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Public-Water Supplies During Droughts in Eastern Kansas

by

Howard G. O'Connor
Charles K. Bayne
Arif Yukler
Frank C. Foley

OPEN-FILE REPORT

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ABSTRACT

During droughts, 264 municipal and 168 rural water districts in 43 eastern Kansas counties experience shortages or other water problems. Although the annual precipitation in eastern Kansas averages 30 to 40 inches, there are large year-to-year variations in both precipitation and runoff. Also there is a general lack of extensive and reliable ground-water aquifers.

Factors that contribute to water-supply problems during droughts include (1) increased useage without increased capacity, (2) changed ground-water or surface-water conditions, (3) poor maintenance programs, (4) local funding problems, (5) poor operating and data records, (6) inadequate surface-water storage, (7) inadequate aquifer capability or well-field design, (8) inadequate pumping, storage, or distribution capacity, and (9) inadequate education and action programs to correct known deficiencies.

Factors that could resolve or improve public water supplies and prevent drought shortages include (1) continuing assessment of water-supply needs and water-supply availability, (2) improved water-supply records and associated data, (3) improved educational, informational and training programs for operators of water supply systems and consulting engineers, (4) adequate funding of water-supply facilities and water-supply programs, and (5) increased use of water information, water data, and support from State water agencies.

INTRODUCTION

Purpose of Investigation

This investigation is intended to describe existing water-supply systems in eastern Kansas in respect to present and future adequacy and to describe alternative water sources.

The first purpose is to summarize briefly the water-supply features of each public system in counties in eastern Kansas. The adequacy of each public supply, is considered, both in terms of water quality and quantity, for the years 1973-74 and for susceptibility to a severe drought.

The second purpose is to describe alternative sources of water that could be planned or investigated for improving the present water supply or for utilization during a severe drought.

Location and Features of the Area

The area discussed in this report includes 43 counties in eastern Kansas, as shown in Figure 1. Water supplies are obtained principally from surface-water sources, although some systems obtain ground water to provide all or part of the supply.

The normal annual precipitation for this area ranges from about 30 to 40 inches (Fig. 2), but the large variations in precipitation from year to year and the variations in precipitation patterns result in very large differences in runoff (normally two to 10 inches per year). Because many of the largest unregulated streams have had periods of little or no flow during past droughts, some public supplies that depend on streamflow have become inadequate.

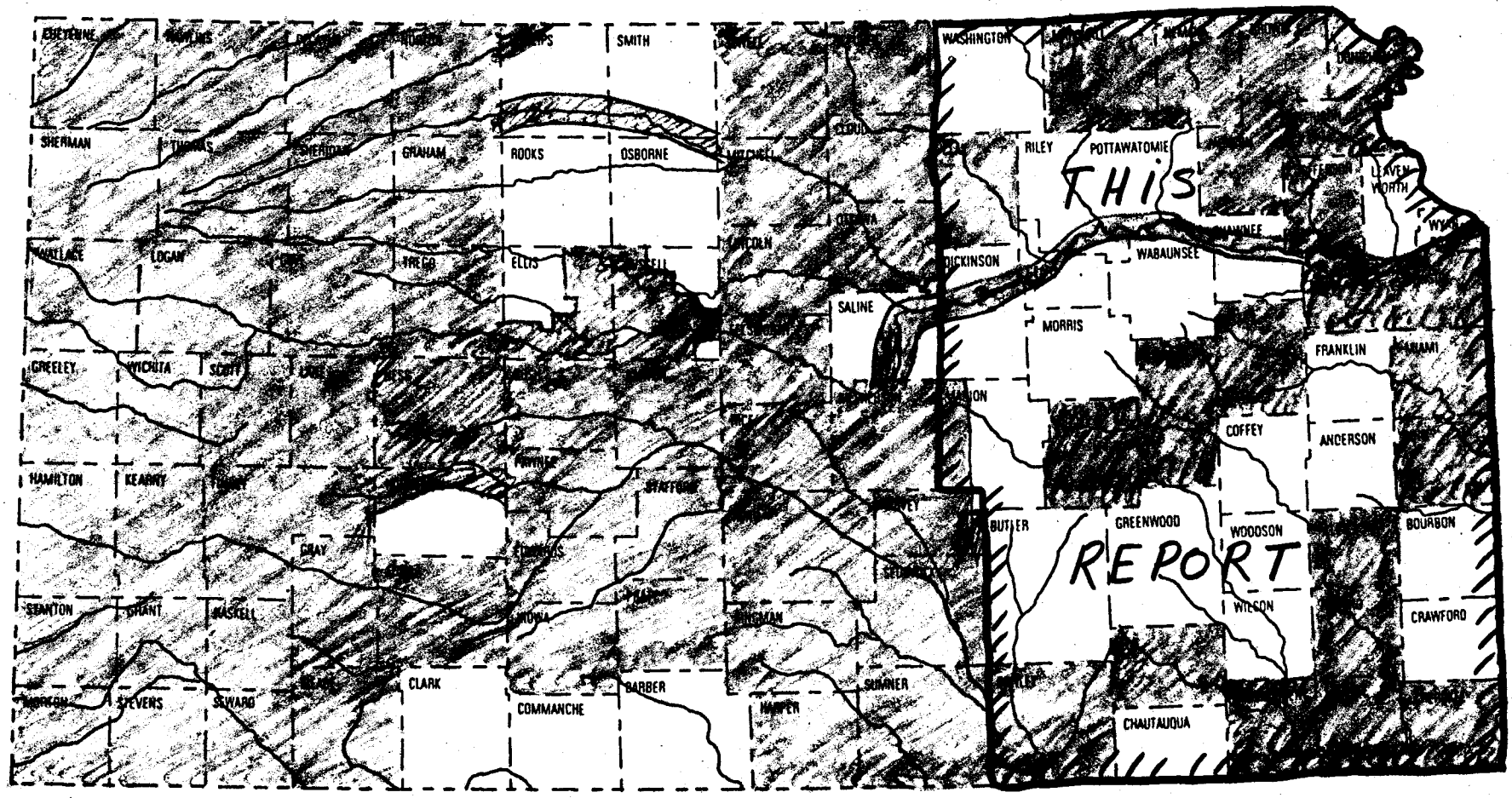

Figure 1.--Map of Kansas showing area discussed in this report and areas for which groundwater reports have been published or are in preparation.

0 50 100
Scale in miles
0 50 100
Scale in kilometers

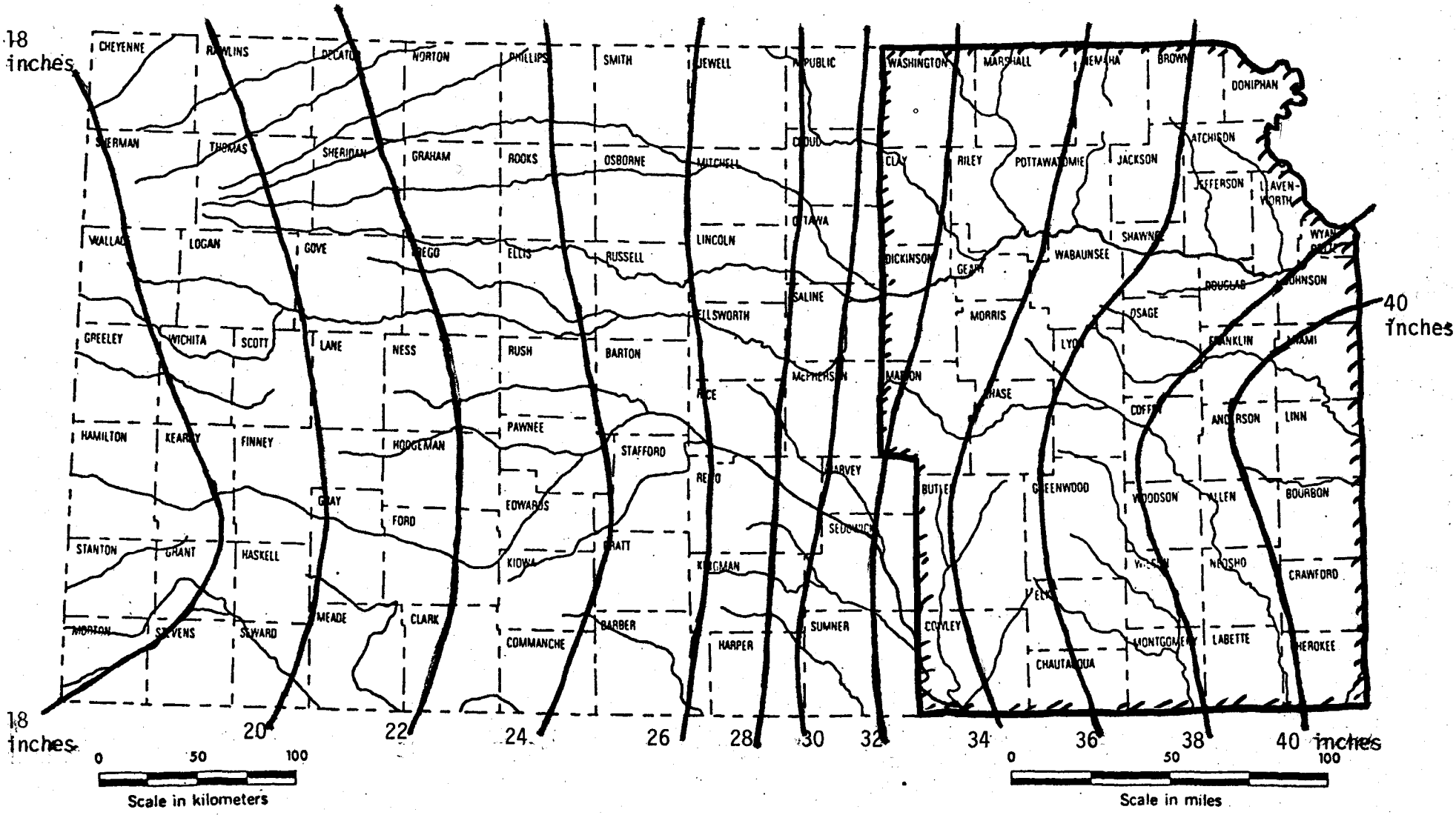

Figure 2.--Map showing normal annual precipitation for Kansas, 1941-1970 (after L. D. Bark).

The general lack of extensive ground-water aquifers in much of the 43-county area also is a factor that contributes to public-supply shortages during droughts. In some parts of the area, the chemical quality of the ground water limits its usefulness for public supplies because of excessive dissolved solids, hardness, sulfate, chloride or other constituents.

The 1972 population of the area was 1,351,395 (Kansas State Board of Agriculture, 1972). Of this total population, 1,114,764 lived in cities or urban areas served by public water supplies; 100,504 lived in rural areas served by rural water districts and 136,127 lived in small cities or rural areas that had no public water supplies.

In May 1974, there were 264 municipal water systems and 168 rural water districts (May, 1974). Ninety-five of the municipal supplies and 105 of the rural supplies are obtained chiefly or entirely from surface-water sources. One-hundred-twelve of the rural water districts purchase their water supply from a municipality or another rural water district.

Methods of Investigation

This report was prepared using the published and unpublished information on public water supplies available from the Kansas Department of Health and Environment, the Division of Water Resources of the Kansas State Board of Agriculture, the Kansas Water Resources Board, the U.S. Geological Survey and the Kansas Geological Survey. Information on rural water districts collected from the U.S. Farm Home Administration by the Kansas Water Resources Board was made available for use in this investigation.

No field work was done as part of the study because of the additional time and cost involved and because of the large amount of data already available from the various state and federal agencies.

Ground water reports have been completed or are in progress in about two-thirds of the area (Fig. 1). These reports together with geologic maps available for all of the area and the Kansas Department of Health and Environment's inventory of public water supplies provide the basis for an appraisal of the quality and quantity of ground water in each county. The adequacy of the water supply and sources of emergency water are, in many cases, judgements of the authors.

Acknowledgements

The authors wish to acknowledge the assistance of the Kansas Department of Health and Environment in providing information and water analyses on each of the public water supplies described. The Kansas Water Resources Board generously made available information on the location and distribution of areas served by Rural Water Districts which they had previously obtained from the Farmers Home Administration, U.S. Department of Agriculture.

PUBLIC WATER SUPPLIES

Problems

Public water supplies may be adversly affected during a drought because of a number of problems including the following:

1. An increase in useage or peak demand without an adequate total supply or temporary storage facilities to meet peak requirements.

2. A change in ground-water or surface-water conditions that effectively reduces the available supply. A decrease in ground-water supplies may result from an increased demand on the aquifer caused by additional water use for industrial, irrigation, and other purposes, by reduced recharge to the aquifer because of changes in land use or by changes in the relation of surface water to ground water. Thin, shallow aquifers may be directly affected by droughts resulting in water-level declines, significantly reduced saturated thickness of water-bearing materials, reduced well yields, and concurrent increases in water demand.

A decrease in surface-water supplies may result from changes in land use and land treatment that reduce run-off or increase sedimentation rates into reservoirs. Increased ground-water or surface-water pumpage outside of the local area also may reduce the total local supply.

3. Poor maintenance programs may cause reduced efficiency of wells, excessive water line leakage or wastage of water, poorly timed drawdown, and reduced storage of water in reservoirs for planned maintenance.

4. Local funding problems may delay or prohibit needed water-supply improvements. The funding problems may be the result of statutory

debt limits, or failure of voters to approve needed water-supply improvements. Lack of approval often is due to inadequate long-rage planning or inadequate educational and information programs at the local level.

5. Poor operating and data records are a frequent deficiency in all but the largest water-supply facilities, particularly public facilities that derive part or all of the supply from ground-water sources. Commonly, there are no records of yearly or more frequent changes in static-water levels, in pumping-water levels, and in well yields and well efficiencies. Thus the basic records needed for differentiating between well problems and aquifer problems are not readily available.

6. Inadequate surface-water storage in reservoirs for droughts of 20-year or 50-year recurrence interval. Owing to gradually increased water needs during a 10-, 20- or 30-year period, combined with reduced storage because of sedimentation, some public supply reservoirs have become inadequate to provide a sufficient quantity of water during droughts.

7. Inadequate aquifer capability, or inadequate well-field design cause water-supply shortages during droughts for an appreciable number of public supply systems. Many of these systems have grown to their present size and extent without benefit of planned investigations to determine the size, distribution and extent of the aquifer, to evaluate the aquifer capabilities, or to determine the proper design, spacing, and pumping rate of wells. Instead, the water-supply facilities have grown by expediency without any long-range plan or any knowledge of the aquifer characteristics to guide the design for potential growth.

8. Inadequate pumping, storage or distribution capacity may become a limiting factor in some public supply systems for providing

adequate water during a drought. Shortages may occur because local users increase their lawn and garden watering during prolonged dry weather and new users may be added, such as farmers or other public-water supply, that overtax the pumping, storage or distribution facilities.

9. Inadequate education and action programs are carried out by managers of public supply systems. Long-range plans are needed for maintaining a reserve water-supply capacity and the associated pumping, storage and distribution systems adequate to meet projected drought demands.

Solutions

Water shortages in public supplies that occur during droughts in eastern Kansas generally can be attributed to one or more of the previously cited causes. Solutions to, or prevention of, these drought-related shortages are relatively simple to describe, but may be difficult to implement the solutions involve the following:

(1) Continuing assessment of water-supply needs and water-supply availability are needed so planning and scheduling of changes, additions, maintenance, or improvements can precede any drought stresses that might cause a water-supply shortage. Assessments should be made of the surface- or ground-water sources, pumping capacity, treatment, storage and distribution systems. Planning and scheduling should include implementation of needed improvements that are recognized during annual public supply inspections by the Kansas Department of Health and Environment.

(2) Improved water-supply records and associated data are needed by almost all the small public supply systems. A large number of the ground-water systems have not been planned, but have been developed and expanded without any systematic investigation. Test drilling is needed to define the size and extent of the aquifer and to determine the best location of well sites. Additional data are needed from pumping tests to determine the aquifers hydraulic characteristics, and evaluate the water quality. In effect, the public supply exists, but data are not available to evaluate the potential water supply or the adequacy of the aquifer under stress of a drought.

A schedule of data collection should be implemented for all public supplies using water from wells. This data should include periodic measurement of static water levels, pumping water levels and pumping rates so that well maintenance may be scheduled, well efficiencies may be

determined, and potential problems may be identified and corrected before drought stresses cause a water-supply shortage.

Public supplies that obtain water from surface impoundments or streams should be reassessed periodically to determine the loss of storage owing to sedimentation so that adequate water-supply storage for drought periods is maintained. The adequacy of both regulated and unregulated streamflow for public supplies should be evaluated in terms of water requirements during droughts.

(3) Improved educational, informational and training programs are needed for operators, governing boards, and consulting engineers who are planning to utilize ground water in the development of public supplies. Very little information is available from test drilling, pumping tests, and water-level measurements to assess most public supplies that use ground water. Few of the planners understand how such information may be used to improve and maintain well efficiencies and to evaluate both the wells' and the aquifer's capacity to provide water during a drought.

An educational and training program on basic ground-water occurrence, aquifer evaluation, well design, and collection and use of water-level data should be instituted. A program of this type, perhaps coordinated or sponsored by the Kansas Water Resources Board, would be significantly beneficial to public supply operators, governing boards and consulting engineers.

(4) Adequate funding of water-supply facilities is essential to maintain reliable public supplies during droughts. Funding programs, including support of the local water patrons and governing boards, depend on adequate data records and on adequate educational and informational programs to gain support for planning water-supply facilities.

There may be statutory debt limits that cause problems in funding needed water-supply facilities. The Kansas Water Resources Board, as the prinicipal State agency for water resource planning and coordination, may provide information on federal or state funding assistance available for local water-supply facilities.

(5) Increased use of water information, water data, and support from State water agencies should be utilized by water managers, governing boards, and consultants during the planning phases of developing public water supplies.

Information obtained during the present study, repeatedly points out that few managers of public water supplies and consultants make use of the published and unpublished information on ground water, surface water, and water quality available from State water agencies. In this 43-county eastern Kansas study area, probably less than five percent of the managers of municipal water supplies and consultants contact each of the four state water agencies that have legislatively mandated roles in water administration, water planning, and water research during the planning phases of a public water supply. Probably less than two percent of the managers of rural water districts and consultants participating in programs funded by the U.S. Farm Home Administration contact each of the State water agencies for informaton and support during the planning stages of water-supply developments.

The Kansas Department of Health and Environment has administrative and regulatory functions in the planning and development of all public water supplies. Their assistance and support should be enlisted prior to the beginning of any public water supply planning, improvements or changes in water supply facilities.

The Chief Engineer of the Division of Water Resources of the State Board of Agriculture administers water law and the appropriation of water for beneficial use. Any changes in points of diversion of a ground water or surface water source or any additional diversions or new water developments are of concern to the Chief Engineer. The Division of Water Resources therefore should be contacted for assistance early in the planning for any public water supply developments.

The Kansas Water Resources Board is the designated state agency for water resource planning and coordination. There are 13 federal reservoirs (Fig. 3) authorized, under construction or operating which include 1,012,400 acre feet of State managed water that will supply a two percent chance yield of 353.8 million gallons per day. The Kansas Water Resources Board is the State contracting agency for purchase and sale of state managed water in federal reservoirs in Kansas. The Kansas Water Resources Board is also knowledgeable about state and federal funding sources and assistance available for water resource developments.

The Kansas Geological Survey is a research agency that has statutory responsibilities for investigation of the mineral resources of the state including ground-water resources. Reports describing the geology and ground water resources have been published for about 85 percent of the state. Ground water investigations have been carried out in cooperation with the Water Resources Division of the U.S. Geological Survey since 1937. The Kansas Geological Survey ground water program is also supported by and coordinated with the Division of Water Resources of the Kansas State Board of Agriculture, the Division of Environment, the Kansas Department of Health and Environment and the City of Wichita.

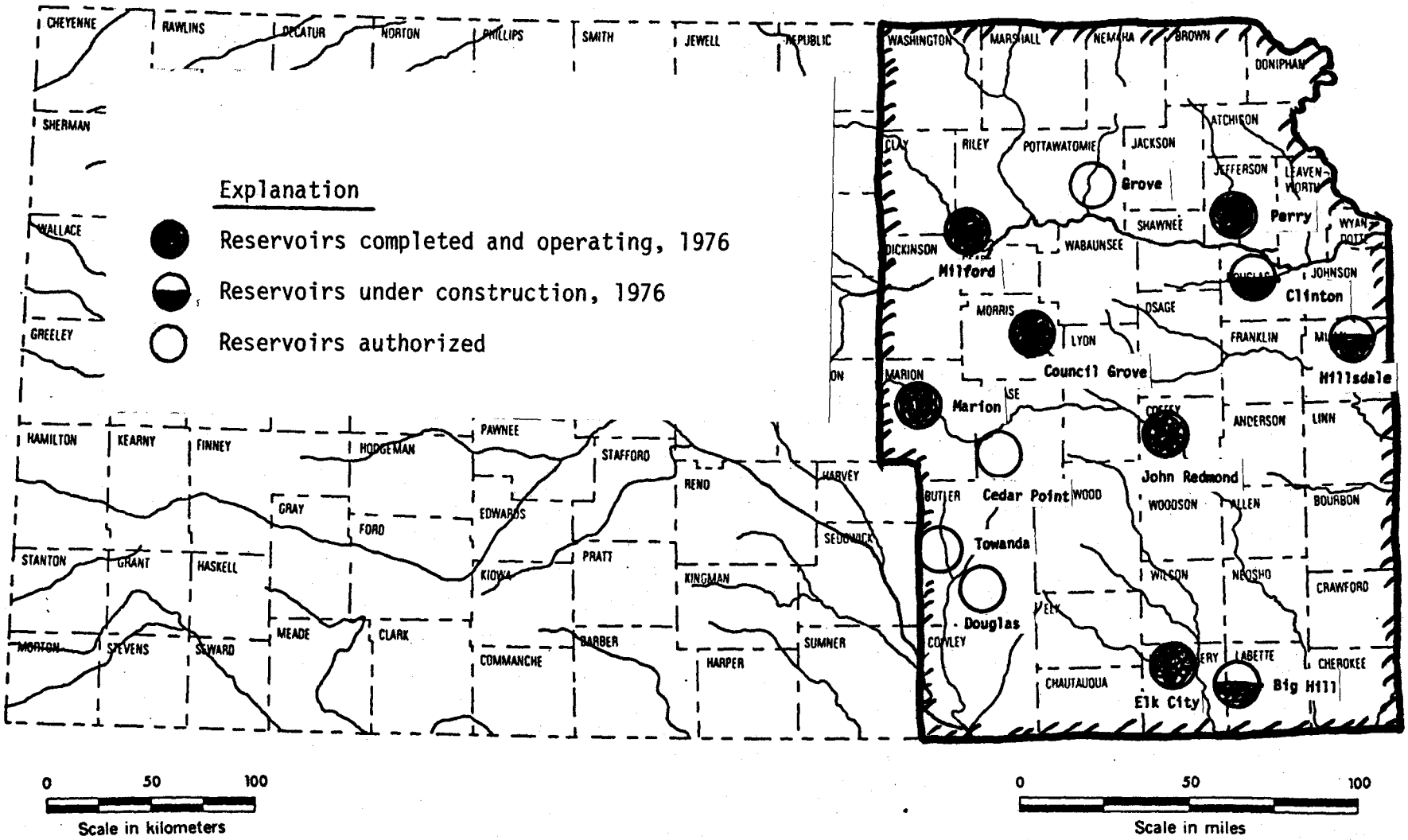

Figure 3.--Map of Kansas showing location of 13 federal reservoirs in which Kansas has state managed conservation storage available for industrial and municipal water supply use.

In addition to published information on the state's ground water resources much unpublished information is available. Approximately 16,000 chemical analyses of fresh to saline water samples are available and approximately 29,000 water well and test hole schedules are in the data files. Records of water level changes are maintained throughout the state from about 800 wells and in addition ±1,500 wells are measured annually each January to moniter changes in the major aquifer systems of western and central Kansas.

Since passage of the Kansas Ground Water Exploration and Protection act by the 1974 Legislature all water well contractors have been required to be licensed, construct wells to prescribed minimum standards of construction, and to file records of the water well construction on a standard Water Well Record form. The Kansas Department of Health and Environment administers the program. The Kansas Geological Survey maintains a public file of these Water Well Records. About five-thousand records of domestic, stock, irrigation, industrial and public water supply wells are received each year (5,648 in FY 1977).

A lithologic sample library is available which contains samples from approximately 2,000 test holes and water wells.

The research facilities of the Kansas Geological Survey include computer storage, retrieval, manipulation and use of many kinds of ground water information and the preparation of computer based graphic displays. Utilization of all useful water information, both published and unpublished to assess and evaluate various aquifers and potential public water supply sources should be incorporated into any public water supply planning to reduce costs and improve the water supply development.

Ground water reports have been completed or are in progress in about two-thirds of the area (Fig. 1). These reports together with geologic maps available for all of the area and the Kansas State Department of Health and Environment's inventory of public water supplies provide the basis for an appraisal of the quality and quantity of ground water in each county. The adequacy of the water supply and sources of emergency water are in many cases judgements of the authors.

Public Water Supplies During Droughts, 1953-54

During the drought of 1953-54 one-third of the 264 public water systems in the 43 counties described in this report were inadequate. Most of the inadequacies were caused by shortages of well water, shortages in rivers or streams or shortages in surface water reservoirs. A few shortages were caused by inadequate pumping capacity, treated water storage capacity or inadequate distribution system (Kansas Water Resources Fact Finding and Research Committee, 1955).

Water shortages generally result in restrictions on water use, higher water rates, inconvenience, and expenditures for emergency actions to bring temporary relief from the shortage. This is generally followed by new and more permanent additions or corrections to the water supply facilities.

Public Water Supplies and Alternative Sources

The general water situation regarding surface water supplies, ground water supplies and water quality for 43 eastern Kansas counties is described followed by a brief description of each public water

supply within that county. Table 1 summarizes in tabular form pertinent information about each of the described public water supplies.

Descriptions of the water supplies for 264 municipal or privately owned water supply systems and 168 Rural Water Districts are given on the following pages. The growth of the number of Rural Water Districts has been quite rapid and complete data on some of these districts is not available. Cut-off date for data on municipal supplies is mid-1973 and for Rural Water Districts is early 1974.

Allen County

Eight municipalities in the county are served by public water supplies (Table 1) and other areas are served by eight rural water districts originating within the county and five rural water districts originating in adjacent counties (Fig. 4). The municipalities of Iola, Humboldt and Moran have their own source of supply. Bassett, Gas City, and La Harpe obtain water from Iola, and Elsmore and Savonburg obtain water from Neosho County Rural Water District No. 2. All of these municipalities use surface-water supplies. Mildred has no public water supply.

The eight Allen County rural water districts, located north, east and south of Iola, obtain water from Iola. The northwestern part of the county is served by Anderson County Rural Water District No. 5 and the west-central part is served by Woodson County Rural Water District No. 1. The northeastern part of the county is served by Bourbon County Rural Water District No. 4 and the southeastern part is served by Neosho County Rural Water District No. 2. A small area in southwestern Allen County is served by Neosho County Rural Water District No. 7.

The limestones and shales that underlie Allen County generally are not good aquifers and do not furnish adequate supplies of water for municipal use. The alluvial deposits in the principal stream valleys are more permeable and larger supplies of water generally can be obtained from this source (Miller, 1969). Well yields from alluvial deposits generally are greater than 10 gpm and rarely as much as 100 gpm. Wells in thin alluvial deposits, are more likely to be affected by drought than deep bedrock wells and can expect diminished yields during prolonged periods of drought.

Humboldt, the second largest city in Allen County, obtains water from the Neosho River to serve a population of 2,320. the water shortage during the 1953-54 drought was met by compulsory restrictions. No major improvements have been made, although, an assured water supply could be obtained by contracting for State managed water in upstream reservoirs.

Moran obtains water from an impoundment on the south fork of the Little Osage River to serve a population of 610. The city experienced no shortage during the 1953-54 drought and the present water supply probably is adequate. In an emergency, water probably could be obtained from Iola. Very limited supplies of water from wells in Pennsylvanian sandstones could augment the regular supply.

Iola, the largest city in Allen County, obtains water from the Neosho River to serve an urban population of 6,720. Iola also supplies water to a combined population of 1,616 in the cities of Bassett, Gas City and La Harpe and in the eight rural water districts. The water shortage during the drought of 1953-54 was met by voluntary restrictions. Since the 1953-54 drought, the eight water districts have been added to the system. However, the city has applied to the state for 300,000 gpd of state managed reservoir conservation storage that should provide an adequate supply during a future drought. Wells in the alluvial deposits of the Neosho River valley could provide limited supplies in an emergency.

Bassett purchases water from Iola to serve a population of 50. The city is dependent on Iola for its supply and should experience no shortage during a future drought.

Gas City purchases water from Iola to serve a population of 454. The city should experience no shortage in a future drought.

La Harpe purchases water from Iola, through an arrangement with Gas City, to serve a population of 500. It is not likely that shortages will occur in a future drought except that quantities may be limited by pipelines and distribution systems.

Elsmore and Savonburg obtain water from Neosho County Rural Water District No. 2 to serve a combined population of 2,260. The adequacy of the supply for these two cities is dependent on the amount of water available from Neosho Rural Water District No. 2.

Allen County Rural Water Districts No. 1-8 obtain their water supplies from the City of Iola to serve a population of 552. Problems in the water supplies of these water districts due to drought are not anticipated since the Iola water supply is considered adequate.

Anderson County

Three municipalities in the county, Colony, Garnett, and Greeley, have their own municipal water supplies; and two, Harris and Westphalia, are served by Rural Water Districts and two towns, Kincaid and Lone Elm, have no public water supplies (Table 1, Fig. 5). The county is mainly agricultural with small towns, the largest being Garnett with a population in 1973 of 2,988. Not much groundwater is available from the limestones and shales which are the predominate rock type in most of the county (Moore, 1940). Normal precipitation is about 40 inches and the construction of impoundments for water supply is important for public, private and livestock use.

Colony, a small impounded water on Deer Creek southeast of town is the source of Colony's water supply. A shortage was experienced in 1953-54 and voluntary restrictions were imposed. A drought would again result in water shortages. Additional impounded storage or provisions for supplemental water supply from RWD #5 needs to be made in order to assure an adequate water supply. There is no local source for a good supplemental groundwater supply.

Garnett's water supply consists of a city lake north of town, a small impoundment at the water treatment plant in the south part of town and an impoundment on Cedar Creek northwest of town. A water shortage was experienced in 1953-54 which was met by voluntary restrictions on water use. Major improvements were made in 1968. The present water supply is probably adequate to provide a normal water supply during a drought. Little fresh groundwater is available from the local Pennsylvanian age limestones and shales. Wells yielding 5 to 20 gpm might be developed locally in the shallow alluvial aquifer along

Pottawatomie Creek north of Garnett and along South Fork of Pottawatomie Creek southeast of town as temporary supplemental supplies. The alluvial fill in these stream valleys is relatively thin and the materials are chiefly fine grained, therefore they are not likely to be a significant source of water during a drought.

In Greeley three shallow wells in the alluvial aquifer in the Pottawatomie Creek valley provide the public water supply. There is at present no reserve water supply capacity to meet either increased needs or decreased well yields (Table 1) which might result from a drought. A systematic program of test drilling in Pottawatomie Creek valley to locate the best areas for future groundwater development and the construction of one or more additional wells would improve the adequacy and reliability of the water supply. Since the town water supply requirements of about 0.030 mgd are small, an increased capacity could most easily be obtained by expansion of the present well yield into the most productive areas of the alluvial aquifer.

The public water supply for Harris is a part of Anderson County RWD No. 4 and is discussed under RWD No. 4.

Anderson County RWD No. 1 purchases water from the city of Garnett. Maximum useage in 1973-74 was about 5,000 gpd and a contract arrangement is for the purchase of as much as 0.010 mgd. The district's water supply therefore seems to be satisfactory but is dependent on Garnett maintaining adequate surface water storage to provide adequate water during a drought.

Anderson County RWD No. 2 was constructed in 1965 and uses an impounded surface water supply located just south of Westphalia. The reported safe yield of the impoundment is 0.036 mgd and the reported

maximum-daily consumption is about 0.038 mgd and average-daily consumption is about 20,000 gpd. The system appears to be marginally adequate to provide normal service during a drought. Additional local surface-water storage to increase the dependable yield would be the most logical method of improving the water supply. Alternative sources would be contract purchase of water from the adjacent Coffey County RWD #3 which obtains treated water from Burlington, Kansas and has available a large capacity in excess of their present needs.

Anderson County RWD No. 3 was started in 1964 and serves a population of 190. Water is purchased from the city of Richmond in Franklin County. Average daily use is .012 mgd. The Richmond water supply will be discussed under the discussion of Franklin County.

Anderson County RWD No 4 was started in 1969 and improved in 1971. Water is obtained from four wells located in sec. 12, T20S, R16E in Coffey County. Water of good quality is obtained from sandstones of the Douglas Group. A dependable yield of 0.115 mgd from the four wells is reported and the maximum daily consumption is reported as 0.048 mgd. The district appears to have an assured water supply adequate to carry through a drought. Additional wells could be completed in the Douglas sandstone aquifer should the need arise.

Anderson County RWD No. 5, the largest district in the county, began operation in 1974. The maximum daily useage is reported to be about 0.260 mgd and the available supply for purchase is reported as 0.374 mgd. The treated water supply is purchased from the city of Iola. No problems are anticipated due to drought provided the city of Iola maintains the necessary firm water supply from the Neosho River and the water treatment and pumping facilities to meet its commitments.

There are no likely alternative sources of local ground water supplies within the district which could reasonably supply the district needs.

In addition to the five RWD's which have been organized in Anderson County and serve a part of the county, there are four RWD's which are organized in other counties but serve small areas in Anderson County. Extreme northeast Anderson County is served by Miami County RWD #3. Northwest Anderson County is served by Franklin County RWD #4. A small area north of the north fork of Pottawatomie Creek in northeast Anderson County is served by Franklin County RWD #6. A small area in southwestern Anderson County is served by Coffey County RWD #3. All of these districts are discussed under the counties in which they are organized.

Atchison County

Atchison County is relatively well endowed with both surface water and ground water resources. Large water supplies are available from the Missouri River along the east edge of the county and well yields of 300 to 2,000 gpm are available from the alluvial aquifer associated with the Missouri River valley. In nearly half of the remainder of the county yields of 10 to 100 gpm can be obtained from the Quaternary age glacial and fluvial deposits. Locally the Quaternary deposits yield 100 to 300 gpm to wells along the channel of a buried glacially filled east trending valley. The areas having the greatest potential well yields also are areas likely to contain groundwater having high concentrations of dissolved solids (500 to 1,000 mg/l), hardness (>300 mg/l) and objectionable amounts of dissolved iron (0.3 to 24 mg/l).

Much useful information on the geology and hydrology of Atchison County is contained in a report by John R. Ward (1973). Any future public water supply development should be made only after a thorough consideration of the hydrologic data in that (Ward's) report.

The Pennsylvanian age rocks which crop out locally and underlie the Quaternary deposits throughout the county are relatively poor water bearing rocks. They generally provide only small supplies, 10 gpm or less and in some areas little or no water. They are not important as potential sources of supplementary water supplies for use during a drought.

Atchison has had no shortage of water during the past drought years because of an inadequate supply in the Missouri River, source of

the city's water, and none is anticipated. Production and treatment facilities of 4.0 mgd and a maximum consumption of 3.3 mgd indicate an adequate facility with little or no susceptibility to a drought problem. Large supplies of groundwater are available in the Missouri River valley alluvial aquifer should this source be needed.

Huron has no public water supply, the residents depending on individual water wells. The town and surrounding area are underlain by about 80 feet of saturated glacial and fluvial deposits capable of yielding 10 to 100 gpm to wells. A public water supply could be developed in the local area from the same water-bearing deposits. Water quality in this locality is relatively good (Ward, 1973).

Lancaster has one well, supplying this municipality with a very hard (total hardness 305 mg/l) but otherwise satisfactory water supply. The water is obtained from Quaternary glacial deposits. Maximum water useage in 1973-74 is reported as 0.028 mgd and maximum dependable yield of groundwater is reported to be about 0.064 mgd. The water supply appears to be adequate at the present.

Shortages or future additions to the water supply can be met by constructing additional wells tapping the Quaternary glacial-fluvial aquifer in the local area.

Muscotah has one shallow well supplying very hard (total hardness 326 mg/l) water for the town. Maximum water useage in 1973-74 is reported as 0.060 mgd, water plant capacity as 0.430 mgd and maximum dependable yield of groundwater as 0.100 mgd. The water supply is not treated except for chlorination.

No problems are anticipated to result from drought conditions. Additional groundwater supplies can easily be developed from the

local Quaternary alluvial aquifer or from the Quaternary glacial-fluvial deposits utilizing the information of Ward (1973).

Effingham experienced no water shortages in the 1953-54 drought years and none are expected if another drought should occur (Table 1). The town has three deep wells which are located in the deep eastward trending buried valley described and mapped by Ward (1973). That the water is obtained from sand and gravel deposits in the lower part of the buried valley-fill deposits is indicated by the higher concentrations of dissolved solids (Table 1) and the greater concentration of salt (sodium 155 mg/l and chloride 125 mg/l) in the water in contrast to the other public water supplies in the thinner glacial-fluvial deposits. Greater concentrations of iron and manganese are also present.

Groundwater supplies to meet drought needs or future expanded needs can easily be met from wells constructed in the glacial-fluvial deposits in the local area, and improved water quality could be obtained by proper location and development of new wells utilizing the information of Ward (1973).

Atchison County RWD No. 1, 2 and 3 were started in 1960, 1964 and 1967 respectively and obtain their water through contract purchase agreements from the Atchison municipal water supply. Because Atchison obtains its water from the Missouri River and has little susceptibility to drought the Rural Water Districts are considered to have firm water supplies which would not be affected by future droughts.

Atchison County RWD No. 4 is under construction. This district will serve a part of southwestern Atchison County and small areas in Jefferson and Jackson counties.

Bourbon County

All of the public water supplies in Bourbon County, except for Fulton, are derived from streams or impoundments. Although normal annual precipitation exceeds 40 inches (Bark, 1971) there is a wide variation in runoff from year to year. During the period 1930-1956 annual runoff in the Marmaton River Basin above Fort Scott ranged from less than one-half inch to more than 31 inches (Kansas Water Resources Board, 1958). Public water supplies utilizing surface water must therefore be designed to provide adequate water during drought periods when there may be long periods of little or no runoff.

Wells which obtain groundwater supplies from the Pennsylvanian age sedimentary rocks generally yield less than 10 gpm and in drought years may yield much less. Most wells deriving water from limestone, sandstone, or shale beds are not adequate and reliable during drought periods. Mississippian and older rocks yield brackish or salty water.

The alluvial valley fill deposits along the principal streams are generally thin and the deposits are mostly fine grained so that only relatively low yielding wells are possible. These are likely to have reduced yields during drought.

Bronson's water supply is obtained from an impoundment about 1 1/2 miles east of town which was constructed in 1958 (Table 1). Maximum water useage in 1973-74 was reported as 0.054 mgd; however, the maximum dependable production of the water treatment plant is only 0.040 mgd. The average daily water useage is about 0.030 mgd and can be met by the present water treatment plant. However, an enlarged treatment plant is needed to meet the maximum water demands. The impoundment is reported to have a safe yield of 0.060 mgd.

Although some supplemental water could probably be obtained in an emergency from local wells drilled into the Pennsylvanian age rocks the quantity and quality of the water would probably not be satisfactory. Hauling water from other public supplies, such as Iola or Fort Scott, would be very expensive. Water supply for drought periods can best be met by maintaining adequate local impounded storage.

Fort Scott, the largest city in Bourbon County (Table 1), obtains its water supply from the Marmaton River and has two impoundments, Rock Creek lake about two miles west of town and Fort Scott lake, about three miles southwest of town. The three sources are reported to provide a safe yield of 6.0 mgd. The maximum dependable production by the water treatment plant is reported to be 3.0 mgd. The average and maximum useage is reported in 1973-74 as 1.5000 mgd and 2.280 mgd respectively. The town supplies water to Bourbon County RWD No. 1, 2 and 3. The water supply is of good quality, having total dissolved solids of only 251 mg/l (Table 1).

The water shortage which occurred during the drought of 1953-54 resulted in compulsory restrictions of water use. Improvements made in 1959 have increased the impounded water safe yield and no problems are anticipated that would result from another drought.

The town has a deep well completed in the Ordovician Arbuckle Limestone. However, the Arbuckle water is of poor quality and cannot be used directly by the city for municipal supply. In an emergency it could be blended with the good quality impounded water to the extent of about 25% and still provide an acceptable quality water for municipal use. Similarly the Arbuckle water in the future might be used as process water for a demineralization plant since the water is only brackish

and could be demineralized at less cost than more highly mineralized water.

Fulton, a small town in northeastern Bourbon County utilizes two shallow wells in the alluvial aquifer of the Little Osage River valley as the source of its water supply. The wells have a reported maximum dependable yield of 0.010 mgd. The average water useage is reported as 0.010 mgd and maximum water useage is reported as 0.015 mgd. The water contains objectionable amounts of dissolved iron and manganese.

Alternatives to the present poor quality and inadequate supply might be found with a systematic test drilling program in the local alluvial aquifer to determine if water of better chemical quality (less dissolved iron and manganese) and greater potential well yields could be located. Appreciable difference in amounts of dissolved rion and manganese and potential well yields commonly may occur within distances of 100 to 200 feet in alluvial aquifers.

Second and third alternatives would be to establish a water treatment plant and an impounded water supply on the Little Osage River or one of its tributaries or to purchase and pipe water form the Fort Scott water supply either singlely or in conjunction with a Rural Water District to serve intervening areas.

Mapleton and Redfield are small towns without public water supplies yet two or three small capacity wells of 5 to 10 gpm yields in the valley alluvial deposits of the Little Osage River and Marmaton River respectively might be obtainable to provide satisfactory public water supplies. A systematic test drilling program in the local alluvial aquifer could determine if satisfactory quantities and quality water could be obtained to provide a municipal water supply.

Other alternatives would be construction of a treatment plant and an impounded water supply near each town.

Uniontown completed in 1958 a small impounded water supply on the Marmaton River at the south edge of town and provides adequate quantities of good quality water. The maximum reported dependable production of the treatment plant is 0.043 mgd and this is nearly the same as the maximum daily useage of 0.042 mgd (Table 1). Safe yields of the impounded water supply is reported as 0.050 mgd.

Although the present system is probably adequate some though ought to be given toward increasing the plant capacity and impounded storage. One or two wells of 5 to 10 gpm capacity might be developed in the shallow alluvial aquifer of the Marmaton River valley which could add 5,000 to 15,000 gpd to the water supply. A test drilling program could determine the quantity and quality of groundwater available from the alluvial aquifer.

Bourbon County RWD's No. 1, 2, and 3 serve the suburban and rural areas around Fort Scott (Fig. 7). Each district has been in operation since the early to mid 1960's, and No. 1 and No. 3 have made improvements since their original construction (Table 1). They obtain good quality treated water from the Fort Scott municipal water supply and have contract agreements large enough to meet their maximum present water requirements and appreciable increase in future requirements.

The ability of each of the Rural Water Districts to meet potential demands during a drought are directly related to ability of Fort Scott to provide the water. Inasmuch as Fort Scott's water supply appears to be adequate, no drought problems are anticipated.

None of the Rural Water Districts have water treatment palnts and cannot process surface water supplies in an emergency situation. Both Arcadia and Girard, a few miles to the south in Crawford County, have water plant capacities to supply the normal water demands of the three Rural Water Districts with good quality groundwater. Water transported by rail from Arcadia or Girard would be much more expensive but could be accomplished relatively easily to meet a temporary emergency situation.

Rural Water District No. 4 to serve northwestern Bourbon County and parts of Allen and Linn counties is being planned.

Brown County

Groundwater is the principal source of water for both public and private water supplies, the town of Horton being the only public water supply utilizing surface water in Brown County. Wells having yields of as much as 450 gpm are obtained from the glacial deposits and yields of as much as 250 gpm are obtained locally from rocks of Permian age in the northwestern part of the county. Pennsylvanian age limestones, shales and sandstone beds, which underlie all of the county, yield only small quantities of groundwater. Wells yielding 10 to 20 gpm are obtainable from alluvial deposits along the principal stream valleys. Groundwater resources of Brown County have been studied and described by Bayne and Schoewe (1967).

Everest experienced a shortage of water, and poor quality water in 1954 from a well yield located within the city. An improved water supply, both in quality and quantity, was provided by a new well field located about two miles south of the city in Atchison County. Water supplied from the old well field contained excessive nitrate (NO_3), more than twice the dissolved solids, and greater hardness than water from the new well field (Bayne, 1967).

