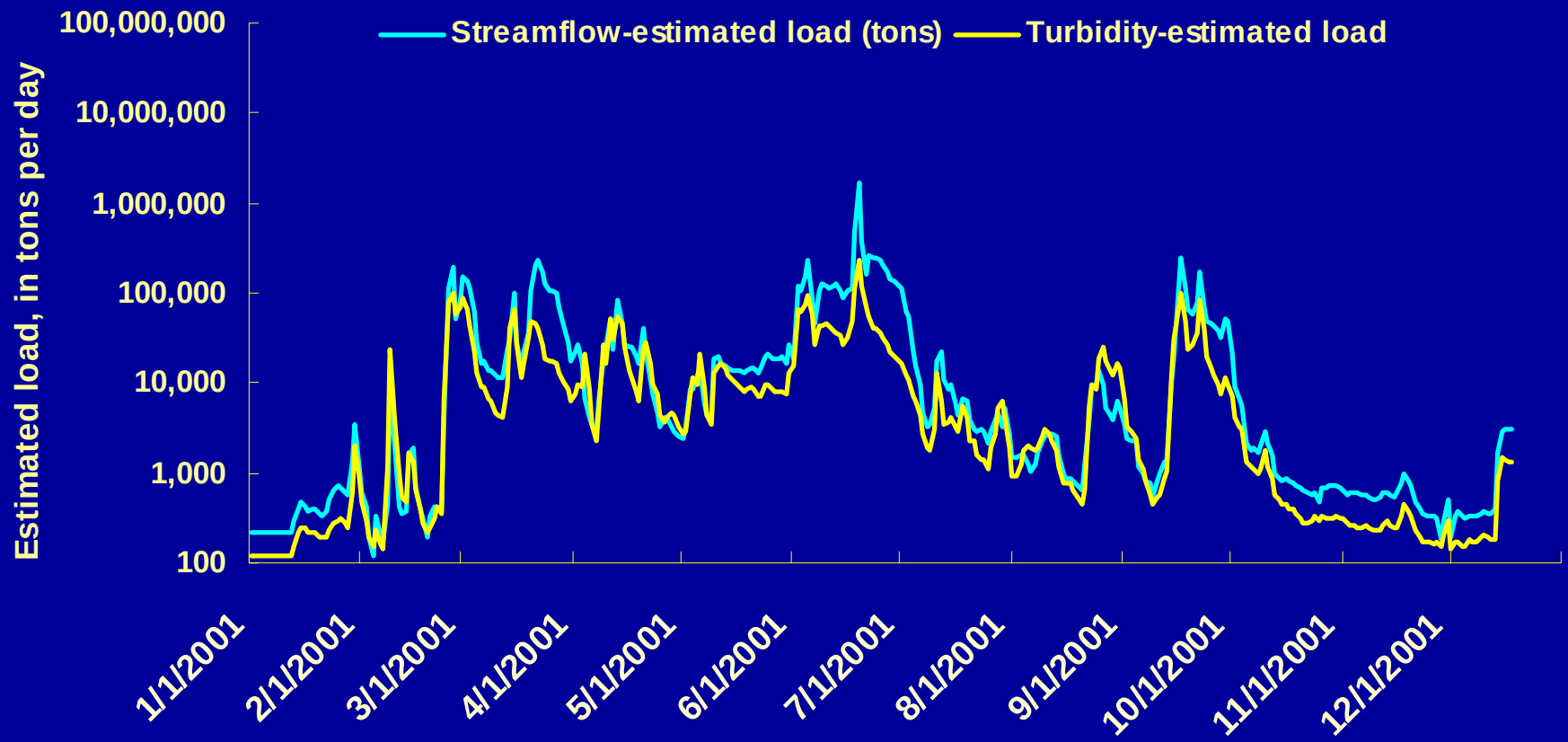
Comparison of Streamflow- and Turbidity-estimated Loads

