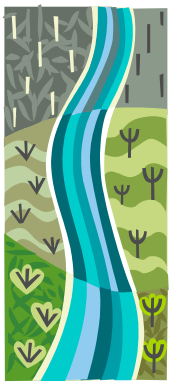

KANSAS WATERSHED RESTORATION AND PROTECTION STRATEGY (WRAPS) PROJECT

OOLOGAH LAKE WATERSHED STAKEHOLDER LEADERSHIP TEAM DEVELOPMENT AND ASSESSMENT SUPPORT

FINAL REPORT

KDHE Project No. 2006-0059

April 2012

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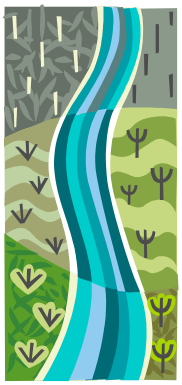

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Figures and Tables

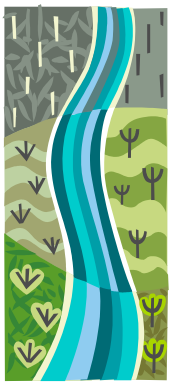
Acknowledgements

This project was made possible with financial support provided by State Water Plan funds administered by the Kansas Department of Health and Environment – Watershed Management Section, granted to K-State Research and Extension through the Kansas WRAPS (Watershed Restoration and Protection Strategy) – Oologah Lake Watershed Stakeholder Leadership Team Development and Assessment Support project (2006-0059).

The successful implementation of the Development phase of this project would not have been possible without the extraordinary efforts of many local agency staff.

The Assessment phase of this project resulted from the dedicated team effort of these KSU personnel:

- Aleksey Y. Sheshukov, Watershed Modeler
- Amir Pouyan Nejadhashemi, Watershed Modeler
- Rohith Gali, Graduate Student, Watershed Modeler
- Josh Roe, Watershed Economist
- Craig M. Smith, Watershed Economist
- Robert M. Wilson, Watershed Planner
- Sue P. Brown, Watershed Communication
- John C. Leatherman, Professor, Agricultural Economics
- William Hargrove, past KCARE Director



Executive Summary

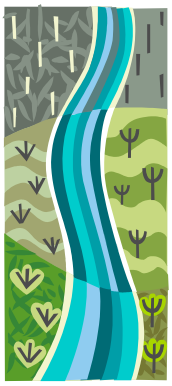
This project served to (a) recruit, organize, and prepare stakeholders, and (b) compile and develop watershed environmental and economic information to assist stakeholders in the Oologah watershed to develop a Watershed Restoration and Protection Strategy (WRAPS) Plan and Report.

Initiated in June 2006 and ending in June 2009, this *WRAPS Development Phase* project focused on three key tasks: (1) identifying watershed stakeholders and agency/ organization partners in the watershed and recruiting them to serve on a Stakeholder Leadership Team and project management team ; (2) initiating and facilitating information/ education activities to generate public interest in and support for the WRAPS project; and (3) facilitating the identification of local watershed issues and concerns and preliminary goals for the overall WRAPS project by the Stakeholder Leadership Team. This *WRAPS Assessment Phase* project focused on three key objectives: (1) characterizing watershed conditions; (2) identifying needs and opportunities for watershed information to support stakeholder decisions; and (3) understanding how the watershed responds to various management scenarios.

The project completed many of its initial goals. The remaining portion of the project will require engagement with the Stakeholder Leadership Team, which has yet to be established.

Project accomplishments include:

- *Stakeholder Education:* We held numerous meetings with local stakeholders and engaged them around the concerns of water quality and watershed management.
- *Corps of Engineering Modeling Interactions:* We provided BMP modeling and scenario development guidance to the Corps to support their modeling efforts, and had numerous constructive interactions.
- *Watershed Assessment*: We compiled existing information related to the Oologah watershed, culminating in development and publication of a Watershed Atlas.
- *Watershed Modeling*: We completed a STEPL modeling analysis of baseline watershed conditions.
- *Economic Analysis*: We developed user-friendly decision tools for stakeholder groups to analyze and compare economic and environmental effects of cropland BMPs, vegetative buffer systems, streambank stabilization systems, and tillage systems.



Introduction

Geographic Scope/Location

The geographic area covered by this project (Figure 1) is the Verdigris River watershed below Big Hill Lake, Elk City Lake, Fall River Lake and Toronto Lake that drains to Oologah Lake. In this report, this portion of the Oologah Lake drainage area (HUC 11070103) will be referred to as the Oologah Lake Watershed. The Oologah Lake watershed encompasses much of Montgomery and Labette Counties, and portions of Wilson and Neosho Counties in southeast Kansas. Towns in the watershed include Independence, Coffeyville, Cherryvale, Liberty, and Mound Valley. The watershed lies within the larger Central Oklahoma/Texas Plains and Central Irregular Plains eco-regions.

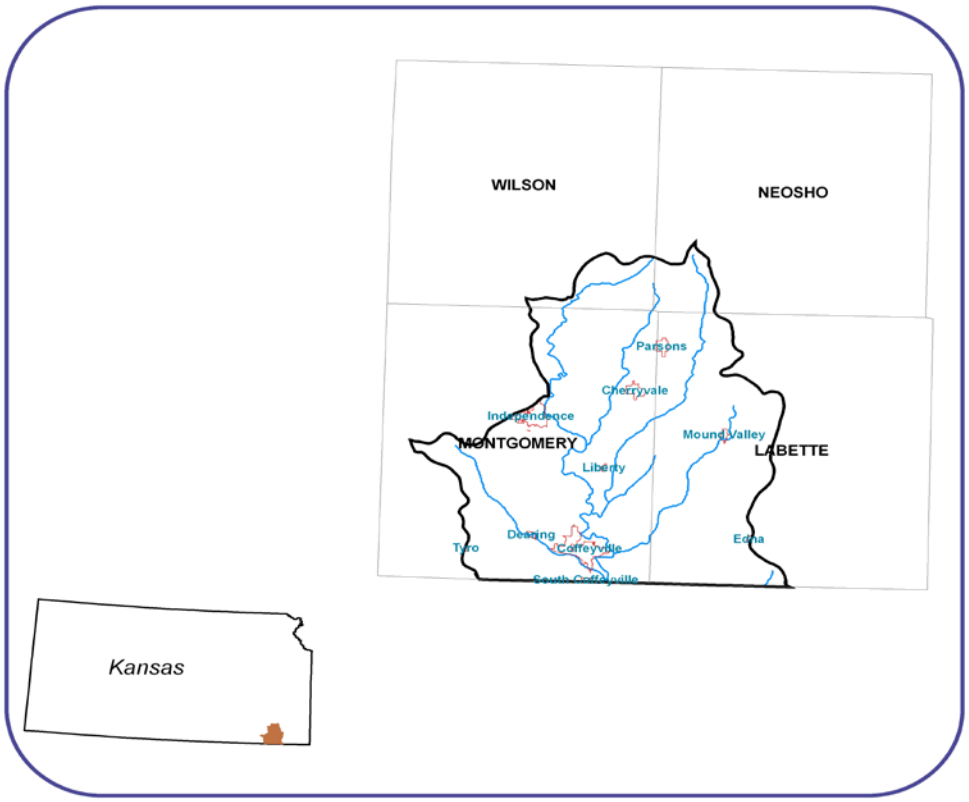


Figure 1: Oologah Lake Watershed Map

Surface Water Resources
The primary waterway is the Verdigris River, which supplies water to Lake Oologah in Oklahoma. The Oologah watershed contains no major lakes, with Toronto Lake, Fall River Lake, Elk City Lake, and Big Hill Lake all upstream.