In 1974 the maximum dependable yield of groundwater was reported as 216,000 gpd and the maximum production and distribution capacity was 180,000 gpd which indicates a satisfactory margin of safety when measured against average and maximum use of 0.050 and 0.075 mgd in 1973-74 (Table 1).

The water is very hard but otherwise of good chemical quality. No shortages are anticipated that cannot be met by developing groundwater from the local glacial drift aquifer.

Fairview and Hamlin, two small towns in the northwestern part of Brown County, use private water supplies. The water supplies of both towns could be improved if the necessary investigations were made to locate and develop a groundwater supply of satisfactory chemical quality from either the Quaternary glacial deposits or the Permian limestones and shales in the vicinity of each town.

Alternative surface water supplies and associated treatment plants would probably be more expensive to develop than groundwater supplies. Participation in Brown County Rural Water District No. 1 would provide a water supply satisfactory to both towns. Water in large enough quantity but of poor quality could be obtained from rocks of the Council Grove Group in the vicinity of Fairview.

Hiawatha, the largest city in Brown County, obtains its water supply from two new wells about four miles north of the city and three older wells south of the city (Fig __, Table 1). The wells range from 20 to 97 feet in depth and obtain groundwater from Quaternary glacial deposits. One well is reported to yield 450 gpm.

The water is of good chemical quality except that it is very hard. Chlorination is the only treatment given. Capacity of the two well fields is reported adequate to meet 1974 maximum requirement and should be satisfactory during a drought. Future additions to the supply can be met by one or more additional wells properly located in the local glacial drift aquifer.

Horton's source of water supply is Mission Lake, an impounded water supply on Mission Creek at the northeast edge of the city. The lake was constructed in 1935. Prior to the lake's construction the city had obtained groundwater from wells in the Little Delaware River valley alluvium and Mission Creek valley alluvium.

Kansas State Department of Health records (1974) indicate Mission Lake has a safe yield of 0.720 mgd. Average and maximum use was reported as 0.500 and 0.650 mgd in 1974 so the lake has only a small margin of excess capacity. The lake is 40 years old and its original capacity has been reduced as a result of sedimentation. The capacity and adequacy of the lake to meet water needs during a drought probably needs to be re-evaluated. The lake water has less hardness and dissolved solids than any of the public supplies utilizing groundwater.

In an emergency the city could probably obtain a supplemental groundwater supply from wells in Little Delaware River valley and Mission Creek valley.

Morrill's water supply is obtained from two drilled wells about one mile south of town. The wells were drilled in 1951 and are about 91 feet deep. Water is obtained from the Permian Grenola Limestone and Roca Shale (Bayne, 1967). The water is of satisfactory quality except that it is very hard and bas a NO_3 content of about 45 mg/l.

The wells have a maximum dependable yield of about 0.058 mgd and in 1973-74 the maximum water useage was about 0.035 mgd (Table 1).

Prior to 1951 the city obtained its water supply from two 90 foot deep wells located in town which tapped the Permian Long Creek Limestone aquifer. This water was of very poor quality because of excessive dissolved solids (2,378 mg/l), excessive hardness (1,732 mg/l) and sulfate (1,464 mg/l).

Additional groundwater of satisfactory chemical quality can probably be developed from the local aquifers. A systematic program of test drilling and sampling should preceed any future additions to the municipal water supply in order to determine the quality and quantity of

water available and locate the best sites for future groundwater developments.

Powhattan uses two shallow wells located in the south part of Powhattan to supply this small town's public water supply. The water plant was constructed in 1965 and has been adequate in quantity of water but of marginal quality. Dependable yield of the well field is reported as 0.043 mgd whereas average and maximum useage amount to only 0.012 mgd and 0.018 mgd. The water is very hard and contains excessive nitrate (87 mg/l) for a good public water supply.

An improved water supply of better quality could probably be located in the local aquifers with a systematic program of test drilling and sampling.

Three alternative sources of groundwater are available, namely (1) the alluvial aquifers along the Little Delaware or the Delaware River, (2) the Permian Limestone and shale aquifers, and (3) the glacial drift aquifer.

Reserve obtains its water supply from one large diameter dug well about 40 feet deep in the alluvial aquifer along Walnut Creek at the east edge of the city (Fig. __). Records of the Kansas State Department of Health (1974) indicate the well has a maximum dependable yield of about 0.058 mgd and the average and maximum useage in 1973-74 was reported as 0.020 mgd and 0.032 mgd (Table 1). The water quality is generally satisfactory except for hardness and the NO_3 content of 58 mg/l is above the recommended maximum of 45 mg/l.

It is very probable that an additional well located on the basis of test drilling and sampling could improve both the water quality and assure the necessary quantity during a drought period.

Although the Walnut Creek allvuial aquifer is at the edge of town an alternative source would be the glacial drift aquifer 1 1/2 to 2 1/2 miles east of town or 1 1/2 to 2 miles west of town.

Robinson experienced water shortages during the drought of 1953-54 when its water supply was obtained from three wells in Wolf Creek valley alluvium. The drought caused a gradual decline in the thickness of saturated water-bearing materials in which the wells were constructed and a consequent reduction in the yield of the wells. In 1963 improvements were made which included construction of additional water supply wells. Six wells now provide a maximum dependable groundwater supply of 0.111 mgd. Average and maximum consumption are reported as 0.020 and 0.032 mgd respectively according to records of the Kansas State Department of Health (1974).

The newer wells yield water that is higher in dissolved solids, sulfate, chloride, nitrate, and hardness than the south well of the old well field and the overall chemical quality of the supply is not as good as before. No drought problems are anticipated with the additional water provided by the new wells. Future well locations should be preceeded by test drilling and sampling to determine the best locations for improved water quality from the local aquifers.

Willis has no public water supply, depending instead on individual wells in the local glacial drift aquifer. A better quality public water supply could probably be obtained from wells constructed in the glacial drift aquifer outside of the town.

Brown County Rural Water District No. 1 boundaries are not yet constructed as shown on Fig. __. At the time of inventory of public water supplies (May, 1974) no information was available on source of

water supply for the district. A small area in west-central Brown County is served by Nemaha County RWD #3.

Butler County

Butler County is the largest county in the State in land area (1,450 square miles) and ranks eleventh in population (37,839). Twelve cities have public water supplies, three of which use surface water impoundments. The remainder use groundwater. Three Rural Water Districts serve the public with water supplies in the central part of the county and an area of about 10 aquare miles in the extreme southwest part of the county is served by Sedgwick County RWD #3 (Cassoday has no public water supply).

Much of the county is adequately supplied with groundwater for stock and domestic use (Moore, 1940; Leonard, 1972). The largest well yields occur in the western one-third of the county but this is also the area where the poorest quality ground-water occurs. Water is obtained in this part of the county from the lower part of the Wellington Formation and the uppermost part of the Chase Group. Gypsum commonly occurs in these rocks causing them to yield water high in calcium and sulfate to wells. Locally the aquifers have been contaminated with oil field brines.

Andover's water company is a privately owned company. It furnishes water to the city of Andover from four shallow wells. The population served is 640 persons. Average daily use is 0.065 mgd and maximum daily use is 0.093 mgd. Maximum dependable production is 0.195 mgd with the dependable production about three times the average daily use. There is little probability that a drought would cause water shortages in the city unless the city has a considerable population increase. An alternate supply or an emergency supply could be obtained by purchase from the City of Wichita.

Augusta's water supply is obtained from two surface water impoundments. Augusta Lake is north of the city and Santa Fe Lake is northwest of the city. The city had a water shortage during the 1953-54 due to inadequate lake storage. The emergency was met by compulsory restrictions on water use and from emergency wells in the alluvial deposits in the Arkansas River valley near Mulvane in northwestern Sumner County. Water was transported through an unused oil pipeline. A population of 6,300 persons is served by the water system. Average daily use is 0.680 mgd and maximum daily use if 1.5 mgd. Safe yield of the impoundments if 1.75 mgd. This supply probably would not be adequate during a prolonged drought and groundwater of good quality is not available as a supplemental supply. The long range solution to the water shortages in the city would be through purchase of state managed conservation storage in either the Towanda Reservoir or the Douglas Reservoir when they are constructed. The short range solution would be by transporting water into the city by pipeline as was done in the 1953-54 drought.

Benton's water supply is obtained from two shallow wells which pump water from the lower Wellington Formation and the Upper Chase Group. The population served by the system is 510 persons. Average daily use is .058 mgd and maximum daily use is .125 mgd. Maximum dependable production is .180 mgd. The city did not have a water shortage in 1953-54 and the system is probably adequate unless a considerable growth in population occurs. The qulaity of the city water is very poor. The water is very high in sulfate and total hardness. Better quality water is not available from wells within a reasonable distance of the city. When the Towanda Reservoir is completed the city could

buy conservation storage. This water would be of much better quality than the present supply.

The Douglas municipal water supply is obtained from ten deep wells east and south of the city, which pump water from the Barneston Formation of Permian age. The population served is 1,200. Average daily use is .140 mgd and maximjm daily use is .320 mgd. Maximum dependable production is .460 mgd. The city was short of water during the 1953-54 drought but presently the supply is adequate. Well yields probably will devrease in a long period of drought. Until the Douglass Reservoir is constructed additional wells are the only source of a supplemental supply.

The Elbing municipal water supply is obtained from two shallow wells which penetrate lower Wellington Formation rocks. The population served is 150 persons. Average daily use is .010 mgd and maximum daily use is .020 mgd. Maximum dependable production is .144 mgd which is more than ten times the average daily use. A water shortage due to prolonged drought is not likely to occur. The quality of the water is poor. It is high in sulfate and hard. A surface water impoundment would be the only source of better quality water.

Eldorado is the largest city in Butler County. The municipal water supply is obtained from two lakes located northeast of the city. The water supply system serves a population of 11,781. Average daily use is .766 mgd and maximum daily use is 1.300 mgd. Maximum dependable production is 6.750 mgd but maximum safe yield is 3.700 mgd. The city had a water shortage during the 1953-54 drought when the city lakes were nearly dry. Restriction on use were imposed and water transported to the city through the same pipeline that served Augusta during the

drought. Part of the drought problems during the 1953-54 drought were because Lake Bluestem had not completely filled before the drought occurred. With increased water use and a prolonged drought before completion of the U.S. Corps of Engineers Eldorado Reservoir water shortages could occur again. Purchase of state managed conservation storage by the city will assure the city of an adequate water supply.

The Latham water supply is obtained from three shallow wells and a small impoundment on a tributary to Rock Creek. The water system serves a population of 170. Average daily use is .010 mgd; maximum daily use was .025 mgd. The water from the wells was a poor quality sodium bicarbonate water high in iron and flouride. The supply is presently adequate but a prolonged drought might deplete the reservoir. Emergency supplies could be obtained from the State Lake about two miles northwest of the city.

The Leon water supply is from three shallow wells which obtain water from the alluvium of Little Walnut River. The system serves a population of 531. The average daily use is .052 mgd and the maximum dily use was .075 mgd. Maximum safe yield is .216 mgd. The city had a water shortage during 1953-54, but, after improvements were made on the system in 1964, the system is probably adequate. In an emergency, supplemental water could be obtained by drilling additional properly spaced wells in the Little Walnut valley.

The Potwin water supply is obtained from three shallow wells drilled into the lower part of the Wellington Formation. The system serves a population of 555. Average daily use if .053 mgd and maximum daily use is .110 mgd. The city did not have a water shortage during the 1953-54 drought and the supply is probably adequate for a drought which may occur in the future. The water from the lower Wellington Formation

is very poor in quality. The city could obtain better quality water through purchase of state managed conservation storage when the Towanda Reservoir is built.

The Rose Hill municipal water supply is from two shallow wells drilled inot the lower Wellington Formation. Population served by the system is 475. Average daily use is .065 mgd and maximum daily use was .120 mgd. Maximum dependable production is .108 mgd. The water use is near a safe capacity of the system presently and would be inadequate with appreciable population increase or another prolonged drought. The water is of poor quality. Additional wells would increase the quantity of water available to the city but the best source of good quality water would be to purchase water from the city of Wichita.

The Towanda water supply is obtained from three deep wells and two shallow wells. The population served is 1,200. Average daily use is .088 mgd and maximum daily use is .175 mgd. Maximum dependable production is .715 mgd. The city did not have a water shortage during the 1953-54 drought and the supply is probably adequate should another prolonged drought occur. The quality of the water is poor. Better quality water could be obtained through purchase of state managed conservation storage from Towanda Reservoir when it is built.

The Whitewater water supply is obtained from three shallow wells which penetrate the lower Wellington Formation. The population served is 520 and the average daily use if .050 mgd. The maximum daily use was .110 mgd. Maximum dependable production is .216 mgd and would probably be adequate should a prolonged drought occur. The quality of the water is poor; it is high in sulfates, iron and nitrate. Should an emergency occur, additional water could be obtained by drilling more wells.

Better quality water could be obtained from a surface water impoundment.

Butler County Rural Water Districts 1, 2 and 3 serve the public east and southwest of Eldorado. All of the RWD's purchase water from the city of Eldorado. Rural Water District No. 1 serves a population of 515 and RWD's 2 and 3 serve populations of 550 and 440 respectively. Average daily use of the three districts totals .108 mgd. Since these water systems purchase their supply from the city of Eldorado the adequacy of these systems depends on the adequacy of the Eldorado supply. Should a prolonged drought occur before Eldorado Reservoir is built, these RWD's could experience a water shortage. Emergency supplies, in that case, could be obtained from wells.

Chase County

All of the public water supplies in Chase County are obtained from groundwater in the alluvial aquifers associated with the principal stream valleys (Table 1, Fig. __). Groundwater from the alluvial aquifers is very hard (calcium and magnesium bicarbonate) and locally contains enough dissolved iron or manganese to be objectionable in a public supply or require treatment facilities for its removal. Pumpage is small enough in the vicinity of each of the water supply well fields that no problems associated with overpumping or dewatering of the aquifer should occur during a drought, although well yields might decline somewhat during a prolonged drought. Adequate groundwater supplies are available to meet the needs of all the public water supplies during drought periods.

Cedar Point, with a population of about 70 persons, is located in the Cottonwood River valley at the west side of the county and has no public water supply. Residents have their own private wells in the Cottonwood River valley alluvial aquifer. A public water supply could be easily developed in the same local aquifer. The groundwater from the Cottonwood River valley alluvial aquifer is very hard and locally contains objectionable amounts of dissolved iron and magnanese for use as a public water supply. Groundwater from Cedar Creek valley southeast of town might provide somewhat better quality water although water from both sources would be very hard. Wells 30 to 40 feet deep should yield 25 to 100 gpm and provide a dependable water supply. Groundwater resources of the county have been described by O'Connor (1951).

In 1974 Cottonwood Falls obtained its water supply from three wells northwest of town in the alluvium of the Cottonwood River valley. A

water shortage occurred during the drought of 1953-54 because of inadequate well capacity. Improvements to the supply were completed in 1965 (Table 1) and the city reportedly now has a dependable groundwater supply of 0.526 mgd. Average useage is about 0.085 mgd and maximum useage about 0.141 mgd. The groundwater is very hard. An ion exchange treatment is used to improve the chemical quality of the water.

Adequate quantities of groundwater are available from wells ranging in depth from 30 to 60 feet in the local alluvial aquifer to maintain a normal water supply during a drought.

As alternatives a surface water supply from the Cottonwood River or from impounded storage on a tributary could be developed, but either of these alternatives would require a water treatment plant and much larger capital investments than the groundwater supply.

One well in the Cottonwood River valley alluvial aquifer provides Elmdale's public water supply (Fig. __). No water shortage occurred during the drought of 1953-54 and no shortage of groundwater would be expected in another drought. The population of Elmdale is 95 and the maximum reported water useage is only about 0.010 mgd. The dependable groundwater yield is reported as 0.144 mgd from one well (Table 1).

Anu future expansion or replacement of the existing well should be based on results of a test drilling program which might improve the water quality by reduction of total dissolved solids, hardness and iron. The most logical alternate source of water supply for the present well would be an additional well in the same local aquifer, its location based on results of a test drilling program.

Matfield Green's water supply was initiated in 1956 and improved in 1961. Two shallow wells in the alluvium of the south fork of the

Cottonwood River east of town are reported to provide a dependable supply of 0.065 mgd. The average daily use if reported as 0.008 mgd and maximum is 0.016 mgd. Water quality is satisfactory except that it is very hard.

Any future shortages which might occur as a result of drought might be met by additional prospecting with a test drilling program in the area downstream, where the valley becomes wider and the alluvial fill materials are more extensive. There are perineal springs which discharge good chemical quality water from the Wreford and Barneston Limestones about three miles southwest of town (O'Connor, 1951). One or more of these springs might supply an alternate source of water which could be hauled by tank truck or piped into town.

Strong City' groundwater supply is derived from the alluvial aquifer of the Cottonwood River valley which serves about 625 customers. The town experienced a water shortage during the drought of 1953-54 but has since improved and added more capacity to its water supply. Two shallow wells are reported to provide a dependable supply of 0.216 mgd of very hard but otherwise satisfactory quality water. Average and maximum useage in 1973-74 is reported as 0.063 and 0.100 mgd (Table 1).

The alluvial aquifer of the Cottonwood River valley is thick enough and extensive enough to provide water during a prolonged drought. Any shortages that might develop using the present two wells could be corrected by construction of one or two properly spaced additional wells.

Chase County RWD #1, to serve an area in the northeast part of the county is in the planning stage. A small area in the east-central part of the county is served by Lyon County RWD #2.

Chautauqua County

All of the public water supplies in Chautauqua County during the drought of 1953-54 experienced water shortages whether the source was groundwater or surface water (Kansas Water Resources Fact Finding and Research Commission, 1955). All of these towns have since made improvements in their supplies and one Rural Water District has also been constructed.

The alluvial deposits along Caney River and along Caney Creek are relatively thin, the deposits are mostly fine grained and yields of wells in these alluvial aquifers decline significantly during droughts. Groundwater obtained from the Pennsylvanian limestones, shales, and sandstones ranges from good quality to salty. Oil field operations have resulted in pollution of some of the fresh water aquifers.

No reports have been published describing the groundwater resources of Chautauqua County although published reports are available for the adjacent counties of Cowley, Elk, and Montgomery in Kansas and Osage County in Oklahoma.

Cedar Vale is provided an impounded water supply from a small overflow dam in the channel of Caney River east of the town and four shallow wells in the adjacent alluvial aquifer of Caney River valley above the dam provides a groundwater supply (Fig. 11). Only the wells were used for water supply during the drought of 1953-54 and they were inadequate. About $29,000 was spent on emergency water supplies during this drought. A water treatment plant has since been added to treat Caney River water.

The four wells provide a dependable yield of 0.210 mgd and the safe yield of the impounded water supply is reported as 0.103 mgd. Maximum

dependable production of the water plant is 0.300 mgd. Average useage in 1973-74 was 0.130 mgd and maximum useage was reported as 0.260 mgd. The municipal supply appears to be adequate in 1974 but plans should be made to increase the dependable supply in the near future. The present water quality of the combined groundwater - surface water supply is satisfactory except that the water is very hard.

The most practical method of increasing the dependable water supply probably would be to develop an additoinal well field of two or more wells either up valley or down valley from the present well field, or to provide additional in-channel storage with another overflow dam upstream from the present dam.

The small town of Elgin in southern Chautauqua County (Fig. __) experienced a water shortage in the drought of 1953-54 which required the expenditure of about $500 to obtain emergency water supplies. Improvements were made in 1965 and in 1974 and the town was reported to have a dependable groundwater supply of 0.030 mgd from two shallow wells. The older of the two wells is a shallow dug well which is not used regularily. The water is very hard but is otherwise of satisfactory chemical quality (Table 1).

Both wells, at the west side of town, obtain water from the alluvial deposits along the Caney River valley and from the underlying Pennsylvanian Elgin Sandstone.

A severe drought might again result in a water shortage. In additional groundwater supply of 15 to 20 gpm from one or more wells properly located so as not to cause excessive interference with the existing wells would greatly improve the reliability of the water supply in a severe drought. The local alluvial and sandstone aquifer probably has

the potential for providing this additional quantity of water at least cost. An alternative supply might be obtained east of town in the alluvial aquifer along Cedar Creek but would be much more expensive because of pipeline costs, and probably would not be as productive.

Peru experienced a water shortage in the drought of 1953-54 which required restrictions on water use. Improvements were last made to the water supply system in 1965. Very hard but otherwise satisfactory quality water is obtained from three deep wells southeast of town that pump water from Pennsylvanian age sandstone aquifers (Fig. 11). The dependable groundwater yield is reported as 0.040 mgd; the average and maximum useage in 1973-74 is reported as 0.024 and 0.038 mgd (Table 1). A severe drought might easily cause a water shortage as the maximum daily useage is approximately the maximum dependable groundwater yield. An additional groundwater supply of 15 to 20 gpm from the local aquifer should be added to the public water supply system as soon as possible.

Alternative sources of supply that might be considered include a pipeline connection to Sedan or Chautauqua RWD No. 1 or in an emergency water could be transported by rail or truck from Sedan. A well inventory and water sampling program followed by test drilling in the area southeast of Peru would probably indicate that a groundwater supply of 0.100 mgd (70 gpm) could be developed in the vicinity of the present well field and would be the least expensive method of expansion. Test drilling and sampling would identiry the best areas for additional wells and also identify any areas of the groundwater reservoir that might contain water polluted by oil field brines.

Sedan was provided water supplies from one impounding reservoir northwest of the town on Deer Creek in the drought of 1953-54 and was

not adequate to provide a normal supply. Compulsory restrictions on water use were imposed to meet the emergency. A second impounding reservoir on Deer Creek has since been constructed (Fig. 11) which increased the impounded safe yield to 0.800 mgd. Average and maximum useage in 1973-74 is reported as 0.205 and 0.380 mgd respectively and no drought caused shortages are anticipated (Table 1). Maximum dependable production of the water treatment plant is reported as 375,000 gpd and increased facilities for water treatment are needed to meet current maximum useage. The water is of good chemical quality.

There probably are no good alternatives for developing a very large groundwater supply in the local area. A dependable supply adequate to serve the city's needs therefore depends on planning and construction of surface water impoundments in advance of needs that provide an assured supply through a severe drought period.

Wells yielding about 10 gpm might be obtained locally in the Pennsylvanian Ireland Sandstone aquifer at depths of less than 200 feet.

In the 1950's water in the alluvial aquifer was reported high in chloride, probably as a result of past oil field operations, and not useable for public supply purposes.

Chautauqua County RWD No. 1, a small district south of Sedan, was constructed in 1966, and in 1973 served a population of 70 persons (Table 1, Fig. 11). Average and maximum useage is reported as 0.006 mgd and 0.008 mgd respectively in 1973-74 and more water is available if purchased from the Sedan public water supply.

The Rural Water District has no standpipe or elevated storage nor does it maintain water treatment facilities. For this reason, it is

rather intermently dependent on Sedan's public water supply and its alternate source must be the same as Sedan's. Two 10 gpm wells completed into the Pennsylvanian Ireland Sandstone at the north and south ends of the district might serve as a temporary emergency water supply.

An area of a few square miles in southeast Chautauqua County is served by Montgomery County RWD #5 and small areas along the northern border of the county are served by Elk County RWD #1.

Cherokee County

Except for the town of Baxter Springs, all of the public water supplies depend entirely on groundwater pumped from deep wells for their source of supply. Baxter Springs has deep wells and in addition uses water from the Spring River for its public water supply. No drought related shortages of water should occur in any of the public water supplies which utilize groundwater.

Wells in the alluvial deposits associated with the Spring River and the Neosho River do not yield very large groundwater supplies and are subject to greatly decreased yields in drought periods. Shallow wells in the Pennsylvanian shales and sandstone units may fail in drought periods and water quality is not as good as from the Ordovician aquifer. The Mississippian limestone aquifer does not yield water of as good quality as the Ordovician aquifer and is not used for public water supplies.

Baxter Springs (Fig. __) utilizes water from the Spring River which is reported to have a safe yield of 3.00 mgd. The water treatment plant can dependably process 2.50 mgd. In addition, the town has three deep wells which range from 1,094 to 1,288 feet in depth and produce water from the Ordovicain Arbuckle Group aquifer. City Well No. 6 pumps 800 gpm and the dependable groundwater yield from the well field is reported as 1.00 mgd. City Well No. 3, the oldest of the wells, is not normally used. Water from the wells and from Spring River is of satisfactory quality (Table 1) and adequate to meet any foreseeable periods of drought. Water levels and yields of the deep wells are little affected by drought because of the large quantities of groundwater stored in the regional aquifer.

City Well No. 3, 1,288 feet deep, is being used (1975) as an observation well. It has been fitted with an automatic water level recorder to moniter continuously the changes in water level in the Ordovician Arbuckle aquifer in the Baxter Springs area.

Alternative sources of water supply do not seem to be needed. An additional well tapping the Ordovician aquifer would be the most logical means of increasing the water supply.

Columbus has three deep wells in the Ordovician Arbuckle Group aquifer and is provided a satisfactory quality and reliable water supply (Fig. 12). City Well No. 4 is 1,700 feet deep, City Well No. 5 is reported as 1,783 feet deep and City Well No. 6 is 1,100 feet deep. Each well is equipped to pump about 500 gpm. The reported maximum dependable groundwater yield is 1.944 mgd and water plant capacity is reported as 1.296 mgd. Average and maximum water consumption is reported as 0.510 and 1.00 mgd respectively (Table 1). No water shortage was experienced during the 1953-54 drought and none is expected as a result of future droughts.

For the foreseeable future the most logical alternative water supply provided by city wells 4, 5, and 6 would be one or more new wells in the Arbuckle aquifer. In an emergency part of the municipal supply might be obtained by arranging purchase of water from adjacent RWD's No. 1, 3 or 4.

Crestline is part of and served by Cherokee County RWD No. 1 and is discussed with the Rural Water District (Table 1).

Galena is provided with a satisfactory groundwater supply by three deep wells in the Ordovicain Arbuckle Group aquifer (Fig. 12). The

older well, known as the Empire Well, is 1,012 feet deep and reportedly pumps 240 gpm. A second well, Galena North, is 1,162 feet deep and pumps about 800 gpm. The third well, Galena South, is 1,177 feet deep and reportedly pumps 400 gpm. A water shortage was experienced during the drought of 1953-54 which was met by voluntary restrictions on water useage. The shortage was caused by lack of adequate pumping equipment rather than a shortage of available groundwater. This deficiency has been corrected and the maximum dependable production using the present pumping equipment is reported as 1.080 mgd. The maximum dependable yield of the wells is reported to be 2.038 mgd. The water provided by the wells is of generally good wuality (Table 1).

Should an emergency shortage of water occur probably the whickest resolution would be to negotiate purchase of water from Cherokee County Rural Water District No. 2 and 3 which abuts Galena on the west. District No. 2 has the well and pumping capacity to supply 50,000 to 70,000 gpd of supplemental water and Cherokee County RWD No. 3 has the capacity to supply about 100,000 gpd. A more permanent resolution of any water shortage would be through construction of one or more additional Ordovician wells in the local area.

Riverton has one well 1,200 feet deep and equipped with an 80 gpm pump to provide its water supply (Fig. 12). The water, obtained from the Ordovician Arbuckle Group aquifer, is of good quality (Table 1). No shortages of groundwater occurred during the 1953-54 drought.

In an emergency the city could probably negotiate for purchase of water from Cherokee County RWD No. 2 whose wells are in Riverton and have the capacity to supply maximum day consumption for both the Rural Water District and town of Riverton.

Roseland (Fig. 12) purchases its water supply from the city of Scammon and has no treatment or production facilities of its own. Average daily useage is reported as 0.009 mgd and maximum day useage is reported as 0.014 mgd (Table 1).

An alternative source of water might be to purchase water from Cherokee County RWD No. 4 which serves the adjacent areas and has adequate production and treatment facilities to supply Roseland.

Scammon's public water supply is provided to two deep wells in the Ordovician Arbuckle Group aquifer (Fig. 12). Well No. 1, drilled in 1902 is 890 feet deep and pumps 50 gpm. Well No. 2, drilled in 1903 is 920 feet deep and pumps 200 gpm. The maximum dependable well yeild is reported as 0.360 mgd whereas average daily consumption and maximum daily consumption is reported as 0.060 mgd and 0.110 mgd respectively. Water production and treatment facilities are capable of producing 0.072 mgd and improvements are needed in these facilities. Water quality is satisfactory.

No drought related water shortages are likely to occur at Scammon with its water supply wells in the regionally extensive Ordovician aquifer. One additional local well would provide insurance gainast any water shortage.

The small town of Treese on the Kansas-Oklahoma border (Fig. 12) experienced a water shortage during the 1953-54 drought. The shortage was caused by inadequate pumping equipment and was handled by voluntary restrictions on water useage. The water pumped from one deep well is only marginally satisfactory (Table 1). As much as 0.300 mgd of water is available if purchased from Cherokee County RWD No. 3.

With the water available from the rural water district no drought caused shortage is anticipated and no additional alternative sources seem needed.

West Mineral's public water supply (Fig. 12) is obtained from one deep well, 1,284 feet deep which pumps water from the Ordovician Arbuckle Group aquifer. Another smiliar well si pumped only when needed and is considered a "standby" well. Average and maximum daily consumption are reported as 0.026 mgd and 0.040 mgd respectively and maximum dependable yield from the wells is reported as 0.380 mgd (Table 1). The chemical quality of the water is marginally satisfactory, the wells being located along the western margin of the area in which the Arbuckle aquifer contains water satisfactory for public water supply use. A water shortage occurred in 1953-54 which caused some voluntary restrictions in water use. The shortage was not caused by inadequate water available from the Ordovician but inadequate pumping and treatment facilities.

In the event of a shortage one additional Ordovician well could be added to the system or purchase of water from Cherokee County RWD No. 5 might be negotiated.

Cherokee County RWD No. 1 serves a population of 510 in the area around Crestline (Table 1, Fig. __). The water supply is obtained from one well about 900 feet deep drilled into the Ordovician Arbuckle Group aquifer. The water is of satisfactory quality and the well is adequate to meet the average and maximum daily consumption. Drought problems will have little or no effect on the ability of the aquifer to supply the district well.

Future needs can be met by an additional deep well, or in an emergency water might be purchased from Cherokee Coutny RWD No. 2

which has the ability to meet maximum daily consumption for both districts.

Cherokee County RWD No. 2 is supplied water with one well 920 feet deep with a capacity of 100 gpm pumping water from the Ordovician Arbuckle Group aquifer. The water is of satisfactory chemical quality and the reported maximum dependable groundwater yield of 0.115 mgd is adequate to meet the average daily and maximum daily consumption of 0.015 and 0.045 mgd respectively (Table 1).

Future needs can be met by installing a larger capacity pump, an additional deep well or negotiating purchase of water from Cherokee County RWD No. 3 which abuts RWD No. 2 and has the pumping capacity and dependable groundwater yield to serve both rural water districts.

Cherokee County RWD No. 3 serves a large area west of Baxter Springs (Fig. __). Water is obtained from two wells each about 1,050 feet deep which pump water from the Ordovician Arbuckle Group aquifer. Maximum dependable yield from the two wells is reported as 0.230 mgd and maximum dependable production through the treatment plant is reported as 0.173 mgd. Average daily consumption os 0.079 mgd and maximum daily consumption is reported as 0.127 mgd.

No drought related shortages are anticiapted. Future increases can be met through expansion of the local well field. Emergency water supply needs could be met by purchase of all or part of the district water needs from Treese, Baxter Springs, Riverton, Cherokee County RWD No. 2, or Columbus all of which are immediately adjacent to the area served by Cherokee County RWD No. 3.

Cherokee County RWD No. 4 completed in 1969 a well 1,110 feet deep in the Ordovician Arbuckle Group aquifer to serve Cherokee County

RWD No. 4 (Fig. 12). The well is equipped with a 160 gpm pump and is reported to have a maximum dependable yield of 0.115 mgd which is also the maximum dependable production through the water treatment plant (Table 1). Average daily and maximum daily consumption are reported as 0.083 and 0.095 mgd respectively. The water, after treatment, is hard but of otherwise good quality. No supply problems caused by dourght are expected but the reported dependable well production and water treatment facilities are not much greater than the maximum daily consumption. Consideration should be given toward increasing the treatment facilities and increasing the dependable well production; either by means of a second well or by utilizing a larger pump and deeper pump setting in the existing production well.

In an emergency water might most easily be obtained by making temporary arrangements to purchase water from Weir City which is adjacent to the district on the north and has about 0.100 mgd excess capacity above their maximum daily consumption. Columbus, adjacent to the district on the south, ahs more than 0.200 mgd excess plant and well capacity and might serve as a temporary source of emergency water supply.

Planned increases in both water plant treatment facilities and groundwater production from their present well or from a second well in the local aquifer should be completed ahead of anticipated needs.

Cherokee County RWD No. 5 and 7, both along the Cherokee-Crawford County border purchase water from the city of Cherokee, a small town on the south border of Crawford County. Cherokee County RWD No. 5 reportedly has an average daily and maximumdaily consumption of 0.019 and 0.028 mgd respectively. The district has purcahse agreements for

0.080 mgd if needed. RWD No. 7 has average daily consumption of 0.015 mgd and maximum daily consumption of 0.020 mgd and 0.030 mgd available if purchased.

Clay County

All of the public water supplies in Clay County utilize groundwater as the source of supply. None of the towns experienced a water shortage during the drought of 1953-54. There are three principal water bearing units in the county, namely (1)the unconsolidated Pleistocene sand and gravel deposits associated with the Republican River valley, (2)the Cretaceous sandstones and (3)the Permian limestones and shales.

The alluvial sand and gravel aquifer extends from the northwest corner toward the southeast to just below Clay Center where the aquifer becomes submerged by the Milford Reservoir. The Cretaceous Dakota Formation is an important sandstone aquifer in a part of the western and northern portions of the county. The Permian Barnestone Limestone yields moderate amounts of groundwater at depths of 200 feet or less in the southeastern part of the county. The Permian Wellington Formation and other Permian beds yield poor quality water or relatively small quantities of groundwater and are less important as sources for public water supplies. The groundwater resources of Clay County have been described by Walters and Bayne (1959).

Milford Reservoir (Fig. 3) contains 300,000 acre feet of state managed conservation storage which provides a 2% chance yield of 128 mgd available for the purchase through the Kansas Water Resources Board. The reservoir is a potential source of good quality water for public water supply systems, particularly in southeastern Clay County.

In Clay Center five wells ranging in depth from 50 to 58 feet have yields of 500 to 900 gpm and provide a reliable supply of satisfactory quality water for the city. The water is very hard (555 mg/l total hardness) but is not treated except for chlorination (Table 1).

The aquifer is of adequate thickness and extent that additional water supply can be obtained by expansion of the well field. Milford Reservoir would be a source of somewhat softer water but would require a water treatment plant to process the water.

Clifton, along the Republican River in the northwest part of the county (Fig. 13) obtains its water supply from two wells each about 65 feet deep in the Pleistocene alluvial aquifer associated with the Republican River valley (Table 1). The water which is very hard is stabilized, softerned by ion exchange softeners, and chlorinated before distribution in the city. The alluvial aquifer is of adequate thickness and extent that any additional water supply can be met by expanding the well field.

Green obtains its water supply from three wells approximately 170 to 190 feet deep tapping the Permian Barneston Limestone aquifer (Table 1, Fig. 13). The depandable groundwater yield is about 0.075 mgd but capacity of the water plant is only 0.018 mgd according to the Kansas State Department of Health inventory. No shortage of groundwater has been experienced because of drought. Some expansion of plant capacity needs to be made in order to satisfy current maximum daily use of 0.022 mgd.

The local aquifer is considered to be adequate if wells are properly spaced. Alternative sources might be wells in the Republican River valley alluvial aquifer about six miles southwest of town.

Idana has four shallow wells about 40 feet deep in a small stream valley south of town (Fig. 13). The depandable groundwater yield of 0.025 mgd and plant capacity of 0.019 mgd (Table 1) are adequate but

the water quality is only marginally satisfactory. Chlorination is the only treatment.

Prospecting in the local alluvial aquifer very probably could result in locating somewhat better quality water with respect to dissolved iron, manganese, and nitrate.

Alternative sources of reliable groundwater supplies would be to move the well field east into the alluvial aquifer associated with the Republican River valley.

Longford obtains its water supply from five wells approximately 100 feet deep pumping from the Cretaceous Dakota or Kiowa formations. Water quality is good. Dependable groundwater yield and plant capacity of 0.144 mgd are adequate.

Chapman Creek valley, north of the town, might provide an alternative groundwater supply but the local Dakota aquifer probably provides better quality water.

Morganville (Fig. 12) has two wells 53 and 57 feet deep pumping from the Republican River valley alluvial aquifer (Table 1). Dependable groundwater yield is reported as 1.0 mgd which is much greater than maximum daily use. The water quality is generally satisfactory except for hardness of 403 mg/l. No drought related water shortages are anticipated.

Additoinal water supply needs can be met most easily by expanding the well field in the local alluvial aquifer.

Residents of Oak Hill depend on individual wells to provide their water supplies. An improved public water supply could probably be developed from wells obtaining water from the alluvial aquifer associated with Chapman Creek above or below the town, or from wells tapping the Dakota or Kiowa formations near the town.

A test drilling and water sampling program could provide needed information on the best sites for well locations.

Wakefield has two wells in the south part of town which supply an adequate and reliable water supply. The wells are each 57 feet deep and obtain water from alluvial deposits associated with the Republican Rivery valley. The water is very hard but otherwise of good chemical quality.

No alternative supply seems necessary but additional wells could be constructed in the local alluvial aquifer or deeper wells could be constructed to test the water from the underlying Permian Chase Group limestones.

Clay County RWD No. 1 was started in 1966 and serves a population of 140 persons in northern Clay County in the area around Garfield Center. The water supply is obtained from two shallow wells in the alluvial aquifer near Morganville.

The water is of satisfactory quality except that it is very hard. The dependable groundwater yield is reported as 43,000 gpd whereas the average use is 10,000 gpd and maximum use in 1973-74 was reported as 25,000 pgd.

The most logical alternative water supply would be additional wells in the same local aquifer.

Two small areas in southwestern Clay County are served by Dickenson County RWD #1.

Coffey County

Shallow wells, deep wells, the Neosho River and surface impoundments provide public water supplies in Coffey County. Nearly all of the county population is served by public water supplies either through municipal supplies or Rural Water districts. The state has purchased a water supply allocation of 34,900 acre feet of water in the John Redmond Reservoir three miles above Burlington. This storage will provide a two percent chance yield of 26.0 mgd and is available for purchase from the state for municipal and industrial use.

Burlington obtains water from the Neosho River at the east edge of the city to provide public water supply (Fig. 14). A small overflow dam in the river channel creates a pool from which the water supply is pumped. The water is of good quality (Table 1). No shortages occurred during the drought of 1953-54 and with the stream regulation now available no shortages are anticipated particularly if the city would negotiate purchase of some of the state managed conservation storage available in John Redmond Reservoir. According to Kansas State Department of Health and Environment the water plant has adequate reserve capacity to provide all the presently required water needs during a drought.

There are no good alternative sources of water adequate to supply Burlington's water needs other than the Neosho River. A well field of 10 to 15 wells properly located and spaced in the alluvial aquifer of the Neosho River valley might provide a water supply of 0.500 mgd in normal years but probably would be inadequate in a prolonged drought.

Gridley has an impounding reservoir north of town on Varvel Creek to provide a dependable supply of good quality water (Fig. 14, Table 1).

Maximum reported water useage in 1973-74 is reported as 0.030 mgd and the impoundment has a reported safe yield of 0.050 mgd and therefore appears to be adequate. The impounding reservoir has been in use since 1960.

There is no adequate source of groundwater available within a reasonable distance from the town. The best alternative source of supply probably would be to obtain water from Coffey County RWD No. 2 provided their transmission lines could supply the needed water.

Lebo has an impounding reservoir one mile northwest of town (Fig. 14) which supplies good qulaity water for this public water supply. Kansas Department of Health and Environment records indicate the impoundment has a safe yield of 0.200 mgd and a water plant capacity of 0.170 mgd which is adequate to meet presently anticipated needs (Table 1). The water supply was started in 1959 and major improvements were completed in 1971. No drought related water supply problems are anticipated.

The most logical alternative water supply sources would be to obtain water from Coffey County RWD No. 3 provided their transmission lines could supply the needed water, or the construction of additional impounded storage to meet future requirements.

LeRoy has experienced no water shortages caused by drought since the public water supply was initiated in 1937 (Table 1). The water supply, obtained from the Neosho River (Fig. 14) is of satisfactory quality. The water plant has a capacity of 0.230 mgd which is in excess of the reported maximum useage of 0.154 mgd in 1973-74.

Although the alluvial aquifer associated with the Neosho River valley at LeRoy is extensive the deposits are relatively thin and wells

pumping from this aquifer would have significantly reduced yields during a drought of more than two years. The groundwater is of satisfactory quality but would be much harder than the river water now used. A test drilling and sampling program could determine the location, spacing, and number of wells needed to provide the entire or a supplemental water supply. Consideration should be given to the negotiated purchase of water from state managed conservation storage in John Redmond Reservoir to provide an assured water supply as the best alternative for future water needs.

Strawn's public water supply is described with and is a part of Coffey County RWD No. 1.

Waverly has five wells ranging in depth from about 185 to 270 feet from Pennsylvanian age sandstone of the Douglas Group and supplies the city of Waverly. Well yields range from about 5 to 20 gpm. The maximum dependable yield of the wells is reported to be 0.036 mgd. Table 1 indicates the maximumw ater useage in 1973-74 as 0.040 mgd and the average daily use as 0.028 mgd. The water supply from the five wells (Fig. 14) therefore is only marginally adequate and the capacity of the system should be increased. The water is a very soft (total hardness 16 mg/l) sodium bicarbonate type of water. The shortages that have occurred in the past have been due to inadequate pumping capacity rather than drought related causes.

A program of test drilling and sampling to determine the best location for additional wells should preceed construction of one or two additional wells each having 10 to 20 gpm capacities.

There are no other alternative sources of groundwater that are economically feasible. Changing to an impounded reservoir surface

water supply and construction of a treatment plant would be much more expensive than improving and enlarging the present groundwater supply.

Coffey County RWD No. 1 supplies the town of Strawn and a small adjacent area from one well in the alluvial aquifer just north of the Neosho River below John Redmond Reservoir (Fig. 14). Water quality is satisfactory except for objectionable amounts of iron and manganese and the water is very hard. Maximum dependable groundwater production is reported as 0.040 mgd and when comapred with maximum and average daily use (Table 1) the water supply is probably adequate. A program of test drilling and sampling in the local alluvial aquifer preceeding construction of a second well might locate a site which would produce groundwater having less dissolved iron and manganese and therefore of better quality. Reduced well yields from the alluvial aquifer might be expected during a long drought and a second well would increase the reliability and adequacy of the groundwater supply in addition to the possibility of improving the water quality.

An alternative water supply could most easily be obtained either through purchase of water directly from Burlington or indirectly through Coffey County RWD No. 3 which presently serves the area immediately adjacent to RWD No. 1 with good quality water purchased from Burlington.

Coffey County RWD No. 2 serves the southwestern part of Coffey County (Fig. 14) as well as much of the adjacent part of southeastern Lyon County and has a contract purchase agreement to purchase as much as 0.200 mgd from the city of Emporia if needed. In 1973-74 the average daily use was 0.094 mgd and maximum daily use was reported as 0.140 mgd. The water is of good quality (Table 1) and the supply is adequate.

No alternative sources of water are required so long as the city of Emporia maintains an adequate water supply. An alternative tie into the Burlington public water supply at the east end of the Rural Water District might reduce pumpage costs to the east end of the district and offer a more assured supply during an extended drought.

Coffey County RWD No. 3 was started in 1973 and provides a public water supply to much of the county north of John Redmond Reservoir as well as parts of the county north and east of Burlington (Fig. 14). A contract purchase agreement for as much as 0.600 mgd from the city of Burlington provides a good quality, reliable water supply (Table 1).

An alternative source of water does not seem to be needed as the Burlington source seems to be adequate. The water available for purchase (0.600 mgd) is ten times the 1973-74 maximum daily use.

An area in northeastern Coffey County is served by Osage County RWD #4 and an area in southeastern Coffey County is served by Anderson County RWD #5.

Cowley County

Seven municipalities in Cowley County have public water supplies, one of which is from a surface water impoundment. Strother field, a combination airport and industrial park, has its own water supply. Four rural water districts serve the rural population in parts of the county. Two water districts are in the process of being organized and Sumner County RWD #4 serves the extreme southwest part of the county.

