

**ASSESSMENT OF BRUSH MANAGEMENT/
WATERSHED YIELD FEASIBILITY FOR THE
WICHITA RIVER WATERSHED
ABOVE LAKE KEMP**

*HYDROLOGIC EVALUATION
AND
FEASIBILITY STUDY*

Executive Summary Report

Prepared for the

TEXAS STATE SOIL AND WATER CONSERVATION BOARD

By the

RED RIVER AUTHORITY OF TEXAS

In Cooperation with

**USDA-Natural Resource Conservation Service
Texas Agriculture Experiment Station, Blackland Research & Experiment Station
Texas Agriculture Extension Service
Texas A&M University, Department of Agricultural Economics
Texas A&M University, Department of Rangeland Ecology and Management**

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EXECUTIVE SUMMARY

DECEMBER 15, 2000

1.0 INTRODUCTION

The Red River Authority of Texas (Authority) in cooperation with the Texas State Soil and Water Conservation Board (TSSWCB) is charged with delineating the Wichita River watershed above Lake Kemp to establish baseline criteria for determining the feasibility of implementing a brush control and management program to increase watershed yield.

The Texas Legislature designated the TSSWCB as the lead agency to conduct comprehensive watershed studies in conjunction with the Texas Agriculture Experiment Station and Extension Service, river authorities, other local entities, and the public to determine the benefits of implementing brush control programs in priority watersheds selected throughout the state.

Water is one of the major issues that Texans must face if future economic development and growth are to be maintained throughout the state, and the Wichita River Basin is certainly no exception. The limited availability of this natural resource has brought about numerous innovative measures aimed at improving watershed management to restore and increase the productivity of the resources. One such measure is that of brush control and management to increase watershed runoff. The United States Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) estimates that brush in Texas uses approximately 10 million acre-feet of water per year as compared to the 15 million acre-feet per year currently consumed for all other purposes.

Increasing watershed runoff and aquifer recharge, as demonstrated in other brush control studies, is believed to be an effective means of improving resource management, but the extent of the overall economic benefit and long-term impacts to the environment need to be further evaluated in order to determine accurate benefits versus cost for program implementation and possible alterations to sensitive ecosystems.

The Wichita River watershed above Lake Kemp in North Texas was selected as one of several sites in Texas to evaluate the long-term effectiveness of implementing brush control as an alternative water management strategy, thereby increasing watershed yield and improving resource management practices. Refer to **Figure ES-1, Vicinity Map** of the study area. The results of this study will provide historical and current hydrological information to assist in determining the feasibility of implementing a watershed specific brush control program. The scope of the study will focus on:

- \$ Delineation of general hydrology and geology of the watershed,
- \$ Description of the changes in general land use and cover characteristics,
- \$ Quantifying the availability of surface and groundwater,
- \$ Identifying possible impacts to the environment and ecosystem, and
- \$ Identifying benefits that may be received as a result of implementation.

2.0 EXECUTIVE SUMMARY

2.1 ABSTRACT

The Wichita River watershed above Lake Kemp covers parts of eight counties in the North Central Texas portion of the Rolling Plains region of the state and contains 1,335,040 acres. In FY 2000 the watershed area is sparsely populated with 6,208 persons, predominately rural in nature. The economy is supported primarily by ranching activities with some farming and the production of oil and gas.

The study was accomplished under the direction of the Texas State Soil and Water Conservation Board in partnership with the Red River Authority of Texas, Texas A&M Research Center and Extension Service, the USDA Natural Resource Conservation Service, Blackland Research Center, local Soil and Water Conservation Districts, and of course, participating landowners within the watershed study area.

Overgrazing by livestock production, range fire suppression and droughts have promoted the spread of noxious brush to the extent that over 825,000 acres (62%) of the watershed area have been infested with mesquite, cedar and mixed brushes. This noxious brush utilizes much of the available water resources without any beneficial return to the watershed and inhibits production capabilities of the region.