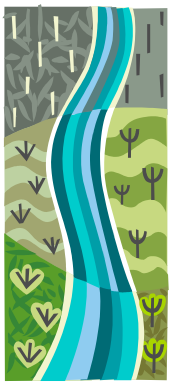
Designated Uses
Designated uses for the surface water resources in this watershed generally include: expected aquatic life support, food procurement, livestock watering, industrial water supply, irrigation use, groundwater recharge, domestic water supply, and primary contact recreation.

Public Water Supplies
The primary public water supplier in the watershed is Public Wholesale Water Supply District #04, including parts of Montgomery, Neosho, and Wilson Counties.

Land Uses/Activities
Grassland in the Kansas part of the Oologah Watershed covers 11% of land area. The grazing density is considered average in the lower third of the watershed and high in the upper two thirds (32-58 animal units/sq. mile) as compared to the entire Verdigris Basin. Cropland covers 70% of the land area. Woodland, which is part of the cross-timbers area of Kansas, covers 11% of the watershed. Water and urban areas constitute the remaining 8% of land cover. The watershed's population density is average in the lower two thirds and low in the upper third of the watershed when compared to densities across the Verdigris Basin (9-26 persons/sq. mile).

Wildlife Habitat
Species common to the area included white-tailed deer, wild turkey, quail, squirrel, rabbit, dove, and raccoon, as well as a rich variety of songbirds.

Watershed / Water Quality Conditions
The Middle Verdigris watershed was designated a "Category I" watershed in the 1998 Kansas Unified Watershed Assessment, meaning that it "does not meet state water quality standards or fails to achieve aquatic system goals related to habitat and ecosystem health" and is thus in need of watershed restoration and protection measures to improve water quality conditions. Overall, the Middle Verdigris watershed was ranked 26th out of 92 watersheds assessed in the report.



Goal, Objectives, and Tasks

Goal

The stated goal of this project, as described in the Project Implementation Plan, was to:

> "Characterize watershed conditions, identify needs and opportunities and understand how the watershed responds to various management scenarios. A primary goal of this project is to provide hydrologic and water-quality monitoring information to assess current conditions and responses to land cover/management conditions."

However, this goal was written with emphasis on the Assessment Phase of the project and does not adequately capture the WRAPS Development Phase, which is critical to the success of the Assessment Phase. The Development Phase goal was to:

> Recruit, organize, and prepare stakeholders in the Oologah Lake watershed to engage in a process leading to the development of a Watershed Restoration and Protection Strategy (WRAPS).

Objectives

The objectives of the WRAPS Development Phase Project were to:

- Provide information and education to build public awareness of watershed issues and to generate public interest in the WRAPS process;
- Identify watershed stakeholders;
- Determine stakeholders' interest/willingness to participate in the WRAPS process;
- Compile and organize known watershed information;
- Begin identifying stakeholder concerns and issues;
- Organize a watershed stakeholder leadership team;
- Secure commitment to participate in watershed restoration and protection strategy;
- Prepare a Development Project report .

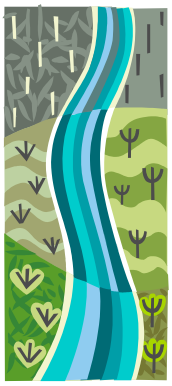
The objectives of the WRAPS Assessment Phase Project were to

1. characterize watershed conditions,
2. identify needs and opportunities for watershed information to support stakeholder decisions, and
3. understand how the watershed responds to various management scenarios.

Tasks/Activities

The major tasks/activities for this project were guided by the five listed “Objectives” on the Project Implementation Plan:

1) Inform and educate watershed stakeholders.
2) Establish assessment criteria.
3) Inventory existing information.
4) Provide technical information to support implementation decisions.
5) Prepare watershed assessment project report.



Summary of Project Activities and Accomplishments

Timeframe
The activities implemented as part of this combined Development and Assessment Phase project were ongoing for approximately three years, starting in June 2006 and ending in June 2009.

Inform and Educate Watershed Stakeholders

Development phase activities were initiated in Summer 2006. These initial activities included meetings with local agency staff (county Extension, county conservation districts, etc.) in August to introduce the WRAPS project and solicit local agency involvement/support.

Project staff met with Montgomery County Extension and Montgomery County Conservation District staff in November to identify next steps for organizing local public meeting to recruit stakeholder leadership team and to discuss local issues of concern. Project staff also met with the Montgomery County Conservation District Board at their monthly meeting in November 2006 to introduce WRAPS, discuss local issues of concern, and to request the Board's endorsement and cooperation in launching the project. The Board expressed interest in the project, but took no action. Project staff was invited to meet with the Board again in early 2007 to continue discussion of water quality issues and involvement by local stakeholders. Despite repeated attempts/ requests by project staff, a follow up meeting with the Board was never scheduled by Conservation District staff.

Project staff participated in an inter-agency coordination meeting with staff from the U.S. Army Corps of Engineers and Kansas Water Office in January 2007 to organize a public meeting/open house in Spring 2007 to obtain stakeholder feedback regarding the Corps feasibility study for Redmond Reservoir and to promote the WRAPS project. Discussion at the inter-agency meeting also included updates on stakeholder identification and recruitment efforts. Corps staff volunteered to work with staff from the City of Tulsa and Oklahoma state agencies to identify and recruit watershed stakeholders to serve on/support the WRAPS stakeholder leadership team. Despite repeated contacts by project staff, the Corps never provided contacts for stakeholders on the Oklahoma side of the watershed.

Project staff continued to work with local agency staff in Montgomery and Labette Counties through early 2007 to identify potential stakeholders. Approximately 30 watershed stakeholders were identified. Stakeholder contacts were also requested from Verdigris Basin Advisory Committee members (through a joint letter from K-State and the Kansas Water Office). No responses were received.

During Spring 2007, project staff continued efforts to engage local agency staff in identifying watershed stakeholders that could be recruited to serve on the stakeholder leadership team. Approximately 50 people were identified. In May 2007, project staff met with SEE-KAN RC&D staff and KDHE watershed management staff to review/discuss the Oologah WRAPS project. Project staff provided updates on the status of the projects, identified concerns regarding local agency participation, and discussed timelines and future tasks.

Project staff met with local agency staff in June2007 to initiate planning for information/ education (I&E) activities, including a public meeting and watershed tour in the fall. Other topics discussed at this meeting included identification of potential BMP demonstration projects, local issues/ problems of concern to agency staff, and ideas for future I&E activities.

Project staff followed up with local agency staff in July 2007 to continue planning for the public meeting and watershed tour, tentatively scheduled for October. The meeting agenda was expected to include presentations about WRAPS, water quality impairments/ TMDLs, and the results of the streambank/ riparian assessment for the Verdigris River conducted by Pittsburg State University under a separate 319-funded assessment grant. Planed tour sites included a streambank site in need of restoration, a mussel habitat area, a riparian area that has been restored, successful application of BMPs for a rural septic system, flood damage, and a stop at Big Hill Lake.

During Summer 2007, project staff compiled and submitted an application on behalf of the Oologah watershed for SFY08 WRAPS grant funding. Project proposals include a demonstration project to restore the streambank site to be highlighted on the watershed tour.

Project staff continued to work with local agency staff (Montgomery County conservation district, NRCS, and Extension) throughout the summer to finalize plans for the public meeting/ watershed tour scheduled for October. The Montgomery County Conservation District agreed to promote/publicize the meeting/tour. Project staff were forced to postpone the meeting/ tour due to lack of public response/ interest. Project staff subsequently met with Montgomery County Conservation District staff in November 2007 to reschedule the meeting/tour; Conservation District staff indicated that they preferred to wait until spring to reschedule the event. Project staff met with local agency staff in February 2008 to discuss the status of funding for the streambank demonstration project and to reschedule the public meeting/ watershed tour for May.

