Kansas Water Resources Research Institute Annual Technical Report FY 2009

Introduction

The Kansas Water Resources Institute (KWRI) is part of a national network of water resources research institutes in every state and territory of the U.S. established by law in the Water Resources Research Act of 1964. The network is funded by a combination of federal funds through the U.S. Department of the Interior/Geological Survey (USGS) and non-federal funds from state and other sources.

KWRI is administered by the Kansas Center for Agricultural Resources and the Environment (KCARE) at Kansas State University. An Administrative Council comprised of representatives from participating higher education or research institutions, state agencies, and federal agencies assists in policy making.

The mission of KWRI is to: 1) develop and support research on high priority water resource problems and objectives, as identified through the state water planning process; 2) facilitate effective communications among water resource professionals; and 3) foster the dissemination and application of research results.

We work towards this mission by: 1) providing and facilitating a communications network among professionals working on water resources research and education, through electronic means, newsletters, and conferences; and 2) supporting research and dissemination of results on high priority topics, as identified by the Kansas State Water Plan, through a competitive grants program.

Research Program Introduction

Our mission is partially accomplished through our competitive research program. We encourage the following through the research that we support: interdisciplinary approaches; interagency collaboration; scientific innovation; support of students and new young scientists; cost-effectiveness; relevance to present and future water resource issues/problems as identified by the State Water Plan; and dissemination and interpretation of results to appropriate audiences.

In implementing our research program, KWRI desires to: 1) be proactive rather that reactive in addressing water resource problems of the state; 2) involve the many water resources stakeholders in identifying and prioritizing the water resource research needs of the state; 3) foster collaboration among state agencies, federal agencies, and institutions of higher education in the state on water resource issues; 4) leverage additional financial support from state, private, and other federal sources; and 5) be recognized in Kansas as a major institution to go to for water resources research.

An Analysis of Sedimentation Reduction Strategies for Tuttle Creek Lake

Basic Information

Title:	An Analysis of Sedimentation Reduction Strategies for Tuttle Creek Lake
Project Number:	2008KS68B
Start Date:	3/1/2008
End Date:	2/28/2011
Funding Source:	104B
Congressional District:	2nd
Research Category:	Not Applicable
Focus Category:	Sediments, Economics, Water Supply
Descriptors:	None
Principal Investigators:	Kyle R. Mankin

Publications

There are no publications.

An Analysis of Sedimentation Reduction Strategies for Tuttle Creek Lake

2009-2010 ANNUAL PROGRESS REPORT

Kansas Water Resources Competitive Grants Program

Principal Investigators and Institutional Affiliations:
Dr. Amirpouyan Nejadhashemi, Biosystems Engineering, Michigan State University
Mr. Craig Smith, Agricultural Economics, Kansas State University
Dr. Jeff Williams, Agricultural Economics, Kansas State University
Dr. Kyle Douglas-Mankin, Biological and Agricultural Engineering, Kansas State University
Dr. Bill Golden, Agricultural Economics, Kansas State University

Project duration: March 1, 2008 to February 28, 2011 (3 Years)

Keywords: Decision support system, Economic analysis, Sediment load, Watershed modeling.

INTRODUCTION

Steady progress was made in the second year of this Kansas Water Resource Institute (KWRI) grant. A watershed model was developed and calibrated for the entire Tuttle Creek Lake watershed including both Nebraska and Kansas sides of the watershed. This watershed model utilized various cropping rotations based on data from University sources and the 2007 Census of Agriculture. Along with the biophysical modeling process, the economics of the different cropping rotations under alternative tillage management strategies were evaluated and described in this progress report. A watershed best management practice (BMP) simulation model also has been developed within the MATLAB computing environment and is ready and able to accept the watershed modeling output. Finally, there were several notable public recognition events which occurred over the past year related to this study. These events are described in detail near the end of this report. This progress report begins by describing the watershed modeling process and results followed by a description of the economic model.

A goal of this stage of the study is to calibrate the Soil and Water Assessment Tool (SWAT) for the Tuttle Creek Lake Watershed (HUC-10270207 and HUC-10270205). Two major rivers (Big Blue River and Little Blue River) discharge water and sediment to the study area. Therefore, there is a need to estimate and incorporate flow and sediment inputs from these rivers. The locations of the inlets are identified in Figure 1.

In order to estimate sediment input to the Tuttle Creek Lake Watershed, we set up and calibrated two watersheds for flow and sediment. We called the first watershed Upper Left (HUC 10270207), which contains the Little Blue River. The second watershed was named the Upper Right (HUC-10270201, HUC-10270202, HUC-10270203, and HUC-10270204), which contains the Big Blue River. The two watersheds are identified in Figure 2. The results from the calibrated models above were used as inputs to the Tuttle Creek Lake Watershed. The final stage involved calibration of the Tuttle Creek Watershed for flow and sediment.

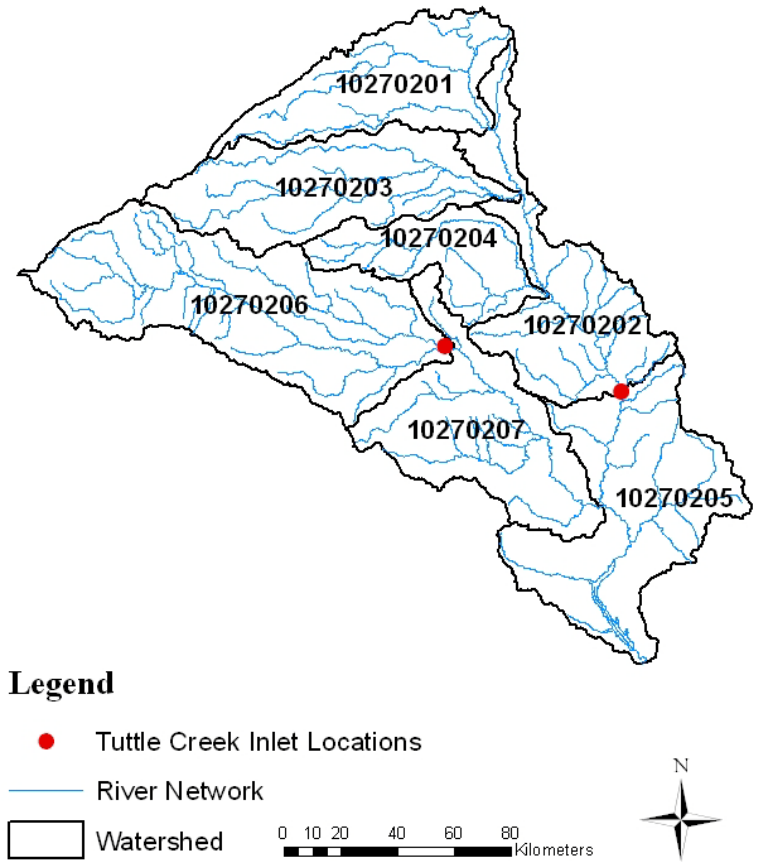

Figure 1. Tuttle Creek Inlets

Figure 2. Upper Left and Upper Right Watersheds

IDENTIFYING THE CALIBRATION AND VALIDATION PERIOD

There is need to identify at least one dry climatological period and one wet climatological period for the model setup and calibration. Precipitation from 24 weather stations over 30 years were used to estimate average annual precipitation shown in Figure 3. The period of 1998-2002 was selected for model calibration and validation; data from 1997 was used for model warm-up.

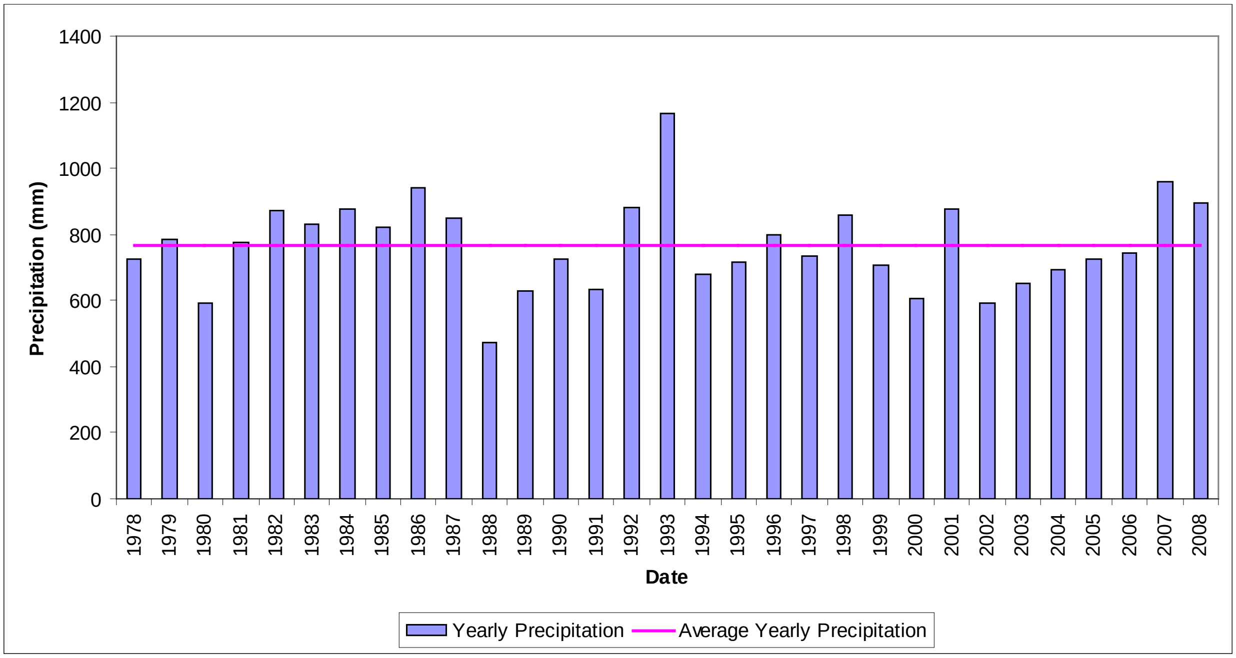

Figure 3. Annual Precipitation for the Big Blue Watershed

Agricultural Land Use Allocation and Rotations

Four different crops (Table 1) and three rotations (Tables 2, 3, 4 and 5) were identified for Upper Left and Upper Right watersheds. These crops and rotations were introduced into the SWAT model.

Agricultural Land Use Allocation – Big Blue Watershed (Nebraska Side)

Table 1. Agricultural Land Use for Nebraska Side of the Big Blue Watershed

Land Use Type	Percentage of Agricultural Land
Corn	63%
Grain Sorghum	3%
Soybeans	31%
Wheat	3%

Crop Rotations and Management Inputs – Big Blue Watershed (Nebraska Side)

Table 2. Crop Rotations for Nebraska Side of the Big Blue Watershed

Rotation	Percentage of Agricultural Land
Corn – Soybeans	55%
Corn	35%
Grain Sorghum – Soybeans – Wheat	10%

Table 3. Grain Sorghum-Soybean-Wheat Rotation Conventional Tillage Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
5/5	Chisel	Chisel Plow Gt15ft		
5/5	Knife Anhydrous Ammonia	Anhydrous Ammonia	54 kg/ha	
5/15	Field Cultivate	Field Cultivator Ge15ft		
5/25	Nitrogen Application	Elemental Nitrogen	11 kg/ha	
5/25	Phosphorus Application	Elemental Phosphorus	38 kg/ha	
5/25	Plant Grain Sorghum	Plant/Begin Growing Season		
5/25	Bicep II Magnum	Atrazine	1.4 kg/ha	
5/25	Bicep II Magnum	Metolachlor	1.1 kg/ha	
7/1	Buctril + Atrazine	Bromoxynil	0.3 kg/ha	
7/1	Buctril + Atrazine	Atrazine	0.6 kg/ha	
9/25	Harvest Sorghum	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		2
4/15	Field Cultivate	Field Cultivator Ge15ft		
5/14	Field Cultivate	Field Cultivator Ge15ft		
5/16	Plant Soybeans	Plant/Begin Growing Season		
5/16	Fertilizer	Elemental Phosphorus	33 kg/ha	
6/14	Round Up Weather Max	Glyphosate Amine	0.9 kg/ha	
10/1	Harvest Soybeans	Harvest and Kill		
10/10	Field Cultivate	Field Cultivator Ge15ft		
10/15	Nitrogen Application	Elemental Nitrogen	65 kg/ha	
10/15	Phosphorus Application	Elemental Phosphorus	31 kg/ha	
10/16	Plant Wheat			
7/1	Harvest Wheat	Harvest and Kill		3
8/1	Chisel	Coulter Chisel Plow		
9/1	Tandem Disk	Tandem Disk Plow Ge19ft		

Table 4. Corn-Soybean Rotation Conventional Tillage Field Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
4/5	Chisel	Chisel Plow Gt15ft		
4/5	Knife Anhydrous Ammonia	Anhydrous Ammonia	96 kg/ha	
4/15	Field Cultivate	Field Cultivator		
4/15	Bicep II Magnum	Atrazine	1.7 kg/ha	
4/15	Bicep II Magnum	Metolachlor	1.3 kg/ha	
4/16	Plant Corn	Plant/Begin Growing Season		
4/16	Nitrogen Application	Elemental Nitrogen	16 kg/ha	
4/16	Phosphorus Application	Elemental Phosphorus	53 kg/ha	
5/20	Status	Dicamba	0.3 kg/ha	
10/1	Harvest Corn	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		2
4/15	Field Cultivate	Field Cultivator Ge15ft		
5/14	Field Cultivate	Field Cultivator Ge15ft		
5/16	Plant Soybeans	Plant/Begin Growing Season		
5/16	Fertilizer	Elemental Phosphorus	33 kg/ha	
6/14	Round Up Weather Max	Glyphosate Amine	0.9 kg/ha	
10/1	Harvest Soybeans	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		

Table 5. Continuous Corn Rotation Conventional Tillage Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
4/5	Chisel	Chisel Plow Gt15ft		
4/5	Knife Anhydrous Ammonia	Anhydrous Ammonia	96 kg/ha	
4/15	Field Cultivate	Field Cultivator		
4/15	Bicep II Magnum	Atrazine	1.7 kg/ha	
4/15	Bicep II Magnum	Metolachlor	1.3 kg/ha	
4/16	Plant Corn	Plant/Begin Growing Season		
4/16	Nitrogen Application	Elemental Nitrogen	16 kg/ha	
4/16	Phosphorus Application	Elemental Phosphorus	53 kg/ha	
5/20	Status	Dicamba	0.3 kg/ha	
10/1	Harvest Corn	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		

Sensitivity Analysis

A sensitivity analysis was performed and the following parameters were identified and ranked as most sensitive in the study area (Table 6 and 7).

Table 6. Sensitivity Analysis for Flow

Parameter	Rank
Initial SCS CN II value	1
Soil evaporation compensation factor	2
Available water capacity	3
Baseflow alpha factor	4
Maximum potential leaf area index	5
Soil depth	6
Surface runoff lag time	7
Channel effective hydraulic conductivity	8
Maximum canopy storage	9
Deep aquifer percolation fraction	10

Table 7. Sensitivity Analysis for Sediment

Parameter	Rank
Lin. re-entrainment parameter for channel sediment routing	1
Manning's n value for main channel	2
Surface runoff lag time	3
Exp. re-entrainment parameter for channel sediment routing	4
Initial SCS CN II value	5
Channel effective hydraulic conductivity	6
Maximum potential leaf area index	7
Soil evaporation compensation factor	8
USLE support practice factor	9
Minimum USLE cover factor	10

Upper Right Calibration

The model was set up based on 30 years (1978-2008) of climatological data from 15 stations in this watershed (Figure 4). Observed streamflow discharge and total suspended solids (TSS) concentration were obtained from the USGS station 06882000 (Big Blue River at Barneston, NE Figure 5). The results of observed vs. uncalibrated and calibrated model output are shown in Figures 6, 7, 8, 9, 10, 11, and 12. Statistical analysis and model performance before and after calibration are shown in Tables 8 and 9.