Kansas River at DeSoto



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Kansas River at DeSoto

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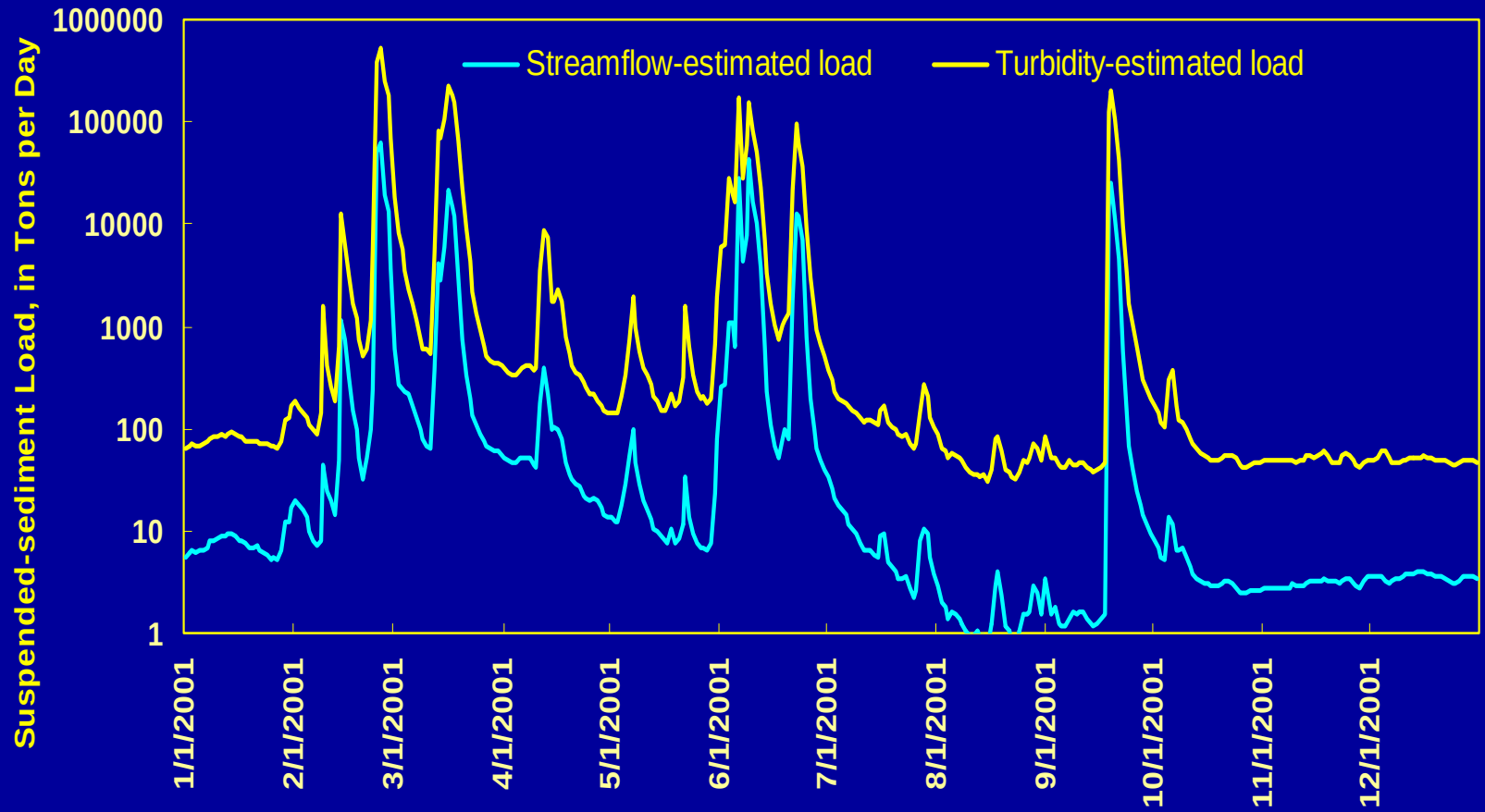
Comparison of Streamflow- and Turbidity-estimated Loads