The meeting/ tour was successfully completed on May 9, 2008. The event began in the morning with presentations covering the WRAPS project and water quality impairments/ TMDLs. This was followed by a tour of the Independence, KS water

treatment plant. A scheduled tour stop at a streambank restoration project site was cancelled due to muddy conditions following locally heavy rains. The public meeting resumed after lunch with presentations about streambank restoration BMPs, a mussel habitat/ reserve along the Verdigris River, and an overview of the Verdigris River streambank/ riparian area assessment project. Unfortunately, non-agency participation in the meeting/ tour was extremely poor with only four landowners attending.

Project staff participated in a joint meeting in June 2008 involving agency representatives from Kansas and Oklahoma. The purpose of the meeting was to learn more about watershed restoration and protection efforts in each state, to coordinate the development of stakeholder leadership teams in both states to contribute jointly to a basin-wide WRAPS for Lake Oologah, and to discuss the status of the Corps' watershed plan. The group discussed TMDLs and other water quality issues on both sides of the state line, status of TMDL development in both states, and specific efforts that each state was making, or could implement in the future, to organize watershed stakeholders. KDHE and EPA Region 7 staff participated in the meeting as well.

Immediately following the bi-state agency meeting, project staff met with KDHE and SEEKAN RC&D staff to discuss the status of stakeholder development efforts for both the Oologah and Big Hill WRAPS projects. Staff agreed that given the size and other characteristics of the Big Hill watershed, it would be appropriate to have a single stakeholder leadership team to cover both the Oologah (Middle Verdigris) and Big Hill watersheds, effectively combining the two projects. Also, in response to a lack of interest on the part of local agency staff, SEEKAN agreed to organize/ sponsor information/ education activities in the fall to help generate local interest in the WRAPS project.

Project staff met with SEEKAN staff in August 2008 to follow up on plans for I&E activities in the fall. Five potential I&E activities were identified, including a streambank tour, a presentation at the Montgomery County Farm Bureau district meeting in September, a riparian management tour and workshop in October, a River Friendly Farms workshop in November, and a meeting with municipal Public water suppliers in December. Under sub-contract to K-State, SEEKAN ultimately organized/ sponsored two information/ education events: a streambank/ riparian area workshop and a grazing/ livestock workshop. These events were identified as being the most relevant to local landowners/ producers in the watersheds.

The riparian workshop was held on October 27, 2008 with approximately 18 people participating, 12 of whom were non-agency stakeholders. The grazing/ livestock workshop was held on December 11, 2008 and included presentations about the River Friendly Farms program offered by the Kansas Rural Center and information about rangeland best management practices. Approximately 17 people participated, 12 of whom were non-agency stakeholders.

Project staff met with KDHE staff and SEEKAN RC&D staff in February 2009 to discuss the status of the development phase activities for the now combined Oologah/ Big Hill WRAPS project and prospects for launching a viable stakeholder leadership team. The group also reviewed the discussion/ outcomes of the joint Kansas-Oklahoma meeting in

June 2008, reviewed the preliminary SWAT watershed modeling results produced by the Corps, discussed the status of the Corps' watershed management plan for the entire Verdigris/ Oologah basin, and reviewed the status of TMDLs in the watershed. All parties agreed that:

- The Corps watershed plan was expected to be on hold indefinitely pending continuation of federal funding for the project.
- Because Lake Oologah is located on the Oklahoma side of the watershed, it was not currently a high priority for Kansas and future WRAPS funding.
- It was unclear as to what progress, if any, Oklahoma agency staff made in organizing stakeholders above Lake Oologah.
- There were no high priority TMDLs requiring attention on the Kansas side of the watershed.
- There was insufficient interest/ support on the part of local agency staff (primarily county Extension offices and Conservation Districts and NRCS) as well as local residents to reasonably support a viable stakeholder leadership team.
- All stakeholder development activities would be put on hold indefinitely pending completion of the Corps' watershed management plan. If/ when the Corps plan is completed, project staff would meet with KDHE and SEEKAN to discuss possible plans for I&E activities to publicize the Corps plan and to seek public input. If public input suggested that the Corps plan was unacceptable to watershed residents, project staff would offer assistance is drafting a revised plan (i.e., WRAPS Planning Phase assistance).

Project staff followed up with Corps staff in April 2009; no additional work had been completed on the watershed plan, and the Corps could not provide a realistic timeframe for completing the plan.

In the end, these efforts failed to materialize the local engagement needed to support a WRAPS project.

As a result, much of the WRAPS Assessment Project effort was geared to anticipating and preparing the watershed assessment information that would be needed by the Stakeholder Leadership Team early in their WRAPS assessment phase.

This Final Report provides the information that will be needed to get a WRAPS Stakeholder Leadership Team started at some time in the future.

Establish Assessment Criteria

Without a Stakeholder Leadership Team, this project assumed that the preliminary assessment information needed for this WRAPS project would be similar to those needed by other similar Stakeholder Leadership Teams.

A future WRAPS project would be needed to review existing data, determine data gaps, and refine assessment needs. These stakeholders should be involved in establishing the assessment criteria that will be given priority, developing potential land management strategies for assessment, and recommending and reviewing monitoring strategies to support assessment and evaluate implementation

Inventory Existing Information

Again, without a Stakeholder Leadership Team, this project assumed that the preliminary assessment information needed for this WRAPS project would be similar to those needed by other similar Stakeholder Leadership Teams.

A future WRAPS project would be needed to identify relevant information regarding watershed conditions, natural resources, culture, customs, institutions, etc.

The project team inventoried watershed informational resources, TMDL needs inventories, previous watershed assessment reports, water-quality studies, USGS monitoring data, wildlife reports, riparian assessments, etc. Details about this process and the data compiled are presented in the *Watershed Assessment* section, below.

Provide Technical Information to Support Implementation Decisions

Interactions with Corps of Engineers SWAT Modeling Effort

The Corps of Engineers SWAT modeling effort never yielded results that were useable to the WRAPS Assessment process. However, substantial interactions and collaborations occurred during the project period.

On August 7, 2006, a meeting was held at the Kansas Water Office (KWO) conference room with US Army Corps of Engineers, KWO, KDHE, KSU and other agency partners with interest in Verdigris Basin/ Oologah Lake water quality issues. The meeting included:

(A) Welcome, introductions, agenda review, etc. from Earl Lewis, KWO;
(B) General overviews: (1) Corps - Lake Oologah Watershed Feasibility Study (2) KSU/KDHE - WRAPS program/ Verdigris Basin WRAPS Activities;
(C) Breakout sessions: (1) Modelers meeting: technical review & discussion of watershed model, data, assumptions, access and use, etc. (2) Planners/Managers meeting: process coordination issues, management strategies, etc.;
(D) Full group reconvention: (1) Report on breakout sessions; full group discussion as needed (2) Identify action items, next steps, etc.

KSU was assigned the task of developing a summary table of BMPs applicable to the Oologah Lake watershed, including descriptions of the practices and guidance for modeling these practices. Descriptions of how to model specific BMPs within the AVSWAT-X model were prepared and presented to the Corps during January 2007. Subsequently, this information was shared with the SWAT model developers; they have used (and, to date, continue to use) this information as a handout during model training workshops. In addition, simulation scenarios (with BMPs that are reasonable for the watershed) were developed and provided to the Corps with the help of Mr. Gary Kilgore.

KSU and the Corps of Engineering met on October 17, 2007. The Corps informed us that they did not have new modeling results to share, but might be able to provide new results on different scenarios by our next meeting in 2008.

Discussions from the joint Kansas-Oklahoma meeting in June 2008, and the follow-up meeting with KDHE in February 2009 (discussed above) led to the understanding/ agreement that the Corps modeling effort was expected to be on hold indefinitely pending continuation of federal funding for the project.