Large quantities of water are available from the Arkansas River valley and smaller quantities generally are available from Walnut River valley and Grouse Creek (Bayne, 1962); however, in all these stream valleys the water is of poor quality and locally have been polluted by oil field brines. Arkansas City presently uses water from the Arkansas River valley alluvium. Winfield used this source until 1969. The limestone and shales which underlie much of Cowley County locally may yield 10 to 100 gpm of water to wells. In other areas these rocks yield little or no water to wells. Almost everywhere the water is hard and locally may be undesirable for use because of high sulfates or high chlorides. In an emergency additional water could be obtainted locally from either the bedrock units or valley deposits for water. From either source exploratory drilling would be necessary to find water of suitable quality and quantity.

Arkansas City obtains its water supply from 10 shallow wells located at the west edge of the city in alluvium of the Arkansas River valley. The average daily use is 2.60 mgd and maximum daily use is reported as 5.20 mgd. Maximum dependable yield of the well field is reported to be 7.0 mgd. A population of 13,508 is served by the system. The system is presently adequate in quantity but the water is of poor

quality. It has excessive quantities of chloride and the concentration of sulfate is near the recommended maximum. There is little chance that the city would experience a water shortage due to drought; however, to obtain a better quality water it probably will be necessary to change to a surface water source.

The Atlanta municipal water supply is obtained from an improved spring in the Florence Limestone member of the Barneston Limestone. Additional water is obtained from shallow wells tapping the same aquifer. Population served is 250. Average daily use of 0.020 mgd and maximum daily use is 0.038 mgd. The city had a water shortage in the 1953-54 drought caused in part by pipeline deficiencies. The emergency was met by drilling additional shallow wells and voluntary restrictions on use. During a prolonged drought the present system probably would not be adequate. An emergency could be temporarily met by drilling additional, properly located wells. Salt water occurs at depths of about 300 feet. The long term solution to drought problems may be in joining RWD #5.

The Burden municipal water supply serves a population of 560. Water is obtained from a spring and two shallow wells in the Barneston Limestone. The city experiences water shortages during drought periods and in past years has met emergencies through voluntary restrictions and hauling water from Winfield by railroad. Average daily is is .050 mgd and maximum daily use was .085 mgd. Present maximum yield is .403 mgd. However, during prolonged drought, the well and spring yields decline. Additional wells west of their present well field would aid in meeting future emergencies. However, the long term solution may be in joining RWD #5.

The Cambridge municipal water supply is from a single well in alluvial fill in Grouse Creek valley lcoated about one mile west of the city. The population served is 110. Average daily use is .010 mgd and maximum daily use is .020 mgd. Maximum depandable production is .043 mgd. The city did not have a municipal water supply during the 1953-54 drought and their present system would probably prove to be inadequate in a similar drought. Additional properly spaced wells in Brouse Creek valley would probably meet an emergency shortage.

The Dexter water supply is from a single well in the valley of Grouse Creek about 1/2 mile west of the city. A population of 297 is served by the system. Average daily use is .020 mgd and maximum daily use was .040 mgd. Maximum safe yield is .100 mgd. The city had a water shorgage during the 1953-54 drought. Water quality is poor due to high chlorides from oil field brines introduced many years ago. Additional properly located wells in Grouse Creek valley would probably meet water needs in a future drought.

Strother Field airport and industrial park jointly owned by the Cities of Arkansas City and Winfield has its own water supply. Water is obtained from eight shallow wells. The water is used principally for industrial uses. Average daily ise us .180 mgd and maximum use is .300 mgd. Maximum dependable production is 1.378 mgd and is probably adequate for the present users under drought conditions. Should an emergency occur, additional properly spaced wells could be drilled in the area.

The Udall municipal water supply serves a population of 675. The first municipal supply for the city was from shallow wells drilled within the town site which obtained water from the Lower Wellington Formation

and the Upper Nolans Formation. These wells yielded an adequate supply of water during normal weather conditions but yields decreased considerably during period of drought. The city had a water shortage during periods of the 1953-54 drought. The water from this source was of very poor quality being high in sulfates. In 1955 the city changed their source of supply to two wells at the edge of the Arkansas River valley in the NW 1/4 sec. 2, T31S, R2E, Sumner County about three miles west of the city. This source of supply is presently adequate but should an emergency occur, additional wells could be drilled near the present wells. Average daily use is .070 mgd and maximum use was .125 mgd.

The Winfield municipal water supply serves an urban population of 10,176 and a rural and suburban population of 829 through RWD's 2 and 4. Water is obtained from a surface water impoundment located on Timber Creek about ten miles northeast of the city. The original supply for Winfield was obtained from the Walnut River at the west edge of the city. This source was abandoned in 1916 because the stream became polluted with oil field brines and wastes from allied industries. The city then obtained water from wells about four miles west of the city. By about 1923 these wells were inadequate and wells were drilled in the alluvial deposits in the Arkansas River valley about nine miles west of the city. BEginning in about 1937 the city experienced trouble with high chlorides from oil field brines and periodically had to replace wells which were of too poor quality. In 1969 the city began using water from the Timber Lake impoundment and with the present source of supply should not experience shortages during a prolonged drought. Average daily use is 1.40 mgd and maximum use is reported as 3.52 mgd.

Rural Water District No. 1 serves a population of 900 in the area southeast of Arkansas City from three shallow wells drilled in the Arkansas River valley alluvium. Average use is .105 mgd and maximum use is .180 mgd. Maximum dependable production is .864 mgd which is probably adequate during a prolonged drought. In an emergency additional wells could be drilled in the river valley. The water from the Arkansas River valley in this area is of poor quality. Deep wells in the area served by the districts system generally yield salt water.

Rural Water District No. 2 serves a population of 394 in an area south of Winfield. Water is purchased from the city and the supply is adequate. Average daily use is .025 mgd.

Rural Water District No. 3 serves a population of 680 in an area east of Arkansas City. Water is obtained from two shallow wells drilled in the Arkansas River valley. Average daily use is .232 mgd and maximum use is .500 mgd which exceeds the maximum dependable yield of .360 mgd. The present system is not adequate for a prolonged drought and might not be adequate even for a minor drought of short duration. Additional wells could be drilled near the present wells to supplement the water supply. The water is of poor quality.

Rural Water District No. 4 serves a population of 435 in a large area northeast and southeast of Winfield. Water is purchased from the city of Winfield and the supply should be adequate during a prolonged drought. Average daily use is .044 mgd.

Sumner County Rural Water District No. 4 serves an area of about 15 square miles in southwestern Cowley County and an area extending into southeastern Sumner County. Water is obtained from a well in the Arkansas River valley at the west edge of Arakansas City.

Sedgwick County Rural Water District No. 3 serves a very small area in extreme northwest Cowley County.

Cowley County Rural Water District No. 5 and 6 are in the planning stage or under construction.

Crawford County

Twelve cities in Crawford County have public water supplies and seven rural water districts are in operation in the county. Two of the 12 cities obtain their water through RWD's. About 96% of the population is served by public water systems which serve about 70% of the area of the county.

In Crawford County large quantities of good quality water are available only from rocks of Ordovician age at depths of about 1,000 feet (Abernathy, 1941; Stramel, 1957). As in Cherokee County, the water from the Ordovician rocks is progressively of poorer quality in the county toward the west and in Crawford County the water becomes highly mineralized about one-half way across the county. Ordovician water is used from wells located in western Crawford County but is not of desirable quality.

All of the public water supplies in the county are obtained from groundwater except an area in the northwest part of the county which is served by Bourbon County RWD #1 which uses surface water purchased from Fort Scott. Only small quantities of water are available from shallow wells in the surficial rocks and water from Mississippian age rocks is not suitable for use.

Arcadia's water supply is obtained from two deep wells which penetrate rocks of Ordovician age. A population of 439 is served by the system. Average daily use is .036 mgd. The water contains above the desired limits of sodium chloride but otherwise is of acceptable quality. The water system is adequate for present and future needs.

Arma's water supply is obtained from two deep wells which penetrate rocks of Ordovician age. A population of 1,467 is served by the system and average daily use is .150 mgd. The Arma water supply is presently

adequate and it is not expected that a shortage would exist during a prolonged drought.

The community of Capaldo is served by a single well which obtains water from rocks of Ordovician age. A population of 130 is served by the system and average dialy use if .013 mgd. The water of Capaldo is high in sodium chloride. The system is presently adequate and the community should not experience a water shortage during a drought but could be short of water due to mechanical breakdown in the single well. In an emergency Capaldo could purchase water from RWD #2 or RWD #4.

The city of Cherokee obtains its water supply from two deep wells which penetrate rocks of Ordovician age. A population of 753 is served by the system and in addition water is sold to two rural water district. The water is hard but of good quality otherwise. Average daily urban use is .068 mgd. The system is presently adequate and should not experience a water shortage should a prolonged drought occur. If needed additional wells could be drilled in the general vicinity of the present wells.

Frontenac's water supply is obtained from two deep wells which penetrate Ordovician age rocks. A population of 2,620 is served by the system and average daily use is .240 mgd. The water is of good qulaity at Frontenac; however, at Capaldo which is two miles west the water contains an excess of sodium chloride. The water system at Frontenac is presently adequate and there should not be a shortage of water should a prolonged drought occur.

Girard obtains its water from two deep wells which obtain water from rocks of Ordovician age. A population of 2,797 is served by the system and average daily use is .250 mgd. Girard is located near the

center of the county and water from the city wells is quite high in sodium chloride. The quality of water available from the present system is adequate and there should be no shortage should a drought occur. Better quality water could be obtained shoutheast of the city; however, the city probably would have to go as much as six miles in a southeast direction to obtain good quality water.

McCune obtains its water supply from one deep well which penetrates rocks of Ordovician age. A population of 528 is served by the system and average daily us is .036 mgd. The water from the McCune city wells is high in sodium chloride. Better quality water could be obtained toward the east; however, good quality water probably would not be found at a distance of less than 7 or 8 miles from McCune. Presently the McCune water supply is adequate when only quantity is considered and probably would be adequate during a prolonged drought. However, the system depends on a single well and could experience shortages due to mechanical breakdown.

The city of Mulberry obtains its water supply from a single well about 1,000 feet deep which penetrates rocks of Ordovician age. A population of 644 is served by the system and average daily use is .050 mgd. The system is presently adequate and no shortage is anticipated should a prolonged drought occur. However, the city depends on a single well and has experienced a shortage due to mechanical breakdown.

The chemical quality of the water at Mulberry is different from other public supplies in the area. This water is a sodium biCarbonate type water and contains a very high bicarbonate ion concentration along with very low chloride and no sulfate. It is probable that this water is softened by natural zeolites contained in the aquifer.

The Pittsburg water supply is obtained from four deep wells which penetrate Ordovician age rocks. A population of 21,000 is served by the system and the average daily use is 2.80 mgd. The city has experienced water shortages in the past but the shortages have been dur to rapid growth in use exceeding the capacity of the pumping and distribution facilities. The city is presently expanding its pumping facilities. The water at Pittsburg is of good quality.

The Walnut water supply is obtained from one deep well which penetrates rocks of Ordovician age. The city also has two shallow wells used for standby purposes. These wells obtain water from alluvial deposits in Walnut Creek valley southeast of the city. A population of 373 is served by the system and the average daily use is .030 mgd. The quantity of water available through the system is adequate. However, the quality of the water is very poor. The concentration of the chloride ion is near 700 mg/l. If water could be purchased through Bourbon County RWD #1 much better quality water would be available to the city.

Rural Water District No. 1 obtains water from a single deep well which penetrates Ordovician age rocks. A popultion of 440 is served by the system and average daily use is .035 mgd. The water is moderately hard but otherwise of good quality. The system is presently adequate and probably would not have a water shortage during a prolonged drought. The district is dependent on a single well and could experience a water shortage due to a mechanical breakdown. The district could contract to purchase emergency water from either Mulberry of Frontenac. Additional wells could be drilled almost anywhere in the district.

Rural Water District No. 2 obtains water from two deep wells which obtain water from Ordovician age rocks. A population of 714 is served by the system and average daily use if .046 mgd. The water is a sodium chloride - sodium bicarbonate type water and probably undergoes some natural softening. The system is presently adequate and the district probably would not experience a water shortage during a prolonged drought. If additional wells are drilled better quality water is available in the southeast part of the district.

Rural Water District No. 3 water supply is obtained from a single deep well which obtains water from Ordovician age rocks. A population of 225 is served by the system and average daily use is .015 mgd. The system is presently adequate and the district should not experience a shortage due to a prolonged drought. However, a shortage could occur due to a mechanical breakdown of the single well. Arrangements could be made to purchase emergency water from Mulberry.

Rural Water District No. 4 obtains its water supply from two deep wells which penetrate rocks of Ordovician age. A population of 1,862 is served by the system and average daily use is .120 mgd. The system is presently adequate and probably would not experience a shortage during a prolonged drought. Additional water could be obtained by adding one more well. Any new well should be drilled in the southeastern part of the district. In this area there is less pumpage and better quality water.

Rural Water District No. 5 serves an area in southeastern Crawford County and northeastern Cherokee County from a single well which penetrates Ordovician age rocks. A population of 968 is served by the district and the average daily use if .140 mgd. The system is presently

adequate and probably would be adequate through a prolonged drought. The district is subject ot a water shortage due to mechanical breakdown but could purchase water from RWD #4 whose wells are located near that of RWD #5.

Rural Water District No. 6 obtains water from four shallow wells located in the valley of Neosho River in northeastern Labette County. A population of 1,300 is served by the system and average daily use is .091 mgd. The system is presently adequate but probably would experience a water shortage during a prolonged drought due to diminished well yields. The water is of good quality and additional water could be obtained from one or more additional properly spaced wells.

Rural Water District No. 7 obtains water from a single deep well located in the southeastern part of the district. A population of 1,071 is served by the system and the average daily use is .075 mgd. The water is quite hard and is a sodium chloride type of water. The water supply is presently adequate but may prove to be inadequate if useage increases of during a prolonged drought. Additional water can be obtained from wells. These wells should be drilled in the extreme southeastern part of the area to obtain the best quality water.

Bourbon County RWD No. 1 serves an area in northwestern Crawford County and southwestern Bourbon County. Water for the district is purchased from Fort Scott.

Dickinson County

Seven cities in Dickinson County have municipally owned water systems serving an aggregate population of 16,456. All of these water supplies, except for the city of Herington, used groundwater. Herington obtains water from a city owned lake. One rural water district is under construction and another district is being organized. A small area in south-central Dickinson County is served by Marion County RWD #1.

Rocks of the Wellington Formation underlie the western two-thirds of the county and rocks of the Chase Group underlie the eastern one-third of the county. Lower Wellington and Upper Chase rocks locally contain gypsum much of which has been removed by solution, forming one or more zones of interconnected solution permeability. (Moore, 1940). Wells which penetrate these permeable zones may yield relatively large quantities of water but generally the water is very high in sulfates and undesirable for domestic and many industrial uses. Extreme northwest Dickinson County is underlain by Cretaceous age rocks which yield water of good quality. In westernmost Dickinson County where the gypsum or solution channels are absent only small quantities of water are available. Ground water is also available from alluvium of the Smoky Hill River valley (Latta, 1949).

Abilene's water supply is obtained from nine shallow wells which penetrate upper Chase Group rocks containing solution channels. In the area of the Abilene well field the Chase Group rocks are overlain by dune sand which forms an ideal catchment area for precipitation which falls in the area. Formerly the Abilene water supply was obtained from a single large spring which flowed from the solution channels into

a catchment basin located near the north bluff of the Smoky Hill River. A population of 8,265 is served by the system and the average daily use is 1.038 mgd. Maximum dependable yield of the wells is estimated at 6.30 mgd but since the aquifer depends on local precipitation for recharge, well yields would probably diminish during a prolonged drought. Should a water shortage occur additional wells could be drilled in the vicinity of the present well field. Water is available from the allvuial deposits in Smoky Hill River valley. However, this water is of inferior quality to that presently used.

The Chapman water supply is obtained from three shallow wells which obtain water from the alluvial deposits in the Smoky Hill River valley. A population of 1,540 is served by the system and average daily use is .120 mgd. The reported maximum dependable yield from the wells is 1.000 mgd. The city had a water shortage during the 1953-54 drought but improvements have been made on the system and should be adequate should another drought occur. Additional water can be obtained from properly located wells in the river valley.

The Enterprise water supply is obtained from three shallow wells in the alluvial deposits in the valley of Smoky Hill River. A population of 990 is served by the system and average daily use is .140 mgd. The reported maximum dependable yield is .432 mgd. Like the city of Chapman, the city experienced a water shortage during the 1953-54 drought but improvements were made in 1971 and the city should not experience any water shortage in a prolonged drought. Should a shortage occur either due to growth or drought additional wells can be drilled in the Smoky Hill River valley.

The Herington water supply is obtained from a city lake located west of the city. A population of 3,802 is served by the system. The

average daily use is .388 mgd. Herington experienced a water shortage during the 1953-54 drought and the emergency was met by voluntary restrictions on use and by drilling deep wells near the power plant and shallow wells below the dam to the lake. Water from the deep wells which penetrated the Barneston Formation was very high in sulfates but was blended with lake water which is also quite high in sulfates but of better quality than the Barneston water. After improvements were made in 1972 the system should be adequate but may experience a shortage in a prolonged drought. Since the groundwater in this area is of poor quality additional water should be obtained through additional impoundment capacity. Although an emergency could be met as it was in 1953-54 by drilling wells which yield water of undesirable quality.

Hope obtains its water supply from seven shallow wells which yield water from rocks of lower Wellington age. The water is typical of water from the lower Wellington in this general area. It is very high in sulfates which renders the water very hard. A population of 527 is served by the Hope water system and average daily use is .050 mgd. The reported maximum dependable yield is .380 mgd. The city experienced a water shortage during the 1953-54 drought and although improvements were made in 1955 the system may prove inadequate in another prolonged drought. Should a shortage occur additional wells would alleviate the shortage but the water from such wells would be of poor quality. Better quality water could be obtained from an impoundment on Lyon Creek.

The Manchester water supply is obtained from two shallow wells which penetrate rocks of Cretaceous age in extreme northwest Dickinson County. A population of 122 is served by the system and average daily

use is .010 mgd. Maximum dependable yield is estimated to be .072 mgd. The water is of excellent quality and the supply should be adequate but should a shortage occur additional wells would alleviate the shortage.

Solomon obtains its water supply from three shallow wells located northeast of the city at the edge of the alluvium in the Smoky Hill River valley. A population of 1,210 is served by the system and average daily use is .100 mgd. Formerly the city wells were located in the southwest part of the city but in the 1930's they began to increase in sulfate and chloride content and finally had to be abandoned. The chloride content of the present water supply is quite low but the sulfate is high. Should the city experience a water shortage due to drought additional wells could be drilled in the general vicinity of the present wells. Better quality water might be obtained northeast of the city in the area underlain by dune sands. In this area conditions may be present similar to those in the Abilene well field in which rocks containing solution channels are overlain by dune sand. The dune sand would form an ideal recharge area and the solution channels would readily transmit water to wells.

Rural Water District No. 1 is under construction at the present time. The district will serve an area in northwestern Dickinson County and a small area in southwestern Clay County.

Rural Water District No. 2 is in the planning stage. A large area in southwestern Dickinson County and part of eastern Saline County will be served by this district.

Marion County Rural Water District No. 1 serves a small area in south-central Dickinson County. This district is discussed with the section on water supplies in Marion County.

Doniphan County

Five municipalities in Doniphan County have public water supply systems serving an urban population of 5,345. In addition four rural water districts serve a part of the rural population and the cities of Bendena, Denton, Leona and Severence. All the public water supplies in the county obtain water from shallow wells. The wells produce water either from alluvial deposits in the stream valleys or from glacial deposits in upland areas (Bayne, 1973).

The limestones, sandstones and shales which underlie Doniphan County generally are not good aquifers although, locally, domestic or stock wells obtain water from these rock units. Large quantities of water are available from alluvial deposits in the Missouri River valley and moderate to small supplies are available from these deposits in tributary streams. In upland areas many of the water supplies for domestic and stock use and locally for public use are obtained from sand and gravel deposits in the glacial drift. During a prolonged drought wells in alluvial deposits in the larger stream valleys would be the most dependable source of water. Wells in glacial deposits range widely in dependability during drought periods.

The Bendena water supply is obtained through Doniphan County Rural Water District No. 2. Use dependability and quality will be discussed under the discussion for RWD #2.

The city of Denton obtains its water supply through Doniphan County Rural Water District No. 3. The municipal supply will be discussed under the discussion of RWD #3.

The Elwood water supply is obtained from two shallow wells in the alluvail deposits in the valley of the Missouri River. The city had a

water shortage during the 1953-54 drought but the shortage was caused by inadequate pumping and pipeline facilities rather than a lack of water. The population served by the system is 1,840. Average daily use is 0.112 mgd and maximum daily use is 0.173 mgd. The system at present has a maximum dependable yield of 0.290 mgd. The water is hard and high in iron. The alluvial deposits in and around the city are capable of yielding very large quantities of water to wells and the city should experience no water shortage in the future.

The Highland water supply is obtained from two shallow wells which penetrate glacial deposits. The system serves a population of 758. The average daily use is .096 mgd and the maximum daily use is .160 mgd. Maximum dependable production is .288 mgd and should be adequate through a prolonged drought. Should a shortage occur additional supplies could be obtained from properly located wells in the glacial deposits in or near the city. The water is moderately hard but otherwise of good quality.

Leona obtains its water supply through Doniphan County Rural Water District No. 1 and will be discussed in the discussion of RWD #1.

Severence obtains its water supply through Rural Water District No. 3 and will be discussed in the discussion of RWD #3.

Troy obtains its water supply from two shallow wells located in the valley of Mosquito Creek about two miles north of the city and from three standby wells located in, and south of the city. A population of 1,230 is served by the system. Average daily use is .090 mgd and maximum daily use was .150 mgd. The maximum daily plant capacity is 0.360 mgd and is probably adequate in case of a prolonged drought.

The city sells water to RWD #5. The water is hard but otherwise of good quality.

Wathena obtains its water supply from two shallow wells in the alluvial valley deposits of the Missouri River at the east edge of the city. A population of 1,316 is served by the system. Average daily use is 0.151 mgd and maximum daily use was .252 mgd. Maximum dependable yield is .375 mgd. The water is hard and high in iron. The aquifer is capable of yeilding very large quantities of water to wells and a shortage should not occur in the future. Additional wells could be drilled in the valley.

The city of White Cloud obtains its water supply from a single well located at the southeast edge of the city in alluvial deposits in the Missouri River valley. A population of 201 is served by the system. Average daily use is .020 mgd and maximum daily use was .040 mgd. Maximum dependable production is .072 mgd and is probably adequate should a drought occur in the future. The aquifer is capable of yielding very large quantities of water to wells. The water is hard and very high in iron. The city is dependent on a single well for its supply and might experience a temporary shortage in case of pump failure. Consideration should be given to drilling a second well to obtain better quality water or serve as a standby well.

Rural Water District No. 1 obtains its water supply from a single shallow well in the alluvial deposits in the valley of Wolf River. The system serves the city of Leona and a small area around the city. Average daily use is .010 mgd and maximum daily use is .015 mgd. The maximum daily production is .033 mgd and is probably sufficient in case

of a prolonged drought. The district is dependent on a single well and may experience a temporary shortage in case of a pump failure. Consideration should be given to drilling a standby well in the general area of the present well. The water is of very good quality.

Rural Water District No. 2 obtains its water supply from a single well located in Bendena. Water is obtained from glacial deposits. Residents of the city of Bendena are the principal users. The system serves a population of 110. Average daily use is .006 mgd and maximum dependable yield is .050 mgd which should be sufficient to carry the district through a prolonged drought. The system is dependent on a single well and could experience a temporary water shortage should there be a pump failure. The district should consider another well for standby purposes. The water is hard and high in nitrates.

Rural Water District No. 3 serves a population of 300 which includes the residents of the cities of Denton and Severence and the rural areas located in the general area between the two cities. Water is obtained from two shallow wells located in the city of Denton. Water is produced from glacial deposits underlying the area. Average daily use is .020 mgd and maximum dependable production is .070 mgd which should be adequate in case of a prolonged drought. Should a shortage occur additional wells could be drilled in this general area.

Rural Water District No. 5 serves a population of 2,500 in a large area lying generally between the cities of Troy on the west and Wathena on the east and extending from the Missouri River valley on the north to Doniphan on the south. Water is purchased from the city of Troy. Average daily use is .041 mgd. The Troy water supply is probably adequate

but in a prolonged drought well yields may drop and require additional wells. Under the most serious conditions the system could be connected to the Wathena supply. However, in this case poorer quality water would be obtained.

Douglas County

Three of the four cities having public water supplies in Douglas County are adjacent to the Kansas River valley and obtain their water from wells in alluvium or from surface water in the Kansas River. Baldwin in the south part of the county obtains its water supply from wells in the Ireland Sandstone Member of the Lawrence Formation.

The rural water districts have wells in the Kansas River alluvium and the Ireland Sandstone aquifer. The principal aquifers are described by O'Connor (1960) and Fader (1974).

Baldwin has experienced shortages of water in 1953-54 and at several times since, mainly because of a lack of capacity of their wells and inadequate storage. The city has increased both the number of wells and storage capacity but still experiences maximum water use in excess of plant capacity (Table 1). At the present the city has 27 wells, the largest having a yield of about 45 gpm. The water is of good quality having dissolved solids of only 139 mg/l and a total hardness of 80 mg/l. A program of test drilling to delineate the aquifer and to determine the sites for an orderly expansion for doubling or tripling the present well field capacity should preceed any major water supply development in the local aquifer. Alternative choices would be to construct a water treatment plant to use water from the city lake southeast of Baldwin or develop groundwater or surface water supplies 9 to 13 miles to the north in the Kansas River valley or to negotiate purchase of state managed conservation storage from the Clinton Reservoir now under construction on the Wakarusa River southwest of Lawrence.

Eudora experienced water shortage problems during the drought of 1953-54 and have remedied the situation. The three wells in the Kansas

River valley alluvial aquifer are capable of producing 0.907 mgd, compared to a 1973-74 maximum demand of 0.380 mgd. The allvuail aquifer is capable of supplying water of adequate quality and quantity during a drought period.

Lawrence experienced water shortages in 1953-54 and other years which have been the result of the rapid growth of the city and of failure of the city to contruct production treatment, storage and transmission facilities rapidly enough to meet peak summer demands. The most recent improvements in plant facilities were in 1974 and long range plans include a complete new treatment plant in the southwest part of town to utilize surface water from Clinton Reservoir now under construction. Adequate water is available from wells in the Kansas River valley alluvial aquifer and from the Kansas River to supply city needs. The city has filed an application for the pruchase of 14.9 mgd from state managed storage in Clinton Reservoir to meet future needs.

The Lecompton water supply is obtained from two wells in the Kansas River valley alluvial aquifer and production and treatment facilities are approximately double the present maximum useage. A severe drought is unlikely to cause the city any water supply problems. The water is very hard and high in iron.

Douglas County Rural Water District No. 1 - The Kansas River alluvial aquifer which supplies this districts water will provide a stable supply through a drought. Additoinal insurance aginast shortage caused by mechanical breakdown of the one existing well would be assured by an additional water supply well.

Douglas County Rural Water District No. 2 has four wells in the Ireland Sandstone Member of the Lawrence Formation which provide a

reliable and satisfactory water supply. Well yields might decrease somewhat during a severe drought. The present wells are so closely spaced that there is probably considerable interference between pumping wells. Any future wells needed to meet increased pumpage should consider the benefit of better spacing to reduce interference.

Douglas County Rural Water District No. 3, an area in northwestern Douglas County, is served by two wells in the Kansas River valley alluvial aquifer. The water supply should be adequate and dependable during a drought and both well yields and pumping capacity seem adequate when measured against existing demand.

An area in southwestern Douglas County is served by Osage County RWD #5.

Elk County

Four cities in Elk County have public water supplies. All of these supplies are obtained from impoundments or from streams. The Longton water supply is primarily from a surface water source but the city has two shallow wells in the alluvial fill of Elk River for standby purposes. A total population of 2,473 is served by the four water systems. At the present time there are no RWD's organized in the county which are in operation. Elk County Rural Water District No. 1 is being organized and when completed will serve much of southern Elk County and small areas in Chautauqua County. A small are of about two square miles in north-central Elk County is served by Greenwood County Rural Water District No. 1.

The rocks which underlie Elk County are not good aquifers. Other than alluvium in Elk River valley the quantity of water available to wells is generally small. In Elk River valley moderate quantities of water are locally available and locally small to moderate quantities of water can be obtained from wells in northwest Elk County. Bayne (1958) indicates that dependable and adequate groundwater for public supplies are generally not available in Elk County.

The Grenola water supply is obtained from an impoundment on the Caney River. A population of 374 is served by the system and average dily use is .030 mgd. The system was not adequate during the 1953-54 drought and porbably would not be adequate should another drought occur. Since groundwater in large enough quantities is not available about the only source of emergency water would be additional impounded capacity.

The Howard water supply is obtained from a city lake. A population of 1,074 is served by the system and average daily use is .062 mgd.

The city had a water shortage during the 1953-54 drought which was solved by drastic curtailment in use. Should another prolonged drought occur the city could again experience a shortage of water. A temporary or permanent impoundment on Elk River south of the city could furnish emergency water to the city.

The Longton water supply is obtained from an impoundment on Elk River and two shallow wells used only for standby purposes. A population of 375 is served by the system and average daily use is reported to be .060 mgd. The system is adequate at the present time but did experience a shortage of water during the drought of 1953-54 and probably would again have a water shortage should a prolonged drought occur. Should a shortage occur, additional properly spaced wells in the Elk River valley could furnish an emergency water supply when operated along with the supply in the impoundment.

The Moline water supply is obtained from three small impoundments west of the city. A population of 650 is served by the system and average daily use is .095 mgd. The city experienced a water shortage during the 1953-54 drought. To meet the emergency wells were drilled below the impoundments in an effort to salvage seepage water. No major improvements have been made since the 1953-54 drought and the city would probably experience a shortage should another drought occur. The city needs additional capacity in the present impoundments to meet a future emergency.

Rural Water District No. 1 is in the planning stage. This district would serve much of southern Elk County and small areas in northern Chautauqua County.

Greenwood County Rural Water District No. 1 serves a small area of about two square miles in north-central Elk County and an area in southern Greenwood County. This district is described under the discussion of Greenwood County.

Franklin County

Eight cities in Franklin County have municipally owned water systems. In addition, six rural water districts have been organized in the county and five other rural water districts organized in adjacent counties serve small areas in Franklin County. Of the eight municipal water system, three are from surface water sources and five are from wells. Rural water districts numbers 2, 4 and 5 in Osage County are discussed under Osage County; Rural water district no. 3 in Miami County under Miami County and Anderson Rural Water District No. 3 under Anderson County. Anderson No. 3 purchases water from the city of Richmond in Franklin County.

The Lane municipal water supply is obtained from a single shallow well in the valley of Pottawatomie Creek. A population of 295 is served by the system. Average daily use is .030 mgd and maximum dependable yield is 120 mgd. The system is probably adequate for a short term drought but well yields may diminish during a prolonged drought. The limestones and shales in southeastern Franklin County are not good aquifers and would not be adequate for supplemental supplies. The city could experience a termporary water shortage due to pump failure and should consider another well near their present source.

The Ottawa water supply is obtained from the Maris Des Cygnes River and serves a population of 10,600. Rural water districts number 1 and 2 with a combined population of 824 purchase water from the city. Ottawa experienced a water shortage during the 1953-54 drought due principally to low flow in the river and inadequate pumping facilities. However, the present system is probably adequate. In an emergency the supply might

be supplemented by release of water from Pomona or Melvern Reservoirs. There is no state managed storage in these reservoirs. Average daily use is 1.60 mgd and maximum dependable production is 3.25 mgd.

The Pomona municipal water system serves a population of 700. Water is obtained from three deep wells which pump water from sandstone in the Douglas Group. Average daily use is .060 mgd and maximum dependable production is .130 mgd. The system is probably adequate at present although there was a water shortage during the 1953-54 drought. Should a shortage occur during a prolonged drought additional wells could be drilled in general area of the present source. Special treating facilities would be needed to utilize water released from Pomona Reservoir.

The Princeton water system serves a population of 195. Water is obtained from an impoundment on Middle Creek. The city sells water to Franklin County Rural Water District No. 3 which serves an area of about 15 square miles around the city. Average daily use is .015 mgd and maximum dependable production is .036 mgd. The present system is adequate under normal conditions or probably through a short drought but a prolonged drought would cause the flow in Middle Creek to diminish and result in a shortage for the city. Arrangements should be made with Rural Water District No. 2 to tie into that district's system should an emergency occur. Franklin County Rural Water District No. 4 and 6 could be used as an emergency source of water.

The Rantoul water supply is obtained from two shallow wells drilled in alluvial deposits of Maris Des Cygnes valley. The system serves a population of 300. Average daily use is .015 mgd and maximum dependable production is .086 mgd. The system should be adequate during a prolonged

drought. However, should a shortage occur, additional wells could be drilled in the valley.

The Richmond water supply is obtained from a city owned lake located about one mile southeast of the city. A population of 480 in the city is served by the system and in addition water is sold to Anderson County Rural Water District No. 3 which serves a population of 190. The average daily use for the city of Richmond is .060 mgd and maximum dependable production is .144 mgd. The system is probably adequate under normal or short drought conditions but shortages could occur during a prolonged drought. Purchase of water from Franklin County Rural Water District No. 6 or Anderson County Rural Water District No. 4 could be a source of emergency water. However, pipeline limitations might seriously affect the quantity of water available from these sources.

The Wellsville municipal water supply is obtained from ten shallow wells which obtain water from sandstone in the Douglas Group. A population of 1,425 is served by the system. The city did not have a water shortage during the drought of 1953-54 but may experience a shortage during a prolonged drought. Average daily use is .120 mgd and maximum dependable production is .160 mgd. Additional properly spaced wells could be drilled to meet a future emergency due to drought.

The Williamsburg water supply is obtained from six deep wells which pump water from sandstones of the Douglas Group. A population of 350 is served by the system. Average daily use is .025 mgd and maximum dependable yield is .0576 mgd. This water supply may be affected by a severe drought, but the emergency could be met by drilling additional wells or water could be purchased from Rural Water District No. 4, although this source could be limited by the size of existing pipelines.

Franklin County Rural Water District No. 1 purchases water from the city of Ottawa. The system serves a population of 450 and the average daily use is .029 mgd.

Franklin County Rural Water District No. 2 purchases water from the city of Ottawa. The system serves a population of 374 and the average daily use is .024 mgd.

Franklin County Rural Water District No. 3 purchases water from the city of Princton. The system serve a population of 106 and average daily use is .008 mgd.

Franklin County Rural Water District No. 4 obtains its water supply from six deep wells which obtain water from sandstones in the Douglas Group. A population of 1,200 is served by the system and average daily use is .063 mgd. The maximum dependable yield is .173 mgd. The system should be adequate during a prolonged drought but should an emergency occur additional wells can be drilled.

Franklin County Rural Water District No. 5 obtains water from two deep wells located in Douglas County about one mile north of the Franklin County line. A population of 325 is served by the system. Average daily use is .022 mgd and maximum dependable yield is .144 mgd. The system should be adequate during a prolonged drought and should an emergency occur additional wells could be drilled.

Franklin County Rural Water District No. 6 presently obtains water from four shallow wells in the Maris Des Cygnes River valley about one mile east of Rantoul. The system serves a population of 1,088 and average daily use is .071 mgd. Maximum dependable yield is .288 mgd. The district plans to use surface water from the Maris Des Cygnes River

in the near future. The system is adequate at present and should not experience a shortage in a prolonged drought.

Osage County Rural Water District No. 2, 4 and 5; Anderson County Rural Water District No. 3 and Miami County Rural Water District No. 3 which serve small areas in Franklin County are discussed in the discussion of the appropriate county.

Geary County

Three cities and one rural water district in Geary County are served by public water supplies. Two of the cities, Junction City and Grandview Plaza, obtain water from shallow wells in the valleys of the Republican and Smoky Hill rivers just above the point where these streams join to form the Kansas River. Milford obtains water from Milford Reservoir. Geary County Rural Water District No. 1 purchases water from Junction City. Generally Geary County can be considered to have adequate water supplies over most of the county. Most of the upland areas are underalin by rocks of the Barneston and Wreford Formations which are good aquifers and in the valley areas the alluvial deposits are capable of yielding large quantities of water (Latta, 1949; Foder, 1974).

The Grandview Plaza water supply is obtained from three shallow wells which obtain water from alluvial deposits in the Smoky Hill River valley. The population served is 982 and average daily use is .073 mgd. Maximum dependable yield from the three wells is .396 mgd. The system is adequate and probably would not experience a water shortage during a prolonged drought. Additional wells can be drilled in the valley should additional water be needed. The water is hard but otherwise of good quality.

The Junction City municipal water supply is obtained from ten shallow wells in the Republical River valley at the north edge of the city. Population served is 20,176 and average daily use is 2.5 mgd. Maximum dependable yield is 8.0 mgd. The water is hard but otherwise of good quality. Junction City sells water to Rural Water District No. 1. The city should not experience a water shortage during a prolonged drought and additional wells could be drilled in the river valleys if needed.

The Milford water supply is obtained from the Milford Reservoir and serves a population of 562. The average daily use is .030 mgd and maximum dependable production is .170 mgd. The system is adequate and would not experience a shortage during a prolonged drought.

Rural Water District No. 1 purchases water from Junction City and serves a population of 207 located at the west edge of the city. Average daily use is .013 mgd and .060 mgd is available if purchased. The district should not experience a water shortage during a drought because the Junction City supply is adequate.

Rural Water District No. 2 serves a small area in western Geary County from a single well. A population of 207 is served by the district. Average daily use is .013 mgd.

Greenwood County

Six cities in Greenwood County have municipally owned water supply systems and serve a population of about 6,200 (Fig. 23). Two rural water districts have been organized in the county which serve a population of about 1,200. In addition a small area in northeast Greenwood County is served by Coffey County Rural Water District No. 2.

Two of the municipal water supplies are obtained from surface water impoundments and one additional municipal supply is obtained principally from a surface water impoundment but with shallow wells for standby purposes. The other three systems are from shallow wells. The RWD's purchase water from Eureka and Coffey County Rural Water District No. 2 purchases water from Emporia.

Generally the limestones, sandstones and shales which underlie Greenwood County are not good aquifers (Moore, 1940). Locally good stock and domestic wells are obtained in sandstones of the Wabaunsee Group or limestones of the Shawnee Group but yields large enough for public supply are not generally available except in local areas from alluvial deposits in stream valleys.

The Eureka municipal water system depends on three surface water impoundments for its supply and serves a population os 3,789. One impoundment is on Otis Creek about nine miles northwest of the city another is on Fall River in the city and the third is from Lake Eureka about five miles north of the city. The city experienced a water shortage during the 1953-54 drought and probably would again during a prolonged drought. Present average daily use is .450 mgd and maximum dependable production is .844 mgd. In an emergency shallow wells in the alluvium of Fall River valley would furnish small quantities of water. The long

range solution to a water shortage would be in enlarging the surface water impoundments.

Fall River obtains its municipal water supply from three shallow wells in the alluvium of Fall River valley. The system serves a population of 183. Average daily use is .010 mgd and maximum dependable yield is .070 mgd. The system should be adequate during a prolonged drought but should shortage occur additional wells could be drilled in the Fall River valley.

The Hamilton municipal water supply is obtained from six shallow wells in the valley of Slate Creek southwest of the city. The system serves a population of 290. Average daily use is .030 mgd and maximum dependable yield is .200 mgd. The city experienced a water shortage during the 1953-54 drought and probably would again have a shortage during a prolonged drought.

The alluvial deposits in Slate Creek valley are thin and the stream runs on or only slightly above the base of the alluvial fill. Water levels in the alluvial fill respond to fluctuations in the stream but with considerable lag. When the stream stops flowing the water level in the alluvium drops and well yields decline. During a prolonged drought the alluvium may become largely drained and cause a water shortage. Additional wells are of little value when the aquifer is drained. An impoundment on the stream to maintain a higher water level in the valley fill probably would increase the supply of water during an emergency.

The Madison water supply consists of an impoundment on Verdigris River at the north edge of the city and seven shallow wells in the same area. Water is obtained principally from the surface impoundment with

the wells being used for standby purposes. A population of 1,156 is served by the system. Average daily use is .125 mgd and maximum dependable production is .586 mgd. The system is probably adequate and the city should not experience a water shortage during a prolonged drought. Additional wells drilled in the valley could furnish some emergency water.

The Severy water supply is obtained from an impoundment reservoir about two miles east of the city. A population of 403 is served by the system. Average daily use is .050 mgd and maximum reported safe yield of the impoundment is 0.120 mgd. The system is adequate during normal cnditoins or a short term drought. The city experienced a shortage during the 1953-54 drought and probably would again be short of water during a prolonged drought. In an emergency the city could purchase water from Rural Water District No. 1. However, pipelines may restrict the quantity available and also Rural Water District No. 1 purchases water from the city of Eureka which does not have any large excess above their own needs. The long term solution to water shortages at Severy would be to obtain water from the Fall River Reservoir or to construct a larger municipal reservoir.

The Virgil water supply is obatined from two shallow wells in the Verdigris River valley. The system serves a population of 180. The average daily use is .015 mgd and maximum dependable production is .040 mgd. The system is probably adequate to withstand the effects of a prolonged drought and should a shortage occur additional wells in the Verdigris River valley should alleviate a shortage.

Rural Water District No. 1 purchases water from the city of Eureka and therefore is dependent on the adequacy of the Eureka water supply. Rural Water District No. 1 serves a population of 780 and average daily

use is .051 mgd. This district should, along with the city of Severy, consider obtaining water from Fall River Reservoir or from a new municipal impoundment. Should the Eureka supply fail there is no good alternative although small yielding wells could be obtained from alluvial deposits of Fall River valley.

Rural Water District No. 2 is in the planning stage and no data on source or population served is available.

Jackson County

Nine cities in Jackson County have public water supplies. Eight of the cities obtain water from wells and the ninth (Holton) obtains water from a lake although this city has wells for standby use. A total population of about 5,500 is served by these water systems. In addition to the city supplies, three rural water districts have been organized in the county and serve a population of about 1,200 (Fig. 24).

Generally large quantities of water are not readily available in Jackson County. Domestic and stock supplies can generally be obtained but locally quantities available for these uses are not adequate. Allvuial deposits in the stream valleys generally yield the largest quantities of water to wells. However, these wells may have reduced yields during a prolonged drought. Glacial deposits underlie much of the surface in the county. These deposits generally will yield adequate quantities of water for domestic and stock use if 30 or 40 feet of the deposits are present but locally even small quantities for domestic supplies cannot be obtained. Moderage to large quantities of water are available from sand and gravel in the glacial deposits in local areas and these deposits are used as a source of water by several of the cities. Small to moderate quantiteis of water are available in local areas from limestones of the Council Grove Group and sandstones in the Pennsylvanian rocks yield small to moderate water. Walters (1953) has described the groundwater resources. Generally water in the bedrock aquifers is of poorer quality in the deeper aquifers.

The Circleville water supply is obtained from two deep wells which obtain water in part from glacial deposits and in part from Permian Limestones. The system serves a population of 160 and average daily use

is .010 mgd. Maximum dependable production of .050 mgd. The water is of very poor quality (Table 1) being high in sulfates but is probably adequate should a drought occur.

Delia obtains its water supply from two shallow wells which obtain water from alluvial deposits in Cross Creek valley southeast of the city. The system serves a population of 185 in Delia and in addition the city sells water to Rural Water District No. 2. Average daily use is .015 mgd and maximum dependable groundwater yield is .072 mgd. The system is probably adequate should a drought occur and additional wells could be drilled in the general vicinity of the present wells. The water is hard and high in iron but otherwise of useable quality.

The Denison water supply is obtained from two shallow wells which pump water from alluvial deposits in the valley of Cedar Creek at the southwest edge of the city. The system serves a population of 274 and average daily use is .014 mgd. The maximum dependable production is .043 mgd which should be adequate during a prolonged drought. Should a shortage occur additional wells could be drilled in the vicinity of the present wells or the city could connect to the Jackson County Rural Water District No. 3.

The Holton water supply is obtained from Holton City Lake and serves a population of 3,430. The city water system also has nine shallow wells used as standby wells. The average daily use is 0.50 mgd and the maximum dependable production is 1.5 mgd. The system is adequate for present needs and probably would be adequate during a prolonged drought. The surface water supply is of good quality but the groundwater supply is of inferior quality.

The Hoyt water supply is obtained from three deep wells which obtain water from sandstones in the Pennsylvanian rocks. The system serves a

population of 500. Average daily use is .020 mgd and maximum dependable production is .0366 mgd. The sandstones from which water is obtained are relative low yielding and the quality is poor. The city will probably experience a water shortage should a prolonged drought occur. The city should consider purchasing water from Shawnee County Rural Water District No. 4 which obtains water from Topeka. This source would be the most accessible source for a temporary supplemental emergency supply.