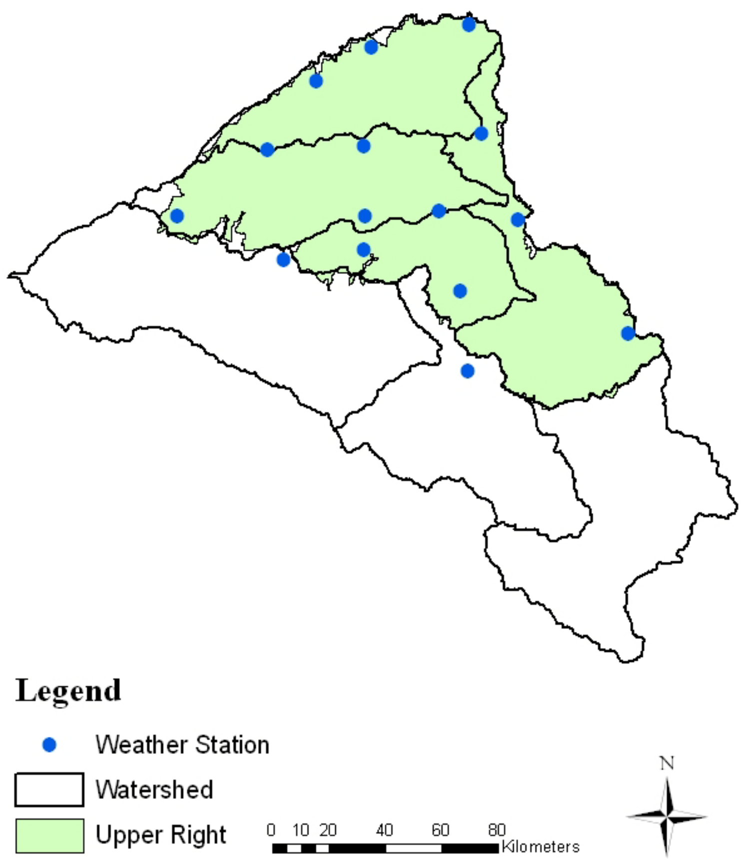

Figure 4. Upper Right Weather Stations

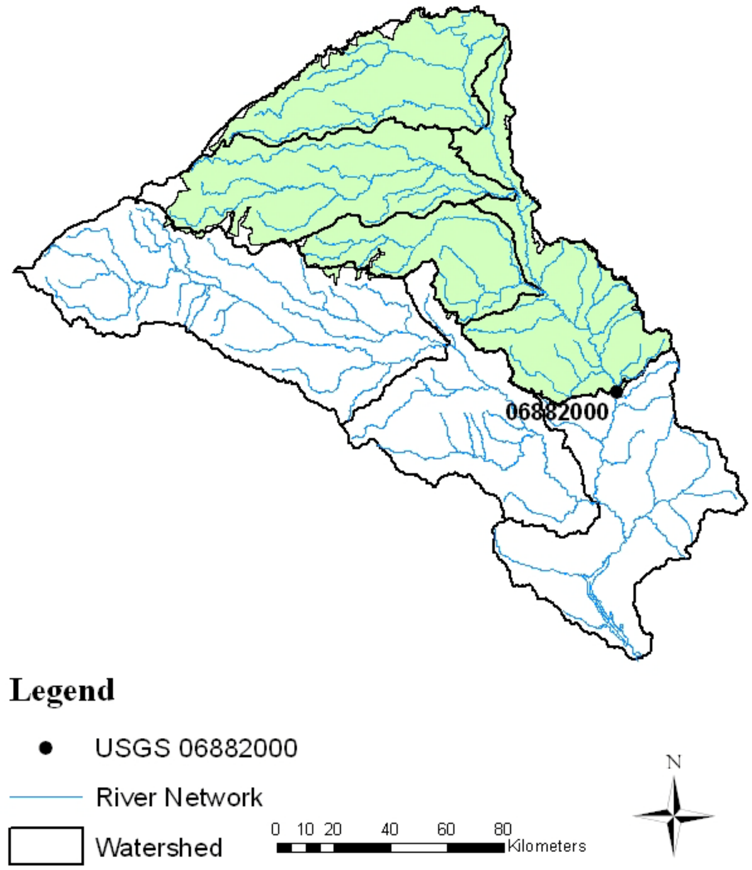

Figure 5. Calibration Point for USGS 06882000

Uncalibrated Flow – Upper Right

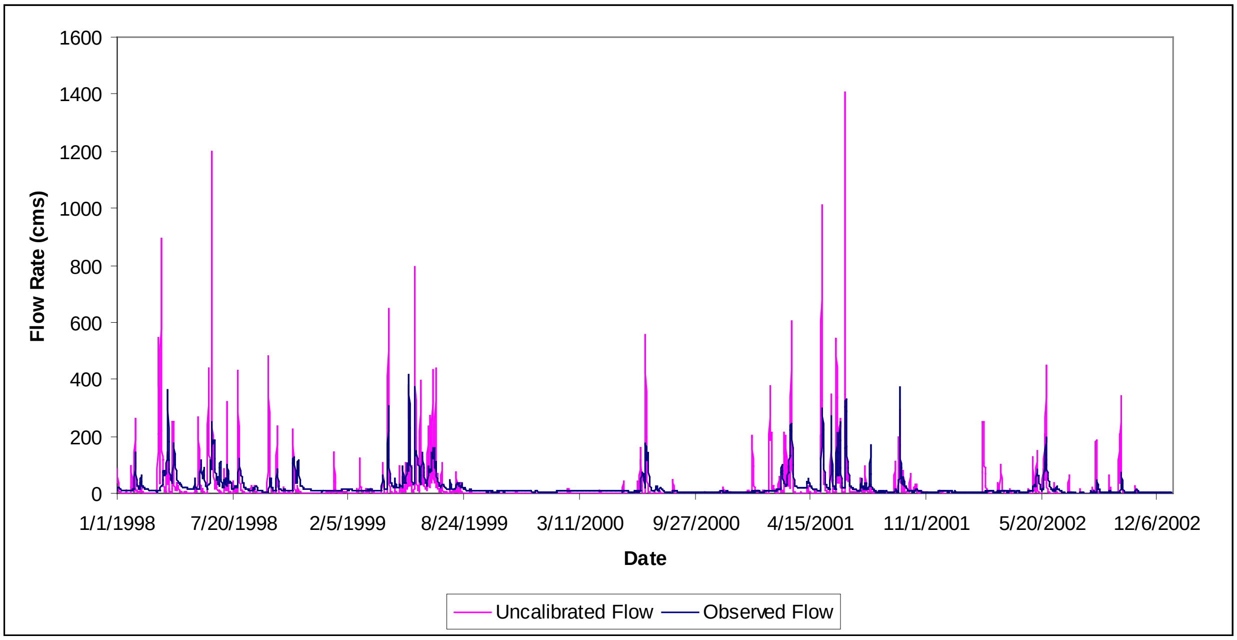

Figure 6. Uncalibrated Flow for USGS 06882000

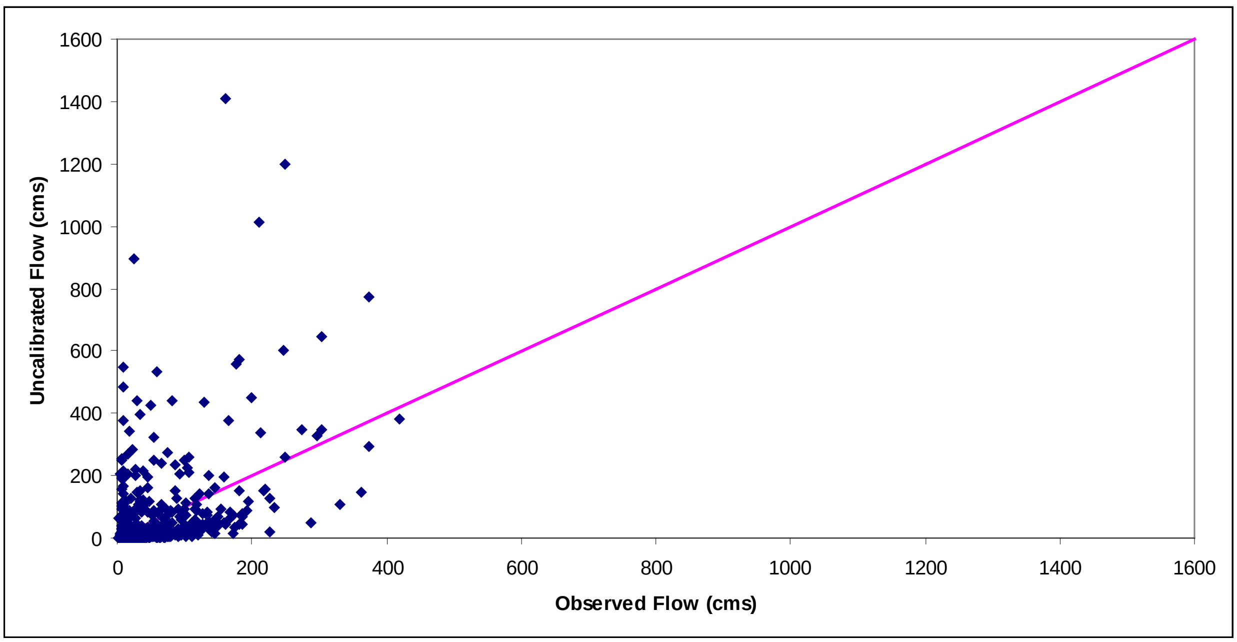

Figure 7. Observed vs. Uncalibrated Flow for USGS 06882000

Calibrated Flow – Upper Right

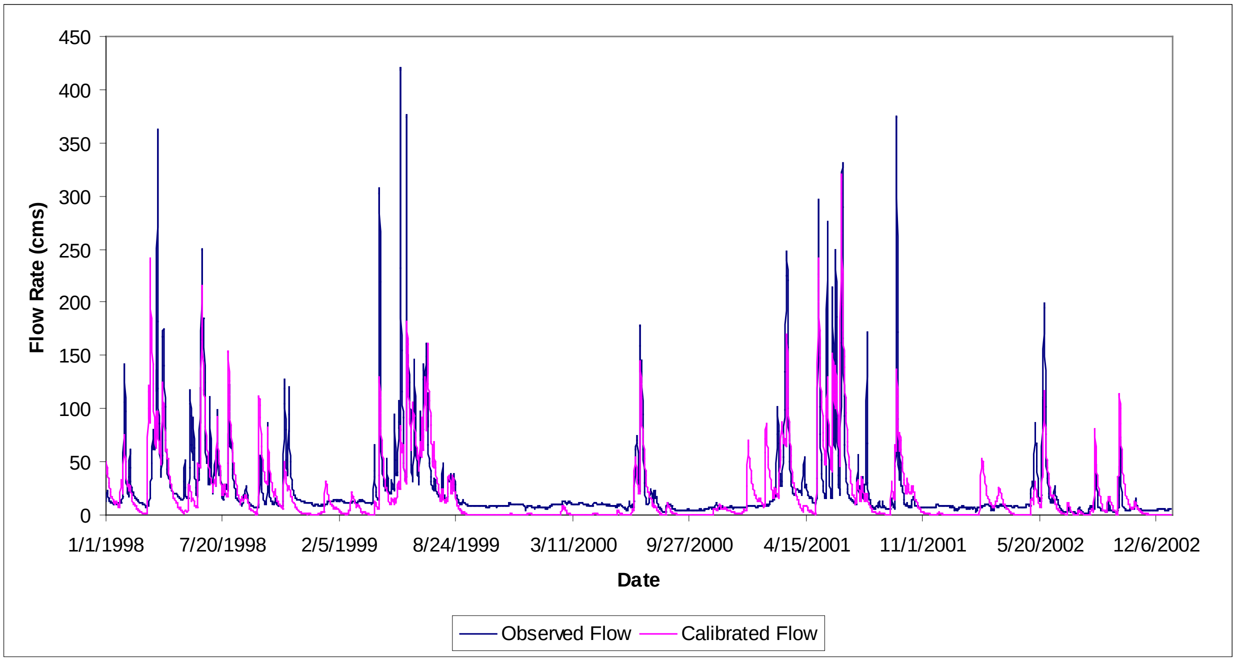

Figure 8. Calibrated Flow for USGS 06882000

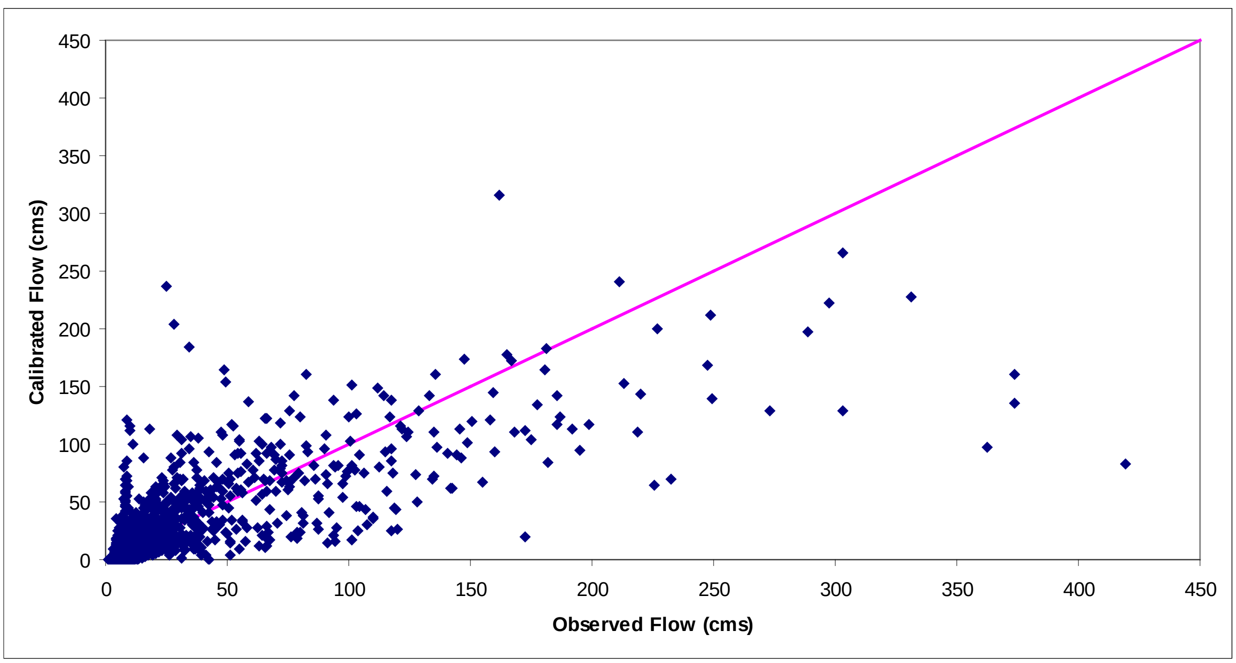

Figure 9. Observed vs. Calibrated Flow for USGS 06882000

Uncalibrated Sediment – Upper Right

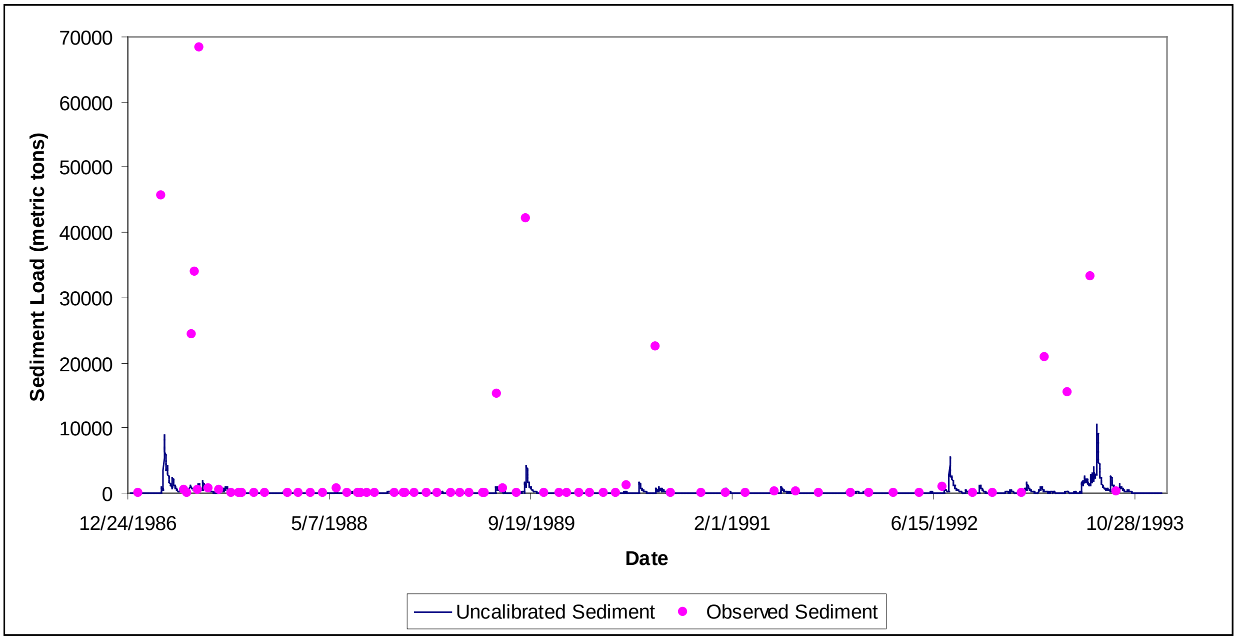

Figure 10. Uncalibrated Sediment for USGS 06882000

Calibrated Sediment – Upper Right

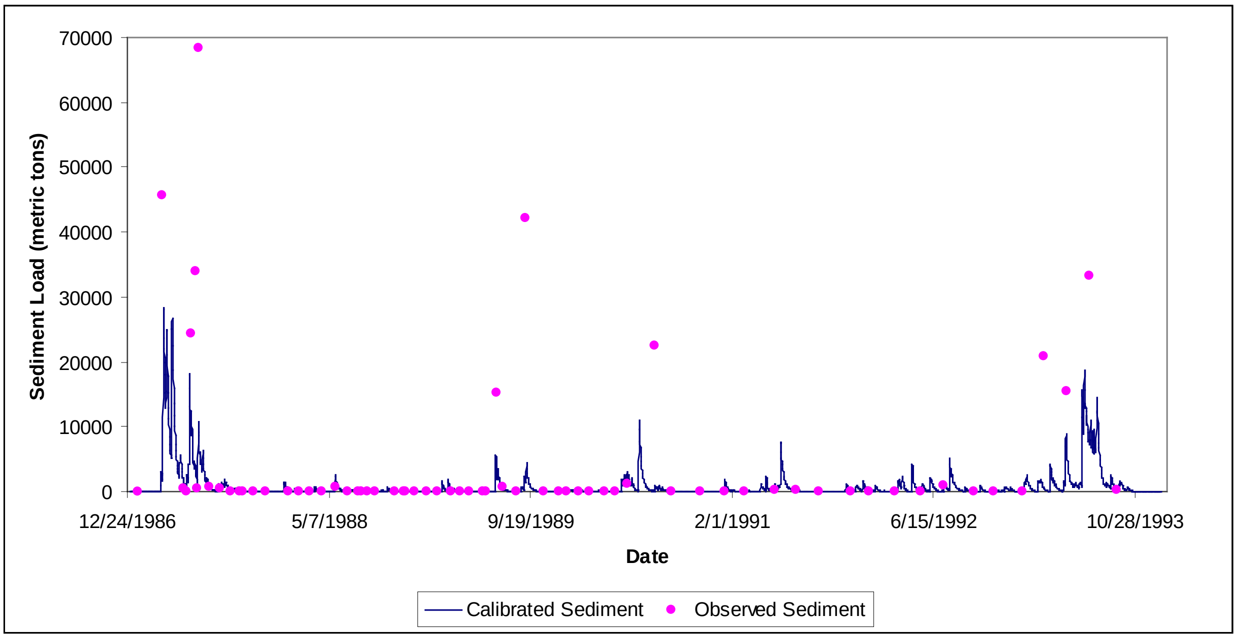

Figure 5. Calibrated Sediment for USGS 06882000

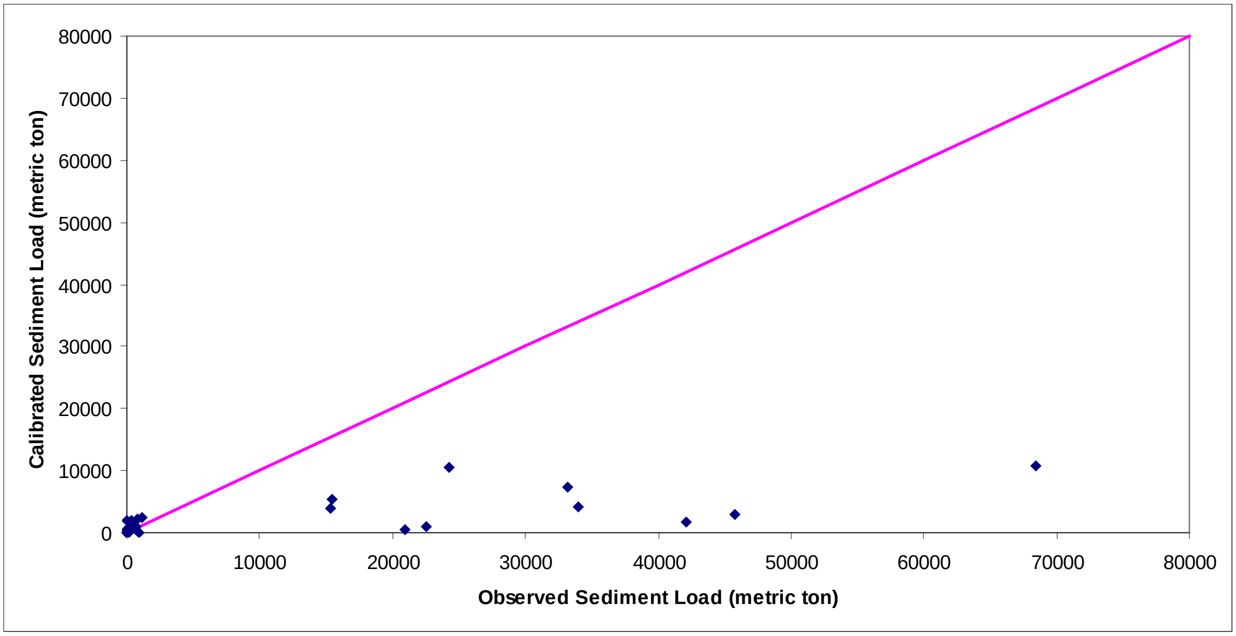

Figure 6. Observed vs. Calibrated Sediment for USGS 06882000

Calibration Results – Upper Right

Table 8. Uncalibrated Results for USGS 06882000

Parameter	Method	Value
Flow (1998-2002)	Nash-Sutcliffe Efficiency	-1.949
	R^2	0.276
	RMSE	69.592
Sediment (1987-1993)	Nash-Sutcliffe Efficiency	-0.003
	R^2	0.702
	RMSE	13423.647

Table 8. Calibration Results for USGS 06882000

Parameter	**Method**	**Value**
Flow (1998-2002)	Nash-Sutcliffe Efficiency	0.552
	R^2	0.570
	RMSE	27.112
Sediment (1987-1993)	Nash-Sutcliffe Efficiency	0.138
	R^2	0.589
	RMSE	11928.647

Upper Left Calibration

The model was set up based on 30 years (1978-2008) of climatological data from 12 stations in this watershed (Figure 13). Observed streamflow discharge was obtained from the USGS station 06884025 (Little Blue River at Hollenberg, KS), while total suspended solids (TSS) concentration was obtained from Kansas Department of Health and Environment sampling point 000232 (Little Blue River near Hollenberg, KS), shown in Figure 14. The results of observed vs. uncalibrated and calibrated model output are shown in Figure 15, 16, 17, 18, 19, 20 and 21. Statistical analysis and model performance before and after calibration are shown in Tables 10 and 11.