Before using results from the Corps SWAT model (at some point in the future), KSU will need to resolve several issues to determine the utility of the results for WRAPS planning.

(1) The Corps of Engineers is using the model to get pollutant loadings to the lake. This has led them to calibrate the model using annual data. This is a different time scale than has been used by KSU in the past and may limit utility of the results.
(2) GIS land-cover data (from 1992) will need to be assessed for its ability to represent current land uses.
(3) Impact of using older version of SWAT (2000 rather than current 2005 version) will need to be assessed. For example, 2005 has working bacteria modeling algorithm (that is not functional in 2000) and ability to use higher-resolution SSURGO soils data (rather than low-resolution STATSGO). SWAT does not allow input files to be transferred from 2000 to 2005 format; the modeling "project files" would need to be re-constructed from the raw data sources.
(4) Methods of inputting model data for target BMPs will need to be developed. Inputting "actual BMP implementation" is a labor-intensive process, perhaps outside the time and funding allocated to this task. We will need to determine a cost- and time-effective method for analyzing the impacts of BMPs.
(5) Because of challenges with the SWAT model architecture, many types of modifications to the SWAT model require building a new model from scratch (e.g., if we used different soil data or land-use data, all model project files would need to be re-constructed).

In summary, the goal of this project was to provide information to help the stakeholders make better decisions (e.g., regarding BMP selection, spatial targeting). The actions needed to produce a level of modeling detail consistent with this goal will need to be determined in collaboration with the stakeholder leadership team. SWAT modeling results from the Corps of Engineering might be useable for some purposes (such as spatial targeting), but other modeling tools might provide more efficient methods to provide stakeholders with adequate information for their decisions.

In addition to working with the Corps of Engineers in their modeling effort, the project team also completed assessment activities in preparation for working with the stakeholder leadership team. The following sections describe these activities and outcomes.

Watershed Assessment

Watershed Atlas

Extensive information about the watershed area was collected, compiled, and published as a Preliminary Assessment Report (often called the “Watershed Atlas”). This information was published as a K-State Research and Extension publication, thus making it available digitally online:

Oologah Watershed Assessment: Preliminary Report. K-State Research & Extension Publication #EP-136. 58 pages. <www.ksre.ksu.edu/library/h20ql2/EP136.pdf>

This publication included the following topics:

1.0. Oologah Watershed Assessment
  1.1. Watershed Summary
  1.2. Overview of Water Quality Issues and Potential Pollution Sources
2.0. Climate Mapping System
  2.1. Precipitation Map
  2.2. 30-Year Average Daily Maximum Temperature Map
  2.3. 30-Year Average Daily Minimum Temperature Map
3.0. Land Use/ Land Cover
  3.1. Land Use (GIRAS 1980s)
  3.2. Land Use (NLCD 1992)
  3.3. Land Use (NLCD 2001)
4.0. River Network
5.0. Hydrologic Soil Groups
6.0. Water Quality Conditions
  6.1. The 303d List of Impaired Waterbodies
  6.2. Water Quality Observation Stations
  6.3. USGS Gage Stations
  6.4. Permitted Point Source Facilities
  6.5. Confined Animal Feeding Operations (CAFOs)
  6.6. 1990 Population and Sewerage by Census Tract
7.0. Agricultural Economy
  7.1. Corn Cost-Return Budget
  7.2. Soybean Cost-Return Budget
  7.3. Wheat Cost-Return Budget
  7.4. Grain Sorghum Cost-Return Budget
  7.5. Alfalfa Cost-Return Budget
  7.6. Common Cropland BMPs in Oologah Watershed
    7.6.1. Vegetative Buffer: Economic Analysis and Discussion
    7.6.2. Streambank Stabilization: Economic Analysis and Discussion
  7.7. Economic Contributions of Recreation at Big Hill Lake
  7.8. Census Data
8.0. Modeling
  8.1. Subbasin Map
  8.2. Input Data
  8.3. Model Outputs

TMDL Reports

The TMDL documents provide a rich source of watershed information:

Verdigris Basin TMDL. Waterbody: Verdigris River. Water Quality Impairment: Fecal Coliform Bacteria. <http://www.kdheks.gov/tmdl/ve/VerdigrisR_FCB.pdf>

Verdigris Basin TMDL. Waterbody: Verdigris River. Water Quality Impairment: Biological Impairment. <http://www.kdheks.gov/tmdl/ve/VerdigrisNut.pdf>

Within these documents are descriptions and discussions of key water quality conditions and sources, and guidance for potential action. Major topics include:

1) Introduction and problem identification – basic waterbody and watershed data
2) Current water quality condition and desired endpoint – summary of available stream and lake data
3) Source inventory and assessment – data on land uses, point sources
4) Allocation of pollutant reduction responsibility – modeling-based load allocations
5) Implementation – potential activities, state and federal educational and funding support programs, milestones
6) Monitoring – plans for future efforts
7) Feedback – process used by KDHE during TMDL development

More information about KDHE's TMDL process can be found at the KDHE, Division of Environment, Bureau of Water, Watershed Planning Section web site:

Kansas Total Maximum Daily Loads (TMDLs). <www.kdheks.gov/tmdl/>

Watershed Modeling

There are several water-quality watershed models, ranging from simple to complex, that can be used for Oologah watershed assessment. Simple models like STEPL and REGION5 developed by the Environmental Protection Agency (EPA) use mainly empirical equations to model hydrologic and water-quality processes. The complex models like Soil and Water Assessment Tool (SWAT) incorporate multiple submodules that use physically based distributed equations to model various processes in the watershed. The use of complex models requires specific knowledge of physical processes as well as technical skills to run the model.

For Oologah watershed, the project team used the STEPL model to provide basic information to initiate discussion of water quality issues with the stakeholders. The Corps of Engineers developed, but did not complete, a SWAT model for the watershed.

Data collection

Data for the SWAT model of Oologah watershed were collected from a variety of online and printed data sources and knowledgeable people within the watershed. Data sources included GIS data, including topography, land use/ land cover, and soil spatial distribution. Other input data were available in online databases that were loaded into the model as tables with items manually distributed over subwatersheds.

The digital elevation map (DEM) for the basin was downloaded from the USGS National Elevation Dataset (NED) (see Figure 2).

Figure 2: Oologah Watershed showing topography

The land use dataset used in the model is the USDA National Land Cover Dataset (NLCD) prepared in 2001 (see Figure 3 and Table 1).