The Mayetta water supply is presently from three whallow wells located about two miles north of the city. Water is obtained from sandy zones in glacial deposits. The system serves a population of 280. Average daily use is .018 mgd and maximum dependable production is .038 mgd. The system is barely adequate during normal conditions and would experience a water shortage during a prolonged drought. The city plans to purchase water from Jackson County Rural Water District No. 3. Under this arrangement the system should be adequate and the water of improved quality.

The Netawaka water supply is obtained from a single well which pumps water from glacial deposits. The population served is 210. Average daily use is .021 mgd and maximum dependable production is .040 mgd. The quality of the water is very poor. It has sulfates and chlorides above recommended limits. The water is pumped from sand and gravel deposits in a glacial channel cut deeply into rocks of the Wabaunsee Group and these rocks probably contribute highly mineralized water to the aquifer. The Netawaka water system is adequate during normal climatic conditions but might not be adequate during a prolonged drought. Test drilling in the local area might locate water of better quality and adequate quality. Connection to a rural water district with a better quality water source could also provide an improved water supply.

The Soldier water supply is obtained from two shallow wells which derive water from rocks of the Council Grove Group. A population of 185 is served by the system. Average daily use is .010 mgd and maximum dependable production is .029 mgd. The system is probably adequate for present use and probably would be adequate during a prolonged drought. The quality of water is very poor (Table 1). Should an emergency shortage occur additional wells could be drilled. However, the quality of the water would be poor.

The Whiting water supply is obtained from two shallow wells located about two miles north of the city. The system serves a population of 290 and average daily use is .013 mgd. Maximum dependable production is .036 mgd. The system is adequate during normal climatic conditions. However, the city may experience a water shortage during a prolonged drought. The water is of generally good quality. Additional wells could be drilled near the existing wells should a water shortage occur.

Rural Water District No. 1 purchases water from Shawnee Rural Water District No. 4. The district serves a population of 600. Average daily use is .039 mgd and has .100 mgd available is purchased. Under present use the district is not likely to have a shortage of water during a prolonged drought.

Rural Water District No. 2 purchases water from Delia and serves a population of 120. Average daily use is .006 mgd and the district has available .015 mgd if purchased. The Delia water system is adequate to furnish water to the district.

Rural Water District No. 3 is in the planning stage and no data on source or population served is available.

A small area in east-central Jackson County is to be served by Atchison County Rural Water District No. 4 which is not in the planning stage.

Jefferson County

Seven cities in Jefferson County obtain their water supplies from municipally owned water systems. One city obtains water through Rural Water District No. 1. Five rural water districts have completed organization and are in operation. Seven other RWD's are either in the process of organization or construction. An urban population of 5,081 is served by the municipal systems and the rural water districts presently serve a population of 2,971 (Fig. 25, Table 1).

Five of the cities obtain all their water from wells or springs. One city (Valley Falls) obtains its water supply in part from springs and in part from a city lake.

Rural Water Districts No. 1, 2, and 6 obtain water from wells. Rural Water District No. 3 obtains water from wells and purchases from Valley Falls and Rural Water District No. 10 obtains water from Perry Reservoir.

Except for the alluvium which occurs in the valleys to the rocks which underlie the surface of Jefferson County are rather poor aquifers. Glacial deposits which occur in the upland areas yield some water to wells but these deposits are highly dissected by erosion in much of the area and are partially drained of their water. Small to moderate quantities are locally available for domestic and stock supplies in areas where thick glacial deposits occur and contain permeable materials. The Pennsylvanian rocks underlying the area are very poor aquifers or contain poor quality water. Small quantities of water are locally available from the upper weathered part of these rocks. Groundwater supplies in Jefferson County have been described by Davis and Carlson (1952), Fader (1974) and Winslow (1972).

The city of McLouth obtains its municipal water supply from eight shallow wells and two springs. The system serves a population of 651 and average daily use is .060 mgd. The maximum dependable yield is .140 mgd. The city experienced a water shortage during the 1953-54 drought and although improvements have been made on the system since that time may again experience a water shortage during a severe drought. Additional wells in the vicinity of their present wells would supply water for emergency supplies. Water could be purchased from RWD #13 although quantities would be restricted by pipeline size.

The city of Meriden obtains its water supply through Rural Water District No. 1. The supply is obtained from three shallow wells located in Kansas River valley about six miles south of the city. A population of 1,376 is served by the system and average daily use is .090 mgd. Maximum dependable production of .432 mgd. The system is adequate at present and would not be adversely affected during a prolonged drought.

The city of Nortonville obtains water from three deep weils which penetrate permeable materials in glacial deposits. A population of 750 is served by the system and average daily use is .050 mgd. Maximum daily production is .173 mgd. The system is presently adequate but well yields might decrease during a prolonged drought although probably not enough to cause a water shortage. Thicker and more permeable materials occur in an abandoned pre-glacial valley north and east of the city in which wells could be drilled to alleviate a water shortage.

The city of Oskaloosa obtains water from a city owned lake located south of the city. A population of 1,025 is served by the system and average daily use is .100 mgd. The maximum dependable production is .280 mgd. The system is adequate in normal weather conditions and

probably adequate for a short term drought but would probably experience a water shortage during a prolonged drought. Emergency supplies would be obtained through Rural Water District No. 7; however, quantities would probably be limited by pipeline restrictions. The long range solution to water shortages would be through purchase of water from Perry Reservoir or installation of wells in Kansas River valley or development of additional local reservoir storage.

The Ozawkie water supply is obtained from two shallow wells. The system serves a population of 197 and average daily use of .022 mgd. Maximum dependable yield is .120 mgd. The system is presently adequate and should not experience a water shortage during a prolonged drought. More wells could be drilled near the present wells if additional water is needed.

The Perry municipal water supply is obtained from two shallow wells in Kansas River valley. A population of 668 is served by the system and average daily use is .090 mgd. The maximum dependable production is .300 mgd and is presently adequate. The city should not experience a shortage during a prolonged drought. Additional water can be obtained from wells in the Kansas River valley.

The Valley Falls water supply is obtained from springs near the city and from the Deleware River. A population of 1,200 is served by the system and average daily use is .150 mgd. Maximum dependable yield is .350 mgd. The system is presently adequate and there should be no shortage of water during a prolonged drought.

The Winchester water supply is obtained from one deep well in the city and a spring located southeast of the city. Water is obtained from glacial deposits. A population of 590 is served by the system

and average daily use is .086 mgd. Maximum dependable yield is .130 mgd. The system is presently adequate but may experience a water shortage in a prolonged drought. A shortage could be met by additional wells in the general area of the present well or through purchase of water from Rural Water District No. 12 if pipeline restrictions do not forbid this source.

The nitrate (NO_3) content of the water is reported as 82 mg/l and higher than desirable.

Rural Water District No. 1 obtains water from two wells in the Kansas River valley. This system has been discussed in the discussion of the Meriden water supply.

Rural Water District No. 2 obtains its water supply from a single shallow well in the Kansas River valley. A population of 270 is served by the system. Average daily use is .016 mgd and maximum dependable high service capacity is 0.100 mgd. The system is presently adequate and should experience no shortage of water during a prolonged drought. Additional water can be obtained from wells in the Kansas River valley.

Rural Water District No. 3 obtains water from three shallow wells and has a purchase agreement with the city of Valley Falls. A population of 500 is served by the system. Average daily use is .030 mgd and maximum dependable production is .093 mgd. The system is presently adequate and should not experience a shortage during a prolonged drought. If required, additional groundwater could be obtained from wells near the present well field.

Rural Water District No. 6 obtains its water from one shallow well in the valley of the Deleware River adjacent to Perry Reservoir. A population of 475 is served by the system and average daily use is .031

mgd. Maximum dependable production os .042 mgd. The system is adequate presently but porbably would not be adequate during a drought or if additional users are added. Additional water could be obtained from one or more wells near the present well.

Rural Water District No. 10 obtains water form Perry Reservoir. A population of 350 is served by the system. Average daily use is .023 mgd and maximum dependable production is .144 mgd. The system is presently adequate and would not be short of water during a prolonged drought.

Rural Water Districts No. 4, 7, 8, 9, 11, 12, and 13 are in the process of organization and no data is available on source or population served.

A small area in northwest Jefferson County is to be served by Atchison County Rural Water District No. 4. This district is presently being planned.

Johnson County

Twenty cities in Johnson County are served by public water supplies. Eight rural water districts and one multi-municipal county water district are in operation. Johnson County Water District No. 1 serves the metropolitan area in northeast Johnson County and serves 14 cities. About 95% of the population of the county and about 85% of the total area of the county is served by a public water supply.

Except for the alluvial deposits in Kansas River valley the rocks which underlie Johnson County are not good aquifers (Fishel, 1948; Dufford, 1958; O'Connor, 1971). Very small quantities of water are available locally from rocks of Pennsylvanian age and moderate quantities can locally be obtained from alluvial deposits in the smaller stream valleys. Five cities obtain water from impoundements. The other cities obtain water from wells in Kanas River valley or directly from the Kansas River, or Missouri River via the Kansas City, Missouri public water supply or from combinations of these sources.

The city of DeSoto obtains its water supply from two shallow wells in alluvial deposits of the Kansas River valley. A population of 2,100 is served by the system and in addition the city sells water to RWD #6 and #6A. The average daily use if .221 mgd. The system is adequate at the present and would not experience a water shortage should a prolonged drought occur. Should more water be needed it can be obtained from additional wells in the Kansas River valley.

Edgerton obtains municipal water from three small lakes. A population of 488 is served by the system and average daily use is .055 mgd. The system is adequate at the present time but the city probably would experience a water shortage during a prolonged drought. Groundwater

for emergency use is not generally available in this part of the county. Small quantities could probably be salvaged from seepage below the dams to the city lakes in an emergency but the amount available probably would not be sufficient to prevent a water shortage. Additional impoundment capacity is probably the best long range solution to water problems in the city. Edgerton has applied for water from Hillsdale Reservoir when it is built, and will provide an adequate source.

The city of Gardner obtains its water supply from Gardner Lake located north of the city. A population of 2,700 is served by the system and average daily use is .280 mgd. The city did not have a water shortage during the 1953-54 drought and probably would not should another drought occur. Should the city experience considerable increase in water useage a shortage could occur. Additional impounded capacity or wells in the Kansas River valley are sources of additional water. Temporary purchase of emergency water supplies from RWD #7 might also be feasible if pipeline capacity is adequate. Gardner has made application to purchase water from Hissdale Reservoir when it is built.

The city of Olathe obtains its water supply from four shallow wells located in the Kansas River valley and from two city lakes. Cedar Lake, the older and smaller of the lakes, is used only for standby purposes. Water from the shallow wells is treated near the well field. A population of 19,400 is served by the system and average daily use is 2.6 mgd. The system is presently adequate and the city probably would not experience a shortage during a prolonged drought. However, the city is experiencing rapid growth and may have to expand the water system. Additional wells in the Kansas River valley are the best source of additional water. The city wells water to four rural water districts (1, 4, 5, and 7).

The city of Spring Hill obtains its water supply from an impoundment on Little Bull Creek which is tributary to Maris Des Cygnes River. A population of 1,400 is served by the system and average daily use is .100 mgd. The system is adequate at the present time and probably would not experience a shortage should a drought occur but continued growth could make it necessary to expand the system or cause a shortage during a drought. The city has made application to purchase water from Hillsdale Reservoir when it is built.

Johnson County Water District No. 1 obtains water from 21 shallow wells in the Kansas River valley, surface water from the Kansas River and purchase of water from the city of Kansas City, Missouri. The district serves the metropolitan area in northeast Johnson County and serves 14 cities in this area. The cities are: Countryside, Fairway, Leawood, Lenexa, Merriam, Mission, Mission Hills, Mission Woods, Overland Park, Prairie Village, Roeland Park, Shawnee, Westwood and Westwood Hills. A total population of about 180,000 is served by the system and average daily use is 29.7 mgd. This part of Johnson County has experienced very rapid growth and the water system has had to be almost continuously expanded to meet the demand caused by the growth in population. Additional water can be obtained from the present sources and the District has applied for water from Perry Reservoir.

Because of its large water use the district must maintain a reliable supply of its own during any drought. Partial water supply requirements might be obtained by purchase of water from Kansas City, Kansas and Kansas City, Missouri, both of which obtain water from the Missouri River, which must be considered a regulated stream and a very reliable water source.

The 21 wells which the district has can produce about 11 mgd. Additional groundwater could be obtained from wells by developing a second well field in Kansas River valley alluvium south of the river between Holiday and Wilder. Other potential sources for future additional water supplies that should be appraised are (1) the quantity and quality of additional water available during a severe drought from the Kansas River, (2) the potential of obtaining ater from the Missouri River directly or through purcahse agreements with Kansas City, Kansas or Kansas City, Missouri, (3) purchase of state managed water from Perry Reservoir. The district has already made application to the Kansas Water Resources Board for 45.0 mgd from Perry and the costs and feasibility of this source should be evaluated against other potential sources.

Johnson County Rural Water District No. 1 purchases water from the city of Olathe. A population of 901 is served by the system and average daily use is .059 mgd. The supply seems adequate but emergency supplies might be obtained from Rural Water District No. 3 and 6.

Johnson County Rural Water District No. 2 obtains water from the city of Olathe and from a small impoundment on the Blue River. The district is in the process of contracting to purchase water from Kansas City, Missouri. The district serves the city of Stanley as well as a large rural area in southeastern Johnson County. A population of 2,275 is served by the system and average daily use is .125 mgd. The system is presently adequate and the district should not have a shortage should a drought occur but population growth may require expansion of source and facilities. Some emergency water supplies might be obtained by purchase from Johnson County Water District No. 1 or from Rural Water Districts 4 and 5.

Johnson County Rural Water District No. 3 purchases water for its water supply from the city of Bonner Springs. A population of 1,904 is served by the system and average daily use is .124 mgd. This district borders Johnson County Water District #1 and probably will experience considerable population growth which in turn may require expansion of the system. Additional water could be obatined from wells in alluvial deposits of Kansas River valley. Temporary emergency supplies might be obtained by purchase from Johnson County Water District #1 or Rural Water District #1.

Johnson County Rural Water District No. 4 serves a small area near the center of the county and purchases water from the city of Olathe. A population of 398 is served by the system and the average daily use is .026 mgd. Temporary emergency water supplies might be obtained from Johnson County Water District #1.

Johnson County Rural Water District No. 5 serves a large area in south-central Johnson County. The District purcahses water from the city of Olathe. Population served is 1,522 and the average daily use is .099 mgd. Temporary emergency water supplies might be obtained from Rural Water District No. 2 although transmission line capacity would restrict the amount that could be obtained.

Johnson County Rural Water District No. 6 purchases water from the city of DeSoto. The district serves an area south of the city of DeSoto. The population served is 629 and average daily use is .041 mgd. Temporary emergency water supplies might be obtained from Rural Water District No. 1 or from a well in alluvium of the Kansas River valley or from the city of Olathe.

Johnson County Rural Water District No. 6A serves a small area west of the city of DeSoto. This district purchases water from the city of DeSoto through Rural Water District #6. A population of 306 is served by the system and average daily use is .020 mgd. Temporary emergency water supplies could be obtained from a well in Kansas River valley alluvium.

Johnson County Rural Water District No. 7 serves a large area in southwestern Johnson County. The district purchases water from the city of Olathe and th average daily use is .117 mgd. Temporary emergency water supplies might be obtained from Gardner or Rural Water District No. 6.

Labette County

Eight cities in Labette County have public water supplies. All of these cities obtain water from surface water impoundments. In addition to the city supplies eight rural water districts have been organized in the county. Much of the rural area in northern part of the county obtains water from districts organized in other counties.

The rocks which underlie Labette County are generally poor aquifers. Water in quantities sufficiently large to supply a public water system is generally not available. Supplies for individual farms are difficult to obtain in parts of the area. Many farms depended on shallow dug wells or cisterns for a water supply and generally hauled water during the dry season of the year. Groundwater resources of the county have been described by Jungmann and Williams (1968). The larger public water supplies must plan for adequate surface water sources in order to have adequate water supplies during a severe drought.

The city of Altamont obtains its water supply from an impoundment on Hackberry Creek southeast of the city. The city also has a single shallow well used presently only for standby purposes. A population of 923 is served by the water system and the average daily use is .096 mgd. The city experienced a shortage of water during the 1953-54 drought but since have constructed the impoundment onHackberry Creek. The system is presently adequate but should a prolonged drought occur the city may be short of water. In an emergency caused by a shortage some water could be obtained from the standby well and other wells which could be drilled in the vicinity but a dependable supply probably cannot be developed from wells. Emergency water may be available from Rural Water District #5 or #8. However additional impounded storage is probably the best source of water.

The city of Bartlett obtains its water supply from an impoundment at the west edge of the city. A population of 140 is served by the system and average daily use is .015 mgd. The system is presently adequate and would probably be adequate during a prolonged drought. Should a shortage occur water could be contracted from Rural Water District #8.

The city of Chetopa obtains its water supply from the Neosho River. A population of 1,640 is served by the system and the average daily use is .205 mgd. The system is presently adequate and there should be no shortage should a drought occur. The potential for a groundwater supply in Neosho River valley during a drought is not very good but would have to be determined by test drilling. Supplies of 5 to 50 gpm might be available from shallow wells.

The city of Edna obtains its water supply from an impoundment southwest of the city. A population of 475 is served by the system and average daily use is .030 mgd. The system is presently adequate and there should be no shortage should a prolonged drought occur. In an emergency water could be purchased from Rural Water District #6 or #8. However, quantities may be limited by pipeline size.

The city of Labette obtains water from Rural Water District No. 5.

The Mound Valley water supply is obtained from an impoundment on Pumkin Creek. A population of 459 is served by the system and average daily use is .054 mgd. The system is presently adequate but there could be a shortage should a drought occur. However, in an emergency water could be purchased from Rural Water District #7 or #8.

The city of Oswego obtains its water supply from the Neosho River. A population of 2,146 is served by the system and average daily use

is .280 mgd. The system is presently adequate and there should be no shortage should a prolonged drought occur. Rural Water Districts 1, 4 and 8 purchase water from Oswego. Groundwater from wells in Neosho River valley might supply 5 to 50 gpm temporarily in an emergency.

The city of Parsons obtains its water supply from an impoundment on Labette Creek north of the city. Parsons maintains facilities on Neosho River east of the city for pumping water should an emergency occur on the other source. A population of 12,500 is served by the system and average daily upmpage is 2.850 mgd. The system was adequate during the 1953-54 drought and no shortage is expected should another prolonged drought occur. Groundwater from wells in Neosho River valley might supply 5 to 50 gpm for well temporarily in an emergency. Rural Water Districts 2 and 5 purchase water from Parsons.

Labette County Rural Water District No. 1 purchases water from the city of Oswego. A population of 146 is served by the system and average daily use is .008 mgd. Temporary emergency water supplies might be obtained from Rural Water District 5 or 8.

Labette County Rural Water District No. 2 purchases water from the city of Parsons. A population of 100 is served by the system and the average daily use is .014 mgd. Tempokary emergency water supplies might be obtained by purchase from Neosho County Rural Water District No. 4.

Labette County Rural Water District No. 3 purchases water from the city of Cherryvale in Montgomery County. A population of 265 is served by the system and average daily use is .017 mgd. Temporary emergency water supplies might be obtained by purchase from Neosho County Rural Water District No. 5.

Labette County Rural Water District No. 4 purchases water from the city of Oswego. A population of 165 is served by the system and average daily use is .012 mgd. Groundwater from wells in the Neosho River valley might supply 5 to 50 gpm for well termporarily in an emergency.

Labette County Rural Water District No. 5 purchases its water supply from the city of Parsons. A population of 850 is served by the system and average daily use is .055 mgd. Groundwater from wells in the Neosho River valley might supply 5 to 50 gpm per well temporarily in a drought emergency.

Lagette County Rural Water District No. 6 purchases water from the city of Coffeyville in Montgomery County. A population of 894 is served by the system and average daily use is .036 mgd. In an emergency water might be obtained by purchase from Rural Water District No. 8.

Labette County Rural Water District No. 7 purchases water from the city of Parsons through Neosho County Rural Water District No. 4 and Labette County Rural Water District No. 2. A population of 186 is served by the system and average daily use is .010 mgd. In an emergency water might be obtained by purchase from Rural Water District No. 8 or Mound Valley.

An area along the northern part of Labette County extending into the county about three miles is served by Neosho County Rural Districts 4 and 5 and Crawford County Rural Water District No. 6. A small area in west-central Labette County is served by Montgomery County Rural Water District No. 6. These systems are discussed under their respective county discussions.

Leavenworth County

Four cities in Leavenworth County have municipally owned water systems. Lansing purchases water from Leavenworth and a sixth (Basehor) purchases water from a rural water district. In addition to the municipal supplies there are nine rural water districts organized in the county and two rural water districts organized in other counties which serve part of Leavenworth County. An urban population of 32,912 is served by public water supplies while 4,692 are served by rural water districts.

In the valleys of Missouri River and Kansas River large quantities of water are available from wells or from the streams. Generally the surface water is of better quality than the groundwater and the groundwater in the Kansas River valley is of better quality than that in the Missouri River valley. Elsewhere in the county the rocks locally yield adequate quantities of water for stock and domestic use but in much of the area only very meager quantities of water are available. It is in these areas that most of the rural water districts are located.

The water supply for Basehor is purchased from Rural Water District No. 4. The system is duscussed in the section on Rural Water District No. 4.

The Easton water supply is obtained from two shallow wells in the eastern edge of the city. A population of 453 is served by the system. Average daily use is .028 mgd and maximum dependable yield is .144 mgd. The present system is adquate and the city probably would not experience a water shortage during a severe drought. Should a shortage occur additional wells could be drilled in the valley of Stranger Creek.

Eight Views Subdivision is a very small private water system that serves the Miva Land Development Corporation subdivision southeast of Basehor. Eight service connections provide water to about 30 people from four shallow wells. The reported maximum dependable yield of the well field is nine times the maximum daily consumption. The water is hard but otherwise of good chemical quality.

The city of Lansing purchases water from the city of Leavenworth.

The Leavenworth municipal water supply is obtained from the Missouri River. Average daily use of Leavenworth and Lansing is 3.80 mgd and maximum dependable yield is 6.0 mgd. The combined population of the two cities served by the system is about 30,000. The supply is presently adequate and any shortage which might occur during severe drought conditions would be due to limitations of the treatment and distribution system rather than the source. The city sells water to Rural Water Districts 1, 2, 3, 5, and 8.

The Linwood water supply is obtained from two shallow wells in Stranger Creek valley at its junction with Kansas River. Population served by the system is 350 and average daily use is .016 mgd. Maximum dependable yield is .086 mgd. The system is presently adequate and probably would not experience a shortage during a severe drought. Additional wells could be drilled in the vicinity of the present wells.

The Tonganoxie municipal water supply is obtained from two shallow wells which obtain water from the Tonganoxie sandstone. A population of 2,079 is served by the system and water is sold to Rural Water District No. 6. Average daily use by the urban population is .250 mgd and maximum dependable yield is .600 mgd. The system is presently

adequate and probably would be adequate during a severe drought. Additional water could be obtained by drilling more wells into the Tonganoxie sandstone in the vicinity of the present wells. Long range planning could evaluate the economics of continued development of wells in the local aquifer versus a new well field in the Kansas River valley.

Rural Water District No. 1 purchases water from the city of Leavenworth. A population of 74 is served by the system. Average daily use is .005 mgd.

Rural Water District No. 2 purchases water from the city of Leavenwroth. A population of 384 is served by this system. Average daily use is .025 mgd.

Rural Water District No. 3 purchases water from the city of Leavenworth. A population of 139 is served by the system. Average daily use is .009 mgd.

Rural Water District No. 4 obtains its water supply from four shallow wells and two deep wells. The district serves a small area around the city of Basehor and sells water to the city. Total population soerved is 875 and average daily use is .053 mgd. Maximum dependable yield is .130 mgd. The system is adequate at the present time but continued growth or a severe drought may cause a water shortage. Additional water could be obtained from more wells or water could be purchased from Wyandotte County Rural Water District No. 2. However, pipeline restrictions may limit this source.

Rural Water District No. 5 purchases water from the city of Leavenworth. A population of 486 is served by the system. Average daily use is .032 mgd.

Rural Water District No. 6 purchases water from the city of Tonganoxie. A population of 269 is served by the system. Average daily us is .017 mgd.

Rural Water District No. 7 purchases water from the city of Bonner Springs. A population os 751 is served by the system and average daily use is .049 mgd.

Rural Water District No. 8 purchases water fromthe city of Leavenworth. A population of 714 is served by the system and average daily use is .046 mgd.

Rural Water District No. 9 obtains its water supply from four deep wells in the valley of Stranger Creek. Water is from the Tonganoxie Sandstone. A population of 1,000 is served by the system and average daily use is .106 mgd. Maximum dependable yield is .173 mgd. The system is presently adequate but with continued growth additional water will be needed. A severe drought would probably cause a shortage of water. Additional wells could be drilled in the general area of the present supply wells.

Linn County

Six cities in Linn County have municipal water supplies and three rural water districts have been organized within the county. In addition to these water supplies an area in northwestern Linn County is served by Miami County Rural Water District No. 3. All the public water supplies in the county are obtained from surface water sources.

Except for the alluvial deposits adjacent to the streams in the county the rocks underlying the county are poor aquifers. Locally water is available in great enough quantities for stock and domestic use but quantities large enough for a public water supply are not generally available in the area. Groundwater resources of the county have been described by Seevers (1969).

The Blue Mound water supply is obtained from a city lake located about one mile northwest of the city. The population served is 330 and the average daily use is .025 mgd. Maximum dependable production is .040 mgd. The system is adequate at the present time. However, a water shortage could occur during a prolonged drought. Should a water shortage occur only small quantities of water would be available from wells. Additional impounded capacity is about the only source of additional water during an emergency.

The city of LaCygne pumps water from the Maris Des Cygnes River for its water supply. A population of 994 is served by the system. In addition the city sells water to Rural Water Districts 1, 3 and 3S. Average daily us is .085 mgd. The water source for this water supply is adequate. However, the pumping and distribution system may prove inadequate during prolonged periods of high use. Seevers (1969) indicates well yields of 10 to 100 gpm can be obtained from the alluvial deposits in the Maris Des Cygne valley.

The city of Mound City obtains its water supply from an impoundment on LIttle Sugar Creek southwest of the city. A population of 790 is served by the system. Average daily use is .065 mgd. The system is adequate at the present time and probably would not experience a shortage during a prolonged drought. Should a shortage occur only small quantities of water could be obtained from wells. Additional impounded capacity would be the best source of additional water during an emergency. Purchase of water from Rural Water District No. 2 could help alleviate a water shortage. However, quantities available from this source would be limited by pipeline size.

The city of Parker obtains its water supply from a city lake. A population of 230 is served by the system. Average daily use is .015 mgd. The system is presently adequate but a water shortage may occur during a prolonged drought. Only small quantities of water would be available from wells during an emergency. Water could be purchased from Linn County Rural Water District No. 3 if the district's pumping capacity and pipelines are large enough.

The city of Pleasanton obtains its water supply from two impounding reservoirs, one located northeast of the city and the other located at the west edge of the city. A population of 1,360 is served by the system and in addition water is sold to Linn County Rural Water District No. 2. Average daily use is .130 mgd. The system is presently adequate and should not experience a shortage during a prolonged drought. Should an emergency occur water could be obtained from the Maris Des Cyges River about two miles northeast of the cities impoundment from wells in the Maris Des Cygne valley.

The city of Prescott obtains its water supply from a city lake located about one mile east of the city. A population of 229 is served by the system and average daily use is .025 mgd. The system is adequate at the present time but may be marginally adequate during a prolonged drought. Only very small quantities of water could be obtained from wells during an emergency and water could be purchased from Bourbon Conty Rural Water District No. 1 or Linn County Rural Water District No. 2 if water is available and pipeline capacities are adequate. Additional impounding capacity may be the long range answer.

Rural Water District No. 1 purchases water from the city of LaCygne. A population of 725 is served by the system. Average daily use is .034 mgd.

Rural Water District No. 2 purchases water from the city of Pleasanton. A population of 380 is served by the system. Average daily use is .025 mgd.

Rual Water Districts No. 3 and 3S purchase water from the city of laCygne. A combined population of 1,155 is served by the systems. Average daily use of the two districts is .067 mgd.

Miami County Rural Water District No. 3 serves a small area in northwestern Linn County. This water supply is discussed in the section on Miami County.

Lyon County

Eight cities in Lyon County have public water supplies and five rural water districts have been organized in the county. Five of th cities use surface water and three use groundwater. Coffey County Rural Water District #2 serves a large area in southeastern Lyon County. This district purchases water from Emporia.

In most of Lyon County groundwater in quantities large enough to supply a public water supply are generally not available (O'Connor, 1958). Alluvial deposits in Neosho and Cottonwood River valleys are the most prolific aquifers in the county. Well yields of 10 to 100 gpm can be obtianed. Rocks of Permian age in northwestern Lyon County generally contain quantities of water sufficient for individual stock or domestic wells and locally reliable stock or domestic wells can be obtained in Pennsylvanian rocks. However, nowhere are large quantities of water available from these rocks.

The city of Admire obtains its water supply from an impoundment reservoir northwest of the city. A population of 153 is served by the system and average daily use is .012 mgd. The impoundment is jointly used by Admire and the city of Allen. The system is presently adequate and probably would be adequate should a prolonged drought occur. Only small quantities of water could be obtained from wells should an emergency occur.

The city of Allen obtains its water supply from an impoundment reservoir which it uses jointly with Admire. The Allen water system serves a population of 196 and the average daily use is .015 mgd. The system should be adequate should a drought occur. Emergency water could

be obtained from shallow wells in and near the city although quantities available are small.

The city of Americus obtains its water through Rural Water District No. 1.

The city of Emporia obtains its water supply from the Neosho River. Facilities are maintained on the Cottonwood River and on Lake Kahola for reserve supplies of water. The city sells water to Lyon County Rural Water District 2 and 5 and to Coffey County Rural Water District No. 2. A population of about 25,000 is served by the system and average daily use is 5.0 mgd. The system is presently adequate and probably would be adequate through a prolonged drought. Additional emergency water could be obtained from wells in the alluvial deposits in Neosho and Cotton-Wood river valleys.

The city of Hartford obtains its water supply from the Neosho River. The city also maintains one well in the alluvial deposits in the Neosho valley for standby purposes. A population of 521 is served by the system and average daily use is .060 mgd. The system should be adequate through a prolonged drought.

The Kansas Turnpike Authority purchases water from the city of Emporia.

The city of Neosho Rapids is served by Rural Water District No. 4.

The city of Olpe obtains its water supply from an impounding reservoir on Eagle Creek southwest of the city. A population of 456 is served by the system and the average daily use is .070 mgd. The reported safe yield of the impoundment is 0.060 mgd and maximum dependable production is reported as 0.072 mgd which is less than the average daily use

of Olpe and Rural Water District #4 to which water is sold. Additional impounded storage and production capacity are both needed. In an emergency water might be obtained from Rural Water District No. 2 or hauled from Emporia by rail or highway.

The city of Reading obtains its water supply from five shallow wells in the valley of Duck Creek. A population of 256 is served by the system and average daily use is .020 mgd. The system is averly adequate at the present and the city experienced a water shortage during the 1953-54 drought and would again have a shortage should another prolonged drought occur. Additional wells would probably furnish needed water should a shortage occur. Purchase of water from Melvern Reservoir would alleviate future problems.

Thorndale Acres is a small development east of Emporia which owns its own water system. A population of 38 is served by the system and average daily use is 0.003 mgd. Water is obtained from a single well and the system is adequate to meet present needs. There should be no shortage of water during a drought.

Rural Water District No. 1 serves the city of Americus. The district obtains water from two shallow wells in the alluvial deposits in Neosho River valley. A population of 280 is served by the system and average daily use is .020 mgd. The system is presently adequate and should be adequate should a drought occur. Additional water could be obtained from more wells in the valley area.

Rural Water District No. 2 gets water from Emporia.

Rural Water Distric No. 3 purchases water from the city of Olpe. A population of 245 is served by the system and average daily use is .016 mgd.

Rural Water District No. 4 obtains water form a single well in the alluvial deposits in the valley of Neosho River. The district includes the city of Neosho Rapids. A population of 470 is served by the system and average daily use os .031 mgd. The system is presently adequate and the district probably would not be short of water during a drought. A shortage could occur due to a mechanical breakdown in their single supply well. Additional wells could be drilled in the valley area. An additional well would give a more assured and dependable supply.

Rural Water District No. 5 purchases water from the city of Emporia. A population of 810 is served by the system and average daily use is .380 mgd.

Coffey County Rural Water District No. 2 serves a large area in southeastern Lyon County. The district purchases water from Emporia.

Osage County Rural Water District No. 7 serves a small area in northeastern Lyon County and western Osage County. Water is obtained from Osage City which obtains water from a city lake and Melvern Reservoir.

Marion County

Eight cities in Marion County have public water supplies. All, except for the city of Marion use groundwater. Marion uses surface water from an impoundment on Mud Creek. Two rural water districts have been organized in the county.

Groundwater is generally available in moderate quantities in Marion County. Locally only small quantities of water are available or the water is of poor quality. Rocks of the Wellington Formation underlie much of the western part of the county and locally wells in the lower part of the Wellington yield 100 to 500 gpm. The water in parts of the county is high in calcium and sulfate (moore, 1940). The eastern part of the county is underlain by rocks of the Chase Group. In this area the water is of better quality.

The city of Burns obtains water from three deep wells which penetrate the Barneston Formation. A population of 275 is served by the system and average daily use is .040 mgd. The system is presently adequate and no shortage is expected should a prolonged drought occur. The water is hard but otherwise of good quality.

The city of Durham obtains its water supply from a single shallow well drilled in alluvial deposits in Cottonwood River valley. A population of 190 is served by the system and average daily use is .016 mgd. The system is adequate at the present time and no shortage is anticipated should a drought occur. Should more water be needed additional wells could be drilled in the vicinity of their present well. The water of Durham is of very good quality having a total hardness of 68 mg/l which is much lower than most water obtained from alluvial deposits in this part of the state. Upstream a short distance from the Durham well sandstone of the Kiowa Formation is adjacent to the stream and good

quality water from the Kiowa Formation probably recharges the alluvium.

The city of Florence obtains its water supply from a spring. The spring yields water from the Barneston Formation. The city maintains a well which penetrates the Barneston Formation and is used only for standby purposes. A population of 925 is served by the system and average daily use is .083 mgd. The system is adequate at the present time and should be adequate should a prolonged drought occur. Should more water be needed wells could be drilled into the Barneston Formation. The water is hard but can easily be softened.

The city of Goessel obtains its water supply from three shallow wells which penetrate sand and gravel of Cenozoic age. A population of 437 is served by the system and average daily use is .028 mgd. The system is adequate at the present time and no shortage is expected should a drought occur. More wells could be drilled in the area of the present wells should additional water be needed.

The city of Hillsboro obtains its water supply from 12 shallow wells which are drilled into the Wellington Formation. A pouplation of 2,734 is served by the system and average daily use is .274 mgd. The city was short of water during the 1953-54 drought. However, improvements on the system have been made and no shortage is anticipated should another drought occur. The water from the Hillsboro wells is of very poor quality with total dissolved solids of 1,738 mg/1. Somewhat better quality water should be available from alluvial deposits in south Cottonwood River about three miles south of the city. Water of better quality than that now used is present in Marion Reservoir and the city has applied for purchase of a part of the state managed conservation storage.

The city of Lehigh obtains water from a single shallow well which is drilled into the Kiowa Formation. A population of 200 is served by the system and average daily use if .020 mgd. The system is presently adequate and no shortage is expected should a prolonged drought occur. A shortage could occur due to a mechanical breakdown of the single well. Another well could be drilled in the vicinity of the present well. Water from the present well is of good quality.

The city of Marion obtains its water supply from an impoundment on Mud Creek near the city. A population of 2,250 is served by the system and average daily use is .275 mgd. The city had a water shortage during the 1953-54 drought. However the city has since made improvements and has applied for purchase of part of the state managed storage in the Marion Reservoir. The city should not experience a water shortage should another drought occur. Water from the present source is quite hard and probably the water from Marion Reservoir would also be quite hard.

The city of Peabody obtains its water supply from six shallow wells drilled into the Wellington Formation. A population of 1,620 is served by the system and average daily use is .158 mgd. The city did not have a water shortage during the 1953-54 drought and a shortage could occur because maximum daily use sometimes exceeds maximum dependable well yield. The quality of the water at Peabody os poor with total dissolved solids of 738 mg/l and total hardness of 576 mg/l. Better quality water could be obtained from rocks of the Chase Group several miles east of the city and additional water of better quality should be developed.

Rural Water District No. 1 is presently in the planning stage. This district will serve a large area in northwest Marion County and a small area in southern Dickinson County.

Rural Water District No. 2 serves a small area at the control work at Marion Dam. Water is obtained from a single well and the average daily use is .0015 mgd.

Harvey County Rural Water District No. 1 serves a large area in southwest Marion County and McPherson County.

McPherson County Rural Water District No. 1 serves a small area in northwest Marion County.

Marshall County

Twelve cities have public water supplies in Marshall County. Two rural water districts have been organized in the county. In addition Washington County Rural Water District No. 1 serves an area in northwest Marshall County and Nemaha County Rural Water District No. 3 serves an area in northeast Marshall County. All of the public water supplies are obtained from wells.

The Permian rocks which underlie Marshall County generally yield sufficient water for domestic and stock wells and locally moderate quantities of water are available. However, all of the water from the Permian rocks is ahrd and locally the water is very high in sulfates. In the northeastern part of the county glacial drift overlies the Permian rocks and where sand and gravel occur in the lower part of the glacial drift good supplies of water are available. A pre-glacial buried valley crosses Blue River at a point about dur north of Marysville and trends southeastward through Winifred and Frankfort and leaves the county about at the southeast corner of T4S, R10E. Locally moderate to large quantities of water are available in this buried valley. Groundwater supplies have been described by Walters (1954).

The city of Axtell obtains its water supply from three shallow wells drilled into glacial drift. A population of 510 is served by the system and average daily use of .040 mgd. Axtell did not have a water shortage during the 1953-54 drought and a shortage is not expected should another drought occur. The water from the wells is hard but otherwise of good quality. Additional wells in the local area could provide an increased water supply.

The Beattie municipal water supply is obtained from six wells which are drilled thorugh the glacial drift that underlies the area. Some of the wells are probably drilled into Permian rocks and obtain a part of their water from these rocks. All the wells are low yielding wells. A population of 300 is served by the system and average daily use is .015 mgd. The city had a water shortage during the 1953-54 drought and although more wells have been added to the system the city may experience a shortage sould a prolonged drought occur. Higher yielding wells and better quality water should be found three or four miles east of the city.

The city of Blue Rapids obtains its water supply from two shallow wells drilled in alluvial deposits in Little Blue River valley. A population of 1,345 is served by the system and average daily use is .160 mgd. The system is presently adequate and there should be no shortage should a prolonged drought occur. The water is hard but otherwise of good quality.

The Breman water supply is purchased from Washington County Rural Water District No. 1. A single shallow well is maintained for standby purposes. A population of 50 is served by the system and average daily use is .004 mgd. The system is presently adequate and no shortage is anticipated should a prolonged drought occur. The single standby well probably would not sustain the city's needs without the water from the Rural Water District.

The Frankfort water supply is obtained from three deep wells which penetrate a pre-glacial buried valley. A population of 1,150 is served by the system and average daily use is .155 mgd. The system is adequate

at the present time and no shortage is expected should a drought occur. Additional properly located wells could be drilled if needed.

The city of Marysville obtains its water supply from seven shallow wells drilled into alluvial deposits in the Big Blue River valley in the west edge of the city. A population of 3,700 is served by the system and average daily use is .633 mgd. The system is adequate at present and no shortage is anticipated should a drought occur. Should more water be needed additional properly spaced wells could be drilled in the valley area.

The Oketo water supply is obtained from two shallow wells drilled in alluvial deposits in Big Blue River valley. A population of 150 is served by the system and the average daily use is .012 mgd. The system is adequate at present and no shortage is expected should a drought occur. Additional water can be obtained from more properly spaced wells in the valley area.

The Summerfield water supply is obtained from one shallow well and two deep wells. The deep wells probably obtains water from Permian rocks but may get some water from glacial deposits. The shallow well obtains wter from glacial deposits. A population of 270 is served by the system and average daily use is .025 mgd. The system is presently adequate and there probably would be no shortage should a drought occur. The water from the city wells is very hard and high in sulfates. Additional water could be obtained from more wells but there would be no improvement in quality from wells in this same area.

The Vermillion water supply if obtained from two shallow wells in allvuail deposits in the valley of the Black Vermillion River. A population of 240 is served by the system and the average daily use is

.020 mgd. The city had a water shortage during the 1953-54 drought but the system has been improved since that time and no shortage is expected should another drought occur. Additional water could be obtained from allvuail deposits in Black Vermillion River valley or from gravels in the pre-glacial buried valley which is located three to four miles south of the city.

The city of Waterville obtains its water supply from two shallow wells drilled in alluvial deposits in Little Blue River valley. A population of 761 is served by the system and the average daily use is .072 mgd. The system is presently adequate and no shortage should occur should a drought occur. Additional water can be obtained from properly spaced wells in the valley area.

The city of Winifred obtains its water supply from two privately owned wells which obtain water from alluvial deposits in Roubidoux Creek valley. A population of 35 is served by the system and average daily use is .0035 mgd. The system is adequate at present and there should be no shortage should a drought occur. Should additional water be needed more wells in the alluvial deposits of Roubidoux Creek could be drilled or wells could be drilled inot the buried pre-glacial valley which is present just west of the city.

Rural Water District No. 1 serves an area of about one square mile around the community of Home City. The system is supplied by s single shallow well which obtains water from glacial deposits. A population of 120 is served by the system and average daily use is .007 mgd. The system is adequate at the present time and no shortage is expected should a drought occur. The system would be subject to a shortage due to a break-down in the single supply well. An additional well could be drilled in

the vicinity of the present well. The water for the system is of poor quality. It is very hard and high in sulfates.

Rural Water District No. 2 serves a small area east of Marysville from two shallow wells which penetrate a pre-glacial buried valley. A population of 180 is served by the system and the average daily use is .013 mgd. The system is presently adequate and no shortage is anticipated should a drought occur. Should more water be desired more wells could be drilled in the pre-glacial valley.

Miami County

Four cities in Miami County have public water supplies (Fig. 33, Table 1). In addition three rural water districts have been organized in the county. Districts organized in other counties serve parts of northern, western and southeastern Miami County. Three of the cities with public supplies and all of the rural water districts use surface water.

Except for alluvial deposits in the valley of the Maris Des Cygnes River and in its major tributaries only small quantities of water are available to wells from the rocks underlying the surface of Miami County. Moderate quantities of water can locally be obtained from these alluvial deposits. In local areas in the county supplies of water adequate for individual domestic or stock water supplies are available from Pennsylvanian rocks which underlie the area. However, in much of the county wells which are reliable through a drought period are not obtainable (Miller, 1966).

The water supply for Fontana is obtained from a single well located north of the city. A population of 150 is served by the system and average daily use is .014 mgd. The system is adequate at the present rate of use. However, should a drought occur a shortage of water could occur. The city is subject to shortage due to a mechanical breakdown in their single well. Another well could be drilled near the present well to guard against mechanical failure and provide increased dependable yield. Water could be obtained from Maris Des Cygnes River. However, this source would require additional treatment facilities.

The Louisburg water supply is obtained from the Louisburg City Lake located southeast of the city. A population of 1,089 is served by

the system and average daily use is .125 mgd. The system is presently adequate but should a prolonged drought occur a shortage could occur. Additional surface impoundment or purcahse of water form Rural Water District No. 2 are about the only solutions to a shortage.

The Osawatomie water supply is obtained from an impoundment reservoir and from the Maris Des Cygnes River. A population of 5,500 is served by the system and average daily use is 1.5 mgd. The system is presently adequate but the city had a water shortage during the 1953-54 drought and although the estimated capacity of the system has been doubled the use has also been doubled. The city could experience a shortage should a severe drought occur. Emergency water could be obtained by additional impoundment capacity or by drilling wells in the Maris Des Cygnes valley. Reservoirs upstream from the city may contain enough storage to maintain a flow in the Maris Des Cygnes River in which case the city should not be short of water.

The city of Paola obtains its water supply from Lake Miola east of the city. A population of 5,030 is served by the system and average daily use is .406 mgd. The city did not experience a shortage during the 1953-54 drought and improvements have been made since that time. Although average use has doubled since 1953-54 no shortage is expected should another drought occur. Paola has applied for water from state managed storage in Hillsdale Reservoir when it si completed.