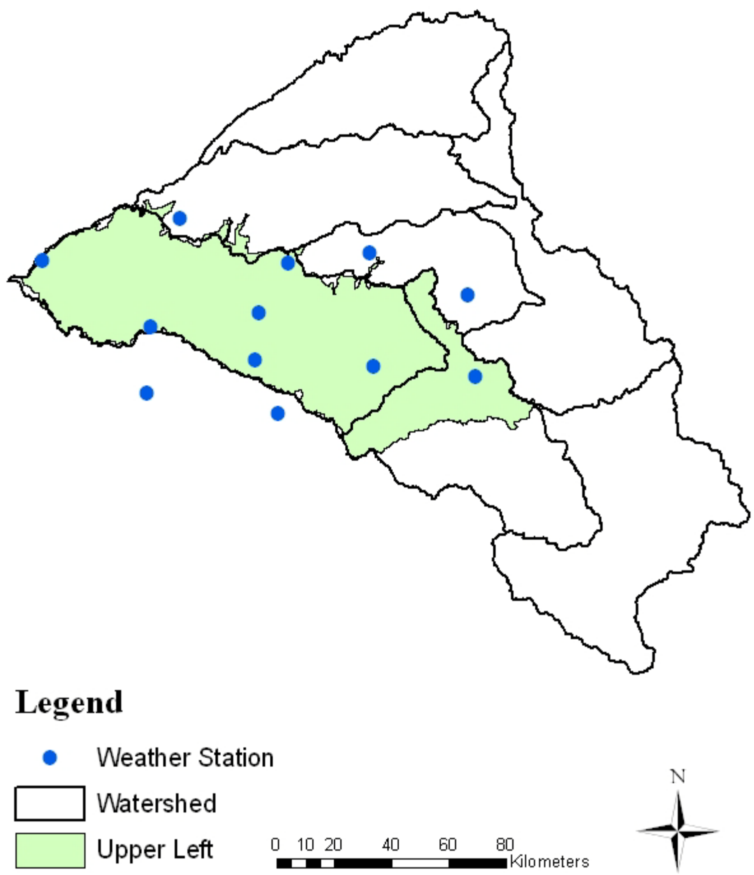

Figure 7. Upper Left Weather Stations

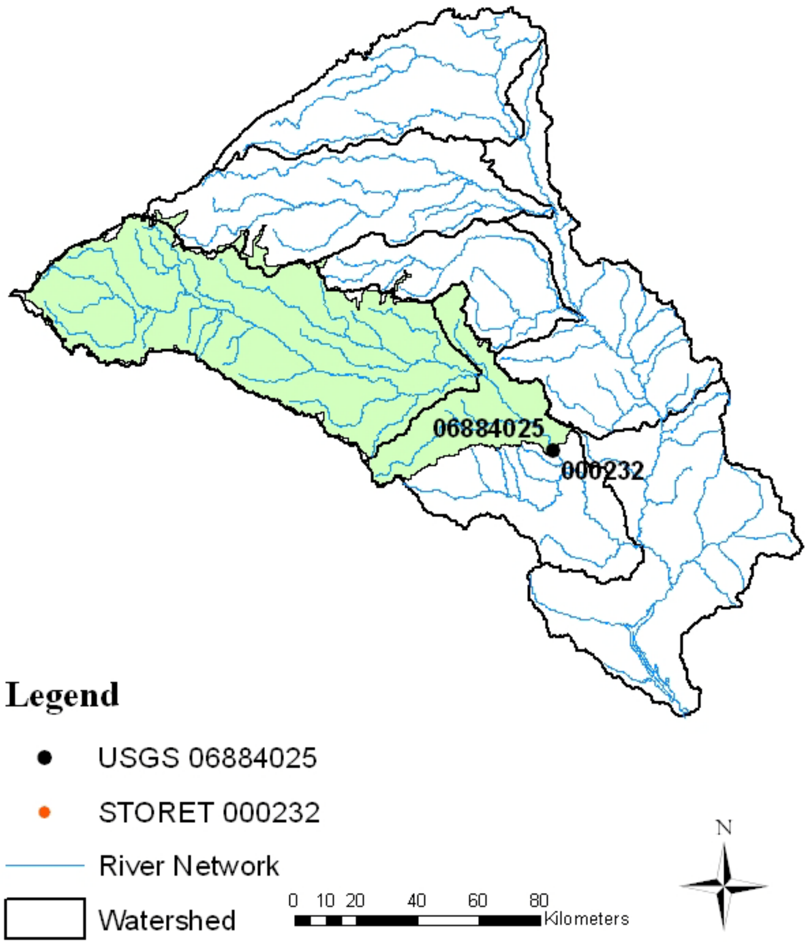

Figure 8. Calibration Point for USGS 06884025 and STORET 000232

Uncalibrated Flow – Upper Left

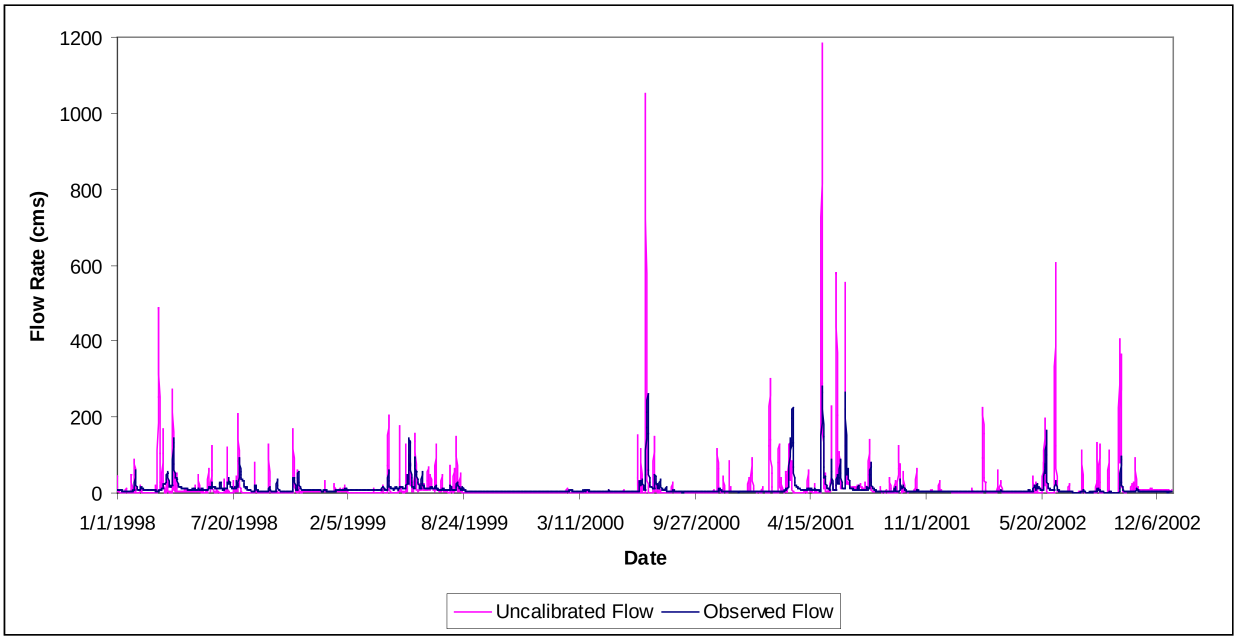

Figure 9. Uncalibrated Flow for USGS 06884025

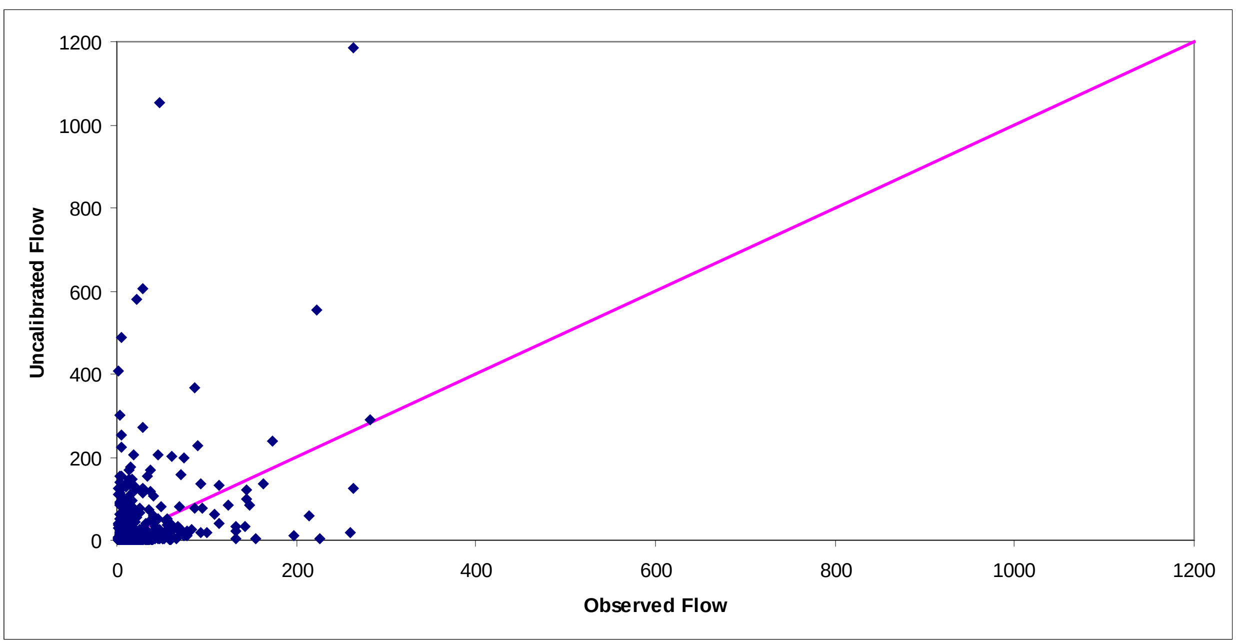

Figure 10. Observed vs. Uncalibrated Flow for USGS 06884025

Calibrated Flow – Upper Left

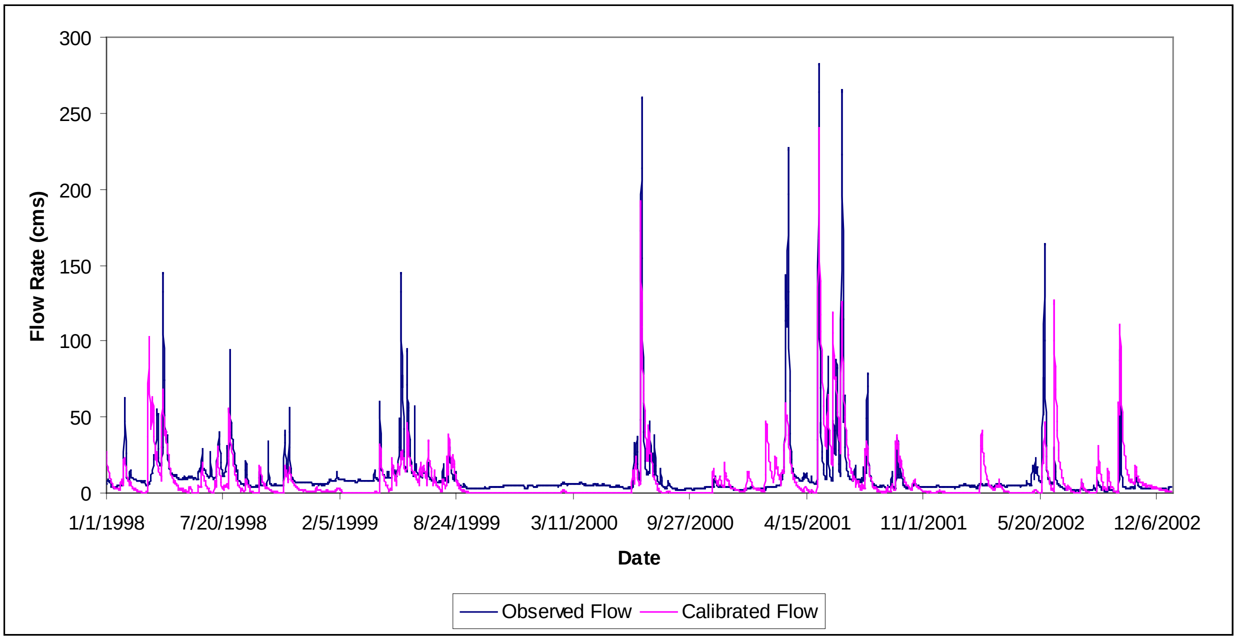

Figure 11. Calibrated Flow for USGS 06884025

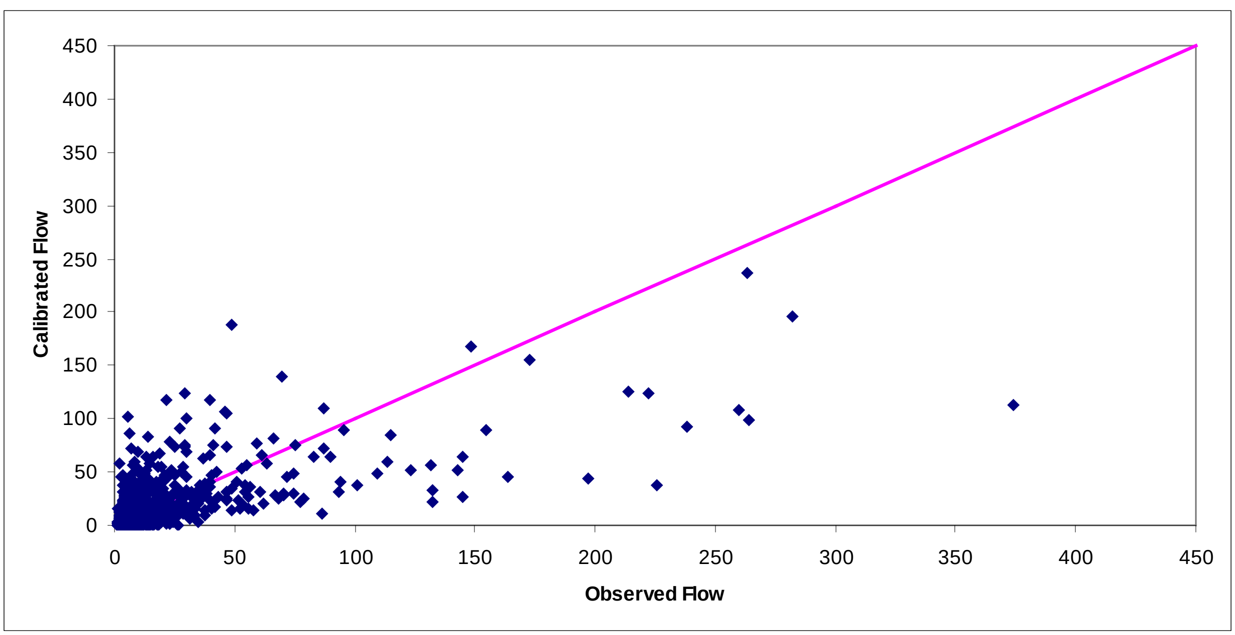

Figure 12. Observed vs. Calibrated Flow for USGS 06884025

Uncalibrated Sediment – Upper Left

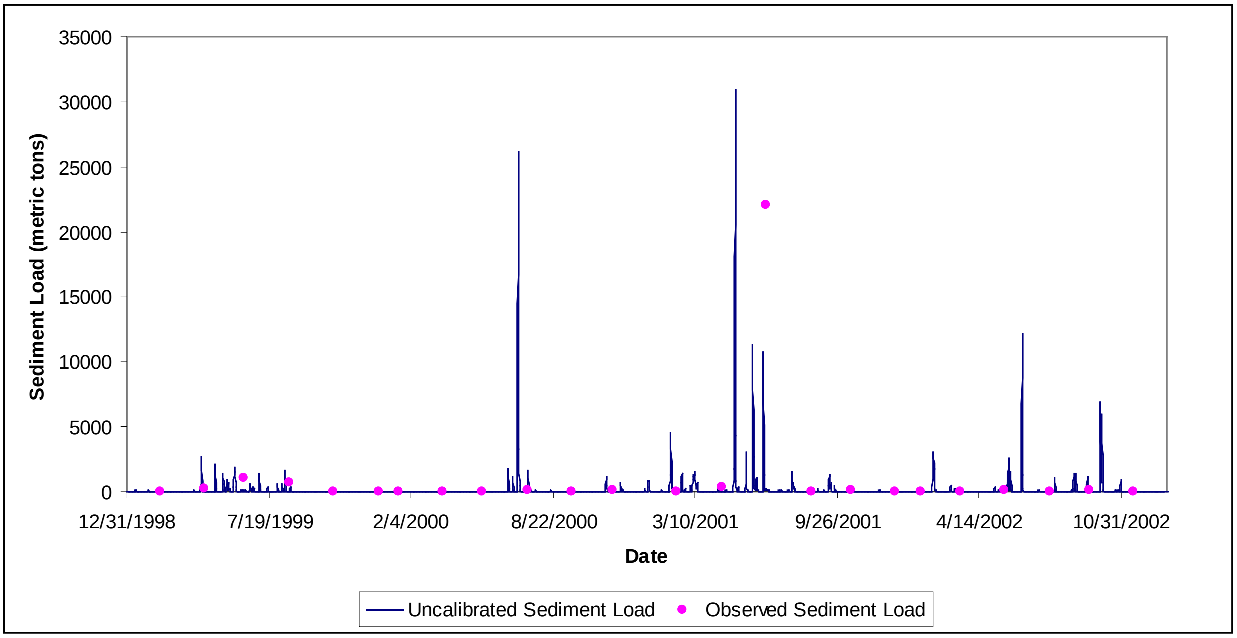

Figure 13. Uncalibrated Sediment Load for STORET 000232

Calibrated Sediment – Upper Left

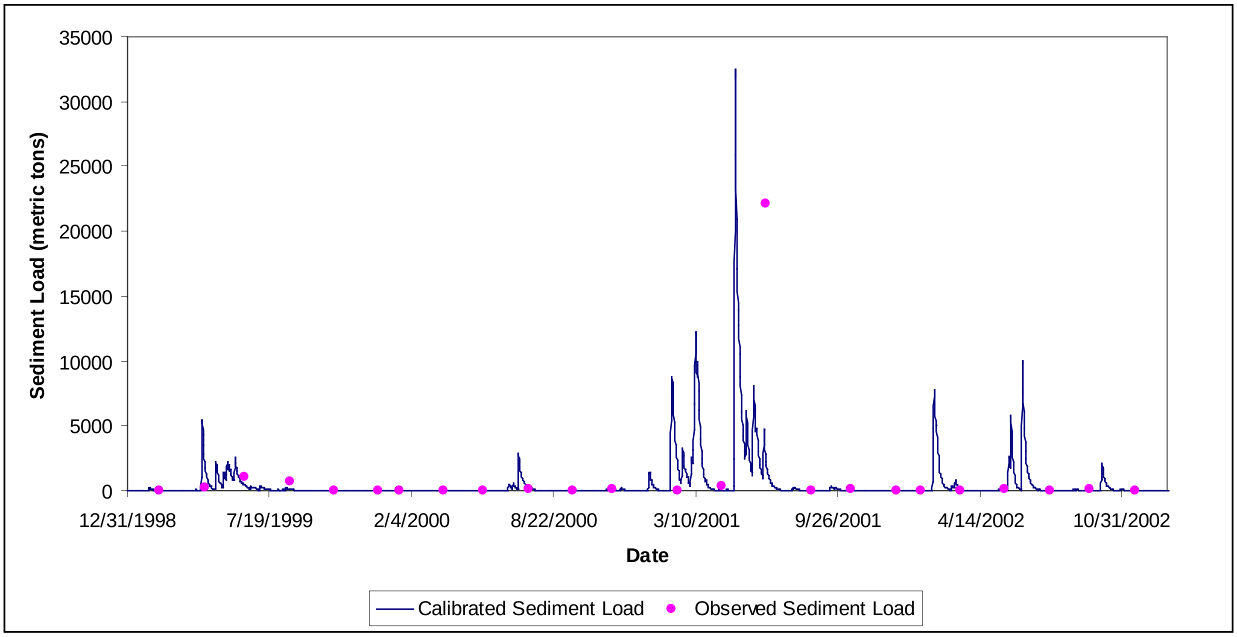

Figure 20. Calibrated Sediment Load for STORET 000232

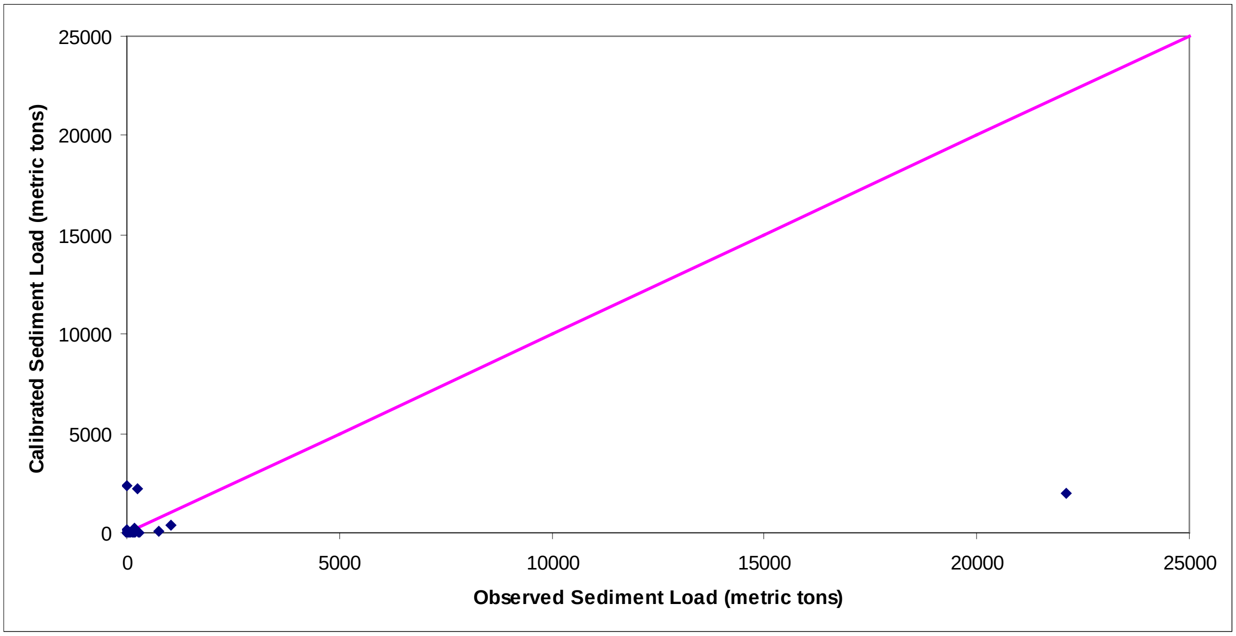

Figure 21. Observed vs. Calibrated Sediment for STORET 000232

Calibration Results – Upper Left

Table 10. Uncalibrated Results for USGS 06884025 and STORET 000232

Parameter	Method	Value
Flow (1998-2002)	Nash-Sutcliffe Efficiency	-4.041
	R^2	0.1715
	RMSE	49.683
Sediment (1999-2002)	Nash-Sutcliffe Efficiency	-0.045
	R^2	0.125
	RMSE	5156.602