Based on the historical average annual rainfall and runoff measurements, the watershed receives an average of over 335,000 acre-feet per year with only 119,100 acre-feet resulting in actual runoff. This represents a net loss of over 216,000 acre-feet of water per year (64.5%) that is attributed to evapotranspiration. The total surface water and groundwater uses from the watershed area are 111,929 acre-feet per year. Much of the water resources contain excessive amounts of dissolved solids and other contaminants which further limit water use and retards economic development of the watershed area.

The results of this study revealed that implementation of the proposed brush control program may be expected to provide a net increase in overall watershed yield at Lake Kemp between a minimum of 27.6% (about 32,900 acre-feet per year) to a maximum of 38.9% (about 46,330 acre-feet per year) over the measured long-term average. The estimated average cost per acre for implementation of the proposed brush control program would be \$70.37 per acre of removed brush with the state funding \$52.78 per acre. Participating landowners would be required to provide an average cost share of \$17.59 per acre.

2.0 EXECUTIVE SUMMARY (continued)

Components of the Wichita River Basin Chloride Control Project have been implemented on the Wichita River that include a 3,090 surface acre reservoir in Knox County and two low-flow diversion facilities in the headwaters of the South and the Middle Forks of the Wichita River in King County. A similar diversion structure is planned for construction on the North Fork in Cottle County in the near future.

The low-flow diversion facilities will divert the highly concentrated brine to the Truscott Reservoir for disposal. When completed, the Chloride Control Project will effectively reduce the dissolved solids level to the point that water impounded in Lake Kemp would meet drinking water standards 98% of the time. **Figure ES-1** also depicts the location of the chloride control diversion facilities and disposal reservoir.

By selectively implementing the proposed brush control program in a manner so as to leave brush above and remove brush below each of the three diversion structures, the two programs would complement each other by replacing the highly concentrated water diverted from the river's base flow by the chloride project with a good quality water added to the runoff of the watershed by the brush control program. Additional benefits can be realized in reducing the time-frame for meeting drinking water standards up to 26% and preventing an increase in operating cost to divert the additional runoff above the diversion facilities.

In light of the present need for Lake Kemp to supplement other surface water supplies, the combination of brush control and chloride control jointly implemented should be considered a high priority for the region. It should also be noted that both brush control and chloride control projects have been recommended for implementation in the Regional Water Plan for Area B.

The proposed brush control program appears to be economically feasible for the Wichita River watershed above Lake Kemp and exhibits a total public benefit-to-cost ratio of 1.33:1. Therefore, it is subsequently recommended for state funding and implementation as described in the report.

2.0 EXECUTIVE SUMMARY (continued)

2.2 WATERSHED DELINEATION AND MODELING

A Geographic Information System (GIS) was utilized to assimilate, manage and analyze hydrological, climatological, land use and cover, and general topography data and prepare a comprehensive simulation model of the Wichita River watershed. The GIS provides spatial display and analysis of relevant watershed data to determine an accurate prediction of results from implementation of the brush control program over the watershed area throughout the planned ten year life. The present brush cover, by type and category, was determined utilizing satellite imagery from the 1999 Landsat-7 Survey and ground verified for positional accuracy and densities. Refer to **Figures ES-2, Areas of Moderate and Heavy Brush** for details.

The watershed was then hydrologically divided into 48 sub-watersheds or sub-basins to accurately identify and select areas for removal of brush that would provide the greatest benefit to land uses and watershed yield. Brush cover was classified in categories of heavy, heavy mixed, moderate, moderate mixed and light. The noxious brushes having the highest uptake of the water resources were identified as cedar, mesquite and mixed brushes. Data layers were developed by the GIS for spatial analysis and integration with the hydrological modeling tool that include soils, topography, climate, and vegetative cover. The GIS will provide long-term assessment of the results and assist both the state and landowners with maintaining the implemented brush control program to achieve optimum benefits.