Rural Water District No. 1 purchases water from Osawatomie. A population of 1,070 is served by the system and average daily use is .070 mgd.

Rural Water District No. 2 serves an area north and west of the city of Paola and also includes much of the eastern part of Miami County.

The district obtains its water supply from an impoundment on north Wea Creek east of Paola. A population of 2,550 is served by the system and average daily use is .226 mgd. This system is presently adequate but should a prolonged drought occur a shortage of water may occur. In an emergency water could be purchased from the city of Paola. However, it is questionable whether Lake Miola would support both systems over an extended drought period. Additional storage capacity on north Wea Creek is probably the long term solution to possible shortages or purchase of state managed water from Hillsdale Reservoir when completed.

Rural Water District No. 3 serves an area in southwest Miami County and part of southeast Franklin County and northwest Linn County. The district purchases water from the city of Osawatomie. A population of 1,213 is served by the system and average daily use is .079 mgd.

Small areas along the northwestern border of the county are served by Franklin County Rural Water District No. 6. Johnson County Rural Water District No. 2 and 7 serve small areas along the northern border of the county and an area in southeastern Miami County is served by Linn County Rural Water District No. 1.

Montgomery County

Ten cities or communities in Montgomery County have public water supplies (Fig. 34, Table 1). Five of the cities own their own water systems, one purchases water from Coffeyville and four obtain water through rural water districts. Eleven rural water districts have been organized in the county and small areas in eastern Montgomery County are served by Labette County Rural Water District No. 3 and 7. All the public supplies are obtained from surface water sources.

Rocks of Pennsylvanian age underlie all of Montgomery County. These rocks contain sandstone beds which are the principal aquifers in the County. Well yields of 20 to 50 gpm are locally available from the sandstone aquifers. The sandstone aquifers may contain fresh water at depths of 200 to 400 feet and in other areas may be saline at depths of about 50 feet. Alluvial deposits in the major stream valleys are the most prolific aquifers in the county and may locally yield as much as 100 gpm to wells. This water is generally very hard but suitable for domestic and stock use. The aquifers in many places in the county have been contaminated by oil field brines from production operations many years ago and from improperly plugged wells. Groundwater is used principally for domestic and stock use. The groundwater resource have been described by O'Connor (1974).

The city of Caney obtains its water supply from an impoundment on Caney Creek northwest of the city and from an impoundemtn reservoir on Otter Creek serveral miles northwest of the city. A population of 2,750 is served by the system and average daily use is .250 mgd. The two reservoirs are adequate at present and no shortage is expected should a prolonged drought occur.

The Cherryvale water supply is obtained from the Verdegris River about six miles west of the city. A population of 2,940 is served by the system and average daily use is .510 mgd. The city sells water to Montgomery County Rural Water District No. 6 and Labette County Rural Water District No. 3. The system is presently adequate and should be adequate through a drought. The city has applied for water from state managed storage in Big Hill Reservoir when it is completed.

The Coffeyville water supply is obtained from the Verdegris River. A population of 17,398 is served by the system and average daily use is 3.90 mgd. The city sells water to the community of Dearing and to Rural Water Districts 7, 10 and 11. The system is presently adequate and no shortage is expected should a prolonged drought occur.

The community of Dearing purchases water from the city of Coffeyville.

The Elk City water supply is obtained from the Elk River. A population of 470 is served by the system and average daily use is .052 mgd. The city sells water to Rural Water District No. 9. The system is adequate at present and no shortage should occur should a prolonged drought occur.

Havana is served by Rural Water District No. 5.

The city of Independence obtains its water supply from the Verdigris River and has applied for 5.0 mgd of water from state managed storage in the Elk City Reservoir. A population of 14,550 is served by the system and the city sells water to Rural Water District 1, 2, 3, 4, 5, and 8. The average daily use at Independence is 2.066 mgd. The system is presently adequate and should be adequate during a prolonged

drought should one occur. The storage from Elk City Reservoir should be all the reserve water supply needed.

The community of Liberty is served by Rural Water District No. 6.

The community of Sycamore is served by Rural Water District No. 4.

The community of Tyro is served by Rural Water District No. 5.

Rural Water District No. 1, 2, 3, 4, 5, and 8 purchase water from the city of Independence. The populations served and average daily use are as follows:

District	Population	Use (mgd)
1	150	.009
2	340	.026
3	80	.005
4	745	.048
5	1,190	.077
8	250	.016

Rural Water District No. 6 purchases water from the city of Cherryvale. The population served is 920 and average daily use is .060 mgd.

Rural Water District No. 7 purchases water from the city of Coffeyville. The population served is 280 and the average daily use is .018 mgd.

Rural Water District No. 9 purchases water from the city of Elk City. The population served is 411 and the average daily use is .029 mgd.

Rural Water District No. 10 and 11 purchase water from the city of Coffeyville. The populations served are 196 and 292 respectively and the average daily use is .013 mgd and .019 mgd.

Labette County Rural Water District No. 3 serves a small area in northeast Montgomery County and an area in northwest Labette County. The district purchases water from the city of Cherryvale.

Labette County Rural Water District No. 7 serves southwestern Labette County and southeastern Montgomery County. The district purchases water from Coffeyville.

Morris County

Three cities in Morris County have public water supplies. One city, Council Grove, obtains water from a city owned lake and the cities of Dwight and White City obtain their water supplies from wells. Permian rocks of the Chase Group crop out in all but southwestern Morris County where the surface rocks are a part of the Wellington Formation of the Sumner Group. The Barneston and Wreford Formations of the Chase Group generally are good aquifers and these rocks are the principal source of wter in the county. In the western and southwestern part of the area the water is generally quite hard and may be high in sulfates. Eastward the quality of the water is better. Yields of wells in the Permian rocks in Morris County are not large. However, moderate quantities can be obtained locally and small dependable supplies are widely available in the county. No rural water districts have been organized in the county and no districts organized in adjacent counties serve areas in Morris County.

The Council Grove water supply is obtained from a city owned lake. A population of 2,600 is served by the system. Average daily use is .338 mgd. The system is presently adequate and no shortage should occur during a prolonged drought. Should emergency water be needed the city is just below Council Grover Reservoir and short term purchase may be arranged.

The city of Dwight obtains its water supply from two shallow wells which obtain water from the Barneston Formation. A population of 412 is served by the system and average daily use is .032 mgd. The system is adequate at the present and should be adequate should a drought occur.

Should additional water be needed more wells can be drilled in the vicinity of the city.

The water supply for White City is obtained from three deep wells which obtain water from the Barneston Formation. A population of 522 is served by the system and the average daily use is .040 mgd. The system is presently adequate and should be adequate should a drought occur. If additional water is needed more wells can be drilled in the vicinity of the city.

Nemaha County

Eight cities in Nemaha County have public water supplies (Fig. 36, Table 1). Seven of these cities obtain water from wells and the eighth (Sabetha) obtains water from a city lake located about five miles west of the city. Two rural water districts have been organized and are in operation in the county and a third district is being planned. This district will serve a large area in western Nemaha County and northeastern Marshall County and extend to Brown County in east-central Nemaha County.

Much of Nemaha County is underlain by glacial deposits which range in thickness from a few feet to 200 feet. Rocks of Permian and Pennsylvanian age crop out principally in northern Nemaha County. Water supplies range widely in the quantity of water available due to the hetrogeneous nature of the glacial deposits and the wide range in thickness of these deposits. The thickest glacial deposits occur in the southern part of the county where a preglacial buried valley is filled with glacial deposits. Coarse sand and gravel at the base of the deposits in the preglacial valley yield moderate quantities of water. In areas where the glacial deposits are thin variation in the water level in wells because of seasonal weather conditions may be large and individual wells which are adequate most of the time may fail to supply enough water. This may occur annually or may occur only during drought periods. In much of the area Permian and Pennsylvanianrocks outcrop. These rocks are not good aquifers and a dependable water supply may be difficult to obtains. Ward (1974) has described and mapped the groundwater resources.

The community of Bailyville is served by Rural Water District No. 2.

The city of Bern obtains its water supply from three deep wells which penetrate glacial deposits in a narrow buried channel which trends southward beneath the city. A population of 225 is served by the system. Average daily use is .020 mgd. The city sells water to Rural Water District No. 1. The system is presently adequate to the needs of the city and Rural Water District No. 1. However, the aquifer from which water is obtained is limited in areal extent and could become overdeveloped. The Permian rocks in the vicinity of Bern are not good aquifers and additional water could not be obtained from them. Additional water could be obtained from the buried channel from which the present supply is obtained but wells should be properly spaced to avoid interference between wells.

The city of Centralia obtains its water supply from five shallow wells located in the city which penetrate glacial deposits. A population of 565 is served by the system and average daily use is .030 mgd. The system is presently adequate but a severe drought might cause reduced well yields and result in a water shortage. Should more water be needed additional wells could be drilled in the vicinity of the present wells. Attempts to locate permeable gravels in the preglacial valley south of the city have been unsuccessful to date. These gravels are locally present and could be located with a test drilling program.

The city of Corning obtains its water supply from a single well which penetrates permeable gravels in a tributary to the preglacial valley which crosses southern Nemaha County. A population of 160 is served by the system and average daily use is .015 mgd. The system is presently adequate and no shortage is expected should a drought occur. The city is subject to a shortage due to a mechanical breakdwon of the

single well. A more assured supply could be obtained by adding another well to the system. Test drilling might locate a water supply having less iron and manganese in the water and therefore of better quality.

The city of Goff obtains its water supply from two deep wells located in the city which penetrate glacial deposits. A population of 240 is served by the system and average daily use is .027 mgd. The system is presently adequate for the city's needs and no shortage is anticipated should a prolonged drought occur. Additional wells could be drilled in the vicinity of the present wells should more water be needed.

The city of Oneida obtains its water supply from a single well located about four miles north of the city. The well penetrates glacial deposits in a southwesterly trending buried valley. A population of 115 is served by the system and average daily use is .010 mgd. The system is presently adequate and should be adequate through a drought but the city is subject to shortage of water due to mechanical breakdown of the single well. An additional well drilled in the buried valley deposits would serve the system should there be a mechanical breakdown or should there be a drought caused shortage.

The city of Sabetha is the only city in the county that uses surface water for its water supply. The city obtains its water supply from a city owned lake located about five miles west of the city. A population os 2,500 is served by the system and average daily use is .250 mgd. The system is presently adequate and should be adequate during a prolonged drought. Should more water be needed additional capacity would be necessary or limited quantities of water may be obtained from wells in a buried valley which trends southward from a point about one mile west and about two miles south of Sabetha.

The Seneca water supply is obtained from five shallow wells and three springs. The wells are located in the valley of Nemaha River at the east edge of the city and obtain water from alluvial deposits and glacial deposits which underlie the valley. The springs are located southeast of the city at the edge of Nemaha River valley and the water is from glacial deposits. A population of 2,500 is served by the system and average daily use is .325 mgd. The system is adequate at present and no shortage is anticipated should a drought occur. Should more water be needed wells drilled in the Namaha valley which utilize the full thickness of alluvial and glacial deposits whould yield moderate quantities of water.

The city of Wetmore obtains its water supply from two shallow wells which penetrate glacial deposits in the preglacial buried valley. A population of 410 is served by the system and average daily use is .020 mgd. The system is adequate for present needs and would be adequate during a prolonged drought. In event of a shortage additional wells properly spaced could be drilled into the local aquifer.

Rural Water District No. 1 purchases water from the city of Bern. The district serves an area underlian principally by Permian and Pennsylvanian rocks where dependable water supplies are difficult to develop. A population of 204 is served by the system and average daily use of water is .013 mgd.

Rural Water District No. 2 purchases water from the city of Seneca and serves the community of Baileyville and a small rural area surrounding the community. A population of 360 is served by the system and average dialy use is .017 mgd.

Rural Water District No. 3 is presently being planned. The area served will be a large area in northeastern Marshall County, much of west-central and northwestern Nemaha County and extending across the county to Brown County on the east. Data on source of water and population served is not available.

Neosho County

Eight cities or communities in Neosho County have public water supplies all of which obtain their water from surface water impoundments or directly from the Neosho River (Fig. 37, Table 1). Eight rural water districts have been organized in the county. Seven of the rural water districts purchase water from the various cities and Rural Water District No. 2 has its own impoundment in Canville Creek southwest of the city of Stark. This city purchases water from Rural Water District No. 2. Crawford County Rural Water District No. 6 serves a small area in wouth-eastern Neosho County.

The rocks which underlie Neosho County generally are not good aquifers. Locally Pennsylvanian sandstones may yield as much as 30 gpm to wells. However, smaller quantities are most common. Alluvial deposits in the principal streams may locally yield as much as 30 gpm to wells. Water from the Pennsylvanian limestones is generally quite hard and yields of wells which obtain water from these rocks are small.

All the public water supplies in the county are from surface water sources. Wells in the Pennsylvanian limestones and sandstones are used for domestic and stock purposes and in local areas these wells may not be adequate during dry seasons. The groundwater resources have been described by Jungmann (1966).

The Chanute water supply is obtained from the Neosho River at the east edge of the city. A population of 10,300 is served by the system and average daily use is 1.628 mgd. The city was short of water during the 1953-54 drought but the city should not have a shortage should another drought occur. Releases of water from the John Redmond Reservoir should maintain a more uniform flow past the city water intake.

A more assured water supply during droughts could be obtained by contracting to purchase state managed water from John Redmond Reserovir. Small to moderate quantities of water could be obtained locally from the alluvium in the Noesho River valley. However, many areas in these deposits have been contaminated by oil field brines. In local areas the Cottage Grove Sandstone and Noxie Sandstone yield small to moderate quantities of water to wells which could be used in an emergency. The city sells water to Rural Water District No. 7.

The community of Earlton obtains its water supply through Rural Water District No. 6 which in turn purchases water from the city of Thayer.

The city of Erie obtains its water supply from the Neosho River. The city also maintains a single shallow well which obtains water from alluvial deposits in the Neosho River valley for standby purposes. A population of 1,470 is served by the system. The system is presently adequate except that maximum daily use exceeds maximum dependable production capacity; therefore, additional production capacity is needed. Additional emergency wells could be drilled in the valley of Neosho River.

The city of Galesburg obtains its water supply from an impoundment on Labette Creek. A population of 140 is served by the system and average daily use is .020 mgd. The system is presently adequate. However a shortage of water may occur should a prolonged drought occur. Emergency water could be obtained from Lake Parsons down stream from the Galesburg impoundment or by increasing their present impoundment capacity.

The city of Stark obtains its water supply through Rural Water District No. 2.

The city of St. Paul obtains its water supply from the Neosho River. A population of 885 is served by the system and the average daily use is .078 mgd. The system is presently adequate and no shortage is expected should a prolonged drought occur. St. Paul like other cities in the county is dependent on discharges from John Redmond Reservoir maintaining a flow in the Neosho River. A more assured supply could be obtained by contracting to purchase state managed water in John Redmond Reservoir. The city sells water to Rural Water District No. 8.

The Thayer water supply is obtained from an impoundment reservoir located southwest of the city. A population of 445 is served by the system and average daily use is .030 mgd. The city sells water to Rural Water District No. 1, 5 and 6. The Thayer water supply is little more than adequate at present and should a prolonged drought occur the city and the rural water districts could be subject to a water shortage. An increase in impounded capacity is the best long range solution to a possible shortage. Some emergency water could be obtained from wells drilled into sandstone in the Chanute Shale. These sandstones may be present either above or below the Thayer coal bed near the city.

Tulakes community obtains water from a small impoundment on a tributary to Village Creek west of Chanute. A population of 74 is served by the system and the average daily use is .0074 mgd. The system is marginally adequate at present and might be inadequate through a prolonged dourhgt. Should an emergency develop about the only source of emergency water would be through purchase from the city of Chanute.

Rural Water Districts No. 1, 5 and 6 purchase water from the city of Thayer and are subject to shortages which may affect the city. Popu-

lations served by the districts are No. 1 - 34, No. 5 - 116 and No. - 250. The average daily use is .002, .008 and .027 respectively.

Rural Water District No. 2 obtains its water supply from an impoundment reservoir on Canville Creek southwest of the community of Stark. The system serves an area in northeastern Neosho County and southeastern Allen County. The cities of Stark, Savonburg and Elsmore are also served by the system. Population served is 1,907 and average daily use is .087 mgd. The system is adequate at present but may not be able to withstand a severe drought. Additional impoundment capacity should be built. Groundwater in quantities large enough to supply more than individual domestic or stock supplies are not available in this area.

Rural Water District No. 3 serves a small area southwest of the city of Erie. Water for the system is purchased from the city of Erie. A population of 92 is served by the system and average daily use is .006 mgd.

Rural Water District No. 4 purchases its water supply from the city of Parsons. A population of 1,050 is served by the system and average daily use is .071 mgd.

Rural Water District No. 7 purchases its water supply from the city of Chanute. A population of 300 is served by the system and average daily use is .025 mgd.

Rural Water District No. 8 is located in east-central Neosho County and purchases water from the city of St. Paul. A population of 190 is served by the system and average daily use is .012 mgd.

Crawford County Rural Water District No. 6 serves a small area in southeastern Neosho County. This system is discussed under the Crawford County discussion.

Osage County

Nine cities or communities in Osage County have public water supplies. Three of these supplies are obtained from groundwater sources and the remainder are from surface water sources. In addition to the city supplies eight rural water districts have been organized in the county and an area in southwest Osage County is served by Coffey County Rural Water District No. 3 (Fig. 38, Table 1).

Many of the domestic and stock wells in rural areas obtain water from thin sandstone beds or from bedding planes or fractures in limestone beds. These wells generally have low yields and may prove to be inadequate during drought periods. During the 1953-54 drought cities and individuals from all areas of the county hauled water because of inadequate supplies from wells. The deeper lying sandstones of the Douglas Group which generally contain an adequate quantity of water may be too highly mineralized for use. The groundwater resources of the county have been described by O'Connor (1955).

The city of Burlingame obtains its water supply from an impoundment on Dragoon Creek south of the city. A population of 1,071 is served by the system and average daily use is .110 mgd. The city had a water shortage during the 1953-54 drought but improvements have since been made on the system. The system is presently adequate but a prolonged drought may again cause a shortage of water. The long term solution to shortages is additional impounded storage capacity. Small quantities of water from wells in the alluvium of Dragoon Creek would be available for emergency use.

The city of Carbondale obtains its water supply from an impoundment on Strowbridge Creek east of the city. A population of 1,035 is served

by the system and average daily use is .100 mgd. The city formerly used groundwater for the city supply but this source was inadequate and the city changed to a surface water source. The city sells water to Rural Water District No. 5. The system is presently adequate and should be adequate through a drought should one occur. A reliable emergency source of water is not readily available for the city. Possibly arrangements could be made to obtain water from the Osage County State Lake.

The Lyndon water supply is obtained from a city owned lake. Facilities are maintained for obtaining water from an impoundment on Salt Creek. A population of 1,170 is served by the system and the average daily use is .115 mgd. The city was short of water during the 1953-54 drought but since that time improvements have been made on the system and the system should be adequate should another drought occur. Should emergency water be needed the nearest dependable source of water would be from Pomona Reservoir through Rural Water District No. 3.

The city of Melvern obtains its water supply from five deep wells which penetrate a sandstone in the Douglas Group. The present supply is a sodium bicarbonate type water and is high in chloride. A population of 470 is served by the system and average daily use is .036 mgd. The present water system is barely adequate or inadequate and of very poor quality. An additional 30 to 50 gpm capacity of better quality groundwater could be developed in Marais des Cygne valley alluvium. Surface water could be obtained from the Melvern Reservoir west of the city of the Marais des Cygne River but would require a new treatment plant.

The city of Osage City obtains its water supply from a city lake and from Melvern Reservoir. A population of 2,769 is served by the

system and average daily use is .280 mgd. The system is presently adequate and no shortage is anticipated should a prolonged drought occur.

The city of Overbrook obtains its water supply from three deep wells located about three miles east of the city. Water is obtained from the Tonganoxie sandstone. A population of 800 is served by the system and average daily use is .091 mgd. The system is presently adequate and a drought would have little effect on the yield of the deep wells supplying the system. Should more water be needed additional wells could be drilled near the present well field.

The water supply for Quenemo is obtained from two shallow wells and a deep well in the city. A population of 436 is served by the system and average daily use is .036 mgd. The system is adequate at the present time but may be inadequate should a prolonged drought occur. Should additional water be needed additional wells drilled in the Maris des Cygnes valley should each yield 10 to 20 gpm.

The city of Scranton obtains its water supply from a city lake located south of the city. A population of 601 is served by the system and average daily use is .019 mgd. The system is adequate at present but might not be adequate through a prolonged drought. Additional impounded storage should be provided. Arrangements for purchase of emergency water from Rural Water District No. 5 or No. 8 could be made.

The water supply for Vassar park is obtained from Pomona Reservoir. A population of 920 is served by the system and water is sold to Rural Water District No. 3. The average daily use of water is .041 mgd. The system is adequate and would be adequate should a prolonged drought occur.

Rural Water District No. 1 serves a small area adjacent to the city of Lyndon. The district purchases water from Lyndon. A population of 20 is served by the district and average daily use is .001 mgd.

Rural Water District No. 2 obtains water from a single deep well. The district serves a small area in east-central Osage County. A population of 150 is served by the system and average daily use is .010 mgd. The system is presently adequate but may not be adequate should a prolonged drought occur. The district is subject to a shortage dur to mechanical breakdown of the single well. Another well drilled in the general vicinity of the present well would insure against a shortage dur to mechanical breakdown.

Rural Water District No. 3 obtains its water supply from Vassar Park Public Water Supply through the Kansas Park and Resources Authority. A population of 300 is served by the system and average daily use is .020 mgd. The system is adequate and would be adequate through a prolonged drought.

Rural Water District No. 4 obtains its water supply from two deep wells which penetrate sandstones in the Douglas Group. The water is a very soft sodium bicarbonate type water. A population of 350 is served by the system and average daily use is .020 mgd. The system is adequate under present conditions and should be adequate during a prolonged drought. Should additional water be needed more wells could be drilled in the vicinity of the present wells.

Rural Water District No. 5 serves a large area in northeastern Osage County and southeastern Shawnee County. The district purchases water from the city of Carbondale. A population of 1,800 is served by the system and average daily use is .098 mgd.

Rural Water District No. 6 purchases water from the city of Osage City through Rural Water District No. 7. A population of 280 is served by the system and average daily use is .018 mgd.

Rural Water District No. 7 purchases water from the city of Osage City. A population of 1,050 is served by the system and average daily use is .070 mgd.

Rural Water District No. 8 is in the planning stage. This district will serve a large area in northwest Osage County and southwest Shawnee County. Data pertaining to source of water and population served is not available.

Coffey County Rural Water District No. 3 serves an area in southwest Osage County and northwest Coffey County. Water for this system is purchased from the city of Burlington.

Pottawatomie County

Nine cities in Pottawatomie County have public water supplies. All the cities except Onega use groundwater. Onega uses surface water from the Vermillion River and has two wells for standby purposes. Timber Creek East Water District serves an area in southwestern Pottawatomie County and Rural Water District No. 1 is in the planning stage.

Thin deposits of glacial drift underlie the surface of much of Pottawatomie County. Rocks of the Chase Group, Council Group and Admire Group of Permian age underlie the surface in the remainder of the county. Large supplies of water are available only from alluvial deposits in the Kansas River valley, the Big Blue River valley and locally in the Vermillion River valley. Glacial outwash deposits adjacent to Kansas River valley locally yield moderate to large quantities of water. The Permian rocks and the thin upland glacial deposits generally are not good aquifers. However, locally moderate quantities of water are available from them. Adequate supplies for domestic and stock use are generally available and several of the cities obtain water from the bedrock aquifers. Groundwater supplies in part of Pottawatomie County have been described by Beck (1959) and Fader (1974).

The city of Belvue obtains its water supply from one shallow well drilled in alluvial deposits in Kansas River valley. A population of 180 is served by the system and average daily use is .015 mgd. The system is adequate at the present time and would be adequate during a prolonged drought. The city is subject to a water shortage due to mechanical breakdwon of the single well and with the present system could not increase the daily use a great amount without experiencing periodic water shortages. Large quantities of good quality water are available

in the Kansas River valley and another well would guard against water shortages due to breakdown or growth.

The city of Emmett water supply is obtained from two shallow wells which obtain water from alluvial deposits in Cross Creek valley east of the city. A population of 175 is served by the system and the average daily use is .015 mgd. The system is little more than adequate under the present conditions and there probably would be a water shortage should a prolonged drought occur. Additional low yielding wells could be drilled in the valley of Cross Creek should more water be desired.

The city of Havensville pumps its water supply from a single well which obtains water from lower Permian rocks and, in part, from glacial deposits which underlie part of the city. A population of 170 is served by the system. The city is subject to a water shortage due to mechanical breakdown. Additional water could be obtained from another well in the general vicinity of the present well.

The Olsburg water supply is obtained from three deep wells which probably obtain water from Permian rocks of the Chase Group. A population of 130 is served by the system and average daily use is .008 mgd. The system is adequate under the present conditions and probably would be adequate should a drought occur. Should more water be needed the best source would be additional wells in the general vicinity of the present well.

The city of Onaga obtains its water supply from an impoundment on the Vermillion River and maintains two shallow wells for standby purposes. A population of 880 is served by the system and average daily use is .070 mgd. The system is adequate under the present conditions and should be adequate should a drought occur. Emergency water could be obtained from additional wells in the Vermillion River valley.

The St. George water supply is obtained from a single well in alluvial deposits in the Kansas River valley. A population of 264 is served by the system and average daily use is .018 mgd. The system is presently adequate and there should be not shortage of water should a prolonged drought occur. Large quantities of good quality water are available from the alluvial deposits in Kansas River valley at St. George.

The St. Marys water supply is obtained from five shallow wells which obtain water from alluvium of the Kansas River valley. A population of 1,530 is served by the system and the average daily use is .180 mgd. The system is adequate at the present time and no shortage would be expected should a prolonged drought occur.

The Wamego water supply is obtained from four shallow wells which are drilled in the allvuial deposits of the Kansas River valley. Three of the supply wells are used regularly and one is maintained for standby purposes. A population of 2,750 is served by the system and average daily use is .300 mgd. The system is presently adequate and would be adequate through a prolonged drought.

The Westmorland water supply is obtained from four shallow wells which are drilled into alluvial deposits in the valley of Rock Creek at the southeast edge of the city. A population of 540 is served by the system and average daily use os .054 mgd. The system is adequate at the present time and should be adequate through a prolonged drought. Should more water be needed additional wells could be drilled in Rock Creek valley.

Timber Creek East Water District serves an area in southwest Pottawatomie County near Swamp Angel. A population of 216 is served

by the system and average daily use is .016 mgd. The district obtains its water supply from a single well and is subject of shortage due to mechanical breakdown. Other than mechanical problems which may develop the system is adequate.

Pottawatomie County Rural Water District No. 1 is under construction. This district will serve a large area in south-central Pottawatomie County. Data on population served and source of water is not presently available.

Riley County

Five cities in Riley County have public water supplies. In addition the suburban community of Fairmont Heights has its own water system and the Manhattan airport has a water system separate from the city system. All of these water systems use groundwater.

No rural water districts have been organized in the county. Rocks of the Chase Group of Permian age underlie the area and although large quantities of water are not generally obtainable sufficient water for stock and domestic use are generally available. The cities of Leonardville, Riley and Randolph obtain their water from the rocks of the Chase Group. The other public water supplies are pumped from alluvial deposits of the Kansas and Big Blue River valleys (Foder, 1974).

The water supply for Fairmont Heights, adjacent to the southeast edge of Manhattan, is obtained from a single well drilled into alluvial deposits of the Kansas River valley. A population of 54 is served by the system and average daily use is .005 mgd. The community is subject to a shortage of water only is the single well would have a mechanical breakdown. Additional wells could be drilled in the vicinity of the present well. In an emergency weater could be hauled from Manhattan.

The Leonardville water supply is obtained from four deep wells which are drilled into rocks of the Chase Group. A population of 474 is served by the system and average daily use is .040 mgd. The system is presently adequate and should be adequate through a prolonged drought. Should additional water be needed a well or wells could be drilled in the general vicinity of the present wells.

The Manhattan water supply is obtained from 12 shallow wells which are drilled in allvuial deposits near the junction of Big Blue River and

Kansas River. A population of 28,000 is served by the system and average daily use is 4.50 mgd. The system is adequate at present and should be adequate should a prolonged drought occur. Additional wells could be drilled in the valleys of either Big Blue River or Kansas River should additional water be needed.

The Manhattan Airport water supply is obtained from a single shallow well in allvuial deposits in Kansas River valley. Average daily use of water is .005 mgd. One or more wells could be drilled in the valley should additional water be needed.

The Ogden water supply is obtained from three shallow wells which are drilled in alluvial deposits in Kansas River valley. A population of 2,336 is served by the system and average daily use is .120 mgd. The system is presently adequate and should be adequate should a drought occur. Additional wells can be drilled in the valley area.

The Randolph water supply is obtained from two shallow wells which penetrate rocks of the Chase Group. A population of 141 is served by the system and average daily use is .010 mgd. The system is presently adequate and should be adequate through a prolonged drought. Should more water be desired additional wells could be drilled in the vicinity of the present wells.

The Riley water supply is obtained from three deep wells and two shallow wells which are drilled in Chase Group rocks. A population of 711 is served by the system and average daily use is .060 mgd. The system is adequate at present and should be adequate through a prolonged drought.

Shawnee County

Three cities in Shawnee County have municipally owned public water systems. Three other cities or communities purchase water through rural water districts for their water supplies (Fig. 41, Table 1).

Ten rural water districts have been organized in the county and one each from Jackson County and Douglas County and two from Osage County serve rural areas and small communities in the county.

The Pennsylvanian rocks which underlie most of Shawnee County are generally poor aquifers. Locally small quantities of water are available to wells used for domestic and stock purposes. Small quantities of water are also available to wells from thin glacial deposits. Large quantities of water are available from the allvuial deposits in the valley of Kansas River and smaller quantities are available from alluvial deposits in the valleys of smaller streams. Groundwater resources in the Kansas River valley have been described by Beck (1959), Davis and Carlson (1952) and Fader (1974).

The Auburn water supply is obtained through Rural Water District No. 2 and is discussed under the discussion of that district.

The Lake Jivaro water supply is obtained through Rural Water District No. 8 and is discussed under the discussion of that district.

The Rossville water supply is obtained from two shallow wells drilled in alluvial deposits in Kansas River valley. A population of 945 is served by the system and average daily use is .096 mgd. The system is adequate at present but maximum usage is near plant capacity. Additional water can be obtained from wells in the Kansas River valley.

The Silverlake water supply is obtained from three shallow wells which are drilled in alluvial deposits in the valley of Kansas River.

A population of 978 is served by the system and average daily use is .060 mgd. The system is adequate at present and would be adequate should a prolonged drought occur.

The city of Topeka obtains its water supply from the Kansas River. A population of 150,000 is served by the system and average daily use is 20.0 mgd. The system is adequate at present and would be adequate should a prolonged drought occur. The city could assure its long range water supply needs by contracting to purchase state managed water from Milford or Perry Reservoirs or from the federal government in planned Onaga and Grove Reservoirs.

The city of Wakarusa is served by Rural Water District No. 6 and 7.

Rural Water District No. 1 purchases water from the city of Topeka through Rural Water District No. 2. A population of 396 is served by the system and the average daily use is .026 mgd.

Rural Water District No. 2 purchases water from the city of Topeka. This district also serves the city of Auburn. A population of 1,258 is served by the system and average daily use is .082 mgd.

Rural Water District No. 3 purchases water from the city of Topeka and also maintains two shallow wells for standby purposes. The system serves a population of 2,200 and average daily use is .130 mgd.

Rural Water District No. 4 purchases water from the city of Topeka. This district also maintains two shallow wells in the valley of Kansas River for standby purposes. A population of 2,934 is served by the system and average daily use is .191 mgd.

Rural Water District No. 5 purchases water from Rural Water District No. 4. A population of 224 is served by the system and average daily use is .015 mgd.

Rural Water District No. 6 purchases water from the city of Topeka and maintains an impoundment reservoir on Sherwood Lake southwest of Topeka. The system served a population of 894 and average daily use is .058 mgd. The district sells water to Rural Water District No. 7.

Rural Water District No. 7 purchases water from Rural Water District No. 6. A population of 320 is served by the system and average daily use is .021 mgd.

Rural Water District No. 8 purchases water from the city of topeka and also obtains water from Lake Javaro. A population of 2,740 is served by the system. Average daily use is .178 mgd. The district serves the Lake Jivaro community.

Rural Water District No. 9 serves a small area in southwest Shawnee County. The district purchases water from Rural Water District No. 2 which purchases water from Topeka. A population of 85 is served by the system and average daily use is .005 mgd.

Rural Water District No. 10 purchases water form the city of Silver Lake. A population of 197 is served by the system and average daily use is .013 mgd.

Osage County Rural Water District No. 5 serves an area south of Wakarusa River in southeast Shawnee County.

Osage County Rural Water District No. 8 serves an area in southwestern Shawnee County.

Jackson County Rural Water District No. 1 serves a small are in northeastern Shawnee County.

Douglas County Rural Water District No. 3 serves a large area in southeastern Shawnee County. These districts which are organized in counties other than Shawnee County are described under their respective counties.

Wabaunsee County

Six cities in Wabaunsee County have public water supplies. Two of these cities use surface water and the other four use groundwater (Fig. 42, Table 1). In addition to the city supplies a single rural water district has been organized in the county. A very small area in east-central Wabaunsee County is served by Shawnee County Rural Water District No. 1. An area in the southeastern part of the county is served by Osage County Rural Water District No. 8.

The rocks which underlie much of the western and central parts of Wabaunsee County are of the Chase and Council Grove Groups of Permian age. These rocks and especially the rocks of the Chase Group yield small to moderate quantities of water to wells. The eastern part of the county is underlain by Permian rocks of the Admire Group and Pennsylvanian rocks of the Wabaunsee Group. Neither of these two groups of rocks are prolific aquifers in this area which probably accounts for the organization of rural water districts in this part of the county. Groundwater resources in the Kansas River valley along the north boundary of the county have been described by Beck (1959) and Fader (1974).

The city of Alma obtains its water supply from a city owned lake located southeast of the city. A population of 972 is served by the system and the average daily use is .134 mgd. The system is presently adequate and should be adequate should a prolonged drought occur. The city formerly used shallow wells in Mill Creek valley for the city supply. However, the quantity of water available from this source is limited. Should an emergency occur this source could again be used on a limited basis.

The city of Alta Vista obtains its water supply from four deep wells which penetrate rocks of the Chase Group. A population of 520 is served by the system and average daily use is .030 mgd. The system is adequate at the present time and should be adequate through a prolonged drought. Should more water be needed additional wells can be drilled in the general vicinity of the present wells.

The Eskridge water supply is obtained from three deep wells and two shallow wells which penetrate rocks of the Council Grove Group. A population of 620 is served by the system and the average daily use is .040 mgd. The system is adequate at the present time and should be adequate should a prolonged drought occur. More water could be obtained from additional properly located wells in the general vicinity of the present wells.

The Harveyville water supply is obtained from a city owned lake west of the city. A population of 279 is served by the system and the average daily use is .015 mgd. The system is adequate at present. A prolonged drought may cause a water shortage. Should emergency water be needed shallow wells in the valley of Dragoon Creek should yield small quantities of water or wells which are drilled into one or more of the sandstone bed in the upper part of the rocks of the Wabaunsee Group should yield limited quantities of water. Osage County Rural Water District No. 8 might supply a limited amount of emergency water.

The Maple Hill water supply is obtained from three shallow wells which obtains water from allvuail deposits in the valley of Mill Creek. A population of 397 is served by the system and average daily use is .035 mgd. The system is adequate at the present time and should be adequate through a prolonged drought. Should more water be needed

additional wells could be drilled in the general vicinity of the present wells.

The city of Paxico obtains its water supply from a single shallow well which obtains water from alluvail deposits in Mill Creek valley. A population of 219 is served by the system and average daily use is .020 mgd. The system is adequate for the present but should a prolonged drought occur the city may be short of water. The city is subject to a shortage caused by a mechanical breakdown of the single well. Another well providing better quality water would alleviate the possibility of a shortage in the future either due to drought or mechanical breakdown.

Rural Water District No. 1 serves a large area in northeastern Wabaunsee County. The district obtains its water supply from two shallow wells drilled in alluvial deposits in the valley of Kansas River. A population of 270 is served by the system and average daily use is .015 mgd. The system is adequate for the present needs and should be adequate through a prolonged drought. Should more water be needed one or more additional wells could be drilled in the general vicinity of the present wells.

Shawnee County Rural Water District No. 1 serves a very small area in east-central Wabaunsee County and Osage County Rural Water District No. 8 serves a large area in southeastern Wabaunsee County. These districts are described under the discussions of their respective counties.

Washington County

Ten cities in Washington County have public water supplies. In addition Rural Water District No. 1 serves much of northeastern Washington County. Republic County Rural Water District No. 2 serves an area of about one township in northwestern Washington County. All the public water systems use groundwater for their water supply.

Much of the western two-thirds of Washington County is underlain by rocks of the Dakota Formation which in this area yields small to moderate quantities of water to wells. In the northwestern part of the county the water from the Dakota is of poor quality. The eastern third of the county is underlain by Permian age rocks of the Chase Group and locally by Pleistocene age rocks of glacial origin. Small to moderate quantities of water are available to wells from these rocks. Large quantities of water may be obtained from the alluvial deposits in the Little Blue River and from the valley of Republican River in southwest Washington County. Smaller quantities of water are generally available from alluvial deposits in Mill Creek valley and from other stream valleys in the area.

The Barnes water supply is obtained from two deep wells which obtain water from the Barneston Formation. A population of 240 is served by the system and average daily use is .026 mgd. The system appears to be adequate for the present needs and probably would be adequate during a prolonged drought. Should more water be needed additional wells could be drilled in the vicinity of the present wells.

The Greenleaf water supply is obtained from four shallow wells which are drilled in an abandoned Pleistocene Channel which runs through the city. A population of 525 is served by the system and the average daily use is .060 mgd. The system is adequate at present and no shortage

is expected should a prolonged drought occur. Additional wells could be drilled in the channel area if more water is desired.

The Haddam water supply is obtained from three shallow wells which obtain water from alluvial deposits in the valley of Mill Creek. A population of 313 is served by the system and the average daily use is .036 mgd. Should additional water be needed more wells could be drilled in the Mill Creek valley. Water from the upper part of the Dakota Formation may be of suitable quality for municipal use. Water from the lower part of the Dakota is probably highly mineralized.

The Hanover water supply is obtained from four shallow wells in the valley of Little Blue River and by purchase from Washington County Rural Water District No. 1. A population of 863 is served by the system and average daily use is .080 mgd. The water from the wells in the valley is of poor quality. It is a sodium sulfate type water and is quite hard. Analysis of the water from Rural Water District No. 1 is not available but should be of better quality than the supply from the river valley. The system is adequate and no shortage of water is expected should a drought occur.

The Linn water supply is obtained from two shallow wells which obtain water from the Dakota Formation. A population of 438 is served by the system. The system is presently adequate and should additional water be needed one or more wells could be drilled into the Dakota Formation.

The Mahaska water supply located at the east edge of the city is obtained from two wells which obtains water from the Dakota Formation. A population of 145 is served by the system and average daily use is .015 mgd. Additional water could be obtained from wells drilled into

the Dakota Formation in the vicinity of the present wells but better quality water could probably be obtained several miles east of the city.

The Morrowville water supply is obtained from one deep well and one shallow well within the city. The shallow well probably obtains water from alluvial deposits in Mill Creek valley and the deep well probably obtains water from the Dakota Formation. Water from the Dakota Formation is probably of better quality than that from the alluvial deposits. The system is presently adequate and no shortage should occur during a prolonged drought. Additional wells could be drilled either in the alluvial deposits or in the Dakota Formation.

The Palmer water supply is obtained from two shallow wells which obtain water from the Dakota Formation. A population of 156 is served by the system and the average daily use is .010 mgd. The system is presently adequate and should be adequate through a prolonged drought. The water is of very good quality at Palmer and should additional water be needed one or more wells could be drilled into the Dakota in the general vicinity of the present wells.

The Washington water supply is obtained from three deep wells which are located about two miles west of the city. water is obtained from the Dakota Formation. A population of 1,766 is served by the system and average daily use is .250 mgd. Additional water could be obtained from one or more wells drilled in the Dakota Formation in the general vicinity of the present wells.

The cities of Clifton and Vining located in the southwestern part of the county lie partly in Washington County and partly in Clay County. The Clifton water supply wells are located in Clay County and are described under that county. Vining has no public water supply but some of the people in Vining use water purchased from Clifton.

Wilson County

Most of the population of Wilson County is served by the public water supplies of Fredonia and Neodesha through the two municipal supplies and eight rural water districts that purchase water from the two municipalities.

The Fall River and Verdigris River flow southeastward across the county and have regulated flows from the Fall River Reservoir in Greenwood County and Toronto Reservoir in Woodson and Greenwood Counties.

No groundwater studies have been published for Wilson County but small groundwater supplies are available from the thin alluvial deposits in the Fall River and Verdegris River valleys and locally small groundwater supplies are available from the Pennsylvanian sandstone aquifers in the northwestern and southeastern parts of the county. Groundwater supplies are rather meager.

The city of Altoona obtains water from the Verdigris River. A population of 629 is served by the system and average daily use is 0.055 mgd. Low flows are maintained in the stream by water releases from Fall River Reservoir. No shortage was experienced in 1953-54 and the water supply should not experience a shortage during a drought. Supplemental groundwater supplies of 5 to 50 gpm might be available locally in the valley alluvium but of uncertain quality because of past oil and gas activities.

The city of Buffalo obtains its water supply from an infiltration gallery constructed below the Woodson County State Lake in the alluvium of Woodruff Creek. This provides a dependable water supply of 0.044 mgd for the city (Fig. 44). Average and maximum daily water consumption are reported as .025 mgd and .040 mgd respectively (Table 1). No excess

water supply is available above their present maximum daily water consumption and a severe drought would probably result in water shortages. The water treatment plant and source of supply should both be enlarged and improved. The chemical quality of the water is satisfactory.

Groundwater is sparse in the Buffalo area but wells yielding 5 to 10 gpm probably could be obtained in the Verdigris River valley and piped to town or perhaps in parts of Buffalo Creek valley. A test drilling and sampling program would be needed to determine water availability. Another alternative would be to purchase water from Fredonia through Wilson County Rural Water District No. 5.

The Fredonia water supply is provided by two small overflow dams in the channel of the Fall River and provide a reported safe yield of impounded water supply of 2.00 mgd (Fig. 44). The water plant also has a maximum dependable production of 2.00 mgd. The average daily consumption is reported to be 0.575 mgd and maximum daily consumption is 1.110 mgd and the reserve capacity is therefore quite large.

The water quality is good (Table 1). Fredonia supplies water to four wholesale customers, namely Wilson County Rural Water District No. 1, 2, 5 and 7.

There is no state managed conservation storage in the Fall River Reservoir from which Fredonia could negotiate water purchases. The lack of other cities except the town of Fall River between Fall River Reservoir and Fredonia allows low flow releases to reach Fredonia except for natural losses, and the water quality is better than without the low flow reservoir releases.

Supplemental water supplies of 10 to 20 gpm could be developed in the Pleistocene alluvail aquifer along the Fall River but test drilling and sampling would be needed to determine the best locations for wells.

An alternative water supply could also be developed by construction of an impounded water supply on a tributary of the Fall River, but this does not seem to be needed in the immediate future.

The water shortage in Neodesha which occurred in 1953-54 was caused by inadequate pumping facilities rather than a shortage of impounded water on the Fall River. Major improvements have since been made and the safe yield of the impounded water supply on the Fall River is reported as 2.500 mgd. Production of the water plant is 2.000 mgd whereas average and maximum daily consumption are reported as .600 mgd and 1.100 mgd respectively (Table 1). Water quality is very good and no shortages are anticipated. The city sells water to Neosho County Rural Water District No. 3, 4, 6 and 8.

Alternative water supply sources would include the use of water from the Verdigris River which flows along the east side of the town, development of a number of low yielding wells in the Fall River valley or Verdigris River valley or the construction of additional impounded water supply.

There is no state managed conservation storage for municipal supply in either the Fall River Reservoir or the Tornonto Reservoir.

New Albany is served by Wilson County Rural Water District No. 2 and the water supply is discussed under Wilson County Rural Water District No. 2.

Wilson County Rural Water District No. 1, 2, 5 and 7 purchase treated water from Fredonia and distribute it to rural areas as shown in Figure 44. They each have contract purchase agreements with Fredonia for the water quantities shown in Table 1.