Table 9. Calibration Results for USGS 06884025 and STORET 000232

Parameter	Method	Value
Flow (1998-2002)	Nash-Sutcliffe Efficiency	0.436
	R^2	0.465
	RMSE	16.612
Sediment (1999-2002)	Nash-Sutcliffe Efficiency	0.104
	R^2	0.240
	RMSE	4157.985

TUTTLE CREEK WATERSHED CALIBRATION

The model was set up based on 30 years (1978-2008) of climatological data from 9 stations in this watershed (Figure 22). Observed streamflow discharge was obtained from the US Army Corps of Engineers station (upstream of Tuttle Creek Lake), while total suspended solids (TSS) concentration was obtained from Kansas Department of Health and Environment sampling point 000240 shown in Figure 23. The results of observed vs. uncalibrated and calibrated model output are shown in Figure 24, 25, 26 and 27. Statistical analysis and model performance before and after calibration are shown in Tables 20 and 21.

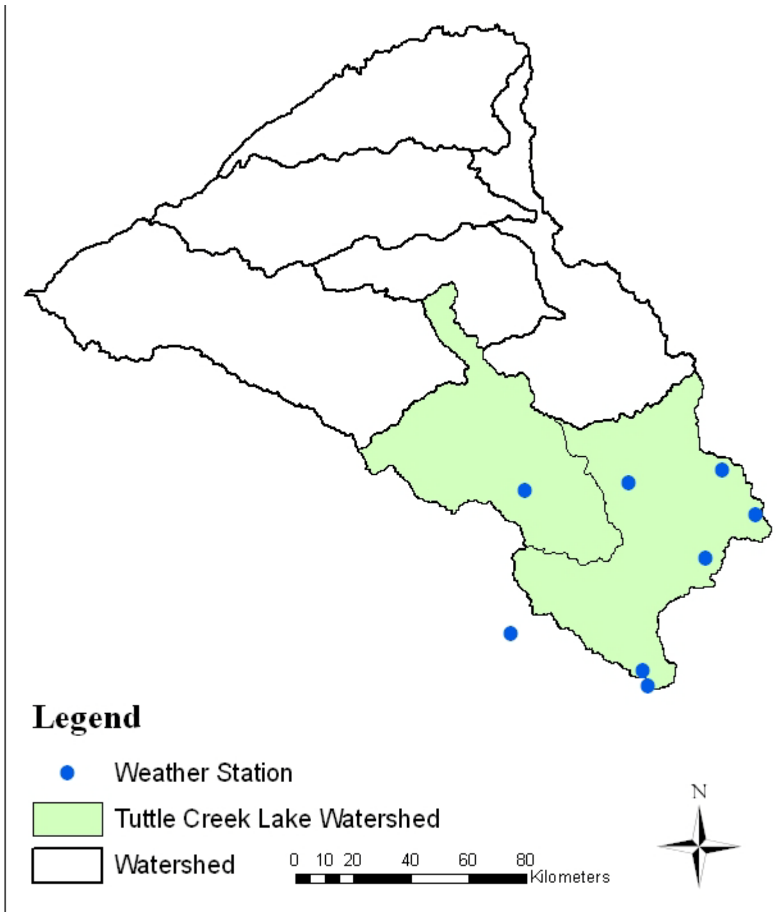

Figure 14. Tuttle Creek Lake Weather Stations

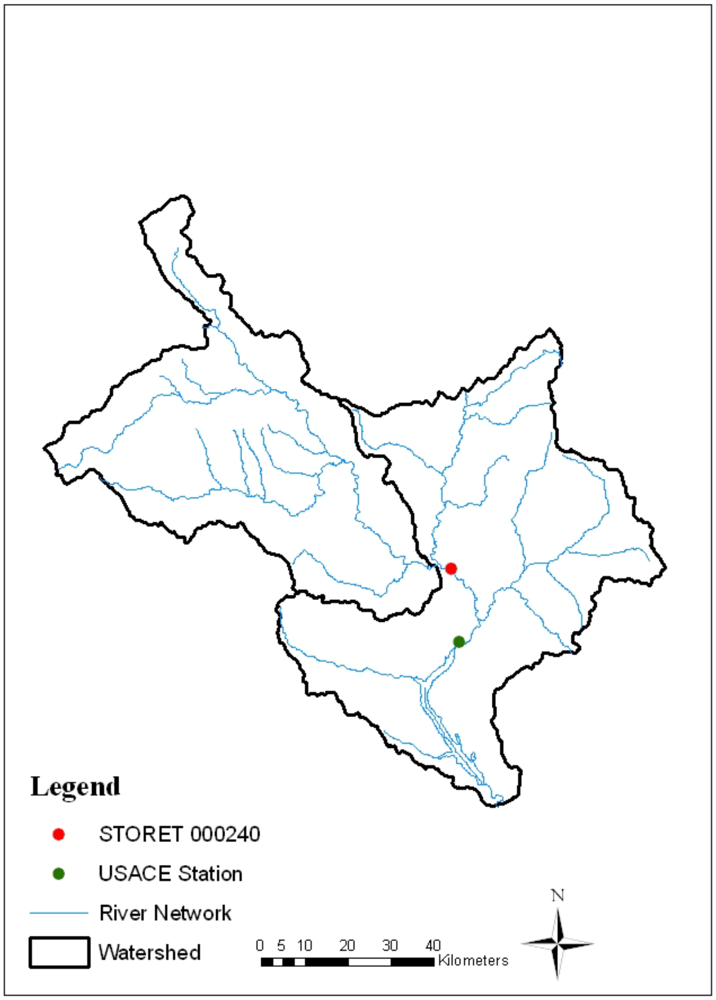

Figure 15. Tuttle Creek Watershed

Agricultural Land Use Allocation – Tuttle Creek Watershed

Four different crops (Table 12) and six rotations (Table 13, 14, 15, 16, 17, 18, and 19) were identified for the Kansas side of the Tuttle Creek Lake watershed. These crops and rotations were introduced into the SWAT model.