The amount of additional water expected from the implementation of the brush control program was estimated by using the Soil and Water Assessment Tool (SWAT) model, a simulation model that predicts the impact of watershed management activities on watershed yield and sedimentation of large unmeasured watersheds. The SWAT model then quantifies the impact of climate and vegetation changes, reservoir management activities, groundwater and surface water uses, channel hydrology, water quality conditions, and water transfers. The model was employed and calibrated by USDA-Natural Resource Conservation Service, Blackland Research Center to predict watershed yield using historical climatology and streamflow data assembled from stations located throughout the watershed.

Calibration of the model was accomplished by adjusting input parameters so that simulated output track measured streamflows as close as possible. Data utilized for calibration purposes were from the period 1960 through 1998.

Since quantitative rainfall, evaporation and streamflow data were inconsistent throughout the study area prior to 1959, brush cover was systematically reduced by categorizing the heavy mesquite areas (as determined by satellite imagery) as moderate mesquite. All areas with natural vegetative cover were classified as open rangeland in poor condition with respect to the erosive nature of the soils. The natural channel loss coefficients for

2.0 EXECUTIVE SUMMARY (continued)

streams were adjusted to correlate with the noted reductions in water table conditions resulting from groundwater withdrawals for irrigation and diversion of highly concentrated brine water in the upper reaches of the watershed by the Chloride Control Project.

The overall hydrologic condition of the watershed is fair, but the highly erosive soil structure may warrant further attention if sufficient grass cover is not provided as brush is removed.

The simulation model was applied on the different brush management techniques with the assumption that identified brush would be removed by the selected means leaving no more than a 5% canopy and would be maintained at this level for a minimum period of ten years.

Following recharge of the aquifers, reduction of brush cover on all eligible acreage would increase streamflow as measured at the Mabelle stream gage by a maximum of 38.9% or about 46,330 acre-feet per year above the current long-term average of 119,100 acre-feet.