Alternative water supplies are described under the discussion of Fredonia.

Wilson County Rural Water District No. 3, 4, 6 and 8 purchases water from Neodesha (Fig. 44) as shown in Table 1. The alternative sources of water are described under the discussion of Neodesha.

Wilson County Rural Water District No. 9 (Fig. 44) obtains its water through purchase agreement with Toronto in Woodson County (Table 1) and alternative sources of water are described under the discussion of Toronto's water supply.

Wilson County Rural Water District No. 10 and 12 are being organized. Rural Water District No. 10 will serve a large area in east-central Wilson County and Rural Water District No. 12 will serve a small area in south-central Wilson County. The source of supply and populations served are not known at present.

Woodson County

All of the public water supplies in Woodson County are obtained from surface sources. Yates Center and Toronto have municipal water supplies whereas Neosho Falls is served by Woodson County Rural Water District No. 1. Rural water districts from Coffey, Greenwood and Wilson coutnies also serve parts of western Woodson County. Groundwater resources are relatively small (Fig. 45, Table 1).

Neosho Falls is a small town on the Neosho River floodplain in northeastern Woodson County and is served by Woodson County Rural Water District No. 1 and is described under the discussion of that district.

Toronto obtained its water supply from wells which were inadequate during the 1953-54 drought years and voluntary restrictions on water useage were imposed. The city has since constructed a water treatment plant and now uses the Toronto Reservoir on the Verdigris River as source of its water supply (Fig. 45). Average daily consumption is reported as 0.070 mgd (Table 1). Plant capacity is reported as 0.230 mgd and safe yield from the reservoir is reported as 1.00 mgd. No drought related problems are foreseen in the near future. Water quality is good.

In an emergency a supplemental water supply could again be obtained from the local Pennsylvanian Ireland Sandstone aquifer although well yields would probably be limited to 10 to 20 gpm. Because of past oil and gas activities there may be some areas of brine polluted water that would have to be identified and avoided in seeking groundwater supplies.

Yates Center partially drained its impounding reservoir in the early 1950's to make needed repairs and the drought of 1953-54 resulted in a water shortage which required compulsory restrictions on use and a search for supplemental groundwater supplies. About $2,000 was spent in obtaining

supplementary groundwater supplies from the local Pennsylvanian Ireland Sandstone aquifer by the construction of several small yielding wells. Major improvements wre completed in 1969 and a dependable safe uield from the impoundment is reported as 1.00 mgd in 1974. Maximum daily consumption is reported as 0.260 mgd so adequate reserves should be available during an extended drought. The water is of good quality.

Alternative emergency sources would include rail or highway transport of water from Toronto, which has plant capacity and impounded storage adequate to supply both cities with water. Wells having 10 to 20 gpm yields might be obtainable locally in the township west of the city but both quantity and quality would have to be determined by test drilling. Development of additional local impounded water supply could also be planned and developed for a long range solution to a larger water supply.

Woodson County Rural Water District No. 1 serves an area of eastern Woodson County including the town of Neosho Falls in the northeast corner, and extends eastward into adjacent Allen County along US Highway 54. The district was constructed in 1968 and serves a population of 560 (Table 1, Fig. 45). Water is obtained from the Neosho River at Neosho Falls and serves an area in which little dependable groundwater supplies can be obtained. Water quality is generally satisfactory.

Although both source and treatment plant are reported adequate some consideration should be given to negotiating purchase of state managed conservation storage water in the John Redmond Reservoir to assure future water supply requirements during an extended drought.

Wyandotte County

There is little likelyhood of a drought caused shortage of public water supplies in Wyandotte County although shortages could result because of lack of treatment and distribution facilities or lack of timely acquisition of the necessary water appropriation rights.

The Missouri River, except for about four miles, forms the northern county boundary. It is a regulated stream and has the largest annual flow of any stream in the state. Its water quality is good. The Kansas River, also a regulated stream which has the second largest flow of any stream in the state, flows along or near the south boundary of the county. In low flows its quality is not as good as the Missouri River. Associated with each stream is an alluvial filled valley that is capable of supplying large yielding wells. Almost the entire county is served with public water supplies. There were no drought caused shortages in 1953-54.

The water resources of Wyandotte County have been described by Fader (1974), Fishel (1948), Fishel, Searcy, and Rainwater (1953), and Furness (1959).

Five rural water districts have been organized in the county. Since organization, Rural Water District No. 1 has been taken into the Kansas City system and Rural Water District No. 3 and 4 have been taken into the Bonner Springs system (Fig. 46, Table 1).

Bonner Springs, located in southwestern Wyandotte County, obtains its public water supply from three wells in the Pleistocene alluvial aquifer associated with the Kansas River valley (Fig. 46). There was no shortage of water in the drought years of 1953-54. Dependable production reported for the three wells is reported as 1.44 mgd whereas average consumption

is 0.800 mgd and maximum consumption is reported as 1.00 mgd (Table 1). The water is very hard but otherwise of good chemical quality.

Additional groundwater could be developed from the alluvial aquifer most easily. The Milford, Onaga, Perry and Clinton Reservoirs, completed or under construction, on tributaries of the Kansas River contain a state managed conservation storage which will supply a two percent chance yield of 244.8 mgd to the Kansas River (Fig. 3).

The public water supply for Kansas City is obtained from the Missouri River (Fig. 46). The water supplyw as begun in 1883 and the most recent improvements were complted in 1970. No water shortages have been caused by drought. The Kansas City public water supply system distributes water over about three-fourths of Wyandotte County. Average daily consumption (1973-74) was reported as 32.00 mgd and maximum daily consumption os 50.00 mgd (Table 1). The treatment plant can dependably produce 60.00 mgd.

No drought related shortages seem likely because the Missouri River is a regulated river and has the largest flow of any stream in the state. A supplemental groundwater supply woulc be developed in either the MIssouri or Kansas river valleys.

Wyandotte County Rural Water District No. 2 serves a population of 384 in northwestern Wyandotte County and purchases its water from the city of Leavenworth through Lansing. The district has 0.100 mgd available if purchased but its average use in 1973-74 was reported as 0.025 mgd. Adequate water of good quality is available which should not be affected by a severe drought inasmuch as Leavenworth obtains its water supply from the Missouri River.

SUMMARY

Historically, when droughts have occurred in eastern Kansas, a considerable number of public water supply systems have experienced water shortages or inadequacies. These shortages have been caused by decreased availability of groundwater, streamflow and lake or reservoir supplies. A few shortages have resulted because of inadequate pumping capacity, treated water storage capacity or inadequate distribution systems.

The public water supplies described in this report are in 43 eastern Kansas counties bounded on the west and including by Washington, Clay, Dickinson, Marion, Butler and Cowley counties and include the eastern 40 percent of the state. The area has a normal annual precipitation of 30 to 40 inches and a mean annual runoff ranging from two to 10 inches. During droughts rainfall may be much less and there may be long periods with little or no runoff.

In a large part of the 43 county area Pennsylvanian and Permian limestones and shales, which have poor water-bearing characteristics for providing satisfactory public-water supplies, are the predominant water bearing rock. During droughts water levels decline in the shallow aquifers. Water level declines generally cause significant decreases in well yields. At the same time water supply demands caused by drought may increase and water shortages may develop.

Each of the 264 municipal water systems and 168 Rural Water Districts are briefly described and evaluated in terms of estimated susceptibility to drought. Data pertinent to each Public Water Supply is tabulated in 43 county tables and the location of the supplies and areas served is

shown on 43 county maps. Nine factors which contribute to water supply problems during droughts are described and five factors which would improve public water supplies or prevent drought shortages are discussed. Alternate sources of water that should be investigated or planned for, or which could be utilized during a drought are described for each of the 432 public water supply systems.

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TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Bassett	Iola Public Water Supply	50	Yes	-	-	350	200	.005	.008	Available if . .100	Purchased --	--	Low	See Iola
Elsmore	Neosho Co. RWD #2	101	--	1965	1973	310	174	--	--	--	--	--	Moderate	Served by Neosho Co. RWD #2
Gas City	Iola Public Water Supply	454	Yes	-	-	350	200	.069	.125	Available if .432	Purchased --	--	Low	See Iola
Humboldt	Neosho River	2320	Yes	1918	None	350	200	.370	.650	1.233			Low	Surface water supply adequate if contract for state managed water from John Redmond
														Reservoir approved.
Iola	Neosho River	6720	Yes	-	-	350	200	.835	1.500	2.070	#1,2, 3,4,5, 6,7,8	376	Low	Surface water supply adequate if contract for state managed water from John Redmond
														Reservoir approved.
LaHarpe	Iola Public Water Supply	560	--	1935	-	350	200	.051	.092	Available if .100	Purchased		Low	See Iola water supply
Mildred	None	52	--	-	-	--	--	--	--	--	--	--	--	No Public Water Supply
Moran	Impounding Reservoir	610	No	1917	1960	390	233	.095	.168	.288	--	--	Low	
Savonburg	Neosho Co. RWD #2	125	--	1965	1973	310	174	--	--	--	--	--	Moderate	Served by Neosho Co. RWD #2
RWD #1	Iola Public Water Supply	24	--	-	-	350	200	.001	.002	Available if .010	Purchased		Low	See Iola
RWD #2	Iola Public Water Supply	40	--	-	-	350	200	.003	.004	Available if .010	Purchased		Low	See Iola
RWD #3	Iola Public Water Supply	60	--	-	-	350	200	.004	.007	--			Low	See Iola

ALLEN COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #4	Iola Public Water Supply	28	--	-	-	350	200	.002	.004	Available if .010	Purchased		Low	See Iola
RWD #5	Iola Public Water Supply	20											Low	See Iola
RWD #6	Iola Public Water Supply	54	--	1960	-	350	200	.004	.006	Available if .010	Purchased		Low	See Iola
RWD #7	Iola Public Water Supply	150	--	1961	-	350	200	.010	.018	Available if .020	Purchased		Low	See Iola
RWD #8	Iola Public Water Supply	176	--			350	200	.011	.016	Available if .020	Purchased		Low	See Iola

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

ANDERSON COUNTY

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Colony	Impounding Reservoir	420	Yes	1922	1953	480	315	.04	.06	.144	---	----	High	Need additional impounding Reser. or connect to RWD 5
Garnett	3 impound reservoirs	2988	Yes	1916	1968	420	249	.400	.650	1.000	#1	510	Low	
Greeley	3 shallow wells	400	---	1960	1963	620	371	.020	.030	.030	---	----	High	Need additional supply well
Harris	RWD #4	54	---	1969	1971	630	391	---	---	---	---	----	Low	
Kincaid	None	212	---	----	----	---	---	---	---	---	---	----	----	No public water supply
Lone Elm	None	65	---	----	----	---	---	---	---	---	---	----	----	No public water supply
Westphalia	RWD #2	---	---	1965	1965	270	168	---	---	---	---	----	----	See RWD #2
RWD #1	Garnett pub. Water supply	50	---	1961	----	420	249	.003	.005	Available if purchased .010			----	See Garnett
RWD #2	Impounding Reservoir	300	---	1965	1965	270	168	.020	.038	.036			High	Need add. impound. capacity
RWD #3	Richmond public sup.	190	---	1964	----	280	165	.012	.020	Available if purchased .100			----	See Richmond (Frankin Co.)
RWD #4	4 deep wells	460	---	1969	1971	630	391	.031	.048	.115			Low	
RWD #5	Iola Public Water supply	1500	---	1974	----	350	200	.150	.260	Available if purchased .374			Low	See Iola (Allen Co.)

ATCHISON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Atchison	Missouri River	12,783	No	1949	-	700	447	2.250	3.286	4.00	#1,2,3	565	Low	
Huron	--	145	--	-	-	--	--	--	--	--	--	--	--	No public water supply
Lancaster	1 deep well	266	--	1964	1964	670	410	.018	.028	.0648	--	--	Low	Need standby well
Muscotah	1 shallow well	245	--	1958	1971	690	427	.010	.060	.430	--	--		Need standby well
Effingham	3 deep wells	600	--	1949	1955	1150	661	.055	.075	.115	--	--	Low	
RWD #1	Atchison Public Water Supply	313	--	1960	-	700	447	.013	.022	Available if Purchased .100			Low	See Atchison
RWD #2	Atchison Public Water Supply	136	--	1964	-	700	447	.009	.015	Available if Purchased .050			Low	See Atchison
RWD #3	Atchison Public Water Supply	116	--	1967	-	700	447	.007	.013	Available if Purchased .050			Low	See Atchison
RWD #4	--													In planning stage
								253						

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Bronson	Impounding Reservoir	395	--	1958	1958	330	193	.030	.054	.040	--	--	High	Need improved treatment plant
Fort Scott	Marmaton River Fort Scott Lake Rock Creek Lake	8,800	Yes	1936	1959	410	251	1.500	2.280	3.00	1,2, 3	4,355	Low	
Fulton	2 shallow wells	242	--	1963	1963	910	591	.010	..015	.010	--	--	High	Need improved and additional water supply
Mapleton	--	110	--	-	-	--	--	--	--	--	--	--	--	No public water supply
Redfield	--	160	--	-	-	--	--	--	--	--	--	--	--	No public water supply
Uniontown	Marmaton River	320	--	1958	1958	430	260	.030	.042	.043	--	--	Moderate	Maximum use approaches maximum treatment capacity
RWD #1	Fort Scott Public Water Supply	3,760	--	1962	1973	410	251	.244	.340	Available if .500	Purchased		Low	See Fort Scott
RWD #2	Fort Scott Public Water Supply	235	--	1964	-	410	251	.015	.023	Available if .040	Purchased		Low	See Fort Scott
RWD #3	Fort Scott Public Water Supply	450	--	1965	1967	410	251	.029	.044	Available if .086	Purchased		Low	See Fort Scott
RWD #4														In planning stage
								254						

BROWN COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Everest	2 shallow wells	350	Yes	1954	1972	590	375	.050	.075	.180	--	--	Low	1 shallow well maintained for standby
Fairview	None	282	--	-	-	--	--	--	--	--	--	--	--	No public supply
Hamlin	None	97	--	-	-	--	--	--	--	--	--	--	--	No public supply
Hiawatha	5 shallow wells	4200	--	1947	1971	540	346	.500	1.000	.820[a/]	--	--	Low	[a/] Additional standby capacity of .600 MGD
Horton	Impounding reservoir (Mission Lake)	2800	No	1924	1936	370	227	.500	.650	1.270	--	--	Moderate	Reported .720 MGD safe yield of impoundment
Morrill	2 shallow wells	356	--	1922	1964	720	452	.022	.035	.058	--	--	Low	
Powhattan	2 shallow wells	170	--	1965	-	920	582	.012	.018	.043	--	--	Low	Improvements in quality needed
Reserve	1 shallow well	130	Yes	1924	1956	900	559	.020	.032	.058	--	--	Low	Need additional well and quality improvements
Robinson	6 shallow wells	296	Yes	1927	1963	910	607	.020	.032	.111	--	--	Low	Improvements in quality needed
Willis	None	99	--	-	-	--	--	--	--	--	--	--	--	No public supply
RWD #1														Under construction 1974
							255							

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TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Andover	4 shallow wells	640	--	1966	1966	800	488	.065	.093	.195	--	--	Low	Considering tie to Wichita Public Water Supply
Augusta	Augusta City Lake and Santa Fe Lake	6300	Yes	1909	1972	440	252	.680	1.5	1.75	--	--	Moderate	Need additional water supply
Benton	2 shallow wells	510	No	1952	1956	2400	1992	.058	.125	.180	--	--	Low	Need better quality water supply source
Cassoday	None	135	--	-	-	--	--	--	--	--	--	--	--	
Douglass	10 deep wells	1200	Yes	1930	1973	770	476	.140	.320	.460	--	--	Moderate	Limited ground water
Elbing	2 shallow wells	150	--	1967	1972	1800	1284	.010	.020	.144	--	--	Low	Need better quality water supply source
Eldorado	Lake El Dorado Lake Bluestem	11,781	Yes	1916	1971	330	192	.766	1.300	6.750	1,2,3	1505	(1)*	Safe yield of two impoundments 3.700 MGD
Latham	3 shallow wells	170	--	1966	1973	960	575	.010	.025	.040	--	--	Low	Impounding reservoir under construction which should give reliable supply
Leon	3 shallow wells	531	Yes	1926	1964	710	436	.052	.075	.216	--	--	Low	
Potwin	3 shallow wells	555	No	1919	1967	2750	2120	.053	.110	.460	--	--	Low to Moderate	Very poor chemical quality
Rose Hill	2 shallow wells	475	--	1959	1959	1900	1455	.065	.120	.180	--	--	High	Need new source, improved quality and quantity
Towanda	3 deep wells 2 shallow wells	1200	No	1917	1970	1630	1031	.088	.175	.715	--	--	Low	Poor quality, need new source
White Water	3 shallow wells	520	--	1962	1968	1240	1008	.050	.110	.216	--	--	Low to Moderate	Need improved water quality
RWD #1	3 shallow wells (and El Dorado Public Supply	515	--	1961	-	660	416	.033	.057	.072	--	--	Low	.030 MGD available if purchased from El Dorado public supply

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #2	El Dorado Public Water Supply	550	--	1965	-	330	192	.049	.066	--	3	440	Low	.100 MGD available if purchased
RWD #3	El Dorado Public Water Supply via RWD #3	440	--	1974	-	330	192	.026	.044	--	--	--	Low	.200 MGD available if purchased
														(1)* Existing Eldorado city water supply reservoirs will be covered by the U.S. Corps of Engineers Eldorado Reservoir and the city will then obtain water from conservation storage included in the new impoundment.

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CHASE COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Cedar Point	None	70	--	-	-	--	--				--	--	--	
Cottonwood Falls	2 SWS	1100	Yes	1911	1965	1530.	922.	0.085	0.141	0.526	--	--	Low	
Elmdale	1 SW	95	No	1949	1969	1270.	745.	0.007	0.010	0.144	--	--	Low	needs standby well
Matfield Green	2 SWS	120	--	1956	1961	960.	593.	0.008	0.016	0.065	--	--		
Strong City	2 SWS	625	Yes	1914	1973	830.	526.	0.063	0.100	0.216	--	--		
RWD #1														in planning stage
								258						

CHAUTAUQUA COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975 1973-74

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Cedar Vale	Caney River 4 SWS	783	Yes	1915	1967	740.	439.	0.130	0.260	0.300			Low to Moderate	
Elgin	1 SW 1 SW (stand-by)	138	Yes	1922	1965	860.	541.	0.020	0.025	0.030			Moderate	
Peru	3 DWS	319	Yes	-	1965	1240.	754.	0.024	0.038	0.040			Moderate	Maximum use approaches system capacity
Sedan	2 city lakes (Imp. Res.)	1648	Yes	1935	1965	410.	236.	0.205	0.380	0.375	#1	70	Low	Need increased water treatment plant capacity
RWD #1	Sedan Public Water Supply	70	--	1966	none	410.	236.	0.006	0.008	Available if purchased 0.014			Low	
								259						

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Baxter Springs	Spring River 3 DWS	4801	no	----	1973	530	292	.750	1.40	3.50	--	--	low	Impoundinent safe yield = 3.0 mgd. max. dependable GW yield 1.0 mgd
Columbus	3 DWS	3442	no	1887	1972	820	495	.510	1.00	1.296	--	--	low	Maximum dependable GW yield = 1.944 mgd
Crestline	1 well	See	RWD #1	--	--	--	--	--	--	----	--	--	--	Served by and part of RWD #1
Galena	3 DWS	3537	yes	1918	1971	930	509	0.400	0.720	1.080	--	--	low	Maximum dependable GW yield = 2.038 mgd
Riverton	1 DW	600	no	1887		430	244	0.030	0.048	0.115	--	--	low	
Roseland	City of Scammon	145	--	1964		630	391	0.009	0.014	----	--	--	--	See city of Scammon
Scammon	2 DWS	480	no	1907	1964	630	391	0.060	0.100	0.072	--	--	high	Maximum dependable yield = 0.360 mgd. Improvements needed in treatment capacity.
Treece	1 DW	252	yes	1924	1924	1190	752	0.025	0.040	0.290	--	--	low	0.300 mgd available if purchased from Rural Water District No. 3
Weir City	1 DW	810	--	1889		690	400	0.040	0.070	0.170			low	
West Mineral	1 DW 1 DW standby	246	yes	1937	1944	1840	1083	0.026	0.040	0.388			low	Previous shortages caused by inadequate pumping and treatment facilities
RWD #1	1 DW	510		1964		450	275	0.033	0.070	0.072			low to moderate	quantity may be inadequate need second well
RWD #2	1 DW	300		1966		930	509	0.015	0.045	0.115			low	need second well
RWD #3	2 DWS	1224		1967	1973	1040	560	0.079	0.127	0.230			low	
RWD #4	1 DW	1270		1969	1969	690	410	0.083	0.095	0.115			low	need second well

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #5	City of Cherokee	296	--	1965	1972	890	520	0.019	0.028				Low	See Cherokee, Crawford Co.
RWD #6														In planning stage
RWD #7	City of Cherokee thru RWD #5	229		1974		890	520	0.015	0.020				Low	see Cherokee, Crawford Co.
								261						

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Clay Center	5SWS	5200	No	1884	1968	1250.	824.	0.860	2.0	4.5			Low	
Cliffton	2SWS	734	No	1948	1967	680.	434.	0.113	0.324	0.417			Low	
Green	3DWS	170	No	1911	1956	1040.	701.	0.010	0.022	0.018			High	Need larger pumps or changed pump settings. Dependable GW yield to 0.075 mgd
Idana	4SWS	80	No	1953	1957	1220.	829.	0.0045	0.010	0.019			Low to Moderate	Need improved water quality
Longford	5DWS	125	No	1936	1936	300.	186.	0.011	0.020	0.144			Low	
Morganville	2SWS	276	No	1950	1973	800.	542.	0.030	0.055	0.036			Low	Dependable groundwater yield ~~= 1.0 mgd~~
Oak Hill	NO PWS		No											
Wakefield	2SWS	686	No	1925	1964	850.	521.	0.090	0.175	0.288			Low	Dependable groundwater yield = 0.500 mgd
RWD #4	2SWS	140		1966	1966	900.	681.	0.010	0.025	0.043			Low	
									262					

COFFEY COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Burlington	Neosho River	2325	No	1918	1967	560.	338.	0.260	0.450	1.348	3	540	Low	
Gridley	Imp. Res.	452		1960	1960	280.	166.	0.020	0.030	0.040			Low	Safe yield of impoundment = 0.050 mgd
Lebo	Imp. Res.	814		1959	1971	270.	155.	0.065	0.100	0.170			Low	Safe yield impundment = 0.200 mgd
Waverly	5DWS		Yes	1915	1961	1000.	594.	0.028	0.040	0.036			High	Need addition well capacity
RWD #1	1SW	300		1964	1964	740.	453	0.010	0.024	0.040			Low to Moderate	Need additional well having better quality
RWD #2	City of Emporia	1445	1970	1972	210.	127.	0.094	0.140	Available if purchased 0.200				Low	See Emporia, Lyon County
RWD #3	City of Burlington	540		1973	none	560	338.	0.035	0.060	0.600			Low	
								263						

COWLEY COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Arkansas City	10 SWS	15000	No	1885	1971	990.	576.	2.600	5.200	7.000			Low	Need better quality
Atlanta	1 spring 2 SWS	250	Yes	1936	1959	550.	328.	0.020	0.038	0.100			Moderate to High	
Burden	1 spring 2 SWS	560	Yes	1912	1968	720.	436.	0.050	0.085	0.403			Moderate to High	
Cambridge	1 SW	110		1962	1062	820.	501.	0.010	0.020	0.043			Moderate to High	
Dexter	1 SW	297	Yes	1928	1973	1870.	1126.	0.020	0.040	0.100			Moderate to High	
Strotherfield	8 SWS	120	No	1940	1971	960	591	0.180	0.300	1.378			Low	
Hoall	2 SWS	675	Yes	1906	1955	670.	412	0.070	0.125	0.216			Low	
Winfield	Timberlake (stand by SWS)	10,176	Yes	1911	1969	360	201	1.40	3.52	4.00	#2,4	829	Low	
RWD #1	3 SWS	900		1957	1972	1630	362	0.105	0.180	0.864			Low	
RWD #2	City of Winfield	394		1962	none	360	281	0.025	0.043	Available if purchased 0.050			Low	
RWD # 3		680		1967	none	1240	721	0,232	0.500	0.360			High	
RWD # 4		435		1972	none	360	201	0,044	0.088	Available if purchased 0.150			Low	
RWD # 5														In planning stage
RWD # 6									264					In planning stage

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CRAWFORD COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Arcadia	2 DWS	439	No	1921	1965	1560	874	0.036	0.060	0.400			Low	
Arma	2 DWS	1467	No	1913	1960	1370	745	0.150	0.241	0.375			Low	
Capaldo	1 DW	130		1915	none	.2750	1576	0.013	0.035	0.028			Low	
Cherokee	2 DWS	753	No	1896	1945	890	520	0.068	0.140	0.580	See Remarks	525	Low	Serves Cherokee Co RWD 5 and 7
Croweburg	1 DW			1961	none	1270	731							See RWD #3
Frontenac	2 DWS	2620	No	1906	1972	860	479	0.240	0.380	0.914			Low	
Girard	2 DWS	2797	No	1907	1969	2360	1300	0.250	0.440	1.152			Low	
Hepler	see remarks													Served by Crawford Co. RWD #1
McCune	1 DW	528		1949	1964	2230	1291	0.036	0.008	0.180			Low	Subject to shortage due to mechanical failure of well
Mulberry	1 DW	644	Yes	1913	1971	2150	1314	0.050	0.070	0.280			Low	1953-54 shortage due to mechanical failure of single well
Pittsburg	4 DWS (DWS were Const)	21,000	Yes	1938	1955	600	338	2.800	3.500	4.650			Low	New well field and treatment plant make construction
Walnut	1 DW 2 SWS	373	Yes	1953	9157	2950	1591	0.030	0.060	0.080			Low	Need better quality
RWD #1	1 DW	440		1961	1973			0.035	0.054	0.115			Low	Subject to shortage due to mechanical failure of single well
									265					

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CRAWFORD COUNTY (contd.) TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #2	2 DWS	714		1961	1968	2120	1259	0.046	0.074	0.072			Moderate	Maximum dependable groundwater yield = 0.092 mgd
RWD #3	1 DW	225		1961	none	1270	731	0.015	0.026	0.072				Subject to shortage due to mechanical failure of single well
RWD #4	2 DWS	1862		1960	1972	1020	590	0.120	0.230	0.288			Low	
RWD #5	1 DW	968		1967	1967	640	356	0.140	0.256	0.230			Moderate	Subject to shortage due to mechanical failure of single well
RWD #6	4 SWS	1300		1972	none	370	216	0.091	0.136	0.128			Moderate to High	Need additional well
RWD #7	1 DW	1071		1972	none			0.075	0.140	0.115			Moderate to High	Subject to shortage due to mechanical failure of single well. Need additional well or increased pumping capacity
									266					

DICKINSON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
ABILENE	3 SWS	8265	Yes	1907	1965	510	312	1.038	2.000				Low	Maximum dependable groundwater yield = 6.3 mgd
CHAPMEN	3 SWS						739						Low	Maximum dependable groundwater yield = 1.00 mgd
ENTERPRISE	3 SWS	1540		1918	1961	1140	717	0.120	0.210				Low	
HERINGTON	Imp. Res	990		?	1971	1110	796	0.140	0.210	0.432			Low to Moderate	
HOPE	7 SWS	3802	Yes	1924	1972	1270	1429	0.388	0.700	1.000			Low to Moderate	Maximum dependable groundwater yield = 0.380 mgd
MANCHESTER	2 SWS	528	Yes	1918	1955	1850	280	0.050	0.092				Low	Maximum dependable groundwater yield = 0.072 mgd
SOLOMON	3 SWS	122		1930	1954	448	834	0.010	0.022				Low	Maximum dependable groundwater yield - 0.288 mgd
DICKINSON RWD #1		1210	No	1929	1966	1130		0.100	0.190					
DICKINSON RWD #2														
									267					

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Bendina				1963	none	660	417							Part of RWD #2
Denton				1965	none	620	376							Part of RWD #3
Elwood	2 SWS	1840	Yes	1937	1962	600	370	0.122	0.173	0.290			Low	
Highland	2 SWS	758		1939	1961	480	297	0.096	0.160	0.288			Low	
Leona				1963	none	290	183							Part of RWD #1
Severence						620	376							Part of RWD #3
Troy	2 SWS 3 SWS (reserved)	1230		1969	1972	710	437	0.090	0.150	0.360	#5	2500	Low	Maximum dependable ground-water yield = 0.518 mgd
Wathena	2 SWS	1316		1948	1949	800	524	0.151	0.252	0.300			Low	Maximum dependable ground-water yield = 0.375 mgd
White Cloud	1 SW	201		1963	1963	1000	685	0.020	0.040	0.072			Low	Subject to shortage due to mechanical failure of single well
RWD #1	1 SW	154		1963	none	290	182	0.010	0.015	0.033			Low	Subject to shortage due to mechanical failure of single well
RWD #2	1 SW	110		1963	none	660	417	0.006	0.010	0.024			Low	Suject to shortage due to mechanical failue of single well
RWD #3	2 SWS	300		1965	none	620	376	0.020	0.036	0.070			Low	
RWD #5	City of Troy	2500		1970	none	710	437	0.041	0.057	Available if purchased 0.100			Low	
									268					

DOUGLAS COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Baldwin	27 SWS	3000	Yes	1961	1965	220	139	0.200	0.270	0.240			High	Need additional groundwater or surface water supply
Eudora	3 SWS	2429	Yes	1937	1970	310	571	0.216	0.380	0.907			Low	
Lawrence	Kansas River 7 SWS	50,000	Yes	1887	1970	430	284	6.9	11.4	11.500			Low	Planned use of 14.9 mgd from Clinton Reservoir in futura.
Lecompton	2 SWS	590	No	1951	1971	820	512	0.035	0.076	0.144			Low	
RWD #1	1 SW	500		1963	1963	680	432	0.030	0.062	0.072			Low	Need standby well or connection to Lawrence supply
RWD #2	4 DWS	224		1967	1967	500	234	0.024	0.035	0.065			Low	
RWD #3	2 SWS	1460		1969	1969	360	233	0.112	0.143	0.432			Low	
								269						

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ELK COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Elk Falls	no DWS													
Grenola	Caney River Imp.	374	yes	1949	none	640.	379.	0.030	0.054	0.140			High	No improvement made since shortage in 1953-54
Howard	City Lake	1074	yes	1922	1936	430.	260.	0.062	0.180	0.275			Moderate to High	need additional impound-ment capacity
Longton	Elk River 2SWS(standby)	375	yes	1928	1928	640.	402.	0.060	0.116	0.460			Moderate to High	No improvements made since shortage 1953-54
Moline	Series of 3 Small Lakes	650	yes	1981	1947	550.	325.	0.095	0.195	0.376			Moderate to High	need additional impound-ment capacity
RWD #1														Planning Stage
									270					

FRANKLIN COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Lane	1 SW	295	Yes	1950	1968	730	448	0.030	0.040	0.072			Moderate	Need standby well
Ottowa	Marais Des Cygnes River	10,600	Yes	1886	1954	300	174	1.600	2.600	3.250	#1,2	824	Low	
Pomona	3 DWS	700	Yes	1938	1960	440	281	0.060	0.090	0.130			Low	
Princeton	Middle Creek Imp.	195		1964	1964	470	294	0.015	0.029	0.036	#3	106	Moderate	
Rantoul	2 SWS	300		1960	1960	1100	691	0.015	0.025	0.086			Low	
Richmond	Richmond City Lake	480		1955	1970	280	165	0.060	0.075	0.144			Low	
Wellsville	10 SWS	1425	No	1926	1967	280	181	0.120	0.160	0.160			Low to Moderate	
Williamsburg	6 DWS	350		1958	1971	620	384	0.025	0.030	0.0576			Low	
RWD #1	City of Ottowa	450		1966	1973	300	174	0.029	0.048	Available if purchased 0.100			Low	
RWD #2	City of Ottpwa	374		1965	none	300	174	0.024	0.041	Available if purchased 0.100			Low	
RWD #3	City of Princeton	106		1965	none	470	294	0.008	0.009	Available if purchased 0.010			Moderate	
RWD #4	6 DWS	1200		1968	1973	480	185	0.063	0.118	0.173			Low	
RWD #5	2 DWS	325		1972	none			0.022	0.025	0.144			Low	
RWD #6	4 SWS Marais Des Cygne River	1088		1973	none			0.071	0.120	0.288			Low	

GEARY COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Grandview Plaza	3 SWS	982		1953	1967	830	525	0.073	0.160	0.396			Low	
Junction City	10SWS	20,176		1917	1964	370	224	2.500	3.200	8.00	#1	207	Low	
Milford	Milford Reservoir	562		1923	1966	570	346	0.030	0.060	0.170			Low	
RWD #4	City of Junction City	207		1966	none	450	275	0.013	0.023	Available if purchased 0.060			Low	
RWD #2	1 SM	207		1968	none	690	419	0.013	0.020	0.046			Low	
									272					

GREENWOOD COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Eureka	Fall River Lake Eureka Otis Creek Res.	3789		1940	none	350	212	0.450	0.890	0.844	#4	780	Moderate to High	
Fall River	3 SWS 1 SW(standby)	183	Yes	1950	1971	1040	662	0.010	0.025	0.070			Low	
Hamilton	6 SWS	390	Yes	1936	1936	620	386	0.030	0.050	0.200			High	Shallow wells have greatly reduced yields in severe drought
Madison	Imp. Res. 7 SWS(standby)	1156	Yes	1947	1970	400	228	0.125	0.250	0.586			Low	
Severy	Imp. Res.	403		1953	1953	430	256	0.050	0.085	0.120			High	
Virgil	2 SWS	180	Yes	1955	1955	980	637	0.015	0.026	0.040			Low	
RWD #1	City of Eureka	780	Yes	1967	none	350	212	0.051	0.076	Available if purchased 0.200				See Eureka
RWD #2														In planning stage
								273						

JACKSON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Circleville	2 DWS	160		1958	1972	1880	1450	0.010	0.016	0.0504			Low	Need improved water quality
Delia	2 SWS	185		1957	1969	1230	809	0.015	0.026	0.036	#2	120	Low	
Denison	2 SWS	274		1956	1970	1050	652	0.014	0.027	0.043			Low	
Holton	Holton City Lake 9 SWS (standby)	3,430	No	1907	1973	600	360	0.500	0.700	1.500			Low	
Noyt	3 DWS	500		1960	1972	360	674	0.020	0.030	0.0366			Moderate	
Mayetta	3 SWS	280		1969	1967	790	491	0.018	0.083	0.0382			Moderate to High	Plan to connect to RWD #3
Netawaka	1 DW	210		1963	1972	2230	1379	0.021	0.030	0.040			Low to Moderate	Need source having improved water quality and additional well.
Soldier	2 SWS	185		1959	1960	3750	3135	0.010	0.020	0.029			Low to Moderate	Need source having improved water quality
Whiting	2 SWS	290		1964	1972	500	368	0.013	0.029	0.036			Low to Moderate	
RWD #1	Shawnee Co. RWD #4	600		1966	none	620	395	0.039	0.067	Available if purchased 0.100			Low	
RWD #2	City of Delia	120		1970	none	1230	809	0.006	0.009	Available if purchased 0.015			Low	
RWD #3														In planning stage
								274						

JEFFERSON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
McLouth	3 SWS 2 Springs	651	Yes	1936	1972	640	404	0.060	0.100	0.140			Moderate	
Meriden	Jefferson Co RWD #1													Part of and listed under RWD #1
Nortonville	3 DWS	750	Yes	1940	1957	730	466	0.050	0.070	0.173			Low to Moderate	
Oskaloosa	Oskaloosa City Lake	1025	Yes	1953	none	360	205	0.100	0.130	0.280			Low to Moderate	
Ozawkie	2 SWS	197		1966	1966	420	259	0.022	0.040	0.120			Low	The new city of Ozawkie is also RWD #4
Perry	2 SWS	668		1944	1964	710	422	0.090	0.120	0.144			Low	
Valley Falls	Delaware River Springs	1200	Yes	1918	1968	610	312	0.150	0.217	0.350			Low	
Winchester	2 DWS Spring	590		1926	1973	860	535	0.086	0.105	0.130			Low to Moderate	
RWD #1	3 DWS	1376		1957	1969	550	365	0.090	0.142	0.432			Low	See Maiden
RWD #2	1 SW	270		1963	1963	900	566	0.016	0.023	0.100			Low	Need additional standby well
RWD #3	3 SWS City of Valley Falls	500		1966	1969	540	320	0.030	0.065	0.093			Low	
RWD #6	1 SW	475		1968	none	500	305	0.031	0.053	0.042			Moderate	Need additional standby well
RWD #10	Perry Res.	350		1971	none	230	155	0.023	0.039	0.144			Low	
RWDs 4-7-8-9-11-12-13								.275						In planning stage

JOHNSON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
DeSoto	2 SWS	2,100		1957	1973	700	453	0.221	0.300	0.576	6 6A	935	Low	
Edgerton	3 City Lakes	188		1960	none	430	255	0.055	0.070	0.080			Moderate	
Gardner	Gardner Lake	2,700		1959	none	330	197	0.280	0.350	0.432			Low to Moderate	
Olathe	Lake Olathe Cedar Lake and 4 SWS	19,400	No	1885	1969	370	216	2.6	5.00	7.500	#1,4 5,7	4619	Low	Cedar Lake used as a reserve water supply only
Spring Hill	Little Bull Cr. Impoundment	1,400	Yes	1944	1970	440	272	0.100	0.165	0.165				
Johnson County Water Dist #1	21 SWS, Kansas River, and City of Kansas	180,000	No		1973	510	297	29.7	42.5	60.00 0.200*			Low	Services the following cities: Countryside, Fairway, Leawood, Lennexa, Merriam Mission, Mission Hills, Mission Woods, Overland Park, Shawnee, Westwood, Westwood Hills
	City Mo.(Missouri River)													
Stanley	City of Olathe													*Available from City of Kansas City, Mo. if Purchased
RWD #1	City of Olathe	901		1960	1967	370	216	0.059	0.100	Available if 0.200	purchased		Low	
RWD #2	Tributary of Blue R Olathe Ks. Ks.City Mo.	2275		1964	none	590	372	0.125	0.210	0.260			Low	
RWD #3	City of Bonner Springs	1904		1964	1973	790	470	0.124	0.210	Available if 0.300	purchased		Low	
RWD #4	City of Olathe	398		1966	none	370	216	0.026	0.044	Available if 0.100	purchased		Low	
RWD #5	City of Olathe	1522		1967	1974	370	216	0.099	0.168	Available if 0.300	purchased		Low	
									276					

LABETTE COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Altamont	Hackberry Creek Imp. 1 SW(standby)	923	Yes	1952	1972	300	177	0.096	0.124	0.140			Moderate	
Bartlett	Imp. Res.	140		1961	1961	430	258	0.015	0.028	0.040			Low to Moderate	
Chetopa	Neosho River	1640	No	1900	1968	430	300	0.205	0400	0.570			Low	
Edna	Imp. Res.	475	Yes	1953	1963	230	135	0.030	0.059	0.140			Low	
Labette	Lb. Co. RWD #5			See Labette Co.		RWD #5								
Mound Valley	Pumpkin Creek Imp.	459	Yes	1936	1936	310	181	0.054	0.090	0.200			Moderate	
Oswego	Neosho River	2146	NO	?	none	480	285	0.280	0.576	1.040	#1,4,8	1036	Low	
Parsons	Labette Creek Imp Neosho River(standby)	12,500	No	1922	1959	350	210	2.850	3.654	6.652	#2,7	950	Low	
RWD #1	City of Oswego	146		1965	none	480	285	0.008	0.010	Available if purchased 0.040				
RWD #2	City of Parsons	100		1964	none	350	210	0.014	0.019	Available if purchased 0.050				
RWD #3	City of Cherryvale	265		1965	none	540	325	0.017	0.029	Available if purchased 0.050				
RWD #4	City of Oswego	165		1966	none	480	285	0.012	0.020	Available if purchased 0.060				
RWD #5	City of Parsons	850		1967	none	350	210	0.055	0.088	Available if purchased 0.200				
								277						

LABETTE COUNTY (contd.)

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #6	City of Coffeyville	894		1967	none	320	184	0.036	0.047	Available if purchased 0.100				Check source
RWD #7	Ne. Co. RWD #4 Lb. Co. RWD #2	186		1967	none	350	210	0,010	0.013	Available if purchased 0.060				
RWD #8	City of Oswego	725		1971	none	480	285	0.040	0.069	Available if purchased 0.200				
								278						

LEAVENWORTH COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Bashor	RWD #4													Part of RWD #4
Easton	2 SWS	453		1957	1971	480	279	0.028	0.050	0.144			Low	
Eight Views	4 SWS	30		1972	none	620	384	0.002	0.004	0.036			Low to Moderate	
Lansing	City of Leavenworth													
Leavenworth	Misouri River	30,000	No	1882	none	510	322	3.80	5.34	6.000	#4,2, 3,5,8	1797	Low	
Linwood	2 SWS	350		1957	1961	770	469	0.016	0.018	0.086			Low	
Tonganoxie	2 SW	2079		1938	1968	470	281	0.250	0.375	0.600	#6	269	Low to Moderate	
RWD #1	City of Leavenworth	74		1961	none	510	322	0.005	0.008	Available if purchased 0.010			Low	
RWD #2	City of Leavenworth	384		1961	none	510	322	0.025	0.042	Available if purchased 0.100			Low	
RWD #3	City of Leavenworth	139		1961	none	510	322	0.032	0.015	Available if purchased 0.050			Low	
RWD #4	4 SWS, 2 DWS	875		1963	1972	600	380	0.053	0.090	0.130			Low to Moderate	
RWD #5	City of Leavenworth	486		1964	none	510	322	0.032	0.054	Available if purchased 0.200			Low	
RWD #6	City of Tonganoxie	269		1964	none	470	281	0.017	0.030	Available if purchased 0.100			Low to Moderate	
								279						

LEAVENWORTH COUNTY (contd.)