Table 12. Agricultural Land Use for the (Kansas side) Tuttle Creek Watershed

Crop	Percentage of Agricultural Land
Soybeans	37%
Wheat	29%
Corn	28%
Grain Sorghum	7%

Crop Rotations and Management Inputs – Tuttle Creek Watershed

Table 13. Crop Rotations for the Tuttle Creek Watershed

Rotation	Percentage of Agricultural Land
Corn – Soybeans	25%
Continuous Soybeans	5%
Continuous Corn	15%
Soybeans – Wheat	25%
Continuous Wheat	10%
Grain sorghum – Soybeans – Wheat	20%

Table 10. Corn-Soybean Rotation Conventional Tillage Field Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
4/5	Chisel	Chisel Plow Gt15ft		
4/5	Knife Anhydrous Ammonia	Anhydrous Ammonia	96 kg/ha	
4/15	Field Cultivate	Field Cultivator		
4/15	Bicep II Magnum	Atrazine	1.7 kg/ha	
4/15	Bicep II Magnum	Metolachlor	1.3 kg/ha	
4/16	Plant Corn	Plant/Begin Growing Season		
4/16	Nitrogen Application	Elemental Nitrogen	16 kg/ha	
4/16	Phosphorus Application	Elemental Phosphorus	53 kg/ha	
5/20	Status	Dicamba	0.3 kg/ha	
10/1	Harvest Corn	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		2
4/15	Field Cultivate	Field Cultivator Ge15ft		
5/14	Field Cultivate	Field Cultivator Ge15ft		
5/16	Plant Soybeans	Plant/Begin Growing Season		
5/16	Fertilizer	Elemental Phosphorus	33 kg/ha	
6/14	Round Up Weather Max	Glyphosate Amine	0.9 kg/ha	
10/1	Harvest Soybeans	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		

Table 15. Continuous Soybean Rotation Conventional Tillage Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
4/15	Field Cultivate	Field Cultivator Ge15ft		
5/14	Field Cultivate	Field Cultivator Ge15ft		
5/16	Plant Soybeans	Plant/Begin Growing Season		
5/16	Fertilizer	Elemental Phosphorus	33 kg/ha	
6/14	Round Up Weather Max	Glyphosate Amine	0.9 kg/ha	
10/1	Harvest Soybeans	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		

Table 16. Continuous Corn Rotation Conventional Tillage Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
4/5	Chisel	Chisel Plow Gt15ft		
4/5	Knife Anhydrous Ammonia	Anhydrous Ammonia	96 kg/ha	
4/15	Field Cultivate	Field Cultivator		
4/15	Bicep II Magnum	Atrazine	1.7 kg/ha	
4/15	Bicep II Magnum	Metolachlor	1.3 kg/ha	
4/16	Plant Corn	Plant/Begin Growing Season		
4/16	Nitrogen Application	Elemental Nitrogen	16 kg/ha	
4/16	Phosphorus Application	Elemental Phosphorus	53 kg/ha	
5/20	Status	Dicamba	0.3 kg/ha	
10/1	Harvest Corn	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		

Table 17. Soybean-Wheat Rotation Conventional Tillage Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
4/15	Field Cultivate	Field Cultivator Ge15ft		
5/14	Field Cultivate	Field Cultivator Ge15ft		
5/16	Plant Soybeans	Plant/Begin Growing Season		
5/16	Fertilizer	Elemental Phosphorus	33 kg/ha	
6/14	Round Up Weather Max	Glyphosate Amine	0.9 kg/ha	
10/1	Harvest Soybeans	Harvest and Kill		
10/10	Field Cultivate	Field Cultivator Ge15ft		
10/15	Nitrogen Application	Elemental Nitrogen	65 kg/ha	
10/15	Phosphorus Application	Elemental Phosphorus	31 kg/ha	
10/16	Plant Wheat	Plant/Begin Growing Season		
7/1	Harvest Wheat	Harvest and Kill		2
8/1	Chisel	Coulter Chisel Plow		
9/1	Tandem Disk	Tandem Disk Plow Ge19ft		

Table 18. Continuous Wheat Rotation Conventional Tillage Operations

Date	Practice	SWAT Practice	Amount	Year
3/1	Finesse	Chlorsulfuron	0.01 kg/ha	1
3/1	Finesse	Metsulfuron-Methyl	0.002 kg/ha	
7/1	Harvest Wheat	Harvest and Kill		
8/1	Chisel	Coulter Chisel Plow		
9/1	Tandem Disk	Tandem Disk Plow Ge19ft		
10/1	Tandem Disk	Tandem Disk Plow Ge19ft		
10/10	Field Cultivate	Field Cultivator Ge15ft		
10/15	Nitrogen Application	Elemental Nitrogen	99 kg/ha	
10/15	Phosphorus Application	Elemental Phosphorus	31 kg/ha	
10/16	Plant Wheat	Plant/Begin Growing Season		

Table 19. Grain Sorghum-Soybean-Wheat Rotation Conventional Tillage Operations

Date	Practice	SWAT Practice	Amount	Year
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		1
5/5	Chisel	Chisel Plow Gt15ft		
5/5	Knife Anhydrous Ammonia	Anhydrous Ammonia	54 kg/ha	
5/15	Field Cultivate	Field Cultivator Ge15ft		
5/25	Nitrogen Application	Elemental Nitrogen	11 kg/ha	
5/25	Phosphorus Application	Elemental Phosphorus	38 kg/ha	
5/25	Plant Grain Sorghum	Plant/Begin Growing Season		
5/25	Bicep II Magnum	Atrazine	1.4 kg/ha	
5/25	Bicep II Magnum	Metolachlor	1.1 kg/ha	
7/1	Buctril + Atrazine	Bromoxynil	0.3 kg/ha	
7/1	Buctril + Atrazine	Atrazine	0.6 kg/ha	
9/25	Harvest Sorghum	Harvest and Kill		
11/5	Chisel	Coulter Chisel Plow		
3/27	Tandem Disk	Tandem Disk Plow Ge19ft		2
4/15	Field Cultivate	Field Cultivator Ge15ft		
5/14	Field Cultivate	Field Cultivator Ge15ft		
5/16	Plant Soybeans	Plant/Begin Growing Season		
5/16	Fertilizer	Elemental Phosphorus	33 kg/ha	
6/14	Round Up Weather Max	Glyphosate Amine	0.9 kg/ha	
10/1	Harvest Soybeans	Harvest and Kill		
10/10	Field Cultivate	Field Cultivator Ge15ft		
10/15	Nitrogen Application	Elemental Nitrogen	65 kg/ha	
10/15	Phosphorus Application	Elemental Phosphorus	31 kg/ha	
10/16	Plant Wheat			
7/1	Harvest Wheat	Harvest and Kill		3
8/1	Chisel	Coulter Chisel Plow		
9/1	Tandem Disk	Tandem Disk Plow Ge19ft		

Uncalibrated Flow – Tuttle Creek

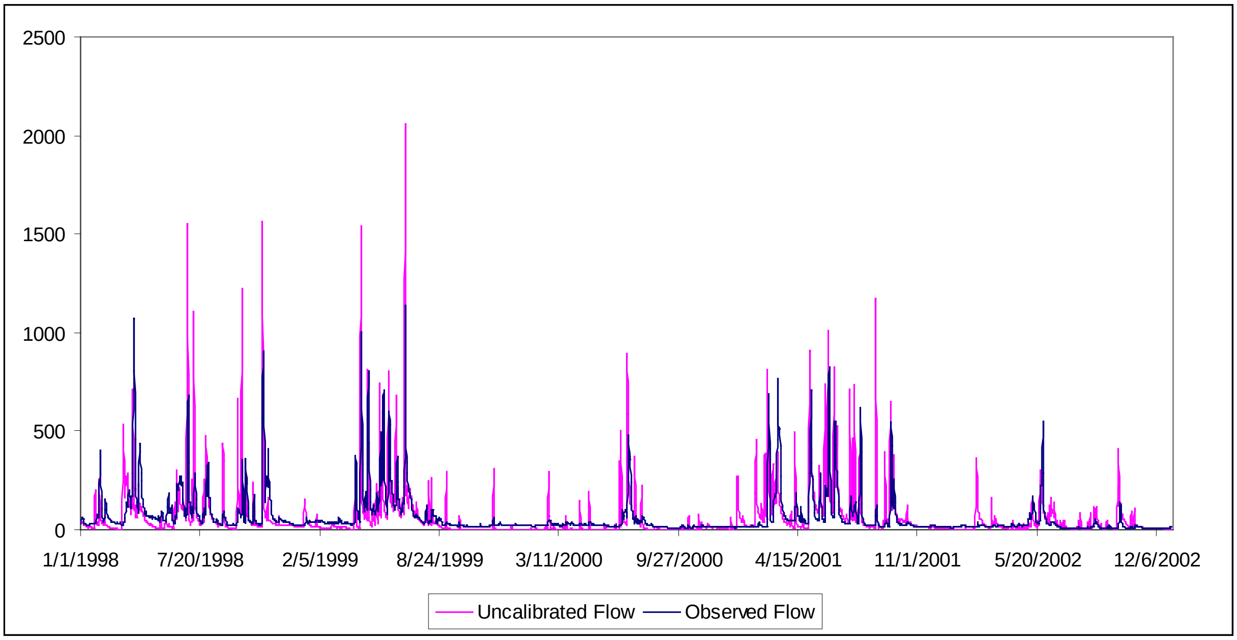

Figure 24. Uncalibrated Flow for US Army Corps of Engineers Station at the inlet of Tuttle Creek Lake

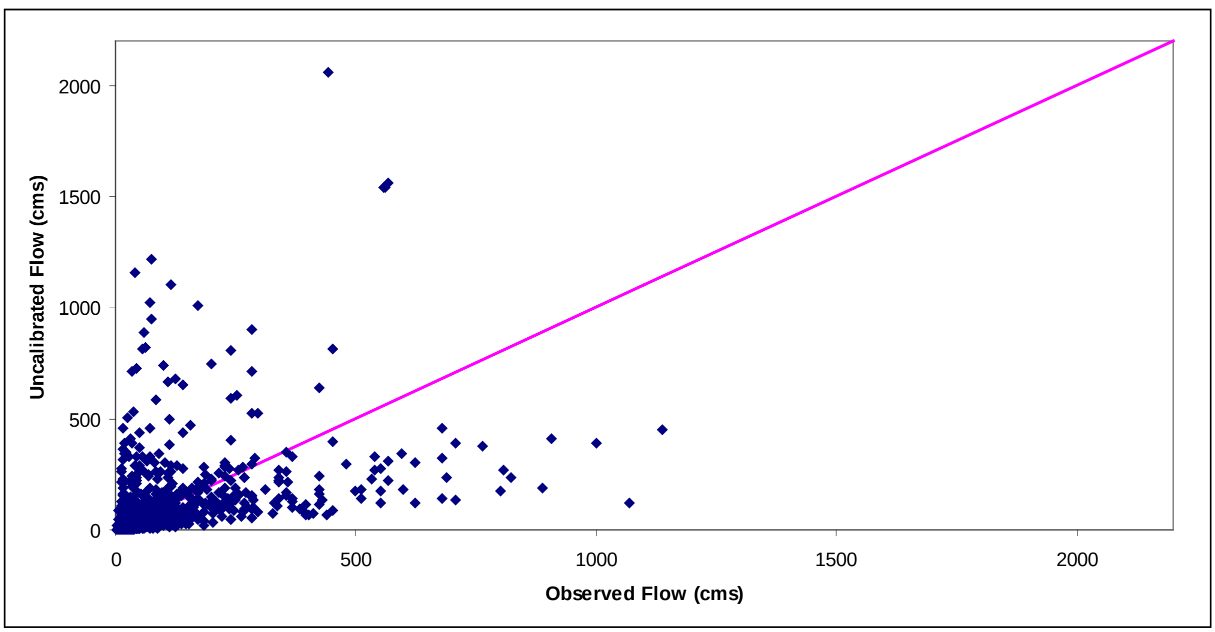

Figure 25. Observed vs. Uncalibrated Flow for US Army Corps of Engineers Station at the inlet of Tuttle Creek Lake

Table 20. Uncalibrated Results for US Army Corps of Engineers Station at the inlet of Tuttle Creek Lake

Parameter	Method	Value
Flow (1998-2002)	Nash-Sutcliffe Efficiency	-0.425
	R^2	0.217
	RMSE	133.113
Sediment (1999-2002)	Nash-Sutcliffe Efficiency	
	R^2	
	RMSE	

Calibrated Flow – Tuttle Creek

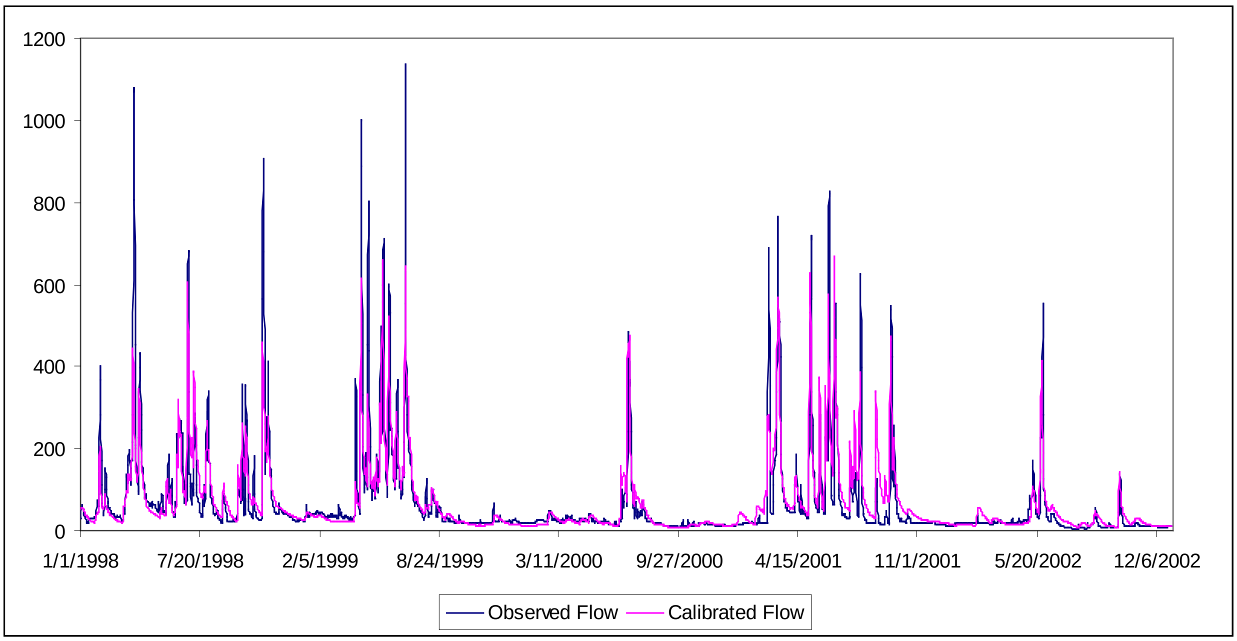

Figure 26. Calibrated Flow for US Army Corps of Engineers Station at the inlet of Tuttle Creek Lake