Little Arkansas River at Sedgwick



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Little Arkansas River at Sedgwick

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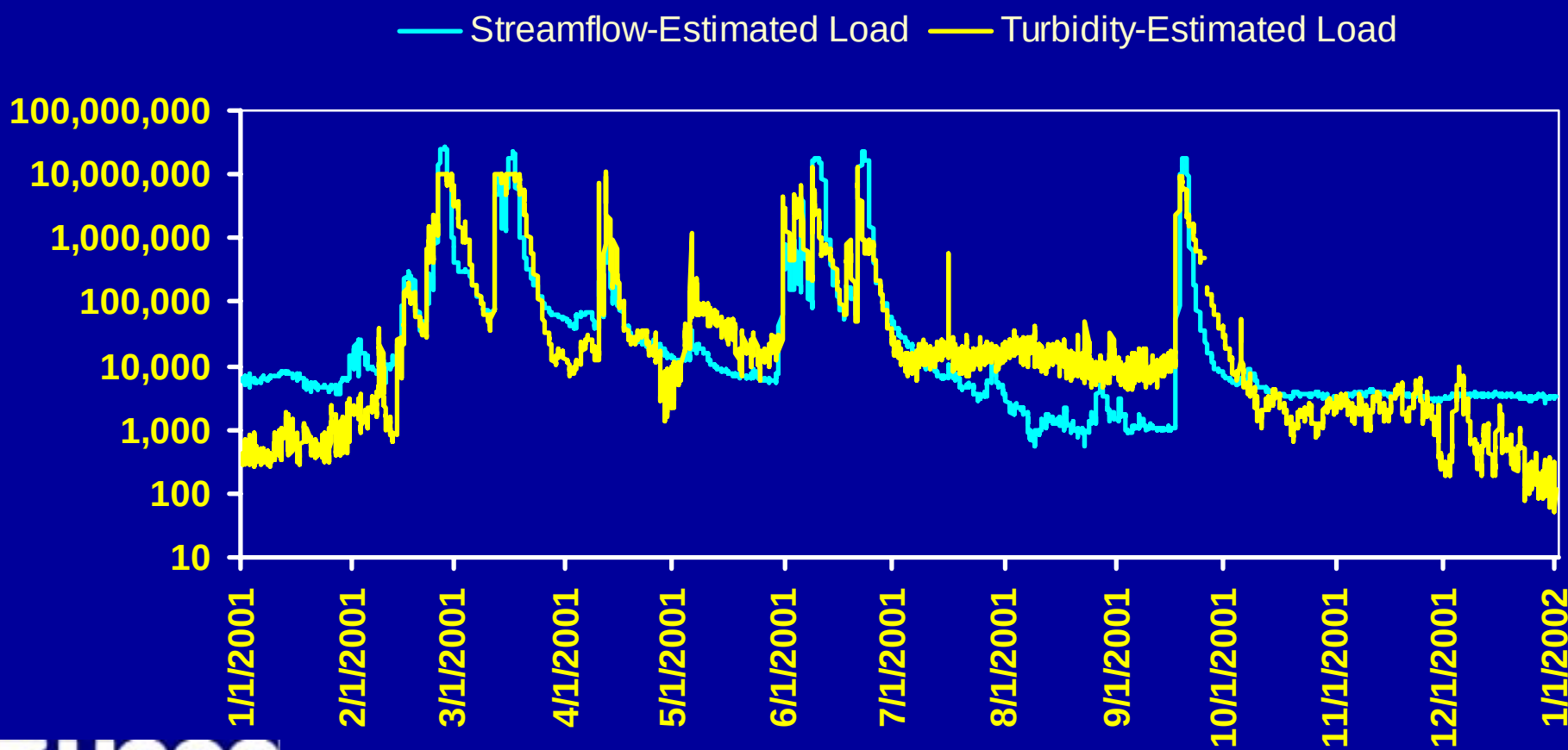
Comparison of Streamflow- and Turbidity-estimated Loads