Wichita River Watershed Areas of Moderate and Heavy Brush

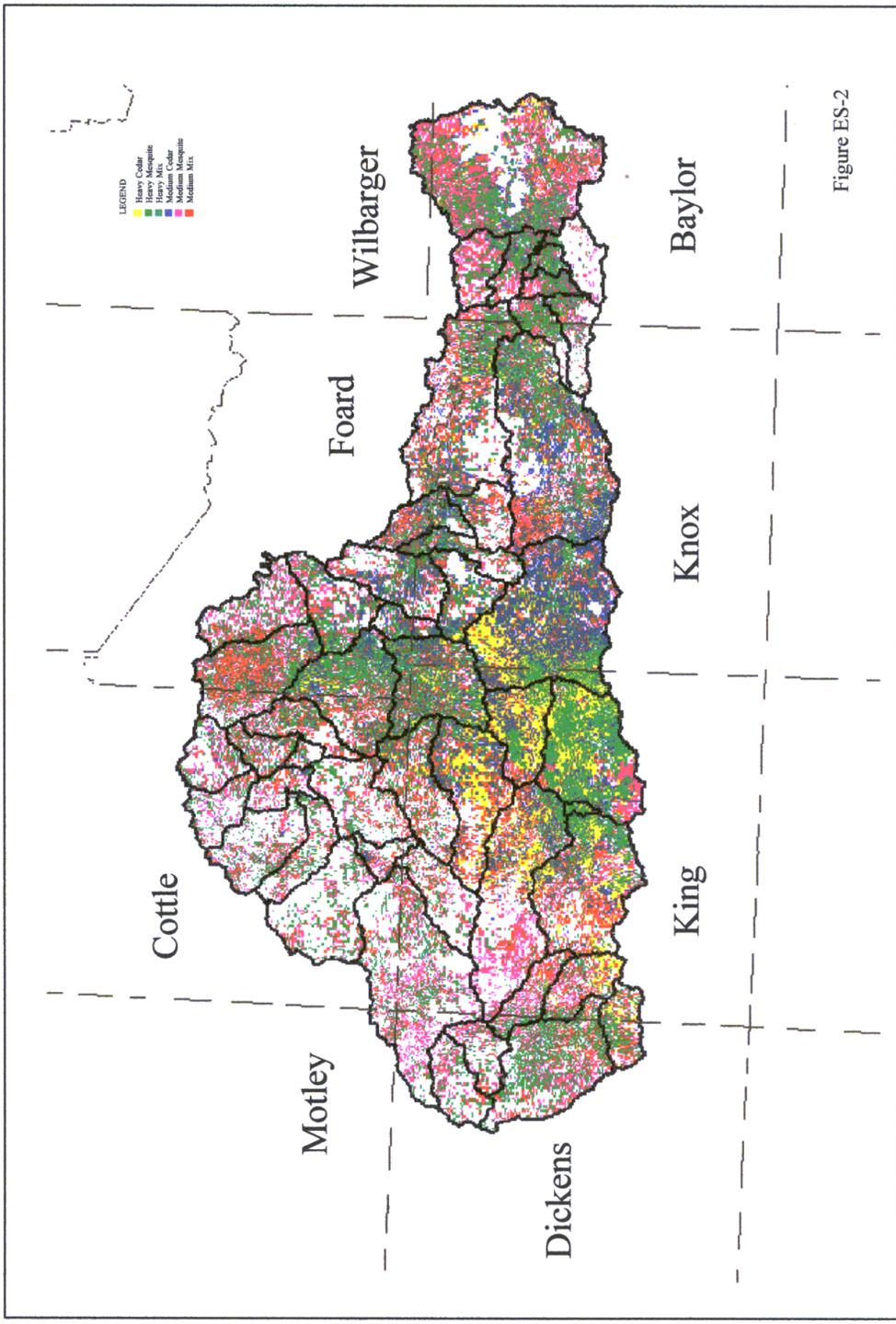


Figure ES-2

Red River Authority of Texas GIS/CDMP Report: USDA-NRCS, National Wetland Inventory, 1999

2.0 EXECUTIVE SUMMARY (continued)

2.3 ECONOMIC ANALYSIS

The total estimated cost to implement the brush control program as described for the Wichita River Watershed above Lake Kemp is **\$58,097,472** or about **\$70.37** per controlled acre. However, the costs will vary with brush type and density categories. Present values of control costs are used for estimation purposes since some of the treatments will be required in the first and second years of the program, while others will not be needed until year six or seven. Present values of total control costs per acre range from \$159.45 for mechanical control of heavy mesquite to \$33.75 for moderate mesquite that can be initially controlled with herbicide treatments.

The state cost share is estimated as the difference between the present value of the total cost per acre of the control program and the present value of the rancher cost. Present values of the state cost share per acre of the brush control range from \$140.75 for mechanical control of heavy mesquite to \$21.70 for control of moderate mesquite with herbicides.

Total treatment cost, rancher cost and state cost share per enrolled acre for the selected brush types and density categories are shown in the following table:

Brush (Type and Density)	Acreage Impacted	Rancher Cost Share	Rancher Percent	State Cost Share	State Percent	Present Value Total Cost
Heavy Mesquite	139,520	18.70	35.87 – 11.60	33.43 – 140.75	64.13 – 88.40	52.13 – 159.45
Heavy Cedar	83,840	18.79	40.53 – 14.58	27.57 – 110.07	59.47 – 85.42	46.36 – 128.86
Heavy Mixed	179,840	21.80	47.02 – 16.92	24.56 – 107.06	52.98 – 83.08	46.36 – 128.86
Moderate Mesquite	144,640	12.05	35.70	21.70	64.30	33.75
Moderate Cedar	122,880	15.13	28.15	38.62	71.85	53.75
Moderate Mixed	154,880	19.09	35.53	34.65	64.47	53.75
Total/Average	825,600	\$17.59	30.44%	\$52.78	69.56%	\$70.37

The estimated cost of increased watershed yield averages \$36.59 per acre foot for the entire Wichita River watershed above Lake Kemp over the ten year planned program life. The estimated cost per sub-watershed ranged from \$17.56 to \$91.76 per acre-foot.