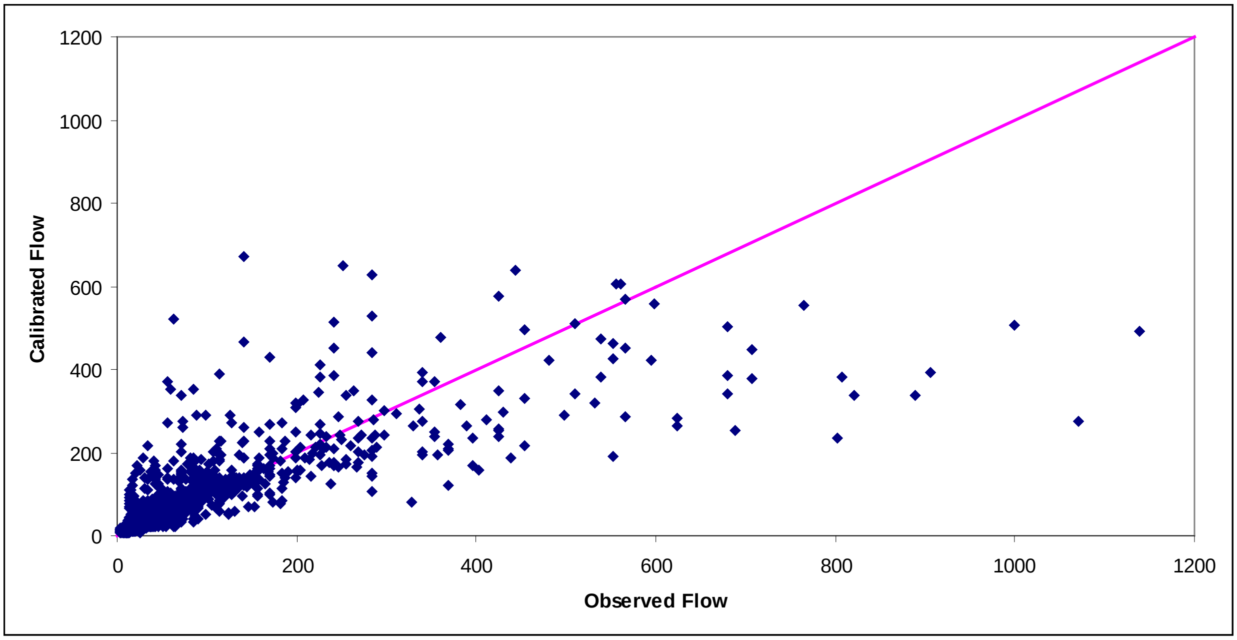

Figure 27. Observed vs. calibrated Flow for US Army Corps of Engineers Station at the inlet of Tuttle Creek Lake

Table 21. Calibrated Results for US Army Corps of Engineers Station at the inlet of Tuttle Creek Lake

Parameter	Method	Value
Flow (1998-2002)	Nash-Sutcliffe Efficiency	0.644
	R^2	0.645
	RMSE	66.539
Sediment (1999-2002)	Nash-Sutcliffe Efficiency	
	R^2	
	RMSE	

AGRICULTURAL ECONOMY

The following cropping budgets were assembled for each crop rotation and tillage system combination in both the Nebraska and Kansas side of the Tuttle Creek Lake watershed. Note that all values are in a dollars per acre basis.

Table 22. Budget for continuous corn

	CORN		
	Tillage Type		
INCOME PER ACRE	Conv.	Red.	NT
A. Yield per acre	110	110	110
B. Price per bushel	4.21	4.21	4.21
C. Net government payment	13.60	13.60	13.60
D. Indemnity payments	-	-	-
E. Miscellaneous income	-	-	-
F. Returns/acre ((A x B) + C + D + E)	476.70	476.70	476.70
COSTS PER ACRE			
1. Seed	85.86	85.86	85.86
2. Herbicide	23.03	23.03	29.93
3. Insecticide / Fungicide	-	-	-
4. Fertilizer and Lime	134.25	134.25	134.25
5. Crop Consulting	-	-	-
6. Crop Insurance	-	-	-
7. Drying	-	-	-
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	131.53	119.72	99.03
10. Non-machinery Labor	9.49	9.49	9.49
11. Irrigation			
a. Labor	-	-	-
b. Fuel and Oil	-	-	-
c. Repairs and Maintenance	-	-	-
d. Depreciation on Equipment / Well	-	-	-
e. Interest on Equipment	-	-	-
12. Land Charge / Rent	76.00	76.00	76.00
G. SUB TOTAL	468.41	456.60	442.81
13. Interest on 1/2 Nonland Costs	13.73	13.32	12.84
H. TOTAL COSTS	482.14	469.92	455.64
I. RETURNS OVER COSTS (F - H)	(5.44)	6.78	21.06
J. TOTAL COSTS/BUSHEL (H/A)	4.38	4.27	4.14
K. RETURN TO ANNUAL COST (I+13)/G	1.77%	4.40%	7.65%

Table 23. Budget for corn-soybean rotation

	CORN			SOYBEANS			ROTATION		
	Tillage Type			Tillage Type			Tillage Type		
INCOME PER ACRE	Conv.	Red.	NT	Conv.	Red.	NT	Conv.	Red.	NT
A. Yield per acre	110	110	110	33	33	33			
B. Price per bushel	4.21	4.21	4.21	8.69	8.69	8.69			
C. Net government payment	13.60	13.60	13.60	13.60	13.60	13.60			
D. Indemnity payments	-	-	-	-	-	-			
E. Miscellaneous income	-	-	-	-	-	-			
F. Returns/acre ((A x B) + C + D + E)	476.70	476.70	476.70	300.37	300.37	300.37	388.54	388.54	388.54
COSTS PER ACRE									
1. Seed	85.86	85.86	85.86	35.00	35.00	35.00			
2. Herbicide	23.03	23.03	29.93	11.86	11.86	18.76			
3. Insecticide / Fungicide	-	-	-	-	-	-			
4. Fertilizer and Lime	117.15	117.15	117.15	36.61	36.61	36.61			
5. Crop Consulting	-	-	-	-	-	-			
6. Crop Insurance	-	-	-	-	-	-			
7. Drying	-	-	-	-	-	-			
8. Miscellaneous	8.25	8.25	8.25	8.25	8.25	8.25			
9. Custom Hire / Machinery Expense	131.53	119.72	99.03	101.89	75.21	58.78			
10. Non-machinery Labor	9.49	9.49	9.49	6.37	6.37	6.37			
11. Irrigation									
a. Labor	-	-	-	-	-	-			
b. Fuel and Oil	-	-	-	-	-	-			
c. Repairs and Maintenance	-	-	-	-	-	-			
d. Depreciation on Equipment / Well	-	-	-	-	-	-			
e. Interest on Equipment	-	-	-	-	-	-			
12. Land Charge / Rent	76.00	76.00	76.00	76.00	76.00	76.00			
G. SUB TOTAL	451.31	439.50	425.71	275.98	249.30	239.77	363.64	344.40	332.74
13. Interest on 1/2 Nonland Costs	13.14	12.72	12.24	7.00	6.07	5.73	10.07	9.39	8.99
H. TOTAL COSTS	464.44	452.22	437.95	282.98	255.36	245.50	373.71	353.79	341.72
I. RETURNS OVER COSTS (F - H)	12.26	24.48	38.75	17.39	45.01	54.87	14.83	34.74	46.81
J. TOTAL COSTS/BUSHEL (H/A)	4.22	4.11	3.98	8.58	7.74	7.44			
K. RETURN TO ANNUAL COST (I+13)/G	5.63%	8.47%	11.98%	8.84%	20.49%	25.28%			

Table 24. Budget for grain sorghum-soybeans-wheat rotation

	GRAIN SORGHUM			SOYBEANS			WHEAT			ROTATION		
	Tillage Type			Tillage Type			Tillage Type			Tillage Type		
INCOME PER ACRE	Conv.	Red.	NT	Conv.	Red.	NT	Conv.	Red.	NT	Conv.	Red.	NT
A. Yield per acre	76	76	76	33	33	33	50	50	50			
B. Price per bushel	4.33	4.33	4.33	8.69	8.69	8.69	6.24	6.24	6.24			
C. Net government payment	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60	13.60			
D. Indemnity payments	-	-	-	-	-	-	-	-	-			
E. Miscellaneous income	-	-	-	-	-	-	-	-	-			
F. Returns/acre ((A x B) + C + D + E)	342.68	342.68	342.68	300.37	300.37	300.37	325.60	325.60	325.60	312.99	312.99	312.99
COSTS PER ACRE												
1. Seed	14.76	14.76	14.76	35.00	35.00	35.00	16.00	16.00	16.00			
2. Herbicide	29.52	36.42	43.32	11.86	11.86	18.76	-	-	-			
3. Insecticide / Fungicide	-	-	-	-	-	-	-	-	-			
4. Fertilizer and Lime	77.92	77.92	77.92	36.61	36.61	36.61	84.82	84.82	84.82			
5. Crop Consulting	-	-	-	-	-	-	-	-	-			
6. Crop Insurance	-	-	-	-	-	-	-	-	-			
7. Drying	-	-	-	-	-	-	-	-	-			
8. Miscellaneous	8.25	8.25	8.25	8.25	8.25	8.25	8.25	8.25	8.25			
9. Custom Hire / Machinery Expense	136.62	108.41	98.66	101.89	75.21	58.78	69.37	58.92	58.92			
10. Non-machinery Labor	8.45	8.45	8.45	6.37	6.37	6.37	7.02	7.02	7.02			
11. Irrigation												
a. Labor	-	-	-	-	-	-	-	-	-			
b. Fuel and Oil	-	-	-	-	-	-	-	-	-			
c. Repairs and Maintenance	-	-	-	-	-	-	-	-	-			
d. Depreciation on Equipment / Well	-	-	-	-	-	-	-	-	-			
e. Interest on Equipment	-	-	-	-	-	-	-	-	-			
12. Land Charge / Rent	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00			
G. SUB TOTAL	351.51	330.20	327.35	275.98	249.30	239.77	261.46	251.01	251.01	268.72	250.16	245.39
13. Interest on 1/2 Nonland Costs	9.64	8.90	8.80	7.00	6.07	5.73	6.49	6.13	6.13	6.75	6.10	5.93
H. TOTAL COSTS	361.16	339.10	336.15	282.98	255.36	245.50	267.95	257.14	257.14	275.47	256.25	251.32
I. RETURNS OVER COSTS (F - H)	(18.48)	3.58	6.53	17.39	45.01	54.87	57.65	68.46	68.46	37.52	56.73	61.67
J. TOTAL COSTS/BUSHEL (H/A)	4.75	4.46	4.42	8.58	7.74	7.44	5.36	5.14	5.14			
K. RETURN TO ANNUAL COST (I+13)/G	-2.51%	3.78%	4.68%	8.84%	20.49%	25.28%	24.53%	29.71%	29.71%			

Table 25. Budget for continuous soybeans

	SOYBEANS		
	Tillage Type		
INCOME PER ACRE	Conv.	Red.	NT
A. Yield per acre	33	33	33
B. Price per bushel	8.69	8.69	8.69
C. Net government payment	13.60	13.60	13.60
D. Indemnity payments	-	-	-
E. Miscellaneous income	-	-	-
F. Returns/acre ((A x B) + C + D + E)	300.37	300.37	300.37
COSTS PER ACRE			
1. Seed	35.00	35.00	35.00
2. Herbicide	11.86	11.86	18.76
3. Insecticide / Fungicide	-	-	-
4. Fertilizer and Lime	36.61	36.61	36.61
5. Crop Consulting	-	-	-
6. Crop Insurance	-	-	-
7. Drying	-	-	-
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	101.89	75.21	58.78
10. Non-machinery Labor	6.37	6.37	6.37
11. Irrigation			
a. Labor	-	-	-
b. Fuel and Oil	-	-	-
c. Repairs and Maintenance	-	-	-
d. Depreciation on Equipment / Well	-	-	-
e. Interest on Equipment	-	-	-
12. Land Charge / Rent	76.00	76.00	76.00
G. SUB TOTAL	275.98	249.30	239.77
13. Interest on 1/2 Nonland Costs	7.00	6.07	5.73
H. TOTAL COSTS	282.98	255.36	245.50
I. RETURNS OVER COSTS (F - H)	17.39	45.01	54.87
J. TOTAL COSTS/BUSHEL (H/A)	8.58	7.74	7.44
K. RETURN TO ANNUAL COST (I+13)/G	8.84%	20.49%	25.28%

Table 26. Budget for soybeans-wheat rotation

	SOYBEANS			WHEAT			ROTATION		
	Tillage Type			Tillage Type			Tillage Type		
INCOME PER ACRE	Conv.	Red.	NT	Conv.	Red.	NT	Conv.	Red.	NT
A. Yield per acre	33	33	33	50	50	50			
B. Price per bushel	8.69	8.69	8.69	6.24	6.24	6.24			
C. Net government payment	13.60	13.60	13.60	13.60	13.60	13.60			
D. Indemnity payments	-	-	-	-	-	-			
E. Miscellaneous income	-	-	-	-	-	-			
F. Returns/acre ((A x B) + C + D + E)	300.37	300.37	300.37	325.60	325.60	325.60	312.99	312.99	312.99
COSTS PER ACRE									
1. Seed	35.00	35.00	35.00	16.00	16.00	16.00			
2. Herbicide	11.86	11.86	18.76	-	-	-			
3. Insecticide / Fungicide	-	-	-	-	-	-			
4. Fertilizer and Lime	36.61	36.61	36.61	84.82	84.82	84.82			
5. Crop Consulting	-	-	-	-	-	-			
6. Crop Insurance	-	-	-	-	-	-			
7. Drying	-	-	-	-	-	-			
8. Miscellaneous	8.25	8.25	8.25	8.25	8.25	8.25			
9. Custom Hire / Machinery Expense	101.89	75.21	58.78	69.37	58.92	58.92			
10. Non-machinery Labor	6.37	6.37	6.37	7.02	7.02	7.02			
11. Irrigation									
a. Labor	-	-	-	-	-	-			
b. Fuel and Oil	-	-	-	-	-	-			
c. Repairs and Maintenance	-	-	-	-	-	-			
d. Depreciation on Equipment / Well	-	-	-	-	-	-			
e. Interest on Equipment	-	-	-	-	-	-			
12. Land Charge / Rent	76.00	76.00	76.00	76.00	76.00	76.00			
G. SUB TOTAL	275.98	249.30	239.77	261.46	251.01	251.01	268.72	250.16	245.39
13. Interest on 1/2 Nonland Costs	7.00	6.07	5.73	6.49	6.13	6.13	6.75	6.10	5.93
H. TOTAL COSTS	282.98	255.36	245.50	267.95	257.14	257.14	275.47	256.25	251.32
I. RETURNS OVER COSTS (F - H)	17.39	45.01	54.87	57.65	68.46	68.46	37.52	56.73	61.67
J. TOTAL COSTS/BUSHEL (H/A)	8.58	7.74	7.44	5.36	5.14	5.14			
K. RETURN TO ANNUAL COST (I+13)/G	8.84%	20.49%	25.28%	24.53%	29.71%	29.71%			

Table 11. Budget for continuous wheat

	WHEAT		
	Tillage Type		
INCOME PER ACRE	Conv.	Red.	NT
A. Yield per acre	50	50	50
B. Price per bushel	6.24	6.24	6.24
C. Net government payment	13.60	13.60	13.60
D. Indemnity payments	-	-	-
E. Miscellaneous income	-	-	-
F. Returns/acre ((A x B) + C + D + E)	325.60	325.60	325.60
COSTS PER ACRE			
1. Seed	16.00	16.00	16.00
2. Herbicide	6.16	13.06	19.96
3. Insecticide / Fungicide	-	-	-
4. Fertilizer and Lime	110.32	110.32	110.32
5. Crop Consulting	-	-	-
6. Crop Insurance	-	-	-
7. Drying	-	-	-
8. Miscellaneous	8.25	8.25	8.25
9. Custom Hire / Machinery Expense	114.44	95.96	75.27
10. Non-machinery Labor	10.79	10.79	10.79
11. Irrigation			
a. Labor	-	-	-
b. Fuel and Oil	-	-	-
c. Repairs and Maintenance	-	-	-
d. Depreciation on Equipment / Well	-	-	-
e. Interest on Equipment	-	-	-
12. Land Charge / Rent	76.00	76.00	76.00
G. SUB TOTAL	341.96	330.38	316.59
13. Interest on 1/2 Nonland Costs	9.31	8.90	8.42
H. TOTAL COSTS	351.27	339.29	325.01
I. RETURNS OVER COSTS (F - H)	(25.67)	(13.69)	0.59
J. TOTAL COSTS/BUSHEL (H/A)	7.03	6.79	6.50
K. RETURN TO ANNUAL COST (I+13)/G	-4.78%	-1.45%	2.85%

Description of the Economic Analysis Model (a MATLAB program)

A simulation model has been developed within a MATLAB computing environment. This section offers a brief description of the simulation model. This model is continually being refined.