Little Arkansas River near Halstead



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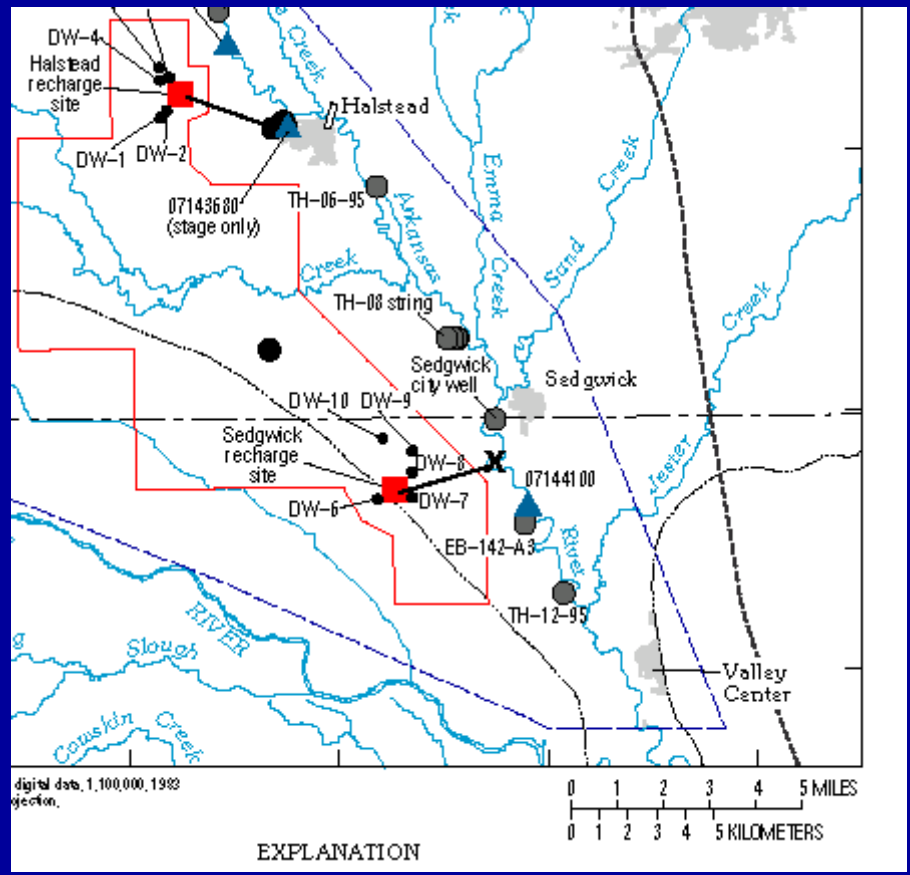
Little Arkansas River near Halstead