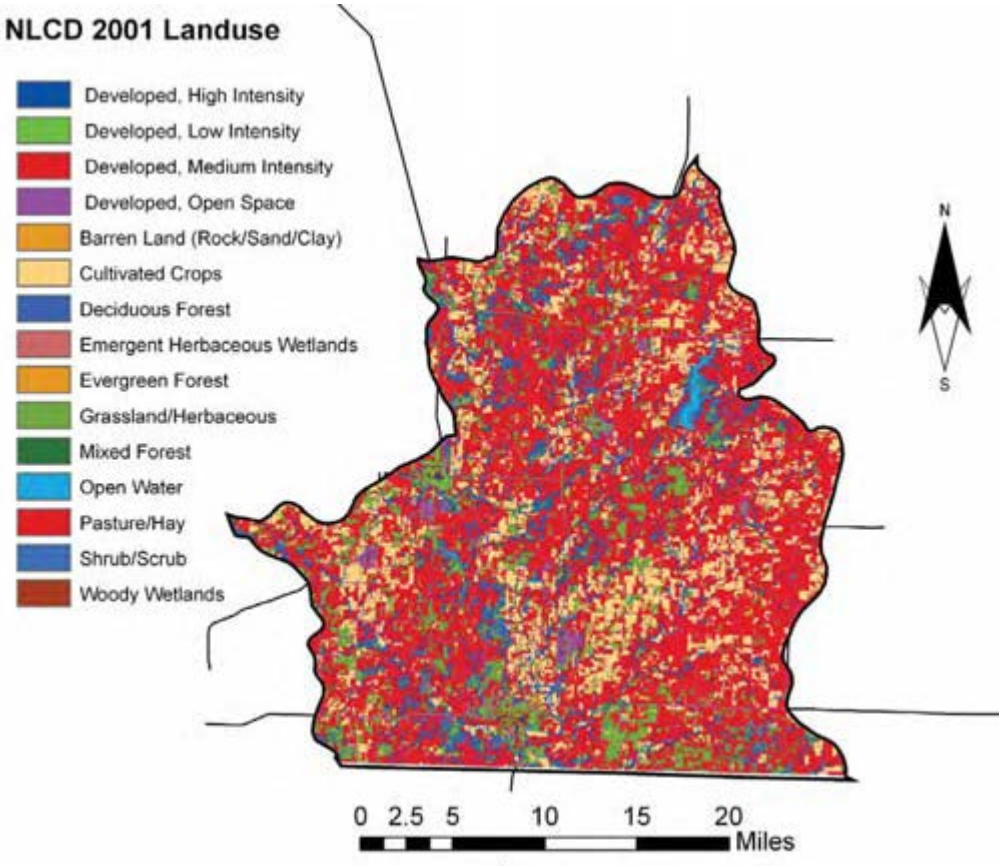


Figure 3: Land use map for Oologah watershed

Table 1: Areas of land uses and its classification (NLCD, 2001)

Landuse	Area (ac)	% watershed area
Cropland	78,950	17.6%
Pasture	233,723	52.0%
Grassland	48,551	10.8%
Forest Land	47,276	10.5%
Shrub	152	0.0%
Urban	33,450	7.4%
Barren	465	0.1%
Wetlands/Water	7,143	1.6%
TOTAL	449,710	100%

The Natural Resources Conservation Service (NRCS) State Soil Geographic (STATSGO) soils database and its geo-spatial coverage were used as an input for the SWAT model. Groups A, B, C, and D represent different soil textures and commonly vary from sandy soils in Group A to clay soils in Group D. High percentage of C and D group soils present higher soil erosion potential. Figure 4 shows soil distribution in the watershed.

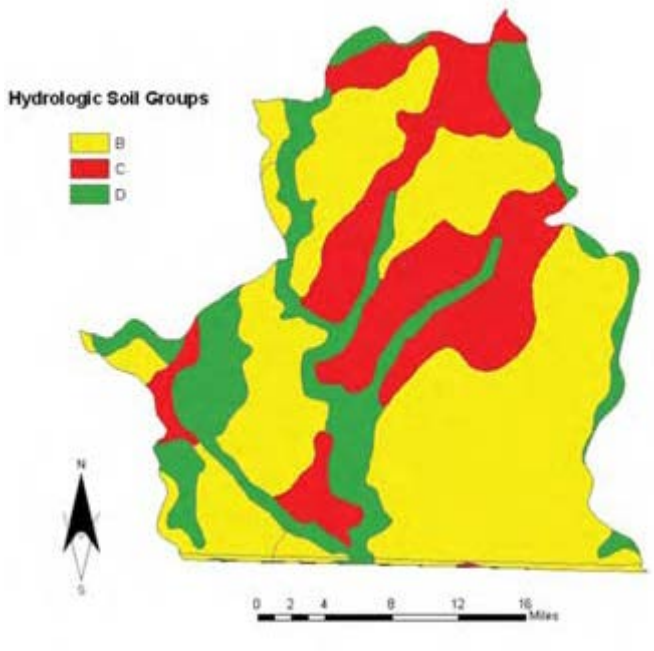


Figure 4: STATSGO Soil map for Oologah watershed

These data (and additional data, as described in the Watershed Atlas) were entered into a STEPL watershed model. The STEPL model (http://it.tetratech-ffx.com/stepl/) is a Microsoft Excel spreadsheet-based model that uses simple algorithms to calculate runoff, nutrient loads, 5-day biological oxygen demand (BOD), and sediment delivery from user-input watershed conditions, such as location, soils, land uses, and management practices. Preliminary STEPL model results are shown in Figure 5.

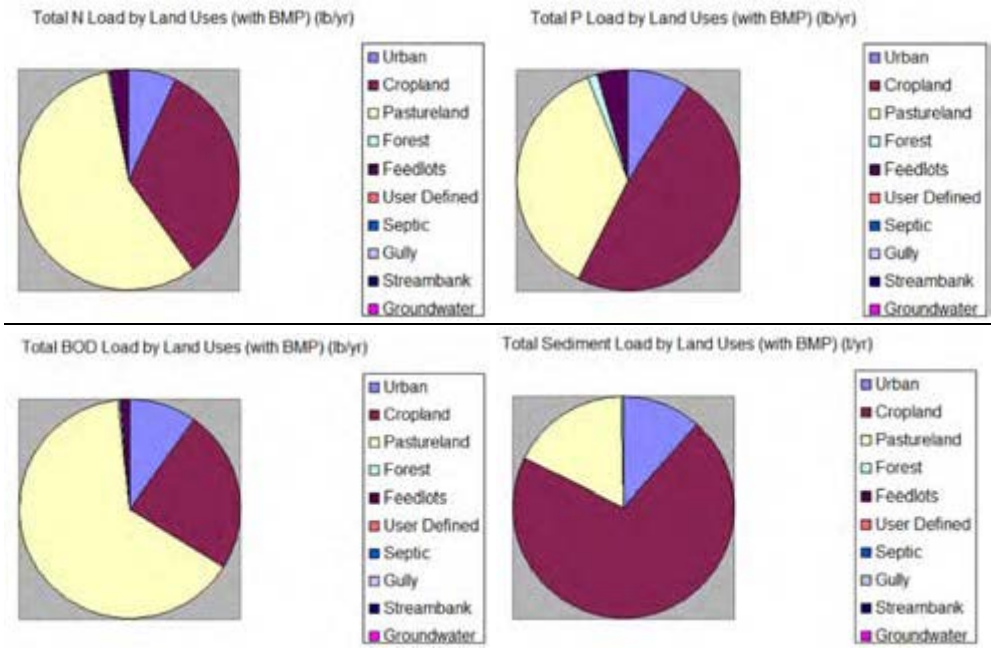


Figure 5: Total pollutant loads for total N, total P, total biological oxygen demand (BOD), and total sediment, summarized by land use, for Oologah Watershed.

Stakeholder engagement

A critical element of the WRAPS watershed modeling process is to engage stakeholders in the collection and verification of watershed data (Mankin, 2008). This process assures that we are modeling "their watershed" using the best local data available. Over a period of several meetings, the watershed modeler meets with stakeholders, presents baseline data, receives feedback and corrections on these data, revises model inputs to represent local data, and re-runs the model using these stakeholder-modified input data.

During the iterative engagement process, the stakeholders develop an understanding of how the assessment data and modeling results can be used to inform, but not dictate, their watershed planning decisions.

Without a Stakeholder Leadership Team, this project was not able to complete the critical stakeholder engagement process needed to make the modeling results truly relevant for the WRAPS planning process.

A future WRAPS project would be needed to work with stakeholders to assure that the watershed model is using appropriate local data and that results address local concerns.

Economic Analysis

General Economic Research

Cost-return budgets have been developed for the Oologah watershed by working with data from the Kansas Farm Management Association (Tables 2 through 6). The budgets are specific to Oologah watershed and vary by inputs and yields. Specific BMP budgets have been developed for vegetative buffers, terraces, streambank stabilization, and reduced/no-till.