Using output from a SWAT watershed model as input, this economic analysis model simulates possible BMP scenarios and estimates the resulting pollutant loading into a reservoir and the costs of implementing the BMPs. Currently two versions of the economic analysis model have been built. The first simulates an optimal BMP scenario where BMPs are placed in areas of the watershed where pollutant loading is reduced at the lowest cost. The other version simulates a random approach to BMP implementation in the watershed. This to some degree represents the status quo approach to BMP implementation and serves as a point of comparison for the optimal approach. Both of these models operate under the criteria of meeting a specified pollutant reduction goal subject to a specified budget constraint. Currently, these models can focus on either sediment, nitrogen, or phosphorus reduction and can accommodate up to three different types of BMPs.

Optimal Approach

From the SWAT model, each HRU (HRUs will be referred to as "farms" from this point forward) in the watershed is assigned a land area (converted to acres), baseline pollutant load (i.e., sediment, nitrogen, and phosphorus), and a resulting pollutant load contribution measured at the watershed outlet under BMP implementation. As mentioned previously, the model is currently capable of considering three different types of BMPs, but the model can be easily expanded to accommodate more BMPs if needed.

Outside of the Matlab model, average annualized costs for the BMPs have been calculated taking into consideration discounting, life of practice, initial investment cost, and annual operation and maintenance costs (Table 28 - note that this table includes some BMPs that may not be examined in this simulation project). Using this data, total costs for each BMP on each farm are determined and assigned. Average costs of pollutant reduction (dollars per pound of pollutant reduced) are calculated for each farm-BMP combination.

The MATLAB simulation model first imports the biophysical/economic data. The analyst's first job is to determine which pollutant to focus on (this is considered the "primary" pollutant while the other two are "secondary" pollutants) and enter a reduction goal for the primary pollutant and a financial budget constraint. The first task of the program is to essentially delete any farm-BMP combination which displays negative pollutant reduction because it is assumed that rational managers of these farms would not elect to adopt BMPs that actually increased the amount of pollutant runoff. Once this search and delete method is completed, the program then proceeds to the selection process for BMP implementation.

In the optimal case, the program will determine the farm-BMP combination which has the lowest average cost of primary pollutant reduction. If this combination will not exceed either the pollutant reduction goal or the budget constraint, then the BMP will be implemented on this farm and the resulting pollutant reduction and cost will be recorded in an output matrix. This farm will then be removed from the possible choice set which prevents it from being selected again. After the first BMP has been implemented, the program iterates to determining the next best farm-BMP combination. This is determined by the farm-BMP combination with the lowest average pollutant reduction costs in the remaining choice set. Again, if implementing this BMP will not violate the constraints mentioned above, then it will be implemented, the output will be recorded, and it will be removed from further consideration. This same process will iterate until either the pollutant reduction goal has been met or the budget constraint binds. Once BMP implementation ceases, the resulting output matrix is exported to an Excel spreadsheet for further analysis. The results file contains information on: the ordering of BMP implementation, farm identification, average cost of primary pollutant reduction for each farm-BMP combination, quantity of pollutant reduction for each farm-BMP combination, total number of BMPs implemented, cumulative area and quantity of reduction, total costs, and the amount of secondary pollutant reduction.

Random Approach

The random approach to BMP implementation occurs in much of the same fashion as the optimal approach with one very important distinction. That is, each farm-BMP combination is selected in a completely random manner in which no consideration is given to the average costs of pollutant reduction assuming neither of the constraints will be violated. Because there is an element of randomness, this algorithm must be simulated many times to ensure that a resulting outcome is not just a “luck of the draw” occurrence. The resulting output can be averaged as well as presented in terms of distributions and confidence intervals.

Next Steps

To this point, the simulation program has been run using hypothetical data but has been built to readily accept the actual SWAT results for the Tuttle Creek watershed which has now been provided. We will need to decide which BMPs to consider and what types of constraints, if any, to consider.

Once this part of the modeling operates satisfactorily, the next steps will be to incorporate and analyze dredging. These further analyses will compare the BMP scenarios to various dredging scenarios to a “do-nothing” scenario in terms of net present values and annualized cost savings. The actual methods used for this part of the analysis are still being determined.

<u>Student Support</u>

This project has provided partial funding for one Agricultural Economics PhD graduate student, Craig Smith. Craig’s plans are to complete, along with Jeff Williams and Bill Golden, all economic analyses tasks as presented in the original project proposal. In addition, Craig hopes to extend this project further using more complex analytical and optimization techniques in an effort to produce dissertation-quality research which will be at the frontier of sedimentation and watershed management research. Craig continues to work with the current Watershed

Economist, Josh Roe, and Jeff Williams in the development and application of *K-State Watershed Manager* in watersheds throughout the state.

During the past year, two notable events took place related to this KWRI project. First, Craig Smith along with Jeff Williams, John Leatherman, and Josh Roe developed a poster titled "Using Watershed Manager to Cost-Effectively Target Cropland Best Management Practices." This poster was presented at the following events:

- Selected to present on behalf of K-State at the *7th Annual Capitol Graduate Research Summit* (top 10 posters from a total of 75 were chosen), Topeka, KS, March 25, 2010
- *K-State Research Forum*, Manhattan, KS, February 11, 2010.
- *K-State Research and Extension Conference*, Manhattan, KS, October 20-22, 2009.
- *From Dust Bowl to Mud Bowl: Sedimentation, Conservation Measures and the Future of Reservoirs*, Kansas City, Missouri, September 14-16, 2009.

Additionally, this poster was chosen as a co-winner of the top poster award at the 7th Annual Capitol Graduate Research Summit. With this honor, a $600 scholarship was awarded and the poster will once again be presented at the 2010 2nd quarter KansasBio meeting in Wichita, KS.

The other notable event related to the KWRI project was that Craig Smith was named the recipient of the 2010-2011 Kenneth E. Grant Research Scholarship from the Soil and Water Conservation Society. This scholarship will be used to further enhance the economic analysis in this KWRI project. Specifically, Craig will use the $1,300 scholarship to attend a MATLAB workshop to further develop his programming and optimization skills and he will also spend several days in Washington, D.C. working with USDA-ERS professionals who specialize in conservation policy analysis. The KWRI project was explicitly referenced in his scholarship proposal.

Table 12 Cost list for selected cropland BMPs

Best Management Practice	Unit	Investment Cost	Life in Years	Annualized Investment Cost /Yr	O&M Factor	O&M Cost/Yr	Total Annualized Cost	Cost-share Rate
Conservation crop rotations	Ac	$38.84	10	$5.00	0.0%	$0.00	$5.00	0%
Farm on contour	Ac	$38.84	10	$5.00	0.0%	$0.00	$5.00	0%
Grassed waterways	Ac	$800.00	10	$102.98	2.0%	$16.00	$118.98	50%
No-till	Ac	$77.69	10	$10.00	0.0%	$0.00	$10.00	39%
Nutrient management plan	Ac	$56.71	10	$7.30	0.0%	$0.00	$7.30	50%
Pond	#	$12,000.00	10	$1,544.64	5.0%	$600.00	$2,144.64	50%
Riparian vegetative buffer	Ac	$1,000.00	10	$128.72	1.0%	$10.00	$138.72	90%
Subsurface fert. application	Ac	$27.19	10	$3.50	0.0%	$0.00	$3.50	0%
Terraces	Ft	$1.02	10	$0.13	3.0%	$0.03	$0.16	50%
Wetland creation	Ac	$820.00	10	$105.55	1.0%	$8.20	$113.75	50%

Sediment Baseline Assessment

Basic Information

Title:	Sediment Baseline Assessment
Project Number:	2009KS71B
Start Date:	3/1/2009
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	2nd
Research Category:	Climate and Hydrologic Processes
Focus Category:	Sediments, Water Quality, None
Descriptors:	
Principal Investigators:	Dan Devlin, Will Boyer, Brock Emmert, Bruce McEnroe, C. Bryan Young

Publications

There are no publications.

Sediment Baseline Assessment

Project Number: 2009KS71B

Start Date: 3/1/2009

End Date: 2/29/2012

Funding Source: 104B

Focus Categories: Sediments, Water Quality

Descriptors: Sediment, Assessment, Sediment Load, Reservoir Sedimentation, Banner Creek Lake

Primary PI: Dr. Daniel. Devlin, Dept. of Agronomy, Kansas State University
Other PIs: Mr. Will Boyer, KCARE, Kansas State University
Dr. Bruce McEnroe, Civil, Environmental, & Architectureal Engineering, University of Kansas
Dr. C. Bryan Young, Civil, Environmental, & Architectureal Engineering, University of Kansas
Mr. Brock Emmert, The Watershed Institute, Inc.

Project Class: Research

I. Technical Report

a. Research:

Problem Statement

This sediment baseline research plan is a comparative watershed study. Seven characteristics in each of the study watersheds will be compared and contrasted to determine 1) process/setting/sources of sediment, 2) potential management measures to reduce sediment movement and transport and 3) a monitoring method to measure management impact effectiveness. The study watersheds were selected based upon availability of existing information from previous research efforts in the candidate watersheds and presumed large differences in the range of sediment loads between them. Each study watershed is of comparative size and located within the same ecoregion in Kansas.

Generally, the term 'baseline' in this study plan refers to the existing sediment load transported with a watershed. A target condition also exists where the sediment load in a watershed is minimized given watershed size and ecoregion in Kansas. For the purposes of this study, that target condition is defined by the smallest baseline sediment load of the study watersheds.

The seven watershed characteristics for assessment are: geomorphology, hydrology, and geology/soils, which comprise the physical setting and process portion of the baseline assessment methodology; riparian condition and land use which encompass the management opportunities in the watersheds and; and biology and chemistry which will be used to assess the current condition and then measure movement toward the desired outcome in the streams and lakes of the watersheds.

The characterization of each of the study watersheds is intended to relate those characteristics to the sediment loads in each watershed. Ultimately, the management goal is to change the characteristics in watersheds with larger sediment loads to something that emulates the characteristics in watersheds with smaller sediment loads and use the monitoring to determine the management practice effectiveness toward that reduction.

In 2005, the Kansas Water Office (KWO) in consultation with the Watershed Restoration and Protection Strategy Workgroup developed a Sediment Management Strategy Outline that provided a summary of the sediment issues in the state that needed to be addressed prior to the development of comprehensive statewide sediment management plan. The sediment issues in that strategy outline were created to be topics for sediment research.

The intent of the research on each of those sediment issues is to enhance the knowledge and understanding of each of the issues. This is important because management and policy decisions will be made at the state level with this enhanced knowledge and understanding to ultimately improve the effectiveness of practices and programs in reducing the adverse impacts of sediment on Kansas lakes and streams. Results of the research on each sediment issue will be used to drive sound, scientifically-based management and policy decisions. Kansas Water Resource Institute (KWRI) convened a sediment conference in 2006 to discuss sediment issues in the state. Experts from all research institutions in the state were invited to attend, review and discuss the sediment issues in the Sediment Management Strategy Outline. The result of that conference was the assignment and creation of sediment white papers (available at http://www.oznet.ksu.edu/library/Sedimentation.htm) which reviewed the current state of knowledge and identified areas where additional studies were still necessary.

In 2008, the KWRI convened a follow-up sediment conference to review the sediment white papers and initiate the production of research methodologies on three of the six sediment issues identified in the original Sediment Management Strategy Outline. The issue of identifying a baseline sediment load within various physiographic and geologic setting in Kansas was one of those three sediment issues address at that conference. Five additional meetings were coordinated by the KWO in 2008 to continue this effort to create a Sediment Baseline Assessment Work Plan. This research work plan represents the result of that effort.

The Baseline Sediment Assessment Workgroup selected three watersheds for the sediment baseline study ranging in drainage area size from just over 19 square miles to over 8 square miles. Two of the three study watersheds are located in the Perry Reservoir drainage area (1,117 square miles) and all three are in the Western Corn Belt Plains ecoregion of Kansas. The watersheds drain into reservoirs at the lower end of each watershed. Those lakes are Banner Creek Lake, Centralia Lake and Atchison County Lake. Previous studies and data collected at these lakes indicate a good mix of probable sediment sources and relatively wide range of sediment loads delivered to the study lakes. Bathymetric surveys to assess the current state, trend and spatial variability of sediment are scheduled for Banner Creek, Centralia Lake and Atchison County Lakes in State Fiscal Year 2010.

Objectives and Methods

Part 1. Physical Setting and Process: Geomorphological Assessment
I. Channel Evolution Assessment in the Banner Creek, Centralia, and Atchison County Lake Watersheds - Bryan Young, KU Department of Civil, Environmental, and Architectural Engineering

The goal is to assess and document the spatial trends of erosion, deposition, and channel adjustment for tributaries to Banner Creek Lake, Centralia Lake, and Atchison County Lake. The stage of channel evolution and the location of important geomorphic features such as knickpoints and natural or man-made grade control will be determined.

Channel Evolution. Streams undergo stages of channel evolution following a disturbance. The stage of evolution gives an indication of the imbalance between sediment supply and sediment capacity. In order to show meaningful trends in erosion, deposition, and channel adjustment, the channel evolution stage should be determined in an entire fluvial system, from each upstream branch down to the reservoir, and not simply at the most pristine reaches or most heavily eroding reaches. The suspended sediment transport in a fluvial system can be correlated with its stage of channel evolution. In addition, the stage of evolution dictates what types of mitigation options might be successful. A channel evolution assessment differs from a Rosgen geomorphic survey in the type, quantity, and analysis of information, as well as in the time and expense required for data collection. A Rosgen survey includes cross-sections at riffles and pools, the longitudinal profile, and pebble counts. The information collected during a Rosgen survey is used to classify the stream and may be used in reference reach design. A channel evolution assessment gives information on the spatial and (inferred) temporal trends of the dominant processes of erosion and deposition. Determining the stage of channel evolution is less time-intensive and can be employed in an entire fluvial system. This type of assessment does not replace, but rather complements, the more in-depth geomorphic surveys performed by the Watershed Institute.

There are two basic approaches for assessing stream channel evolution. The first is field level reconnaissance, which requires that researchers walk the stream and use GPS to log the location of important features. This approach is best suited for small stretches of stream. This approach may not be appropriate due to hazardous conditions or if landowner permission cannot be secured. A second approach uses a helicopter-mounted video camera and GPS system to document stream condition and to locate important geomorphic features. This approach is especially well suited for channel evolution assessment on larger stretches of stream. Helicopter-based videographic surveys have been performed successfully on thousands of stream miles in Iowa (NRCS, NEH Technical Supplement 3B). Data from these videographic surveys have been used to locate and track the results of stream mitigation measures.

Specific tasks:
The specific tasks in this project have been broken into two phases, which are being funded and carried out in separate years. Phase 1 consists of background work, field reconnaissance on tributaries to Banner Creek, videographic data collection on Banner Creek, Atchison County, and Centralia Lakes, and analysis and report writing for Banner Creek Lake. Also included in

Phase 1 is an assessment of the future utility of aerial videography for channel evolution assessment in Kansas.

Phase 2 consists of analysis of the videographic data obtained during Phase 1 for the remaining two watersheds (Atchison County and Centralia) and for report writing. The current scope and budget for Phase 2 assumes that the videographic data will be sufficient for determining the stage of channel evolution and location of important geomorphic features. If the videography is insufficient to determine the important geomorphic information, an adjusted scope and budget will be provided for traditional field reconnaissance in Phase 2.

Phase 1
1. Development of a checklist for determining the channel evolution stage and a list of additional geomorphic features that should be noted during field reconnaissance.
2. Field reconnaissance at selected reaches in the Banner Creek Lake watershed.
3. Aerial videography (via helicopter) over each tributary in Banner Creek Lake, Atchison County Lake, and Centralia Lake reservoirs.
4. Analysis of video footage for Banner Creek Lake.
5. Creation of Excel tables and ArcGIS spatial files. All data will be geo-referenced for easy synthesis with other research.
6. Comparison of field surveys with video footage.