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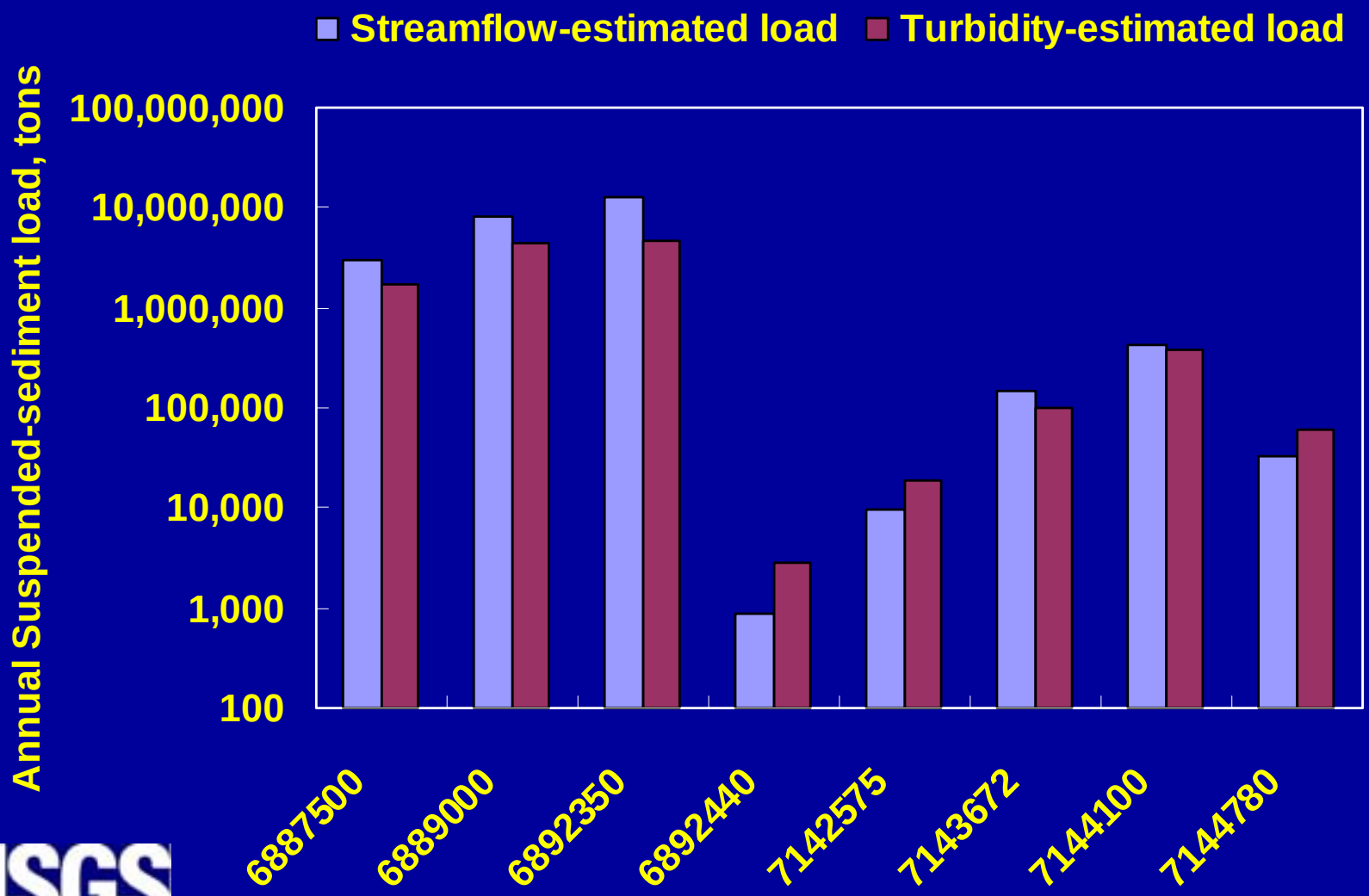
2001 Annual Loads



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Comparison of Measured Instantaneous Suspended-Sediment Loads to Streamflow- and Turbidity-Estimated Suspended-Sediment Loads, 1998-2001

Suspended-sediment Load (tons per day)	Kansas R. at Desoto	L. Arkansas R. at Sedgwick
Mean measured load	49,500	3,010
Mean streamflow-estimated load	106,000	4,610
Percentage difference	-110	-53
Mean turbidity-estimated load	47,200	2,830
Percentage difference	4.6	6.0

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Multiple Regression Analysis

	Station	Lowest PRESS	Mallow's Cp	Adjusted R^2
*	06887500	NTU	NTU	NTU
*	06889000	NTU, Q	NTU, Q	NTU, Q
*	06892350	NTU, Q	NTU, Q	NTU, Q
*	06892440	Q	NTU, Q	NTU, Q
*	06892450	NTU, WT	NTU, WT	NTU, WT
*	07142575	NTU	NTU, Q	NTU, Q
*	07143672	NTU	NTU	NTU
*	07144100	NTU, Q	NTU, Q	NTU, Q
	07144601	NTU	NTU	NTU
	07144660	NTU	NTU	NTU, WT
	07144680	NTU	NTU	NTU, Q
	07144730	NTU	NTU	NTU
*	07144780	NTU, WT	NTU, WT	NTU, WT
	07144790	NTU	NTU	NTU
	07144795	NTU	NTU	NTU, WT

Limitations of Using Turbidity for Estimating Suspended-Sediment Loads

- Upper limit for some turbidity meters
- Many load estimating programs don't allow for continuous turbidity measurements
- Meters are not interchangeable without some kind of adjustment
- After equation is developed need to continue to collect SSC samples to verify the relation
- Still need streamflow to calculate a load!