Program benefits are defined as the total benefits that will accrue to the rancher as a result of implementing the brush control program. In order for the rancher to receive maximum benefit from the program, he is expected to invest or incur costs for an amount equal to his total cost share based on the acreage, brush type and density categories to be removed.

2.0 EXECUTIVE SUMMARY (continued)

Therefore, his total benefits are equal to the maximum amount that a profit maximizing rancher could be expected to spend on a brush control program (for a specific brush density category) based on the present value of the improved net returns to the ranching operation through typical livestock, wildlife and farming enterprises that would be reasonably expected to result from implementation of the brush control program. For the livestock enterprises, most of the improved net returns would result from increased amounts of usable forage produced by eliminating much of the competition for water and nutrients by controlling the brush.

Present values of these benefits will vary with brush type-density categories. The total projected direct benefits to the landowner would be \$19,314,450 or about \$23.40 return per enrolled acre as it relates to the landowner's cost share of \$14,663,635. Additional public benefits are expected to result from the increased watershed yield and improved quality. These benefits may also be indirectly attributed to expanding the water uses out of Lake Kemp. The following table represents the total benefits to be gained, directly and indirectly, within and without the watershed area:

Projected Average Program Benefits	Units	Unit Value	Annual Benefits
Net Increase in Return for Livestock Production	64,000 head	\$136 / head	\$8,704,000
Value of Enhanced Wildlife Habitat for Hunting	403,200 acres	\$0.50 / ac	201,600
Value of Additional Watershed Yield to Region	46,330 ac-ft	\$68 / ac-ft	3,150,440
Net Reduction of Advanced Treatment Costs	17,922 ac-ft	\$405 / ac-ft	7,258,410
Total Value of Benefits to be Gained			\$19,314,450

Assuming that 100% of the landowners participate in the program and the state funds its share of the cost, the benefit-to-cost ratio for the proposed brush control program is 1.33:1. That is, for each dollar the landowner invests into the program, he should expect to receive about \$1.33 in return as average program benefits.

Total public benefits to the regional area would be realized through the increased amount of water available out of Lake Kemp and a notable reduction in treatment cost for public water supply.

Therefore, it is recommended that the Texas Legislature commit to appropriate \$43,395,225 over the next three biennia for funding the proposed brush control program within the Wichita River watershed above Lake Kemp. It is further recommended that at least \$10,000,000 be provided in FY 2001 for initial program start-up cost with the remaining balance to be funded over the next three biennia.

2.0 EXECUTIVE SUMMARY (continued)

2.4 PROGRAM IMPLEMENTATION

It is recommended that implementation of the Wichita Basin Brush Control and Management Program be accomplished over the next four to six years with follow-up maintenance throughout the next ten year period to receive optimum benefits from the program.

It is further recommended that the program be administered through the Texas State Soil and Water Conservation Board (TSSWCB) in accordance with Chapter 203 of the Agriculture Code with certain exceptions to permit a greater cost share flexibility to accommodate the participants in the program. Cost share funds should be administered at the local level by the Soil and Water Conservation Districts (SWCD) participating in the program based on allocations from the TSSWCB. The SWCD's should contract with individual landowners for developing and implementing individual brush control plans.

The TSSWCB should be designated to initiate quality control measures to ensure proper herbicide mix and application, and followup monitoring accomplished under the direction of the TSSWCB with the SWCD's as the primary contact with the participating landowners to ensure the successful implementation and maintenance of the brush control program throughout its design life.

Should consideration be given to coordination of the brush control and chloride control projects for optimum benefit to the region, then it is recommended that up to 16,000 acres of light to moderate mixed brush be excluded out of the proposed brush removal plan in support of the chloride control objectives. Refer to **Figure ES-3** for details of the restricted brush removal zone. This would result in a reduction of about \$215,529 to both the state and landowners without significant impact to the benefits expected to be derived from brush control.