We compiled lists of financial incentives/programs available through EQIP for both water quality and quantity conservation practices. These lists include both average costs and cost share percentages. We have also identified other programs which offer funding for conservation practices. Since vegetative and riparian forest buffers are supported through multiple funding programs, separate lists have been created to help producers calculate the amount of cost share and annual incentive payments that are available.

Table 2: Cost return projection for Corn in the Oologah watershed.

	Yield Level (bu)		
	80	**110**	**140**
INCOME PER ACRE			
A. Yield per acre	80	110	140
B. Price per bushel	$2.70	$2.70	$2.70
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$226.48	$308.39	$390.30
COSTS PER ACRE			
1. Seed	$32.43	$32.43	$36.66
2. Herbicide	33.85	33.85	33.85
3. Insecticide/Fungicide	0.27	0.27	0.27
4. Fertilizer and Lime	37.48	45.40	53.32
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	90.16	98.83	107.50
10. Non-machinery Labor	10.19	11.17	12.15
11. Irrigation			
12. Land Charge / Rent	34.40	43.00	51.60
G. SUB TOTAL	$245.77	$271.94	$302.34
13. Interest on ½ Nonland Costs	9.51	10.30	11.28
H. TOTAL COSTS	$255.28	$282.25	$313.63
I. RETURNS OVER COSTS (F-H)	**-$28.81**	**$26.14**	**$76.68**
J. TOTAL COSTS/BUSHEL (H/A)	$3.19	$2.57	$2.24
K. RETURN TO ANNUAL COST (I+13)/G	-7.85%	13.40%	29.09%

Data acquired from: Sarah L. Fogleman and Gary L. Kilgore, Corn Cost-Return Budget in Southeast Kansas, Kansas State University, October 2006.

Table 3: Cost return projection for Soybeans in the Oologah watershed.

	Yield Level (bu)		
	25	**35**	**45**
INCOME PER ACRE			
A. Yield per acre	25	35	45
B. Price per bushel	$6.08	$6.08	$6.08
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$162.48	$224.19	$285.90
COSTS PER ACRE			
1. Seed	$30.60	$30.60	$32.95
2. Herbicide	8.86	8.86	8.86
3. Insecticide/Fungicide			
4. Fertilizer and Lime	16.41	17.70	21.20
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	73.03	77.25	80.22
10. Non-machinery Labor	8.25	8.75	9.06
11. Irrigation			
12. Land Charge / Rent	34.40	43.00	51.60
G. SUB TOTAL	$178.55	$193.14	$210.89
13. Interest on ½ Nonland Costs	6.49	6.76	7.17
H. TOTAL COSTS	$185.03	$199.89	$218.06
I. RETURNS OVER COSTS (F-H)	**-$22.56**	**$24.30**	**$67.84**
J. TOTAL COSTS/BUSHEL (H/A)	$7.40	$5.71	$4.85
K. RETURN TO ANNUAL COST (I+13)/G	-9.00%	16.08%	35.57%

Data acquired from: Sarah L. Fogleman and Gary L. Kilgore, Soybean Cost-Return Budget in Southeast Kansas, Kansas State University, October 2006.

Table 4: Cost return projection for Wheat in the Oologah watershed.

	Yield Level (bu)		
	35	**45**	**55**
INCOME PER ACRE			
A. Yield per acre	35	45	55
B. Price per bushel	$4.41	$4.41	$4.41
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$164.83	$209.84	$254.85
COSTS PER ACRE			
1. Seed	$9.90	$9.90	$9.90
2. Herbicide	2.75	2.75	2.75
3. Insecticide/Fungicide			
4. Fertilizer and Lime	36.65	43.71	52.06
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	60.61	63.62	66.63
10. Non-machinery Labor	6.85	7.19	7.53
11. Irrigation			
12. Land Charge / Rent	34.40	43.00	51.60
G. SUB TOTAL	$158.16	$177.17	$197.47
13. Interest on ½ Nonland Costs	5.57	6.04	6.56
H. TOTAL COSTS	$163.73	$183.20	$204.04
I. RETURNS OVER COSTS (F-H)	**$1.10**	**$26.64**	**$50.81**
J. TOTAL COSTS/BUSHEL (H/A)	$4.68	$4.07	$3.71
K. RETURN TO ANNUAL COST (I+13)/G	4.22%	18.44%	29.06%

Data acquired from: Sarah L. Fogleman and Gary L. Kilgore, Wheat Cost-Return Budget in Southeast Kansas, Kansas State University, October 2006.

Table 5: Cost return projection for Grain Sorghum in the Oologahwatershed.

	Yield Level (bu)		
	70	**85**	**110**
INCOME PER ACRE			
A. Yield per acre	70	85	110
B. Price per bushel	$2.82	$2.82	$2.82
C. Net government payment	$10.48	$11.39	$12.30
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$207.88	$207.88	$207.88
COSTS PER ACRE			
1. Seed	$12.29	$12.29	$12.29
2. Herbicide	20.34	20.34	20.34
3. Insecticide/Fungicide	5.90	5.90	5.90
4. Fertilizer and Lime	39.68	43.64	50.24
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	7.00	7.00	7.00
9. Custom Hire / Machinery Expense	82.39	86.92	94.47
10. Non-machinery Labor	9.31	9.82	10.68
11. Irrigation			
12. Land Charge / Rent	34.40	43.00	51.60
G. SUB TOTAL	$211.30	$228.90	$252.51
13. Interest on ½ Nonland Costs	7.96	8.37	9.04
H. TOTAL COSTS	$219.26	$237.27	$261.55
I. RETURNS OVER COSTS (F-H)	**-$11.38**	**$13.82**	**$60.95**
J. TOTAL COSTS/BUSHEL (H/A)	$3.13	$2.79	$2.38
K. RETURN TO ANNUAL COST (I+13)/G	-1.62%	9.69%	27.72%

Data acquired from: Sarah L. Fogleman and Gary L. Kilgore, Grain Sorghum Cost-Return Budget in Southeast Kansas, Kansas State University, October 2006.

Table 6: Cost return projection for Alfalfa in the Oologah watershed.

	Yield Level (ton)		
	3.0	**3.5**	**4.0**
INCOME PER ACRE			
A. Yield per acre	3.0	3.5	4.0
B. Price per bushel	$101.00	$101.00	$101.00
C. Net government payment	$12.30	$13.37	$14.44
D. Indemnity payments			
E. Miscellaneous income			
F. Returns/acre ((AxB)+C+D+E)	$315.30	$366.87	$418.44
COSTS PER ACRE			
1. Seed	$10.17	$10.17	$10.17
2. Herbicide	2.51	2.51	2.51
3. Insecticide/Fungicide	7.08	7.08	7.08
4. Fertilizer and Lime	19.90	26.89	33.88
5. Crop Consulting			
6. Crop Insurance			
7. Drying			
8. Miscellaneous	6.38	6.38	6.38
9. Custom Hire / Machinery Expense	109.42	118.08	126.61
10. Non-machinery Labor	12.36	13.34	14.31
11. Irrigation			
12. Land Charge / Rent	31.60	39.50	47.40
G. SUB TOTAL	$199.43	$223.96	$248.34
13. Interest on ½ Nonland Costs	7.55	8.30	9.04
H. TOTAL COSTS	$206.98	$232.26	$257.38
I. RETURNS OVER COSTS (F-H)	**$108.32**	**$134.61**	**$161.06**
J. TOTAL COSTS/BUSHEL (H/A)	$68.99	$66.36	$64.35
K. RETURN TO ANNUAL COST (I+13)/G	58.10%	63.81%	68.50%

Data acquired from: Sarah L. Fogleman and Gary L. Kilgore, Alfalfa Cost-Return Budget in South Central and Southeast Kansas, Kansas State University, October 2006.