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #7	City of Bonner Springs	751		1965	none	790	470	0.049	0.083	Available if purchased 0.200			Low	
RWD #8	City of Leavenworth	714		1966	none	510	322	0.046	0.079	Available if purchased 0.200			Low	
RWD #9	4 DWS	1000		1973	none			0.065	0.100	0.173			Low	
								280						

LINN COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Blue Mound	City Lake	330		1960	1960	260	165	0.025	0.052	0.040			Moderate	Need increased production facilities and additional storage
La Cygne	Marais Des Cygnes River	994		1964	1971	510	315	0.085	0.120	0.360	#1,3, 3s	1880	Low	
Mound City	Little Sugar Creek Imp.	790	Yes	1912	none	430	256	0.065	0.124	0.340			High	Shortage in 1953-54, no major improvements
Parker	City Lake	230		1962	1962	310	178	0.015	0.040	0.030			High	
Pleasanton	R imp. Res. Muddy Creek	1360	Yes	1953	1968	290	168	0.130	0.165	0.360	#2	380	Low	
Prescott	City Lake	229		1964	1964	270	157	0.025	0.035	0.036			Moderate	
RWD #1	City of La Cygne	725		1967	none	510	315	0.034	0.041	Available if 0.100	purchased		Low	
RWD #2	City of Pleasanton	380		1969	1973	290	168	0.025	0.040	Available if 0.100	purchased		Low	
RWD #3	City of La Cygne	630		1973	none	510	315	0.033	0.055	Available if 0.100	purchased		Low	
RWD #3(S)	City of La Cygne	525		1972	1974	510	315	0.034	0.052	Available if 0.100	purchased		Low	
								281						

LYON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Admire	Imp. Res. (Jt. use with Allen)	153	Yes	1966	1966	550	322	0.012	0.018	0.580			Low	
Allen	Imp. Res. (Jt. use with Admire)	196	Yes	1966	1966	550	322	0.015	0.024	0.580			Low	
Americus														Part of RWD #1
Emporia	Neosho River Lake Kahola (reserve) Cottonwood R.	25,000	Yes (H)	1877	1972	210	127	5.000	7.400	12,000	#2,5	1235	Low	
Hartford	Neosho Rvier 1 SW (stand-by)	521	Yes	1955	1965	700	438	0.060	0.108	0.252			Low	
Kansas Turnpike Authority	City of Emporia			1956	--	210	127	0.010	0.022				Low	
Neosho Rapids														Part of RWD #4
Olpe	Imp. Res.	456		1965	1965	280	158	0.070	0.085	0.060	#3	245	High	Need additional impounded storage and treatment capacity
Reading	5 SWS	256	Yes	1944	1964	740	458	0.020	0.030	0.020				
Thorndale Acres	1 SW	38		1963	--			0.003	0.008	0.029			High	
RWD #1	2 SWS	280		1961	1970	820	584	0.020	0.045	0.072			Low	
RWD #2	City of Emporia	425		1967	none	210	127	0.027	0.038	Available if purchased 0.100			Low to Moderate	

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #3	City of Olpe	245		1968	none	280	158	0.016	0.024	Available if purchased 0.080			High	
RWD #4	1 SW	470		1968	none	630	382	0.031	0.050	0.108			Low	Need an additional well
RWD #5	City of Emporia	810		1973	1973	210	127	0.380	0.520	Available if purchased 1.000			Low	

MARION COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Burns	3 DWS	275		1920	1957	730	449	0.040	0.078	0.173			Low	
Durham	4 SW	190		1966	none	210	132	0.016	0.030	0.043			Low	
Florence	Spring 1 SW(reserve)	925		1887	1956	630	369	0.083	0.150	0.396			Low	
Goessel	3 SWS	437		1963	1973	730	456	0.028	0.100	0.216			Low	
Hillsboro	12 SWS	2734	Yes	1919	1970	2100	1738	0.274	0.450	1.000			Low	
Lehigh	1 SW	200		1962	none	310	210	0.020	0.050	0.058			Low to Moderate	Need standby well
Lincolnville	No PWS													
Lost Springs	No PWS													
Marion	Mud Creek (1 Imp. Res)	2250	Yes	1907	1965	930	583	0.275	0.475	0.750			Low to Moderate	
Peabody	6 SWS	1620	No	1917	1965	1080	738	0.158	0.380	0.324			High	Maximum day usage exceeds maximum dependable yield of well field
Ramona	No PWS													
Tampa	No PWS													
RWD #1														In planning stage
RWD #2	1 SW	60		1970	1970	690	405	0.0015	0.0035	0.022			Low	

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Axtell	3 SWS	510	No	1920	1966	750	481	0.040	0.008	0.223			Low	
Beattie	6 SWS	300	Yes	1937	1965	2600	2052	0.015	0.028	0.036			Moderate to High	Need improved quality and quantity
Blue Rapids	2 SWS	1345	No	1907	1934	750	469	0.160	0.677	0.950				
Bremen	WashingtonCo. RWD #1 1 SW(standby)	50		1966	1966	1760	1280	0.003	0.004	Available if purchased 0.005			Low to Moderate	Need improved quality water
Frankfort	3 DWS	1150		1908	1971	590	364	0.150	0.268	1.088			Low	
Home	RWD #1													Part of RWD #1
Marysville	7 SWS	3700	No	1914	1973	430	267	0.6330	1.50	1.50			Moderate	Maximum daily use is equal to maximum dependable production Need additional capacity
Oketo	2 SWS	150		1937	1971	370	616	0.012	0.016	0.058			Low	Need improved quality water
Summerfield	1 SW 2 DWS	270	Yes	1957	1966	3100	2850	0.025	0.035	0.118			Low	
Vermillion	2 SWS	240	Yes	1937	1968	670	411	0.020	0.030	0.144			Low	
Waterville	2 SWS	761		1918	1966	370	604	0.072	0.165	0.792			Low	
Winifred	2 SWS	35		1948	1972	550	330	0.0035	0.006	0.012			Low	Maximum day consumption exceeds maximum dependable yield. Need improved quality and additional capacity
RWD #1	1 SW	120		1966	1966	1500	1121	0.007	0.030	0.022			High	
RWD #2	2 SWS	180		1967	1969	610	360	0.013	0.016	0.060			Low	

MIAMI COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Fontana	1 SW	150		1960	1960	700	412	0.014	0.025	0.029			Low to Moderate	need standby well
Louisburg	City Lake	1089	No	1953	1971	350	205	0.125	0.180	0.280			Low to Moderate	
Osawatomie	Marais Des Cygnes River(Imp.	5500 Res)	Yes	1901	1967	300	177	1.500	2.800	3.000	#1,13	3568	Low to Moderate	
Paola	Lake Miola	5030	No	1885	1957	250	144	0.406	0.650	2.000			Low	
RWD #1	Cit of Osawatomie	1070		1965	none	300	177	0.070	0.110	Available if 0.200	purchased		Low to Moderate	
RWD #2	Wea Creek Imp.	2550		1968	1973	250	144	0.153	0.250	0.273			Low to Moderate	
RWD #3	City of Osawatomie	1213		1968	none	300	177	0.073	0.134	Available if -.300	purchased		Low to Moderate	

MONTGOMERY COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Caney	Little Caney R. Imp. Otter Creek Imp. Res.	2750	No	1907	1970	480	285	0.250	0.480	1.100			Low	
Cherry Vale	Verdigris River	2940	No	1911	1964	540	325	0.510	0.980	0.720	#6	920	Moderate	Maximum daily use exceeds maximum dependable production. Safe yield of impoundment 1.5 mgd is adequate
Coffeyville	Verdigris River	17398	Yes	1895	1973	320	184	3.900	4.588	11.000	#10.11 7	1768	Low	
Dearing	City of Coffeyville													Part of Coffeyville system
Elk City	Elk River	470		1920	1965	670	393	0.052	0.100	0.324	#9,9	811	Low	
Havana	RWD #5													Part of RWD #5
Independence	Verdigris Rvier	13,550	No	1906	1968	390	217	2.066	3.284	6.000	#1,2, 3,4,5, 8	2755	Low	Application for 5.0 mgd from Elk City Res. pending
Liberty	RWD #6			See RWD #6									Moderate	
Sycamore	RWD #4			See RWD #4									Low	
Tyro	RWD #5			See RWD #5									Low	
RWD #1	City of Independence	150		1959	none	390	217	0.009	0.016	Available if 0.100	purchased		Low	
RWD #2	City of Independence	340		1960	none	390	217	0.026	0.035	Available if 0.100	purchased		Low	
RWD #3	City of Independence	80		1960	none	390	217	0.005	0.008	Available if 0.040	purchased		Low	

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

MONTGOMERY COUNTY (cont.)

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #4	City of Independence	745	---	1961	1970	390	217	0.048	0.070	Available if purchased 0.200			Low	
RWD #5	"	1190	---	1963	1969	390	217	0.077	0.112	Available if purchased 0.200			Low	
RWD #6	City of Cherryvale	920	---	1964	None	540	325	0.060	0.089	Available if purchased 0.200			Moderate	
RWD #7	City of Coffeyville	280	---	1964	None	320	184	0.018	0.029	Available if purchased 0.100			Low	
RWD #8	City of Independence	250	---	1966	None	390	217	0.016	0.024	Available if purchased 0.060			Low	
RWD #9	City of Elk City	411	---	1966	None	670	393	0.027	0.040	Available if purchased 0.110			Low	
RWD #9	"	400	---	1966	1969	670	393	0.029	0.040	Available if purchased 0.080			Low	
RWD #10	City of Coffeyville	196	---	1967	None	320	184	0.013	0.019	Available if purchased 0.080			Low	
RWD #11	"	292	---	1972	None	320	184	0.019	0.032	Available if purchased 0.060			Low	

MORRIS COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Council Grove	Council Grove Lake	2600	Yes	1941	1955	300	177	0.338	0.810	1.300			Low	
Dunlap	No PWS													
Dwight	2 SWS	412		x	1958	505	505	0.032	0.054	0.072			Low	
Latimer	No PWS													
Parkerville	No PWS													
White City	3 DWS	522	Yes	1937	1958	880	538	0.040	0.082	0.140			Low	
Wilsey	No PWS													

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Bern	3 DWS	225		1954	1969	760	475	0.020	0.036	0.115	#1	204	Low	
Centralia	5 SWS	565	No	1928	1960	760	485	0.030	0.060	0.144			Low to Moderate	
Corning	1 SW	160		1961	1971	740	483	0.015	0.020	0.072			Low	Need standby well
Goff	2 DWS	240		1942	1954	1670	1273	0.027	0.055	0.150			Low	
Oneida	1 SW	115		1966	none	740	470	0.010	0.015	0.043			Low	Need standby well
Sabetha	Lake Sabetha	2500	No	1913	1954	420	249	0.250	0.500	0.048			Moderate	
Seneca	5 SWS 3 Springs	2500		1907	1973	670	439	0.325	0.600	0.785	#2	360	Low to Moderate	
Wetmore	2 SWS	410		1945	1966	800	541	0.020	0.030	0.260			Low	
RWD #1	City of Bern 1 SW	204		1966	1970	760	475	0.013	0.023	Available if purchased 0.144 0.036(from wells)			Low	
RWD #2	City of Seneca	360		1970	none	670	439	0.017	0.026	Available if purchased 0.100			Low to Moderate	
RWD #3														In planning stage

NEOSHO COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Chanute	Neosho River	10,300	Yes	1918	1960	320	194	1,628	2.800	3.000	#7	300	Low	
Earlton	RWD #6		Yes			440								Part of RWD #6
Erie	Neosho River (standby)	1470		1920	1971	410	270	0.380	0.680	0.620	#3,	92	Moderate	Maximum daily use exceeds maximum dependable production. Need additional moderation capacity
Galesburg	Labette Creek Imp.	140	Yes	1957	1965		247	0.020	0.045	0.065			Moderate	Part of RWD #2
Stark	RWD #2					410								
St. Paul	Neosho River	885		1937	1937	300	250	0.078	0.150	0.400	#8	190	Low	
Thayer	Imp. Res.	445		1960	1960	310	175	0.040	0.040	0.050	#1,5,6	400	Moderate	
Tulakes	Imp. Res.	74		1966	1972	300	186	0.0074	0.0078	0.074			Moderate to High	Usage equal or exceeds maximum dependable production.
RWD #1	City of Thayer	34		1960	none	300	175	0.002	0.003	Available if purchased 0.010			Moderate	
RWD #2	Imp. Res.	1907		1965	1973	310	174	0.087	0.169	0.130			High	Maximum daily use exceeds maximum dependable production and safe yield of impoundment
RWD #3	City of Erie	92		1964	none	440	270	0.006	0.010	Available if purchased 0.050			Moderate	
RWD #4	City of Parsons	1050		1965	none	350	210	0.071	0.120	Available if purchased 0.400			Low	
RWD #5	City of Thayer	116		1965	none	300	175	0.008	0.013	Available if purchased 0.100			Moderate	

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #6	City of Chanute	250		1966	none	300	175	0.027	0.034	Available if 0.100	purchased		Moderate	
RWD #7	City of Chanute	300		1967	none	320	194	0.025	0.039	Available if 0.100	purchased		Low	
RWD #8	City of St. Paul	190		1967	none	410	250	0.012	0.021	Available if 0.100	purchased		Low	

OSAGE COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Burlingame	Dragoon Creek Imp.	1071	Yes	1913	1961	710	434	0.110	0.175	0.360			Low to Moderate	
Carbondale	Strowbridge Creek Imp.	1035	Yes	1951	1973	310	178	0.100	0.130	0.252	#5	1800	Low	
Lyndon	Lyndon City Lake Salt Creek (standby)	1170	Yes	1912	1965	400	235	0.115	0.220	0.288	#1,	20	Low	
Melvern	5 DWS	470		1960	1972	1910	1090	0.036	0.060	0.040			High	Need additional dependable capacity and better water quality.
Olivet	No PWS													
Osage City	City Lake Melvern Res	2769	Yes	1909	1971	330	194	0.280	0.420	1.000	#6,7	1330	Low	
Overbrook	3 DWS	800		1953	1969	1040	615	0.091	0.180	0.153			Low to Moderate	Maximum daily use exceeds maximum dependable production.
Quenemo	2 SWS 1 DW	436		1939	1966	920	609	0.036	0.070	0.072			Low to Moderate	Nee one additional well
Scranton	City	601		1960	none	300	178	0.019	0.060	0.086			Low to Moderate	
Vassar Park	Lake Pomona Reservoir	920		1964	1971	410	245	0.041	0.050	0.108	#3	300	Low	
RWD #1	City of Lyndon	20		1958	none	420	250	0.001	0.002	Available if 0.005	purchased		Low	
RWD #2	1 DW	150		1963	1963	930	590	0.010	0.025	0.030			Low to Moderate	Need standby well
RWD #3	Vassar Park	300		1964	1964	410	245	0.020	0.050	Available if 0.012	purchased		Low	

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #4	2 DWS	350		1967	1967	1000	582	0.020	0.030	0.040			Low	
RWD #5	City of Carbondale	1800		1967	none	310	178	0.038	0.160	Available if purchased 0.300			Low	
RWD #6	Osage City Thru #7	280		--	--	330	194	0.018	0.030	Available if purchased 0.100			Low	
RWD #7	City of Osage City	1050		1973	none	330	194	0.070	0.109	Available if purchased 0.300			Low	
RWD #8														In planning stage

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

POTTAWATOMIE COUNTY

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Belvue	1 SW	180	Yes	1962	1962	740	475	0.015	0.028	0.0288			Low to Moderate	Max day consumption approaches max day dependable production. Need additional prod. capacity.
Emmett	2 SWS	175	---	1956	1965	1020	628	0.015	0.022	0.020			Moderate to Severe	Same as that for Belvue
Havensville	1 SW	209	No	1908	----	805	515	0.010	---	0.110			Low to Moderate	Need standby well
Olsburg	3 DWS	130	Yes	1957	1964	740	435	0.008	0.016	0.040			Low	
Onaga	Vermillion 2 SW	880	Yes	1911	1964	900	557	0.070	0.097	0.338			Low	
St. George	1 SW	264	---	1963	1963	370	241	0.018	0.040	0.043			Moderate	Max day consump. approaches max dependable production. Need add. prod. capacity.
St. Marys	5 SWS	1530	No	1918	1962	1100	687	0.180	0.240	0.900			Low	
Wamego	3 SWS 1 SW (st-by)	2750	No	1899	1973	850	533	0.300	0.600	2.376			Low	
Westmoreland	4 SWS	540	No	1917	1968	730	430	0.054	0.110	0.110			Moderate	Same as that for Belvue
Timber Creek East Water District	1 SW	216	---	1971	None	710	443	0.016	0.024	0.115			Low	Need standby well
RWD #1														In planning stage

RILEY COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Fairmont Heights (Manhattan)	1 SW	54		1956	1956	920	571	0.005	0.012	0.325			Low	
Leonardville	4 DWS	474		1921	1964	800	507	0.040	0.072	0.288			Low	
Manhattan	12 SWS	28,000		1915	1969	380	230	4.500	5.500	7.500			Low	
Manhattan Airport Water Supply	1 SW	50		1964	none	690	451	0.005	0.009	0.053			Low	Need standby well
Ogden	3 SWS	2336		1918	1949	1010	655	0.120	0.200	0.400			Low	
Randolph	2 SWS	141		1964	1964	880	542	0.010	0.025	0.060			Low	
Riley	3 DWS 2 SWS	711		1924	1970	700	421	0.060	0.100	0.338			Low	
									296					

SHAWNEE COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Auburn	City of Topeka													Part of RWD #2
Lake Jivaro	Lake Jivara and City of Topeka	2740		1962	1967	310	183	0.178	0.302	0.115 plus 0.900 Available if purchased			Low	
Rossville	2 SWS	945	Yes	1945	1962	880	526	0.096	0.130	0.144			Low to Moderate	Maximum dependable ground water yield 0.288 mgd. Need additional treatment capacity.
Silver Lake	3 SWS	978	Yes	1946	1972	640	410	0.060	0.090	0.640	#10	197	Low	
Topeka	Kansa River	150,000	No	1910	1973	800	473	20.0	37.0	45.0	#1,2,3,4,5,6,7,8,	16,057	Low	
Wakarusa	Sh. Co. RWD #6,7										8,9			
RWD #1	City of Topeka thru RWD #2	396		1968	none	800	473	0.026	0.030	Available if 0.100	purchased		Low	
RWD #2	City of Topeka thru RWD #2	1258		1958	1971	800	473	0.082	0.139	Available if 0.500	purchased		Low	
RWD #3	City of Topeka thru RWD #2 2 SW(standby)	2200		1957	1973	800	473	0.130	0.150	Available if 0.200	purchased		Low	
RWD #4	City of Topeka thru RWD #2 2 SWS	2934		1957	1973	620	395	0.191	0.324	Available if 1.000	purchased		Low	
RWD #5	Sh. Co. RWD #4	224		1960	none	620	395	0.015	0.025	Available if 0.100	purchased		Low	
RWD #6	City of Topeka Imp. Res.	894		1961	1973	300	179	0.058	0.098	Available if 0.300	purchased		Low	
RWD #7	Sh. Co. RWD #6	320		1961	none	300	179	0.021	0.035	Available if 0.100	purchased		Low	
									297					

SHAWNEE COUNTY (contd.)

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #S	Lake Jivaro City of Topeka	2740		1962	1967	310	183	0.178	0.302	Available if purchased 0.900			Low	
RWD #8	Lake Jivaro City of Topeka	5000		1963	none	310	188	0.197	0.385	Available if purchased 2.0			Low	
RWD #9	Sh. Co. RWD #2	85		1971	none	800	473	0.005	0.009	Available if purchased 0.020			Low	
RWD #10	City of Silver Lake	197		1972	none	640	410	0.013	0.022	Available if purchased 0.100			Low	
									298					

WABAUNSEE COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Alma	Alma City Lake	972	Yes	1922	none	320	191	0.134	0.200	0.388			Low	
Altavista	4 DWS	520	Yes	1946	1969	710	430	0.030	0.050	0.100			Low	
Eskrigde	3 DWS 2 SWS	620		1948	1970	1190	767	0.040	0.075	0.137			Low	
Harveyville	Harveyville Res.	279		1959	none	310	176	0.015	0.032	0.070			Low to Moderate	
Maple Hill	3 SWS	397		1956	1970	1120	733	0.035	0.060	0.216			Low	
Paxico	1 SW	219		1958	1958	2580	1426	0.020	0.032	0.043			Low to Moderate	Need additional well and improved water quality.
RWD #1	2 SWS	270		1970	1970	650	416	0.015	0.028	0.036			Low to Moderate	
									299					

WASHINGTON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Barnes	2 DWS	240	Yes	1955	1955	830	531	0.026	0.050	0.115			Low	
Clifton		SEE CLAY COUNTY												
Greenleaf	4 SWS	525		1907	1960	880	584	0.060	0.094	0.288			Low	
Haddam	3 SWS	313		x	1957	650	410	0.036	0.054	0.144			Low	
Hanover	4 SWS Wash. Co RWD #1	863		1935	1949	1400	992	0.080	0.130	0.330			Low	
Linn	2 SWS	395	Yes	1935	1965	330	200	0.040	0.070					
Mahaska	2 DWS	145		1925	1957	1640	971	0.015	0.031	0.072			Low	
Morrowville	1 DW 1 SW	204		1937	1971	540	335	0.023	0.040	0.202			Low	
Palmer	2 SWS	156	No	1926	1967	200	133	0.010	0.024	0.035			Low	
Washington	3 DWS	1766	No	1949	1964	340	218	0.250	0.486	0.935			Low	
RWD #1														In planning stage
									300					

WILSON COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Altoona	Verdigris River	629	No	1916	none	530	306	0.055	0.080	0.250			Low	
Benedict														Part of and supplied by Wilson County RWD #5
Buffalo	Woodruff Creek Infiltration Gallery			1960	1960	390	222	0.025	0.040	0.040			High	Need increased and improved source and water plant capacity
Coyville	I SW													Part of and supplied by Wilson County RWD #9
Fredonia	Fall River Imp.	3521	No	1938	1967	400	222	0.575	1.110	2.000			Low	
Neodesha	Fall River	2670	Yes	1931	1971	370	208	0.600	1.10	2.000				
New Albany														Part of and supplied by Wilson County RWD #2
RWD #1	City of Fredonia	343		1961	---	400	222	0.039	0.054	Available if purchased 0.100				
RWD #2	City of Fredonia	235		1962	---	400	222	0.015	0.026	Available if purchased 0.100				
RWD #3	City of Neodesha	58		1962	---	370	208	0.004	0.006	Available if purchased 0.020				
RWD #4	City of Neodesha	234		1964	---	370	208	0.015	0.026	Available if purchased 0.100				
RWD #5	City of Fredonia Thru Wi. Co.	231		1966	1967	400	222	0.015	0.026	Available if purchased 0.100				
	RWD #7													
									301					

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
RWD #6	City of Neodesha	44		1964	---	370	208	0.003	0.005	Available if 0.015	purchased			
RWD #7	City of Fredonia	381		1965	---	400	222	0.025	0.042	Available if 0.100	purchased			
RWD #8	City of Neodesha	20		1969	---	370	208	0.001	0.002	Available if 0.010	purchased			
RWD #9	City of Toronto	476		1966	---	580	330	0.010	0.019	Available if 0.050	purchased			
RWD #10 and 12														In planning stage
									302					

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Neosho Falls	Neosho River RWD #1													Served by and part of Woodson County RWD #1
Toronto	Toronto Lake (Verok, Ris River)	486	Yes	1926	1968	580	330	.070	.130	.230			Low	
Yates Center	Imp. Res.	2100	Yes	1927	1969	350	196	.165	.260	1.00			Low	
RWD #1	Neosho River	560		1968	--	370	228	.033	.046	.072			Low	
								303						

WYANDOTTE COUNTY

TABLE 1 - PUBLIC WATER SUPPLIES IN 43 EASTERN KANSAS COUNTIES, BY COUNTIES, 1975

NAME	SOURCE	Population Served 1973 (a)	Shortage in 1953-54	Public Supply		Water Quality		Water Usage MGD(1973-74)		Water Plant Capacity MGD (1973-74)	Supply RWD		Estimated Susceptibility to drought	REMARKS
				Started	Last Improvement	SC	TS	Av.	Max.		RWD No.	Popula		
Bonner Springs	3 SWS	5717	No	1951	1966	790	470	.800	1.00	1.44	3.4	740	Low	
Edwardsville	Kansas City Kansas													Part of the Kansas City, Kansas system
Kansas City	Missouri River		No	1883	1970	630	385	35.00	50.00	60.00			Low	
RWD #2	City of Leavenworth Thru Lansing	384		1952	-	510	322	.025	.043	Available if purchased .100			Low	
RWD #3	City of Bonner Springs	180		1965	-	790	470	.012	.020	Available if purchased .080				District taken in to Kansas City, Kansas Water system
RWD #4	City of Bonner Springs	560		1966	-	790	470	.036	.056	Available if purchased .100				District taken in to Kansas City, Kansas Water system
RWD #5														Under Construction
								304						

Explanation

(To go with Figures 4 through 46)

Public water supply using surface water source

Public water supply using ground water source

No public water supply

Location of surface water source

Location of ground water source

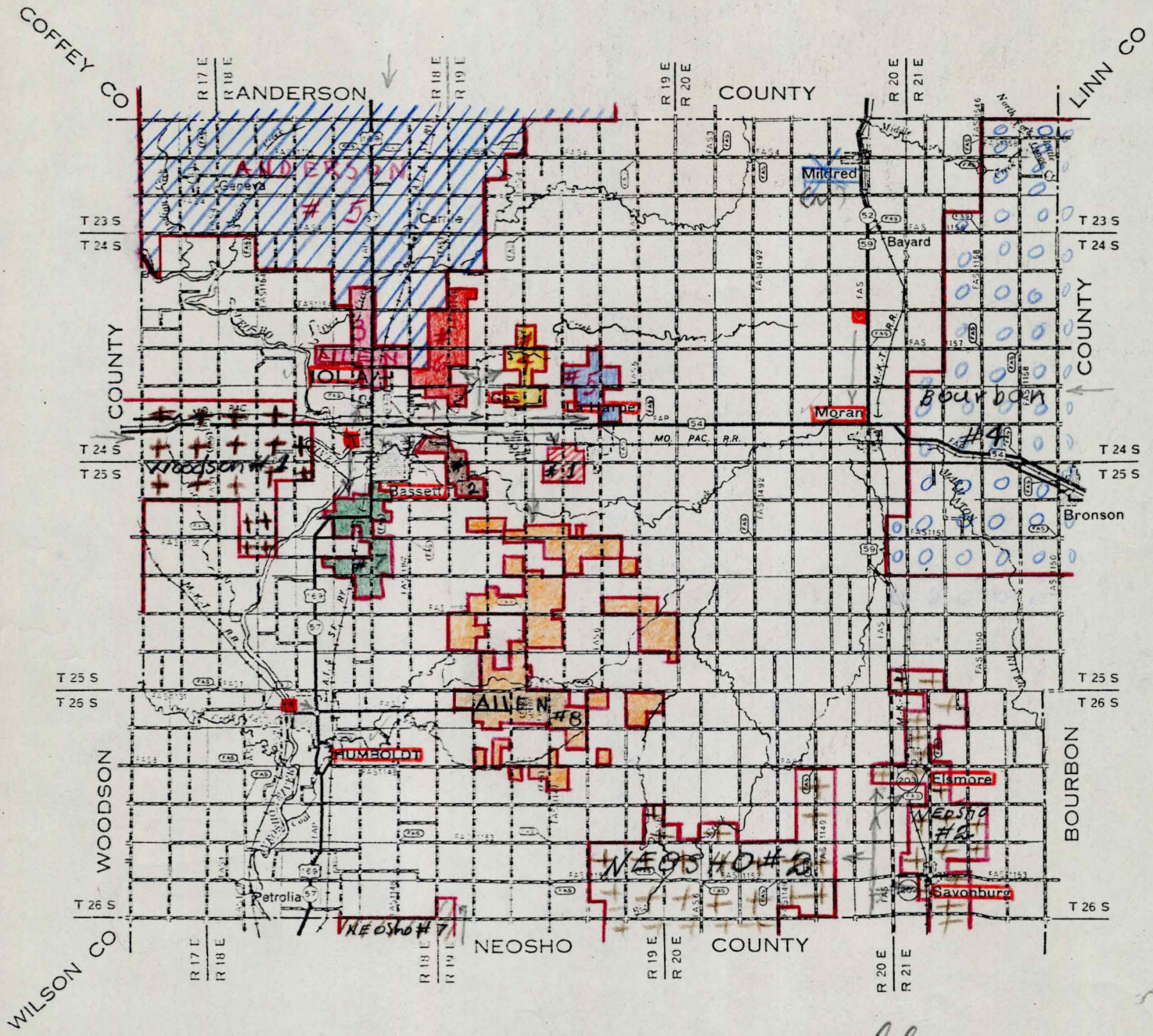


Fig 4

Map of Allen County showing location and area served by public water supplies, type of supply, and location of source.

ALLEN COUNTY
KANSAS

1963

SCALE

Fig. -4

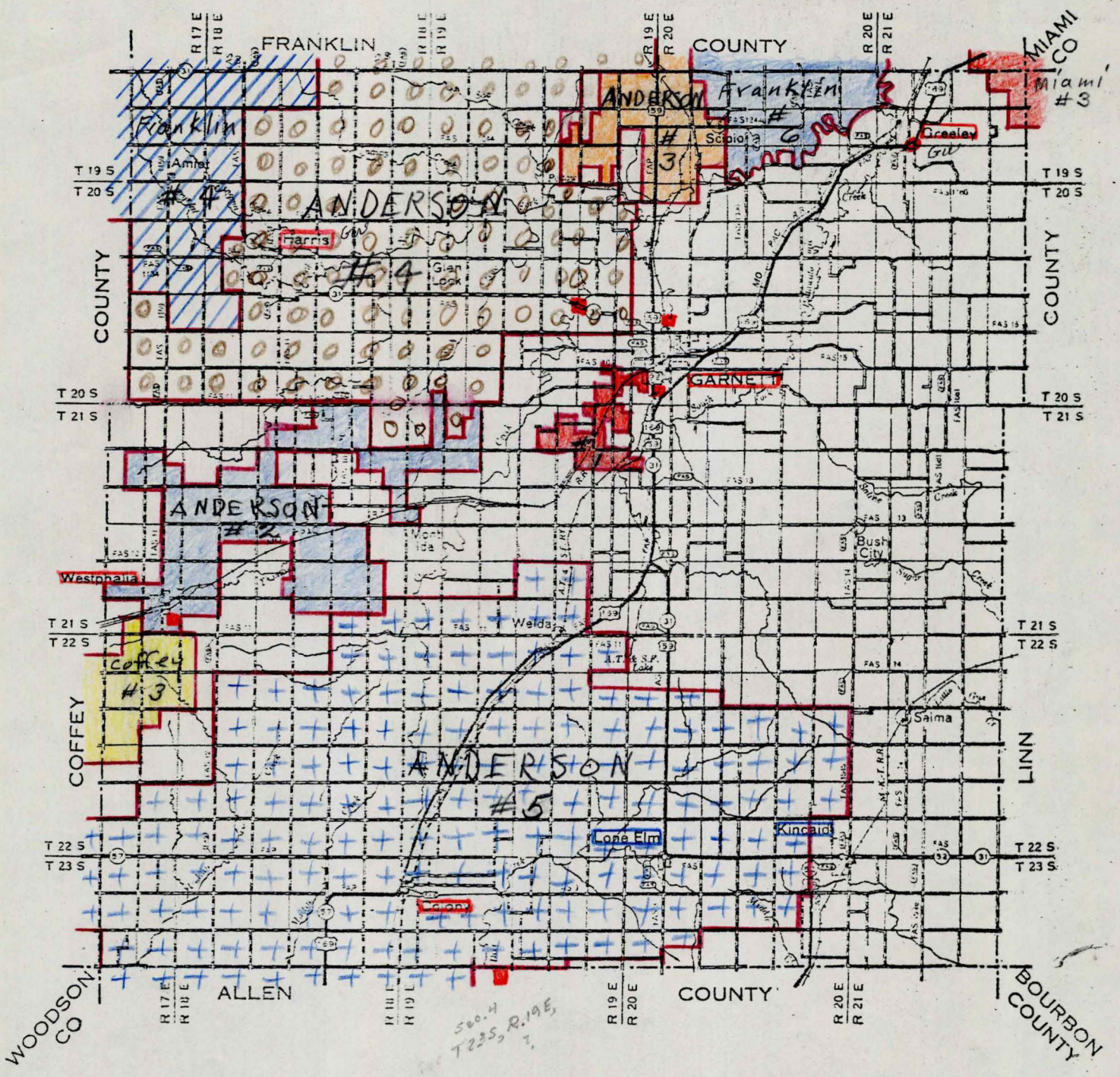
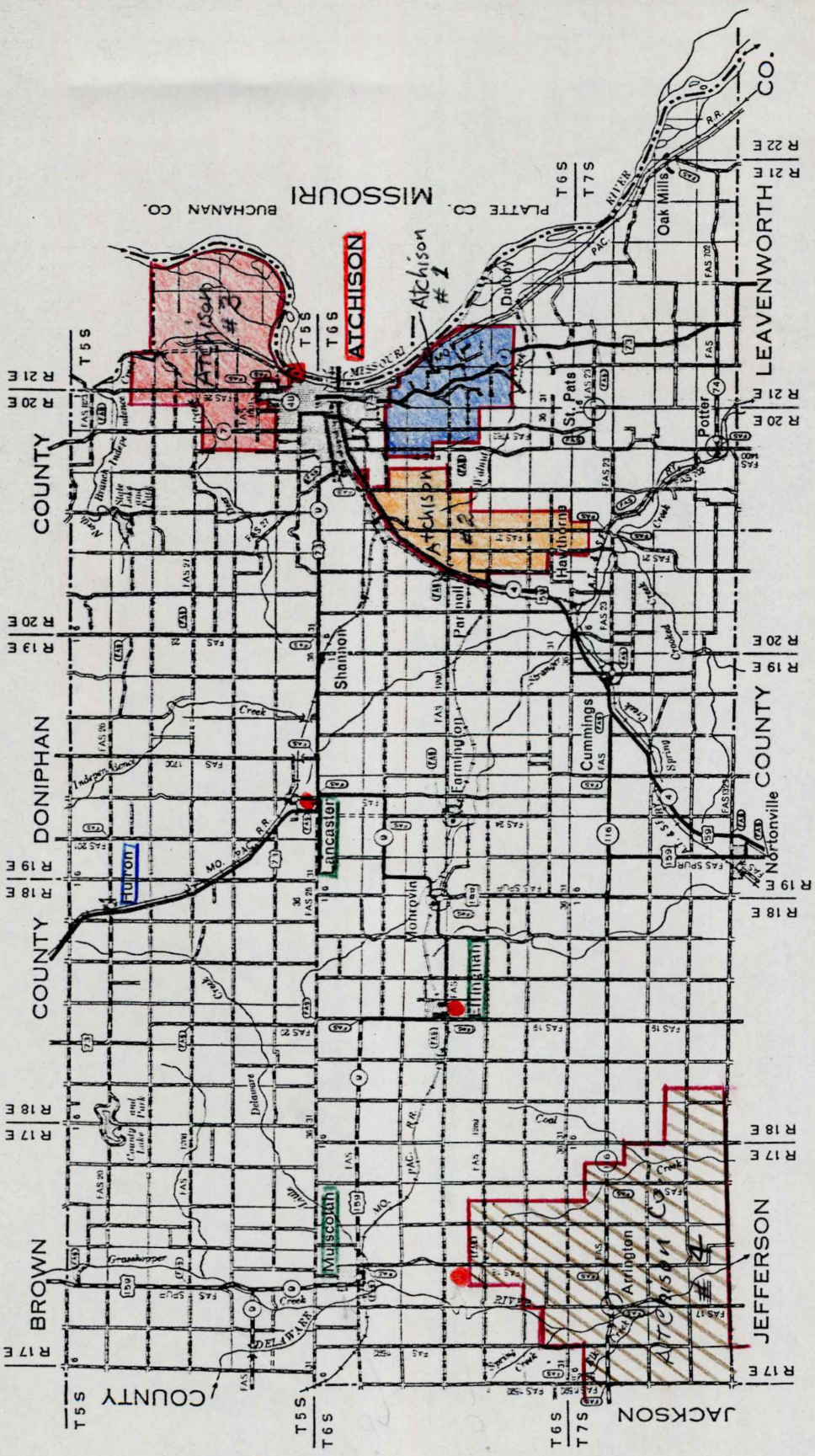


Fig 5 - Map of Anderson County showing location and area served by public water supplies, type of supply, and location of source

ANDERSON COUNTY
KANSAS
1963

Fig 5



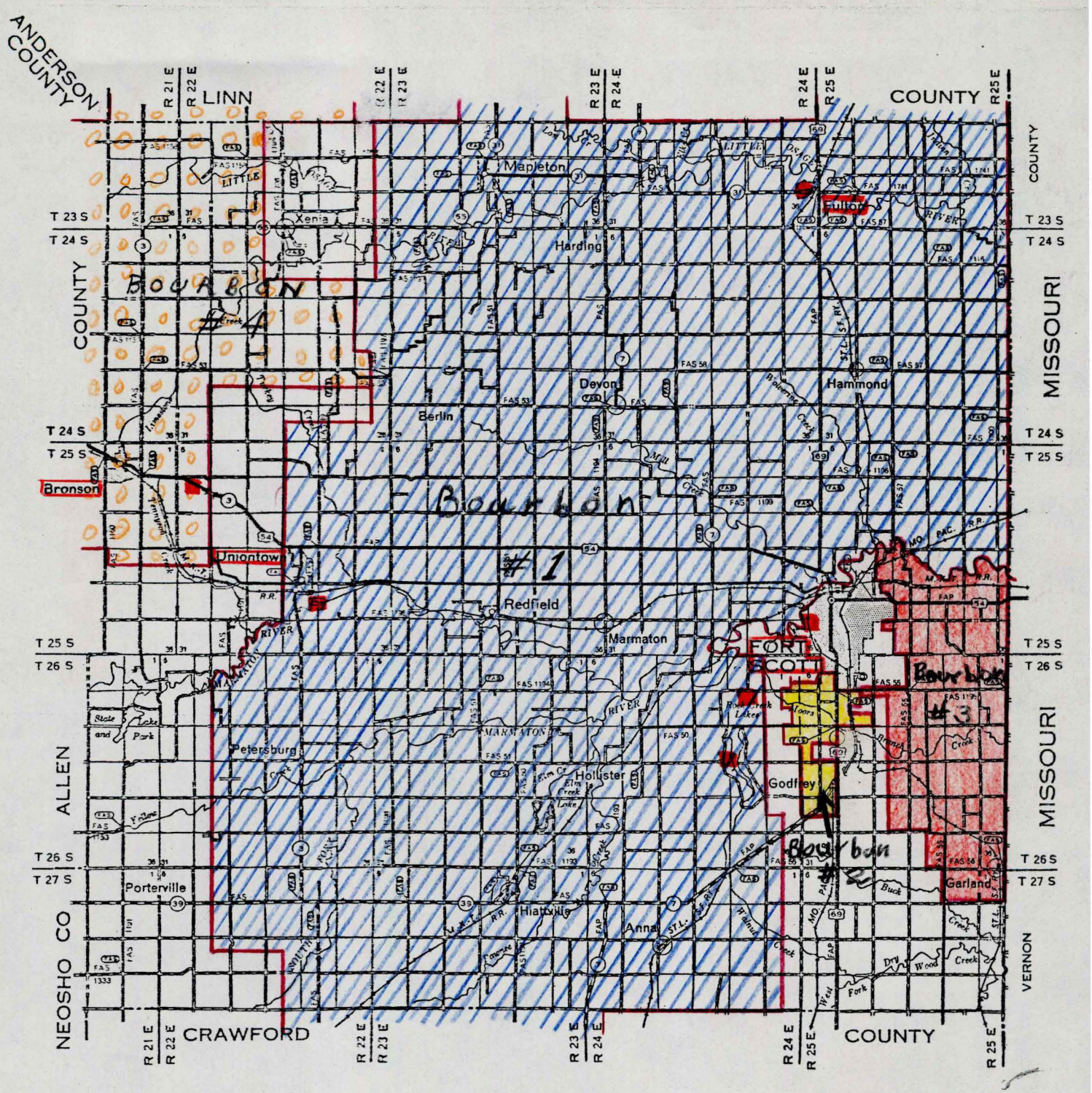
GENERAL HIGHWAY MAP
ATCHISON COUNTY
KANSAS

PREPARED BY THE
STATE HIGHWAY COMMISSION OF KANSAS
PLANNING AND RESEARCH DEPARTMENT
IN COOPERATION WITH THE
U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

SCALE
1966

Fig. 6 —

209

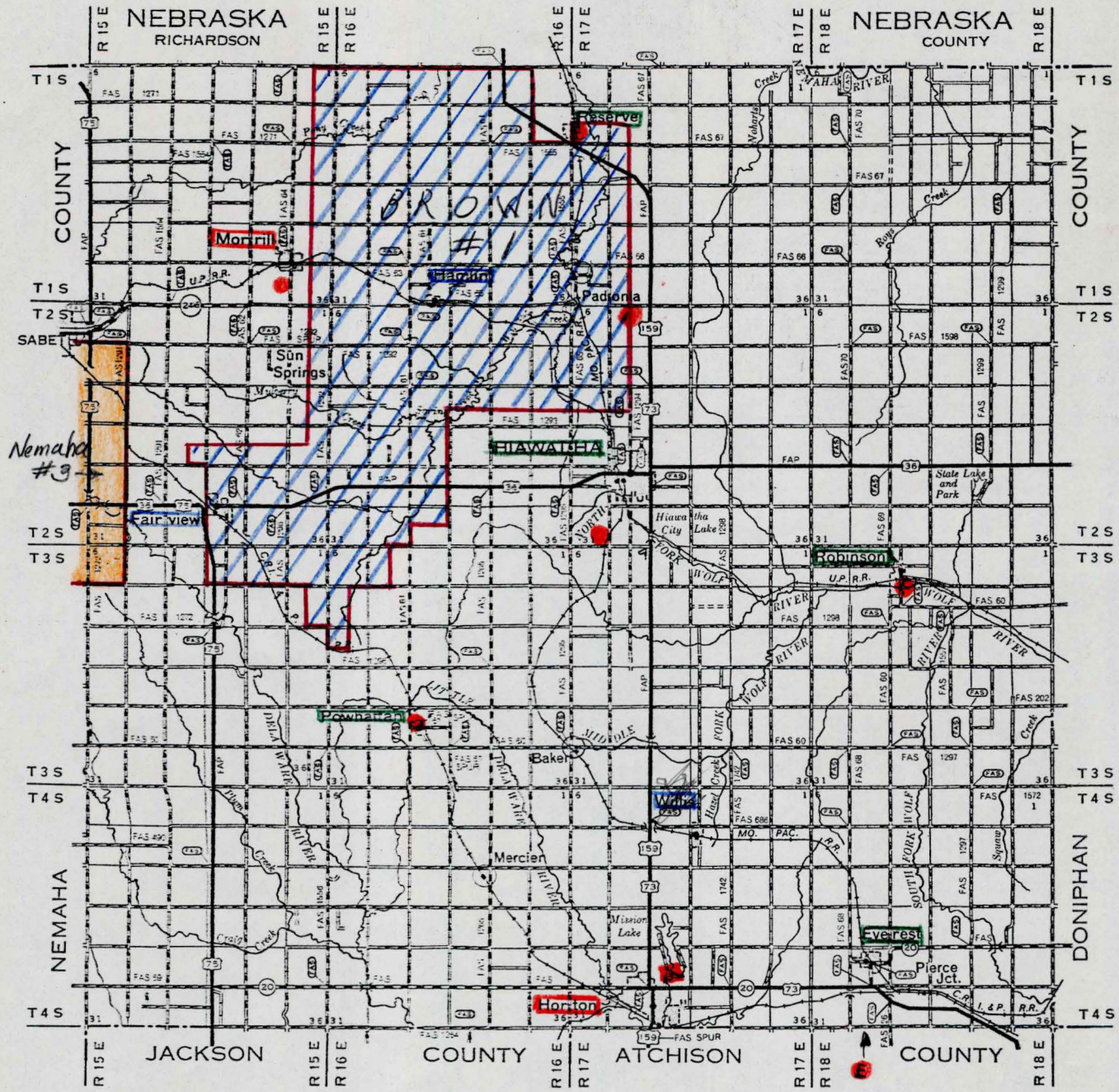


BOURBON COUNTY
KANSAS

SCALE
1965

6

Fig. 7—



BROWN COUNTY
KANSAS

1965

7

Fig. 8 —

211

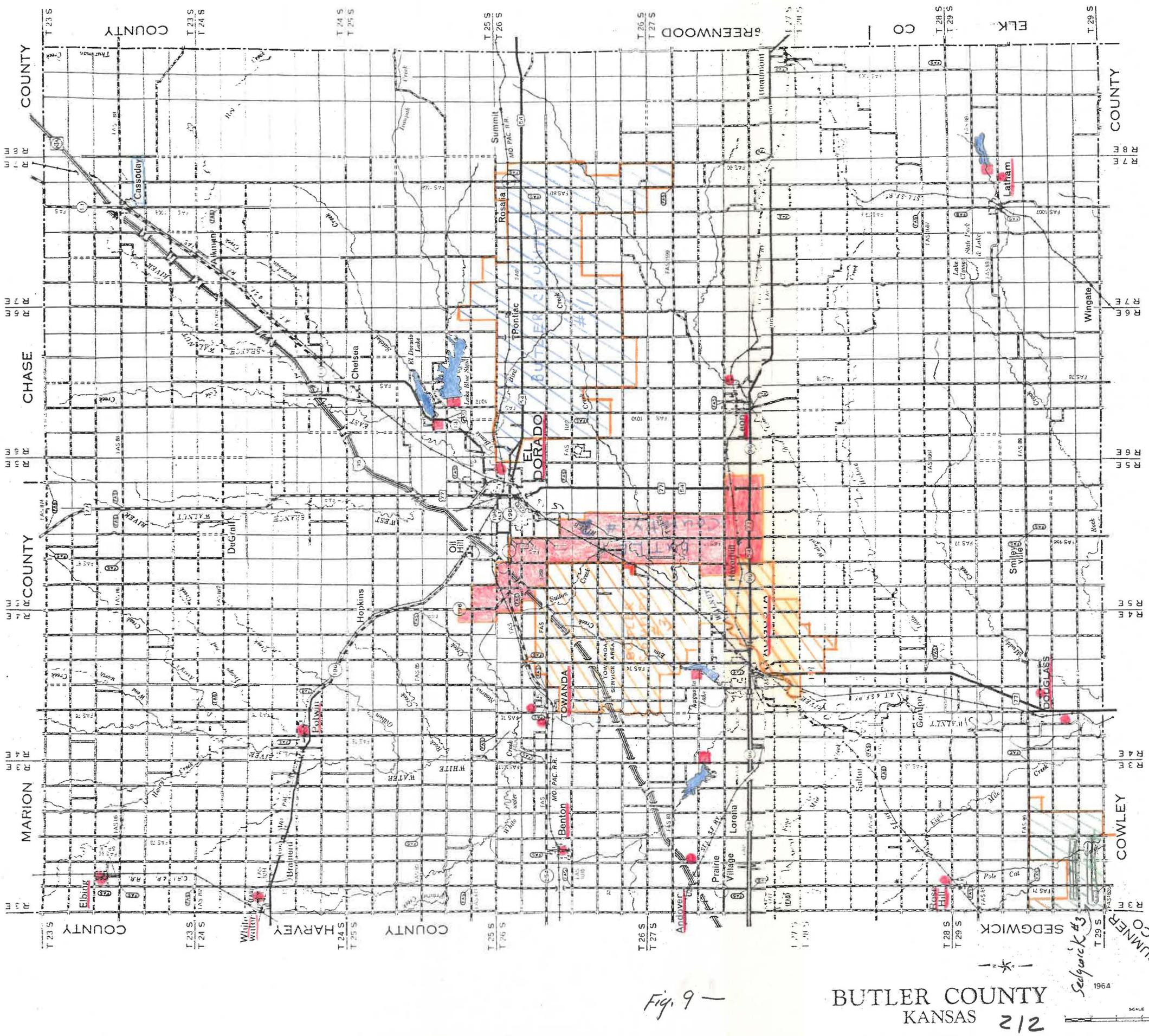
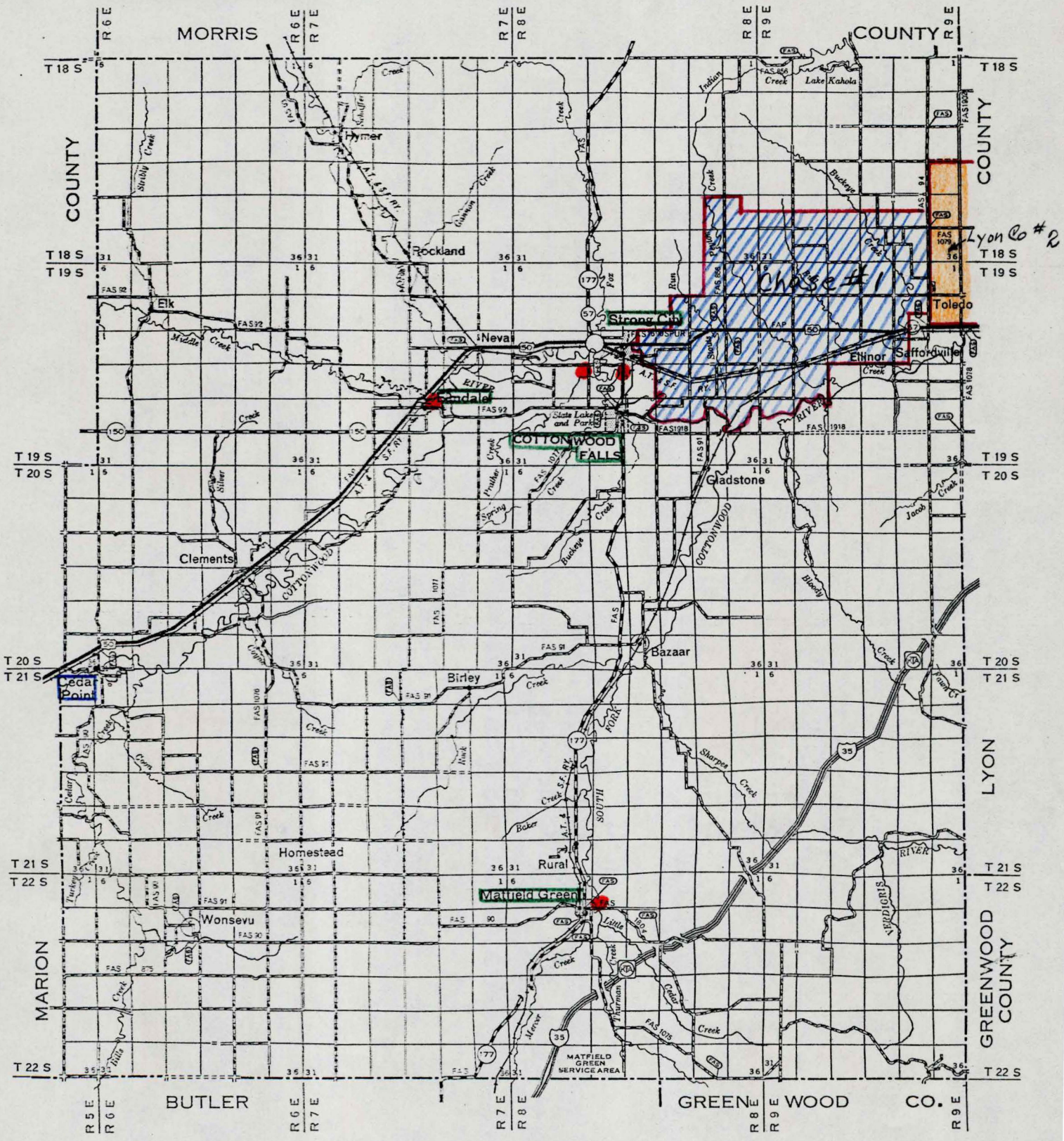