Wichita Chloride Control Project Area

-  County Boundaries
-  Hydrologic Unit Boundaries
-  Reservoirs
-  Identified Chloride Sources
-  Proposed Diversion Facilities
-  Operational Control Facilities
-  Rivers
-  Streams/Creeks
-  County Seat
-  Restricted Brush Removal Zone (16,000 Acres)

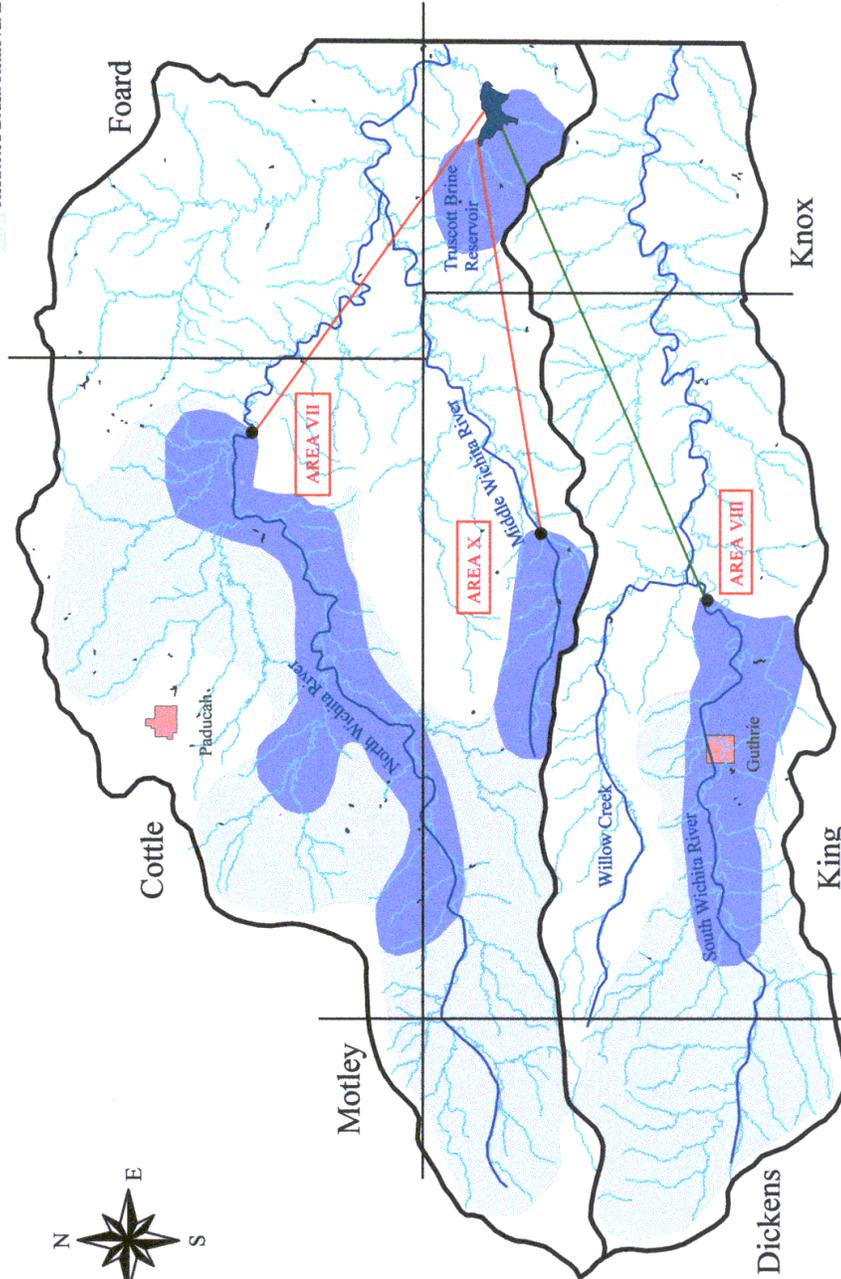


Figure ES-3

REA-47-Town-GIS-CADD-Appendix