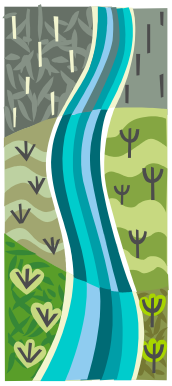
Work Products Created (spreadsheet based decision tools)

K-State Watershed Manager Decision-Making Tool is a spreadsheet program that can support the development of watershed management plans. Using this program, watershed stakeholder groups & technical assistance providers can estimate, optimize, and compare the economic and environmental effects of various watershed management scenarios. This includes cost estimates and estimates of (sediment, phosphorus, and nitrogen) load reductions for a variety of cropland Best Management Practices (BMPs). *K-State Watershed Manager* was developed by a group of agricultural economists at Kansas State University. The goal was to provide a user-friendly tool which could aid watershed groups in developing cost-effective watershed management plans. The tool development was funded in part through the Kansas Department of Health and Environment by U.S. EPA Section 319 Funds in support of Kansas Watershed Restoration and Protection Strategies (WRAPS).

KSU-Vegetative Buffer Decision-Making Tool was developed with assistance and input from KSU Ag Economics faculty, NRCS, and Conservation District personnel (buffer coordinators). This tool allows producers and land-managers across the state of Kansas (including Oologah Watershed) to evaluate the economic benefits and costs of vegetative buffers, and will help them decide if a buffer makes sense for their operation. This tool also incorporates the funding incentives information gathered previously. This tool is on the KSU Agricultural Economics website, AgManager.

KSU-StreambankStabilization Decision-Making Tool was developed with assistance and input from KSU Ag Economics faculty, Watershed Institute, and KAWS.
This tool allows producers and land-managers across the state of Kansas (including Oologah Watershed) to evaluate the economic benefits and costs of streambank stabilization projects, and will help them decide if stabilizing an eroding streambank makes sense for their operation. This tool also incorporates the funding incentives information gathered previously. This tool is on the KSU Agricultural Economics website, AgManager.

KSU-Tillage Decision-Making Tool was developed with assistance and input from KSU Ag Economics faculty and Agricultural Extension agents across the state. This tool allows producers and land-managers across the state of Kansas (including Oologah Watershed) to evaluate the economic benefits and costs of alternative tillage management strategies, and helps them decide if reducing tillage is a feasible option for their operation. This tool incorporates enterprise budgets so that the user can make their decision based on a comprehensive analysis. This tool is on the KSU Agricultural Economics website, AgManager.



Next Steps / Transition into Planning Phase

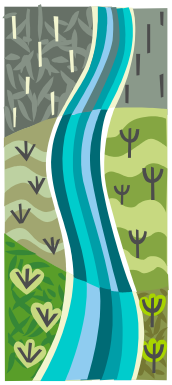
This WRAPS Development and Assessment Phase project achieved many of its objectives. The remaining portion of the project will require engagement with the Stakeholder Leadership Team.

A key step is to use the assessment information (as revised through collaboration with the Stakeholder Leadership Team) to refine the watershed model. The revised model would then be used to define critical areas, quantify the impacts of potential BMPs on pollutant loads to the streams, and assist the Stakeholder Leadership Team in prioritizing this list of BMPs. The Stakeholder Leadership Team would use model results along with local knowledge about the BMPs that most likely will be accepted by the farmers and implemented on the ground.

The economic aspects of the BMP implementation would also be discussed with the Stakeholder Leadership Team. A variety of decision-making tools that have been developed by K-State would be applied to provide the Stakeholder Leadership Team with the most cost-efficient BMP implementation plan.

For each individual impairment or combination of impairments, a list of recommended BMPs and the cost of implementation would be presented, discussed, and approved by the Stakeholder Leadership Team. The list may include buffers, continuous no-till, nutrient management, and waterways for cropland, riparian and native grass habitat buffers for streambanks, and off-stream watering sites, vegetative filter strips, and relocation of pasture feeding sites for livestock.

To facilitate the transition into the planning phase, an overview of the watershed assessment findings, including the targeted areas, the lists of potential BMPs for each impairment, and the approximate cost of the implementation, should be provided to the Stakeholder Leadership Team.



Evaluation of Project Goal, Objectives, and Tasks

The goals of this project were to recruit, organize, and prepare stakeholders, characterize watershed conditions, identify needs and opportunities for watershed information to support stakeholder decisions, and understand how the watershed responds to various management scenarios.

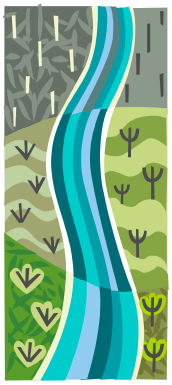
Because a Stakeholder Leadership Team was not successfully established for the Oologah Lake watershed during the WRAPS Development Phase of this project, the Assessment Phase did not accomplish all of its objectives. Nonetheless, many objectives toward the project goal were achieved:

- Compiled an inventory of existing information and reports related to Oologah watershed.
- Published a Watershed Atlas online, summarizing watershed climate, soil, topographic, and land use data; economic analyses of agricultural cropping systems and best management practices (BMPs); and STEPL modeling results.
- Developed user-friendly decision tools for stakeholder groups to analyze and compare economic and environmental effects of cropland BMPs, vegetative buffer systems, streambank stabilization systems, and tillage systems.

The following objectives were note achieved, and will require engagement of the Stakeholder Leadership Team so that the resulting information is relevant and applicable to the WRAPS planning process.

- The Stakeholder Leadership Team must clarify WRAPS objectives and assessment needs (an outcome of a successful Development Phase project).
- The Stakeholder Leadership Team must identify informational and data gaps needed to address their objectives and assessment needs.
- Baseline watershed assessment data must be refined using local data in collaboration with the Stakeholder Leadership Team.
- The watershed model must be revised to reflect the refined watershed data.
- The watershed model must be used to assess watershed responses to various management scenarios.
- Watershed model and economic results must be communicated to the Stakeholder Leadership Team.

We have made substantial progress toward accomplishing the project goals. Once a Stakeholder Leadership Team is established, the results of this project will allow rapid progress toward completion of a WRAPS Report.



Conclusions, Recommendations, and Lessons Learned

Conclusions

The success of every WRAPS project is very much dependent upon cooperation/ collaboration by local agency staff. Throughout the Development phase of this project, local agency staff were very slow to respond to requests for assistance with stakeholder recruitment and other development activities. While local agency staff continued to express interest in the project, follow-up was extremely slow or non-existent. Despite substantial effort and repeated attempts to engage local agencies in moving forward with this project, only minor success was achieved. Ultimately, a stakeholder leadership team was not established and this project did not continue into the Planning phase.

A solid foundation of watershed assessment information was prepared by this project. From their experience with other successful WRAPS Assessment Phase projects in other watersheds, the project team has a clear understanding of the typical steps remaining to complete the assessment project. It is clear that further progress toward completion of a successful Assessment project, and ultimately a WRAPS Plan and Report, will require establishment of an engaged Stakeholder Leadership Team.

Lessons Learned

Several important lessons were learned through implementation of the Development Phase of this project:

- Watershed stakeholders consistently focus their attention and concern on issues that are concrete and highly visible, such as streambank erosion. This is likely due to the fact that many stakeholders are personally impacted by these types of issues.
- Stakeholder interest and awareness of water quality issues related to lakes is strongly connected to their location within the watershed, i.e. stakeholders living near the lake are much more likely to be aware and concerned.
- Stakeholder interest in the impacts of sedimentation, eutrophication, and other water quality problems on recreation and public water supplies is generally far greater than their interest in other impacts, such as aquatic and wildlife habitat.
- Stakeholders overwhelmingly support voluntary, incentive-based approaches to dealing with water quality problems that originate from nonpoint sources, possibly because they associate nonpoint sources with landowners such as themselves.
- The involvement and support of local agency staff is absolutely critical to the success of the WRAPS process. Stakeholders specifically look for local agency involvement as an indicator of WRAPS' merit and worth.