Phase 2
7. Analysis of video footage for Atchison County Lake, and Centralia Lake watersheds.
8. Report writing and map creation. The report and associated digital files will present the data and provide a synopsis of the overall patterns of erosion and deposition according to Simon's model.

This portion of the project will integrate with work to be carried out by other research groups, especially the geomorphic studies performed by the Watershed Institute and the lithostratigraphy studies performed by the Kansas Geological Survey. In addition, this project will help identify locations that warrant further study such as critical shear stress tests in cohesive-bed streams, and photo-electronic erosion pin installation in upstream eroding reaches.

II. Consulting work on Geomorphology Surveys - Brock Emmert, Watershed Institute
TASK 1: SITE SELECTION

Use information—hydrology, litho-stratigraphy, channel evolution determination—gathered by USGS, KGS, and KUCE to help focus reach-scale geomorphology site selection. TWI would also complete a brief field reconnaissance to finalize survey sites. TWI recommends that the geomorphology sites overlap with other field investigations and sites be selected to capture the greatest variety of physical settings.

TWI recommends at least five reach-scale surveys for Banner Creek Reservoir and Atchison County Lake. For Centralia Lake, TWI recommends eight geomorphology surveys—four in each subbasin.

TASK 2: DATA COLLECTION.
TWI will survey the physical dimensions of the channel to determine the dimension, pattern, and profile of the bankfull or channel forming discharge. In addition, TWI will document streambank stability characteristics (bank angle, rooting depth and density, bank composition, bank height ratio, and bank toe protection) to rate the erosion potential within the survey reach. TWI will also note general conditions of the riparian corridor such as corridor width, density, and list the dominant species.

TWI will install monuments for monitoring streambank and streambed erosion at each site. This work will validate erosion predictions from geomorphology survey.

TASK 3: DATA ANALYSIS.
TWI will use the quantitative, objective survey data to classify each stream reach according to the Rosgen Stream Classification of Natural Rivers. For the streambank stability data, TWI will use the Bank Erodibility Hazard Index (BEHI) to rate the bank erodibility and predict an annual erosion rate. TWI will also complete the Pfankuch Stream Stability Evaluation based on field data. Finally, TWI will summarize stream stability ratings for each survey that will validate the channel evolution stage.

TASK 4: MONITORING
In order to validate erosion predictions, TWI will complete a three-year monitoring effort. At each survey, TWI will establish benchmarks for monitoring changes in the stream cross section and profile, lateral erosion, and erosion/deposition of the streambed.

TWI will collect field data on a quarterly basis and provide a quarterly summary of the findings. Monitoring can also be continued (if desired) to measure the success/changes if BMPs are implemented.

An economy of scale applies to this approach, making aerial videography a good candidate for use on larger watersheds in the future.

Part 2. Land Use and Riparian Assessment - Dan Devlin and Will Boyer, Dept. of Agronomy, KSU, and KCARE, KSU.

TASK 1: Obtain and analyze existing GIS databases.
Using available GIS databases determine and map land use, land cover, and, to the extent possible, management practices on the three watersheds. These databases are available from Data Access & Support Center (DASC), USDANRCS, USDA-FSA, USDA-NASS, and USGS. Data collected will include digital orthoimagery, soils data (SSURGO), digital elevation (DEM), land use and cover, crop information, and other geo-referenced databases.

TASK 2: Verify and augment information using local experts.
Once the available GIS databases have been collected and compiled, the next task is to meet with local experts to verify, validate, and augment the data. Local personnel from Extension, NRCS, Conservation Districts, and WRAPS SLT groups will be relied upon to review the preliminary soil, land use, and best management practice information. Incorporating this local

knowledge is necessary to ensure that all data that is reported is accurate and up to date. This local expert group will also be relied upon to offer their guidance and expertise in the direct observation survey, which takes place next.

TASK 3: Conduct a survey of the area, making direct observations of land use and riparian and streambank condition, and ground-truthing the information from Tasks 1 & 2.

Since soil surveys were completed for most counties in Kansas in the 1970's, more than thirty years ago, and cropland management has drastically changed during that period of time, maps need to be updated and more detail added. A watershed survey needs to be conducted to input geo-referenced field data into tablet computers on crop rotations, current conservation and tillage practices (and conditions), grazing lands conditions, and other relevant information. This will be done on a field by field basis for all crop fields and grazing lands within the watersheds.

Outputs: 1) land cover/land use map for watersheds; 2) map of elevation for watersheds; 3) acres of cropland, grazingland, and urban area, in watersheds; and 3) map of location and extent of conservation practices implemented in the watersheds, which would include terraces and waterways (and their condition), range conditions, no-tillage practices, etc.

Results and Their Significance.

Part 1. Physical Setting and Process: Geomorphological Assessment

I. Channel Evolution Assessment in the Banner Creek, Centralia, and Atchison County Lake Watersheds - Bryan Young, KU Department of Civil, Environmental, and Architectural Engineering

This component of the Sediment Baseline Research program focuses on aerial reconnaissance of streams in the three subject watersheds (the watersheds for Atchison County Lake, Banner Creek Lake, and Centralia Lake). The objective is to identify channel evolution stage using the aerial imagery.

Helicopter videography was collected for all three watersheds in March, 2009. This video, along with digital stills, has been georeferenced and made available to other team members in a geographic information system (GIS). Digital still frames have been extracted from the video at representative locations along the streams; these stills have also been made available in the GIS.

Determination of the stage of channel evolution for each stream is underway. Each digital still has been classified for a range of geomorphic characteristics. These characteristics will in a cluster analysis to group adjacent stream segments with similar qualities. Once stream segments have been identified, a channel evolution stage will be assigned by project personnel.

This portion of the program also includes a subaward to The Watershed Institute (TWI). TWI is performing complete geomorphic surveys at select locations in the three watersheds.

Surveys were not conducted in the March 2009 – February 2010 timeframe due to unusually wet and cold conditions.

II. Consulting work on Geomorphology Surveys - Brock Emmert, Watershed Institute
TASK 1: SITE SELECTION
Sites have been chosen in the three watersheds but were late in being chosen.

TASK 2: DATA COLLECTION.

Surveys were not conducted in the March 2009 – February 2010 timeframe due to unusually wet and cold conditions.

TASK 3: DATA ANALYSIS.

TASK 4: MONITORING

Part 2. Land Use and Riparian Assessment - Dan Devlin and Will Boyer, Department of Agronomy, KSU, and KCARE, KSU.

TASK 1: Obtain and analyze existing GIS databases.

GIS databases were obtained to map land use, land cover, and management practices. These data were collected and used included digital orthoimagery, soils data (SSURGO), digital elevation (DEM), land use and cover and crop information. Reports containing the geographical data were distributed at two quarterly sedimentation meetings at the Kansas Water Office in Topeka.

TASK 2. Verify and augment information using local experts.

County extension agents other local experts were met with and their local knowledge was added to the databases.

TASK 3. Conducted a field by field survey of the three watersheds, making direct observations of land use, and ground-truthing the information from Tasks 1 & 2.

Outputs that have been developed and available: 1) land cover/land use maps for watersheds; 2) map of elevation for watersheds; 3) acres of cropland, grazingland, and urban area, in watersheds; and 3) maps of location and extent of conservation practices implemented in the watersheds, which included terraces and waterways (and their condition), range conditions, no-tillage practices, etc.

Publications:

This research did not result in any publications during Year 1 of the project.

Information Transfer Program:

The GIS database of digital photographs and videos have been made available to the research group on the Kansas Water Office website.

Student Support:

This research supported three hourly undergraduate research assistants and one half-time graduate research assistant in the department of Civil, Environmental, and Architectural Engineering at the University of Kansas.

NIWR-USGS Student Internship Program:

No NIWR-USGS interns were supported on this grant.

Notable Achievements and Awards:

Information Transfer Program Introduction

The primary information transfer program of the KWRI is an annual statewide water conference held in March each year. The conference in 2009 was the 26th annual conference. The theme was "Assessing Impacts". Approximately 190 people attended. Twenty-nine scientific papers were presented in plenary and concurrent sessions.

Water and the Future of Kansas Conference

Basic Information

Title:	Water and the Future of Kansas Conference
Project Number:	2008KS69B
Start Date:	3/1/2009
End Date:	2/28/2010
Funding Source:	104B
Congressional District:	2nd
Research Category:	Not Applicable
Focus Category:	Education, None, None
Descriptors:	None
Principal Investigators:	William Hargrove

Publications

There are no publications.

ASSESSING IMPACTS

26th Annual

Water and the Future of Kansas Conference Program

March 26, 2009
Capitol Plaza Hotel
Topeka, Kansas

Sponsored by
Kansas Water Resources Institute (KWRI)
Kansas Center for Agricultural Resources and the Environment (K-CARE)
K-State Research and Extension
U.S. Geological Survey

Agenda

7:30-8:00 **Poster/Display Setup**

8:00-8:30 **Registration, Continental Breakfast**
View Poster Displays

8:30-10:00 **Plenary Session**

8:30-8:40 **Welcome and Opening Remarks**
Bill Hargrove, Director
Kansas Water Resources Institute

8:40-9:00 **Impacts of a New Administration: Challenges and Opportunities for Water Quantity and Quality**
Mike Seyfert, Sen. Pat Roberts Office, Washington, D.C.

9:00-9:20 **Impacts of Climate Change**
Johannes Feddema, Dept. of Geography, KU

9:20-9:40 **The Water-Energy Nexus: Report to the National Academy of Sciences**
Michael Hightower, Sandia Labs, Albuquerque, NM

9:40-10:00 **The Water Footprint of Energy from Biomass**
P.W. Gerbens-Leenes, Univ.of Twente, The Netherlands

10:00-10:20 **Break**

10:20-11:50 PANELS/TOWNHALL MEETINGS 1,2,3,4

Panel Presentations followed by Discussion

Panel/Townhall Meeting 1. Impacts of Biofuels Production on Water.
Panel: Bill Simpkins, Iowa State Univ.; Dennis Keeney, IATP;
P.W. Gerbens-Leenes, Univ.of Twente, The Netherlands

Panel/Townhall Meeting 2. Impacts of Conservation Practices on Soil and Water. Panel: Dan Devlin, Agron. Dept., KSU; Terry Conway, USDA-NRCS; Harold Klaege, Kansas Alliance for Wetlands and Streams

Panel/Townhall Meeting 3. Impacts of Climate Change
Panel: Chuck Rice, Agron. Dept., KSU; Johannes Feddema, Geography Dept., KU; Ray Hammarlund, KS Corporation Commission

Panel/Townhall Meeting 4. Impacts of Aging Infrastructure
Panel: Larry Caldwell, USDA-NRCS, Stillwater, OK; Matt Scherer, Kansas Department of Agriculture

11:50-12:50 **Lunch**

12:50-2:00 **Poster Papers**

2:00- 3:20 CONCURRENT SESSIONS 5,6,7,8

Concurrent Session 5. Impacts of Nutrient Loading in Streams

2:00-2:20 Gulf Coast Hypoxia
Kyle Mankin, Biological and Agricultural Engineering Dept., KSU

2:20-2:40 Estimating Land Use Impacts on Nutrient Loading
Beau Burkitt and John Harrington, Geography Dept., KSU

2:40-3:00 Impacts of Nutrient Loading on Grand Lake
Mike Smolen, OK State Univ.

3:00-3:20 Sources of Phosphorus Loading in KS Streams
Nathan Nelson, Agronomy Dept., KSU

Concurrent Session 6. Sediment Loading in Streams

2:00-2:20 Sources of Sediment Loading in KS Streams
Andy Ziegler and Kyle Juracek, USGS

2:20-2:40 Riparian Area Condition and Sediment Loading in the Delaware River Basin
Jeff Neel – Kansas Alliance for Wetlands and Streams

2:40-3:00 Land Use and Management and its Impacts on Sediment Loading
Dan Devlin and Will Boyer, KSU

3:00-3:20 Biological Impacts of Sediment and Sedimentation in Aquatic Systems
Don Huggins, Kansas Biological Survey

Concurrent Session 7. Twenty Years of Progress in Subsurface Drip Irrigation (SDI)

2:00-2:20 Basic Considerations for Adoption of SDI for Crop Production in Kansas,
Dan Rogers, KSU

2:20-2:40 Progress with SDI for Crop Production in Kansas - A Twenty Year Summary
Freddie Lamm, KSU, Colby, KS

2:40-3:00 Improving Environmental Stewardship of CAFO Effluent Management with SDI
Todd Trooien, South Dakota State University, Brookings, SD

3:00-3:20 Economic Comparison of SDI and Center Pivot Sprinkler Irrigation
Dan O'Brien, KSU, Colby, KS

Concurrent Session 8. Policy Impacts

2:00-2:20 Provisions Impacting Water Conservation and Protection in the New Farm Bill – Eric Banks, USDA-NRCS, Salina

2:20-2:40 Update on the Upper Ark CREP
Susan Stover, Kansas Water Office

2:40-3:00 Update on Environmental Regulation of CAFOs
Donna Porter – EPA Region VII, Kansas City, KS

3:00-3:20 Update on TMDLs and Their Implementation in KS
Tom Stiles, Kansas Department of Health and Environment

3:20-3:40 BREAK

3:40- 5:00 CONCURRENT SESSIONS 9,10,11,12

Concurrent Session 9. WRAPS Case Studies

3:40-4:20 Little Arkansas
Dan Devlin and Ron Graber

4:20-4:40

4:40-5:00

Concurrent Session 10. [Volunteered Papers; Theme to be determined]

3:40-4:00

4:00-4:20

4:20-4:40

4:40-5:00

Concurrent Session 11. KS Groundwater Management Districts: Challenges and Opportunities

Panel:
Dave Brenn, GMD#1
Tim Boese, GMD#2
Mark Rude, GMD#3
Wayne Bossert, GMD#4
Sharon Falk, GMD#5

Concurrent Session 12. KWRI-Funded Research

3:40-4:00 A Real-time Permittivity Sensor for Simultaneous Measurement of Multiple

Water-Quality Parameters. Naiqian Zhang, Ning Tang, Sarah Shultz, and Philip Barnes, Kansas State University.

4:00-4:20 Impact of Treated Wastewater for Irrigation on Nitrate Accumulation and Transport: Field Monitoring and Numerical Simulations. Marios Sophocleous, Margaret Townsend, Fred Vocasek, Liwang Ma, and Ashok KC, KGS and Servi-Tech

4:20-4:40 Quantifying Groundwater Savings Achieved by Salt Cedar Control: A Demonstration Project in the Riparian Zone of the Cimarron River. Gerard Kluitenberg, Jim Butler, Don Whittemore, Wei Jin, David Arnold, and Edward Reboulet, KSU, KGS, and Arnold Ranch

4:40-5:00 Assessment of Seasonal, Pumping-Induced Water Quality Changes in the Ozark Plateaus Aquifer System, Southeast Kansas. Allen MacFarlane, KGS

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	3	0	0	0	3
Masters	1	0	0	0	1
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	5	0	0	0	5

Notable Awards and Achievements

An Analysis of Sedimentation Reduction Strategies for Tuttle Creek Lake

During the past year (2009/2010), two notable events took place related to this KWRI project. First, Craig Smith along with Jeff Williams, John Leatherman, and Josh Roe developed a poster titled “Using Watershed Manager to Cost-Effectively Target Cropland Best Management Practices.” This poster was presented at the following events: • Selected to present on behalf of K-State at the 7th Annual Capitol Graduate Research Summit (top 10 posters from a total of 75 were chosen), Topeka, KS, March 25, 2010 • K-State Research Forum, Manhattan, KS, February 11, 2010. • K-State Research and Extension Conference, Manhattan, KS, October 20-22, 2009. • From Dust Bowl to Mud Bowl: Sedimentation, Conservation Measures and the Future of Reservoirs, Kansas City, Missouri, September 14-16, 2009.

Additionally, this poster was chosen as a co-winner of the top poster award at the 7th Annual Capitol Graduate Research Summit. With this honor, a $600 scholarship was awarded and the poster will once again be presented at the 2010 2nd quarter KansasBio meeting in Wichita, KS.

The other notable event related to the KWRI project was that Craig Smith was named the recipient of the 2010-2011 Kenneth E. Grant Research Scholarship from the Soil and Water Conservation Society. This scholarship will be used to further enhance the economic analysis in this KWRI project. Specifically, Craig will use the $1,300 scholarship to attend a MATLAB workshop to further develop his programming and optimization skills and he will also spend several days in Washington, D.C. working with USDA-ERS professionals who specialize in conservation policy analysis. The KWRI project was explicitly referenced in his scholarship proposal.