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Conclusions

- SSC at 14 of 15 sites was more significantly correlated to turbidity than to streamflow
- Very large differences between annual loads estimated with turbidity vs streamflow at some sites
- Relation with streamflow seems to be affected by altered flow conditions
- Multiple regression analysis (turbidity and streamflow) should be considered for all sites

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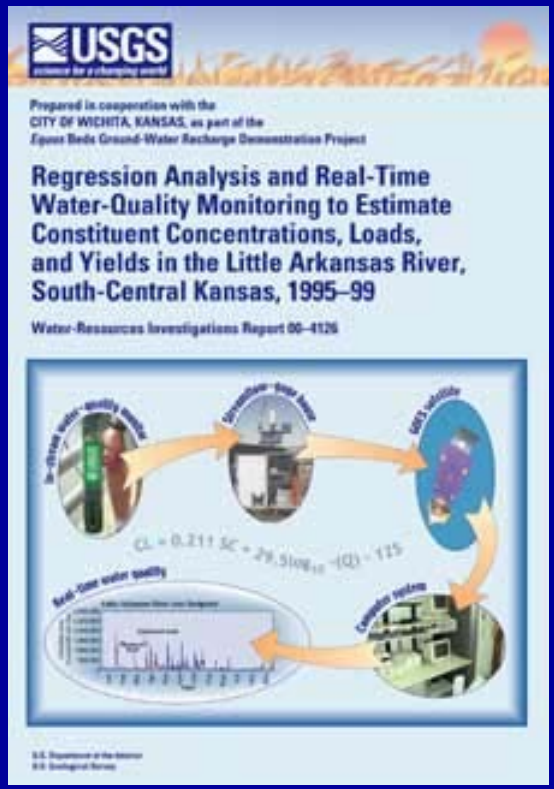
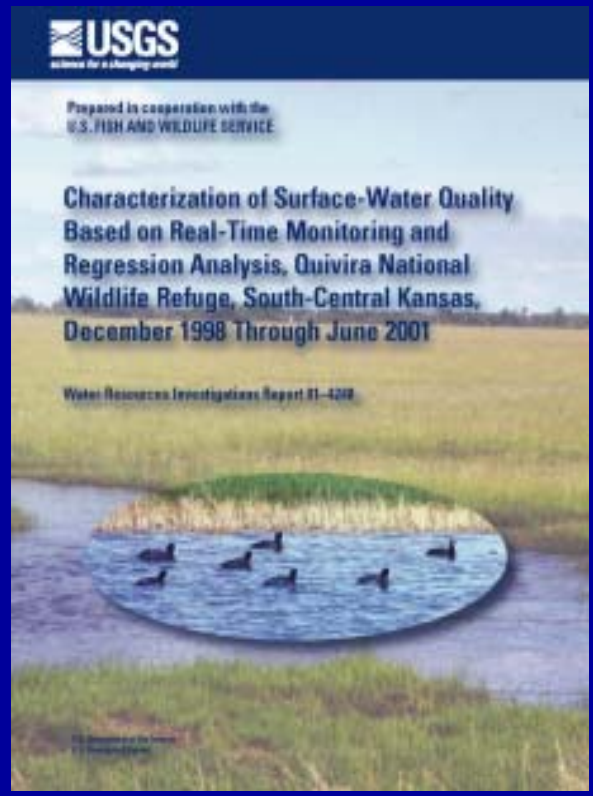
For more information on continuous monitoring in Kansas:





http://ks.water.usgs.gov/Kansas/rtqw/

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