- Stakeholders overwhelmingly prefer implementation activities over planning activities. This reinforces the importance of providing funding for BMP demonstration projects throughout the WRAPS process to help maintain stakeholder interest and involvement.
- The involvement of local landowners and agricultural producers is critical to the success of WRAPS projects as they are widely seen as the people most likely to be impacted (perhaps negatively) by the actions that are ultimately implemented through a WRAPS plan.

Several important lessons were learned through implementation of the Assessment Phase of this project:

- Although a WRAPS Assessment Phase project can and should (for timely progress of the overall WRAPS process) begin before the completion of a WRAPS Development Phase project, it cannot be completed until the Stakeholder Leadership Team (that results from the Development project) is in place and fully engaged in the assessment process.
- Watershed data available through various Internet sources should be considered to be "generalized" information and should be confirmed and revised through interactions with stakeholders having local knowledge and data.
- Successful watershed modeling as part of a WRAPS planning process, requires the active engagement of a Stakeholder Leadership Team in a process we have called *Adaptive Watershed Modeling*, where modelers and stakeholders interact iteratively throughout creation of watershed data, development of scenarios, and analysis of results.
- It is helpful to begin discussions of watershed modeling using simple modeling tools (such as STEPL) to allow discussions with stakeholders to focus on important watershed conditions and local information rather than becoming bogged down in discussion of model intricacies.
- Stakeholders benefit from the use of decision tools that integrate economic and environmental impacts of various field and watershed management decisions, and allow them to compare various scenarios.

Recommendations

Demonstration funding is important to the WRAPS Development process.

A primary recommendation focuses on the need for funding (even in modest amounts) to be included in Development Phase project grants for BMP demonstration projects to satisfy the desire of stakeholders to "act" at the same time they "plan".

Watershed modeling is important to the WRAPS Assessment process.

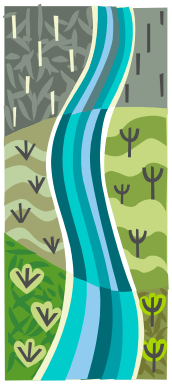
One Kansas individual skeptical of watershed modeling suggested that K-State should instead simply show real data about how various agricultural management practices impact water quality in each locale. He and I discussed how soil types, rainfall patterns, growing seasons, and management practices, among other factors, could impact results, in addition to how expensive it would be to study even a small number of combinations. In a very short time, this individual began to see how models could be used to extend data from specific combinations of these factors to other combinations where water quality data was not available.

Watershed modeling remains highly sophisticated.
The project team has been involved with watershed assessment activities in Kansas for more than 12 years. Over this time, watershed assessment tools and models have evolved. Watershed information can now be accessed in digital format for watershed topography, soils, and land-cover. Watershed models have evolved from dedicated research tools to become more user-friendly both in data input and post-processing of results. However, running watershed models remains a highly sophisticated task; correct results are never guaranteed

Believable watershed modeling requires technical skill and social connection.
The integration of watershed modeling results in the watershed planning process is not a simple endeavor. Once watershed stakeholders lose confidence in the watershed model or modeler, they will not believe the results and will not use these results in their planning. Watershed models generally are not "correct", but their results can be highly instructive and useful to the WRAPS planning process. Helping stakeholders understand how model results should, and should not, be used requires a committed engagement over a long period of time, and often requires an intermediary, like an Extension Agent or Watershed Specialist, who can help the modeler and the stakeholder bridge the communication gap.

In short, watershed environmental and economic modeling is critical to success of a WRAPS project, but requires technical staff with a special set of skills and dedication to the enterprise of stakeholder engagement and partnership.

Evaluation of the WRAPS process.
A framework and related methodologies and tools are needed to more fully evaluate the success and desired outcomes of each WRAPS phase, as well as the overall WRAPS process (including the implementation phase).



References

Gaunt, P.M. 2001. Water Recreation Needs Assessment Report to the Kansas Water Office. Wichita State University.

Kansas Water Office. Elk City Lake Reservoir Fact Sheet. January, 2008. <http://www.kwo.org/ReservoirInformation/ReservoirFactSheets/Elk_City_Lake.pdf>

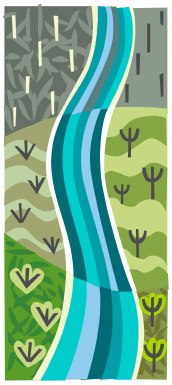
KDHE. 2009. Watershed planning section: TMDLs. Topeka, Kansas: Kansas Department of Health and Environment. <www.kdheks.gov/tmdl>

Mankin, K.R. 2008. WRAPS Adaptive Modeling. *Presentation at the* KDHE WRAPS Regional Watershed Seminar, Lawrence, KS. May 22, 2008.

Nejadhashemi, A.P., R.K. Gali, C.M. Smith, K.R. Mankin, R.M. Wilson, S.P. Brown, and J.C. Leatherman. 2009. Oologah Watershed Assessment: Preliminary Report. Kansas State Research and Extension Publication #EP-136. 58 pages. <http://www.ksre.ksu.edu/library/h20ql2/EP136.pdf>

Rosenberger, R.S. 2001. Benefit Transfer of Outdoor Recreation Use Values. USDA Forest Service.

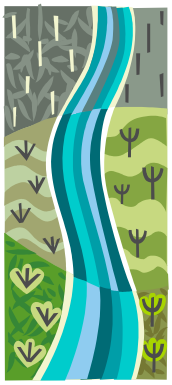
U.S. Census of Agriculture. 2002 <http://www.nass.usda.gov/Census_of_Agriculture/index.asp>



Appendix A

Watershed Atlas

Nejadhashemi, A.P., R.K. Gali, C.M. Smith, K.R. Mankin, R.M. Wilson, S.P. Brown, and J.C. Leatherman. 2009. Oologah Watershed Assessment: Preliminary Report. Kansas State Research and Extension Publication #EP-136. 58 pages.
< http://www.ksre.ksu.edu/library/h20ql2/EP136.pdf >

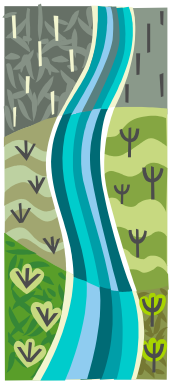


Appendix B

TMDLs

Verdigris Basin TMDL. Waterbody: Verdigris River. Water Quality Impairment: Fecal Coliform Bacteria. < http://www.kdheks.gov/tmdl/ve/VerdigrisR_FCB.pdf >

Verdigris Basin TMDL. Waterbody: Verdigris River. Water Quality Impairment: Biological Impairment. < http://www.kdheks.gov/tmdl/ve/VerdigrisNut.pdf >



Appendix C

Financial Summary

Summary of financial expenditures and matching funds.

Category	Budget	Actual	Match	Total
Salaries	24,571.00	24,571.00	26,416.00	50,987.00
Fringe Benefits	6,060.00	6,060.00	6,601.00	12,661.00
Travel	3,216.00	3,216.00	--	3,216.00
Supplies	273.00	273.00	--	273.00
Contractual Services	--	--	--	--
Other	3,301.00	3,301.00	--	3,301.00
Project Indirect Costs	--	--	--	--
Waived Indirect Costs	--	--	27,872.00	27,872.00
Total	$37,421.00	$37,421.00	$60,889.00	$98,310.00