Fig. 9 —

BUTLER COUNTY
KANSAS 212



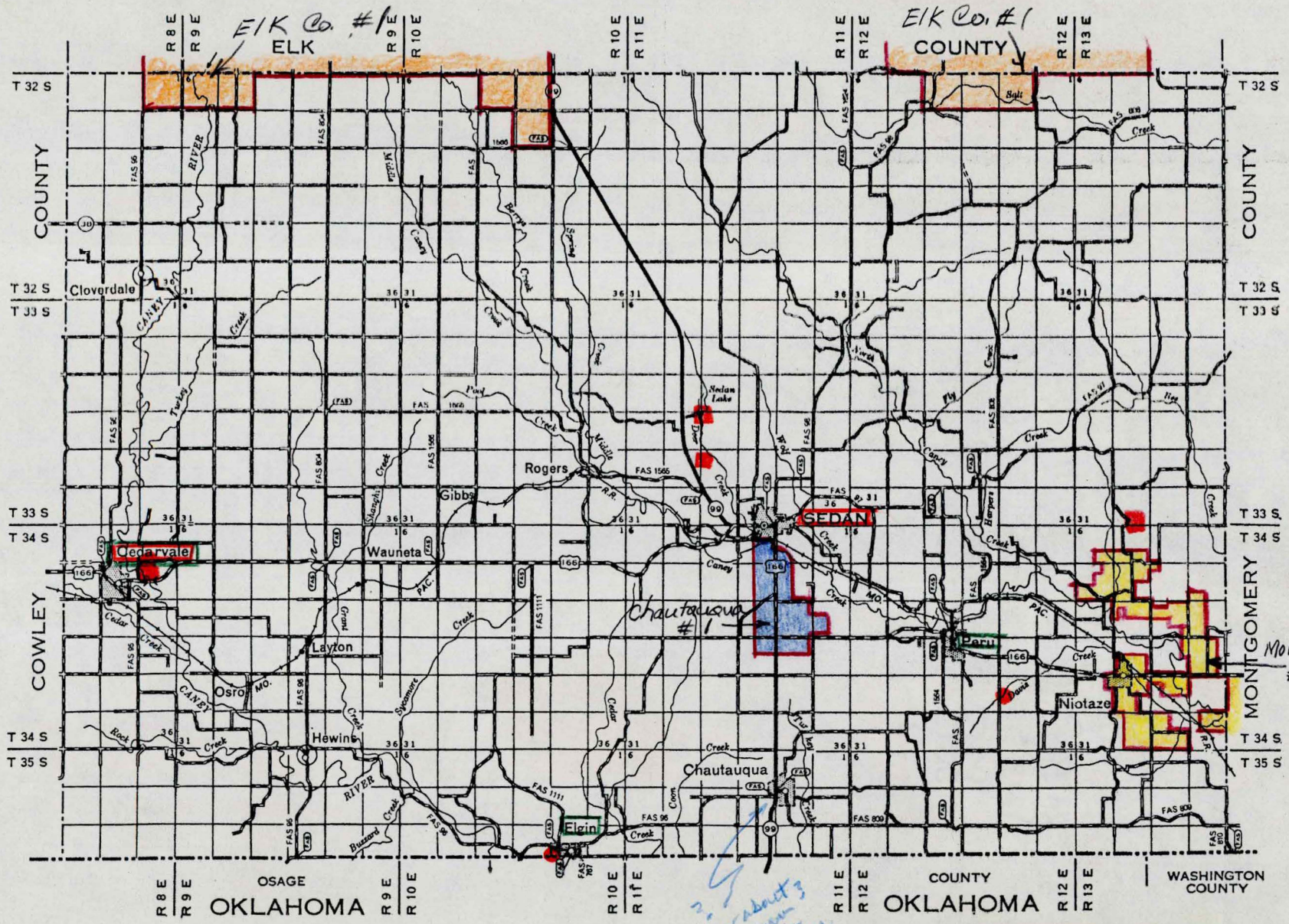
CHASE COUNTY
KANSAS

SCALE
1965

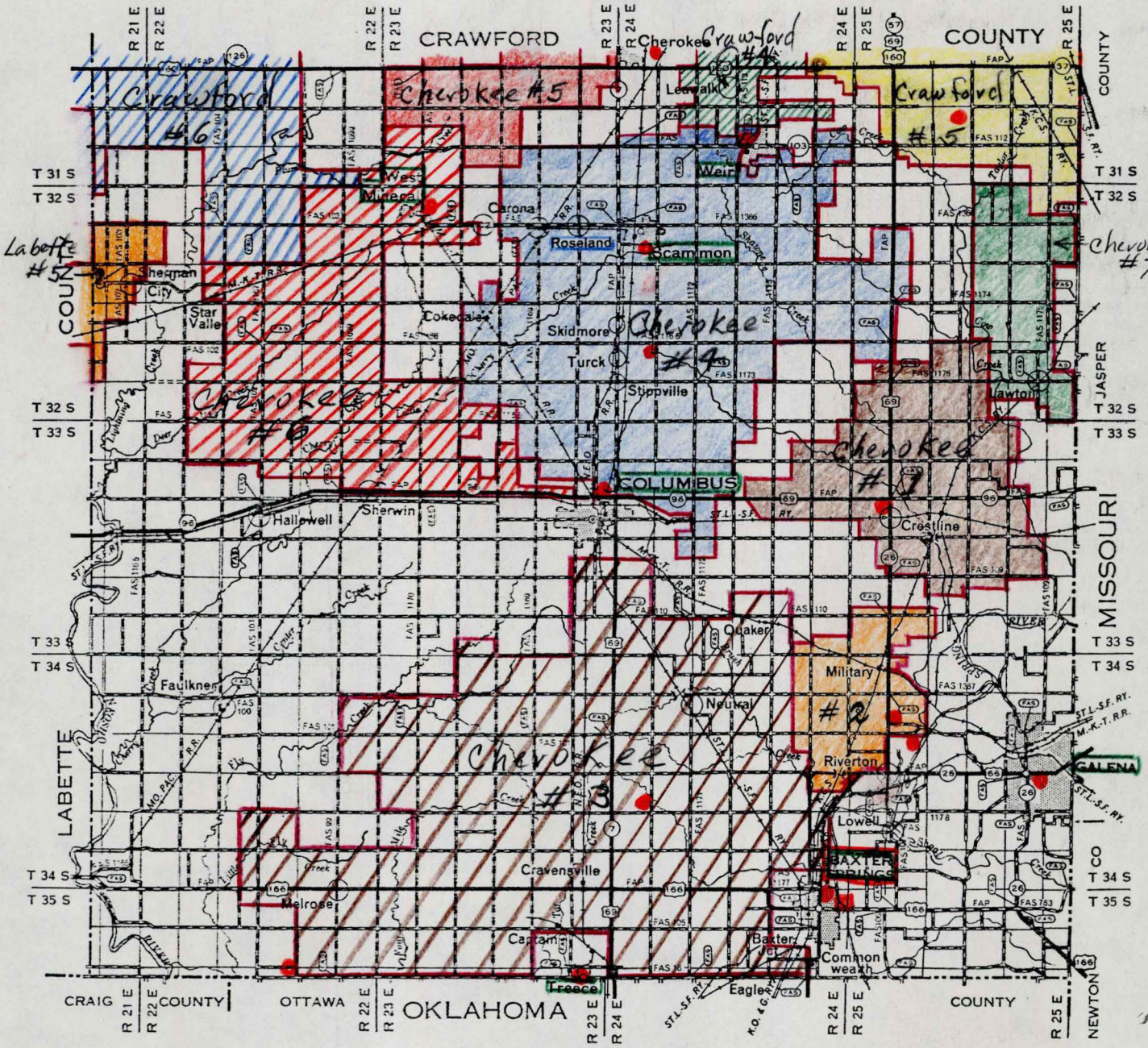
9

213

Fig. 10—



CHAUTAUQUA COUNTY
KANSAS



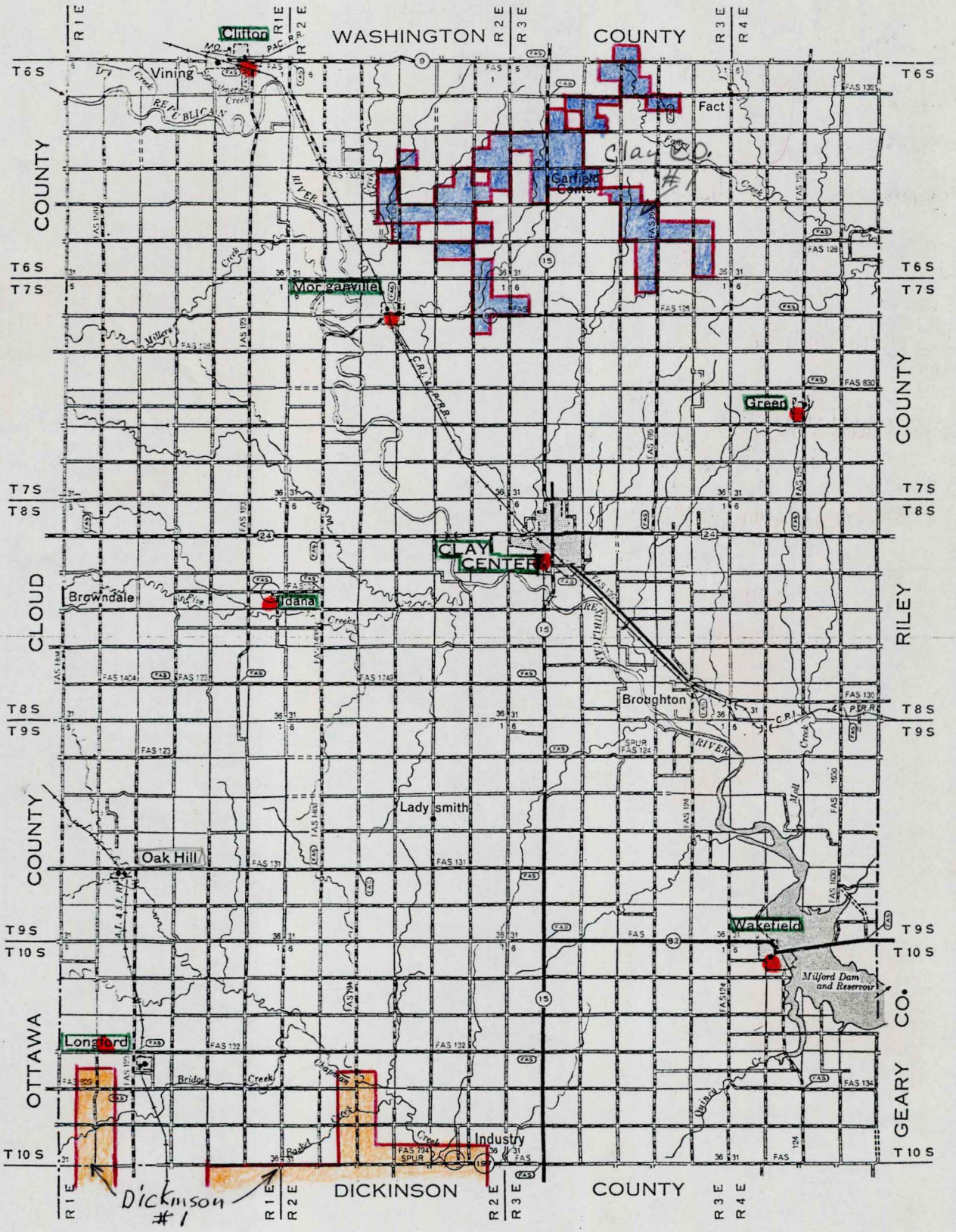
CHEROKEE COUNTY
KANSAS

1963

SCALE

215

Fig. 12 —



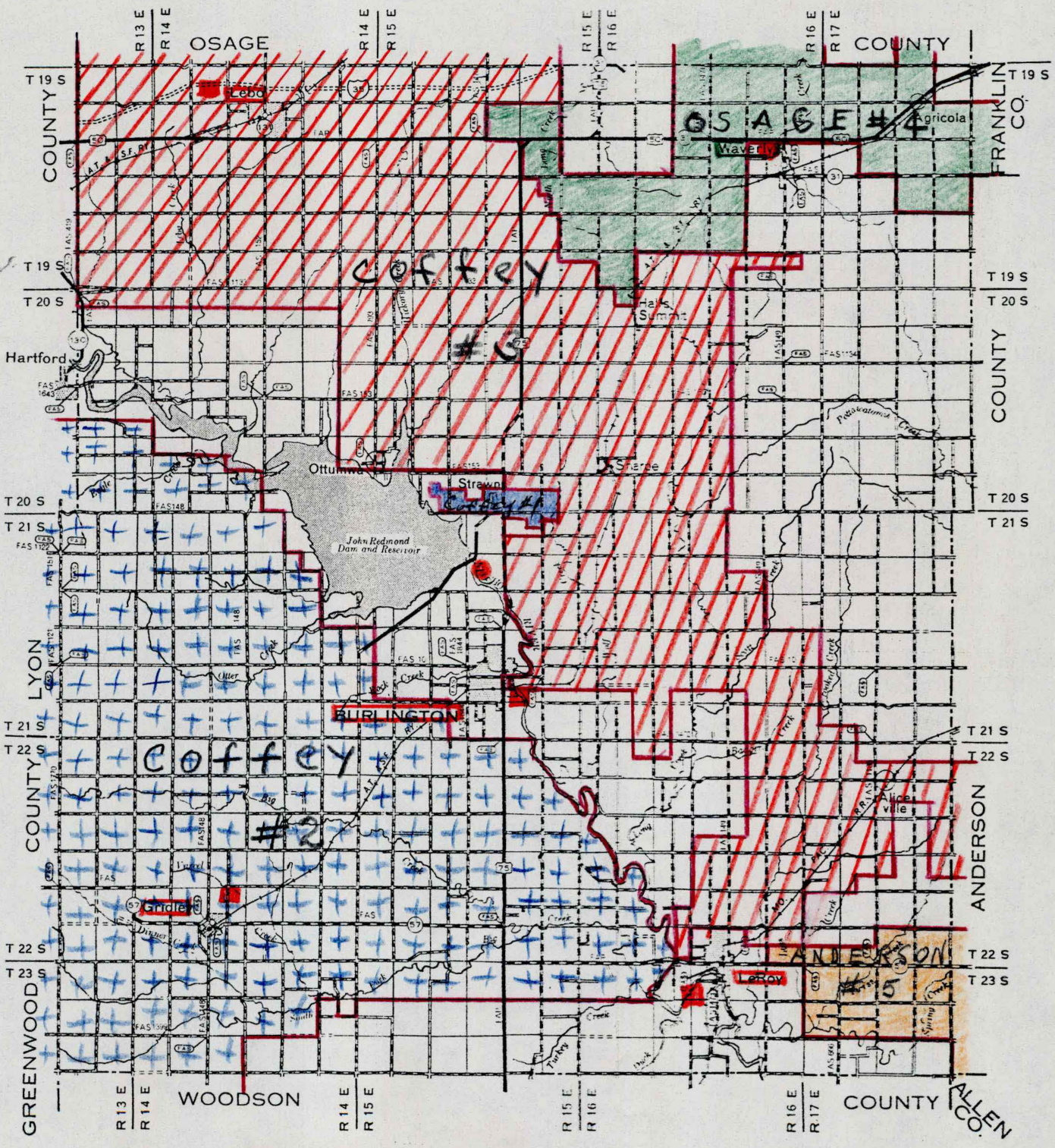
CLAY COUNTY
KANSAS

SCALE
1965

14

216

Fig. 13 —

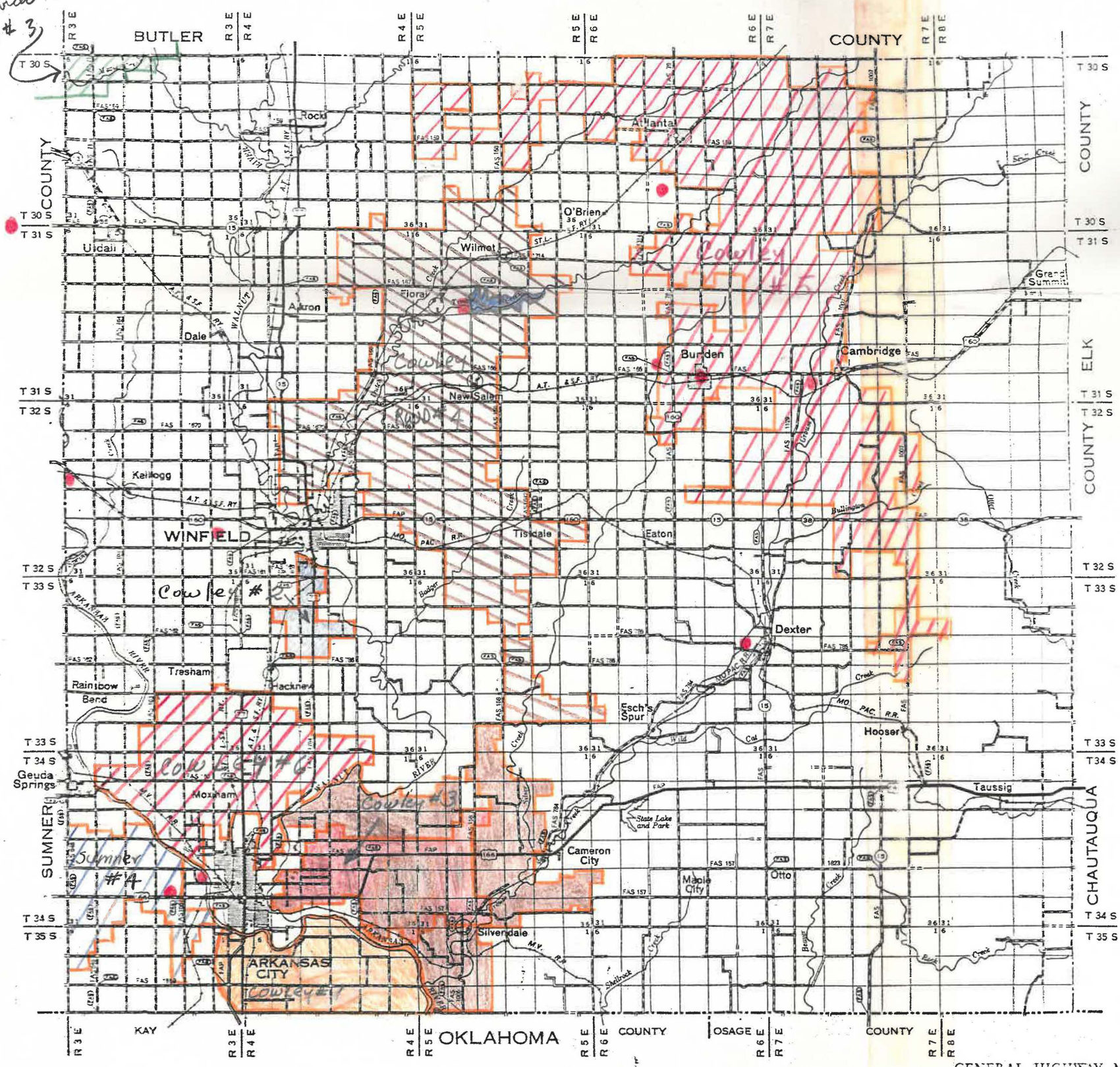


COFFEY COUNTY
KANSAS

1963

217

Fig. 14 —


Sedgwick Co
RWD # 3
BUTLER COUNTY
COUNTY
ELK COUNTY
CHAUTAUQUA COUNTY
SUMNER COUNTY
KAY COUNTY
OKLAHOMA
OSAGE COUNTY
Rock
Atlanta
O'Brien
Wilmot
Floral
Udall
Arkron
Dale
Burden
Cambridge
Grand Summit
New Salem
Kellogg
WINFIELD
Tisdale
Eaton
Dexter
Tresham
Hackney
Rainbow Bend
Esch's Spur
Hooser
Geuda Springs
Moxham
Taussig
State Lake and Park
Cameron City
Maple City
Otto
Silverdale
ARKANSAS CITY
Cowley #1
Cowley #2
Cowley #3
Cowley #4
Sumner #4
RWD #4
T 30 S
T 31 S
T 32 S
T 33 S
T 34 S
T 35 S
R3E
R4E
R5E
R6E
R7E
R8E
ARKANSAS RIVER
WALNUT RIVER
WALNUT CREEK
SLATE CREEK
BUFFALO CREEK
BUCK CREEK
SHIRLOCK CREEK
A.T. & S.F. RY.
MO. PAC. R.R.
ST. L.-S.F. R.R.
U.S.-166
U.S.-160
U.S.-77
U.S.-81
K-15
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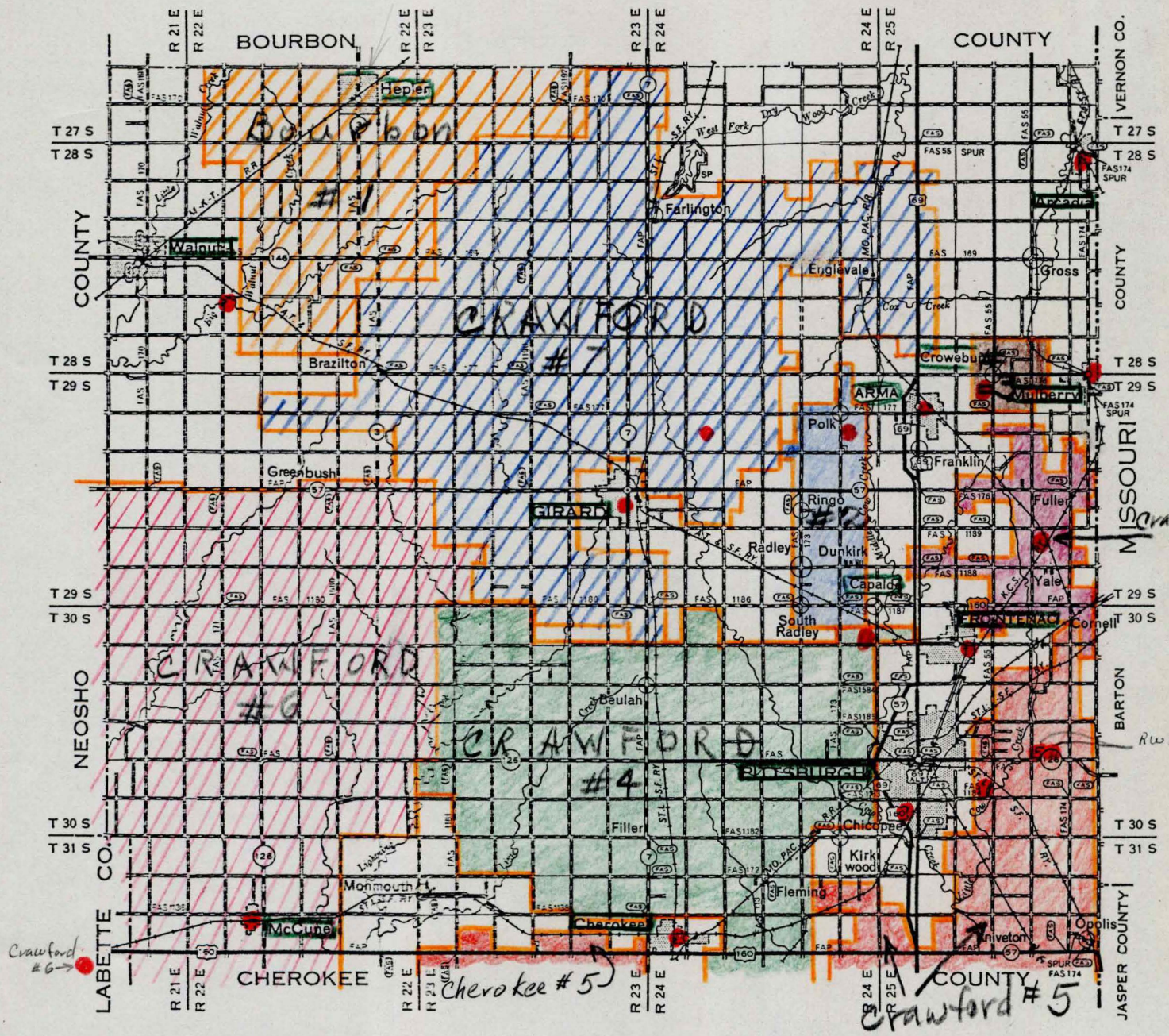
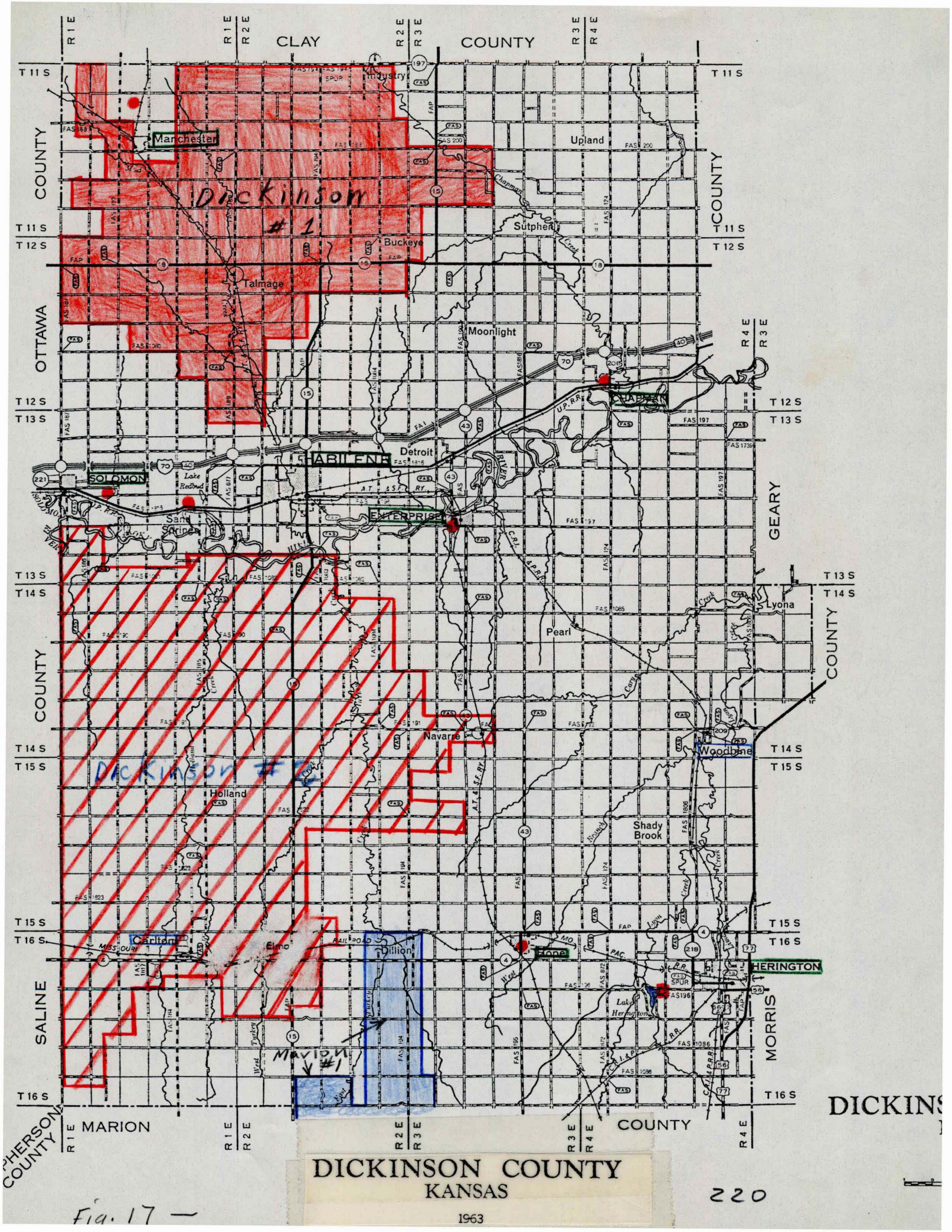


CRAWFORD COUNTY
KANSAS

1963

Fig. 16 —

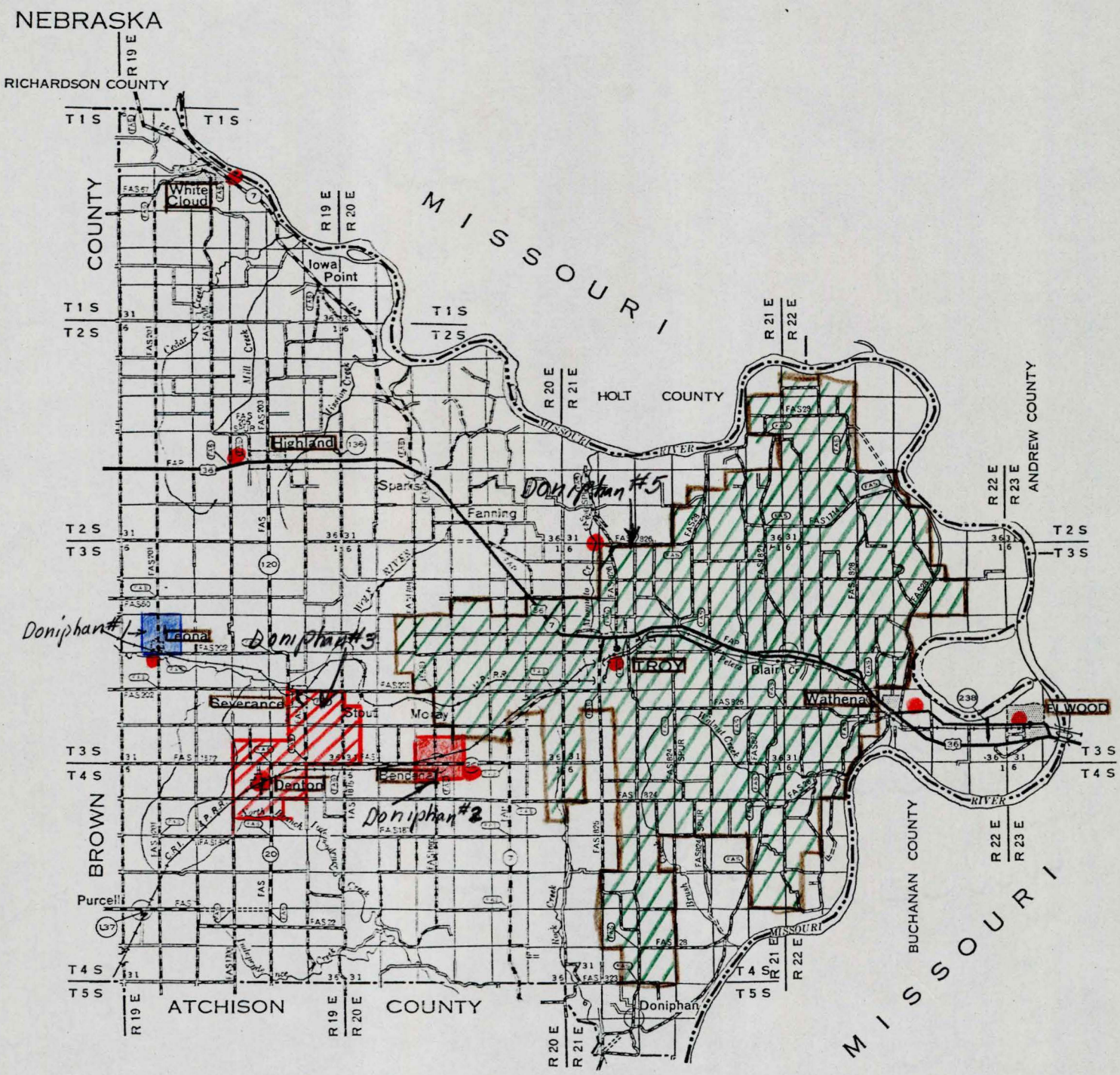


DICKINSON COUNTY
KANSAS

1963

Fig. 17 —

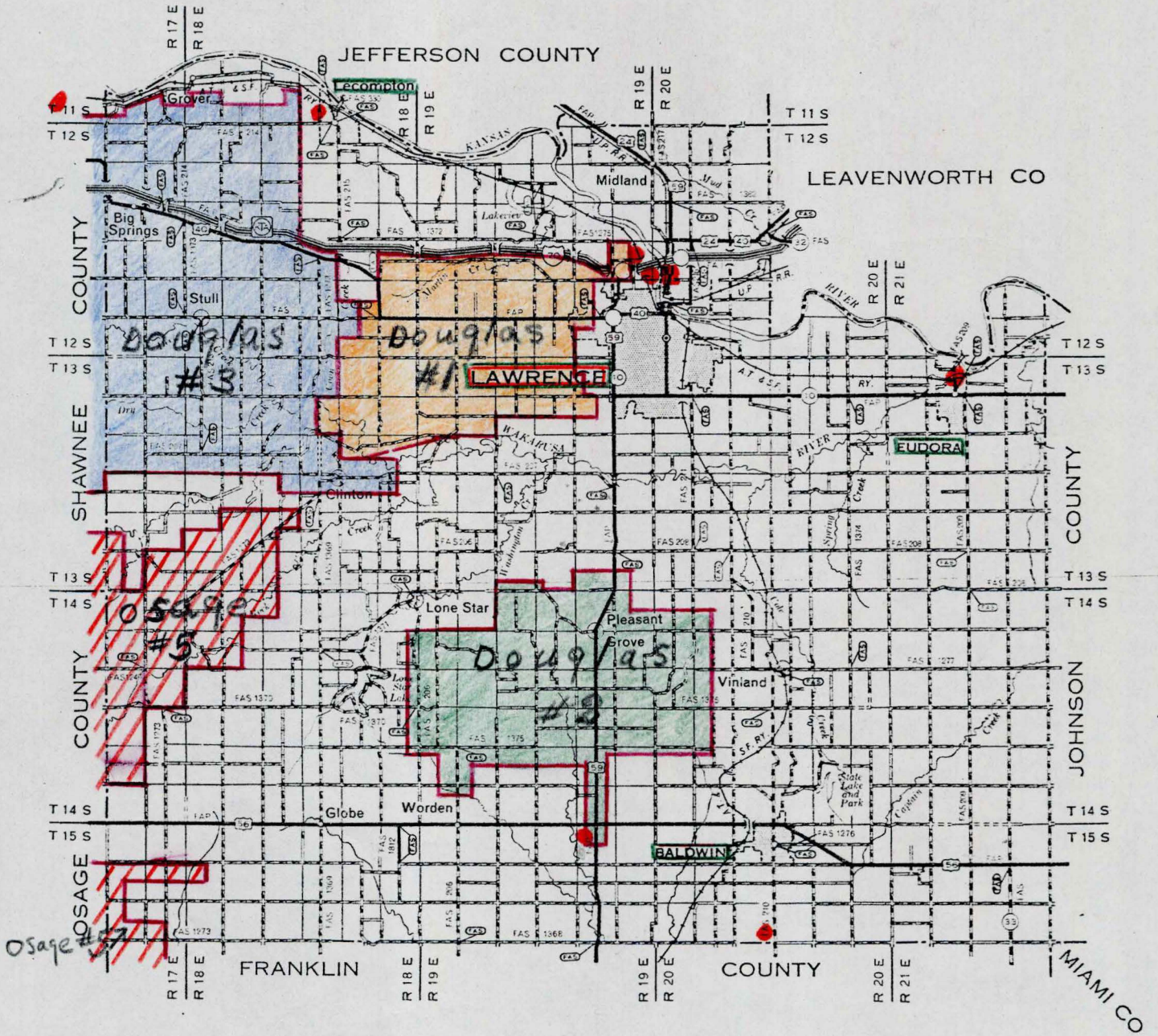
220



DONIPHAN COUNTY
KANSAS

221

Fig. 18 —

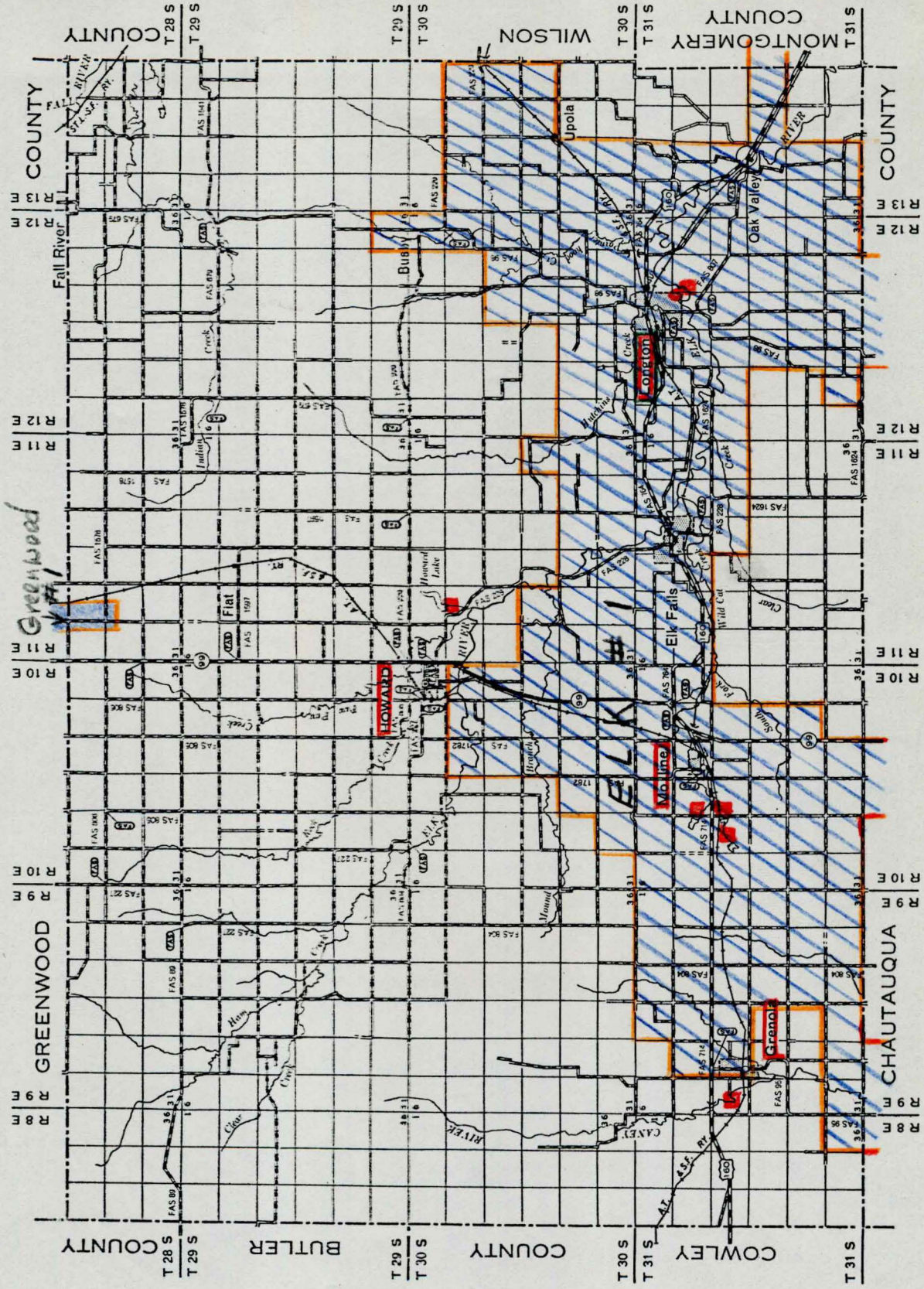


DOUGLAS COUNTY
KANSAS

1964

Fig. 19 —

222



GENERAL HIGHWAY MAP

ELK COUNTY
KANSAS

PREPARED BY THE
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BUREAU OF PUBLIC ROADS

POLYCONIC PROJECTION

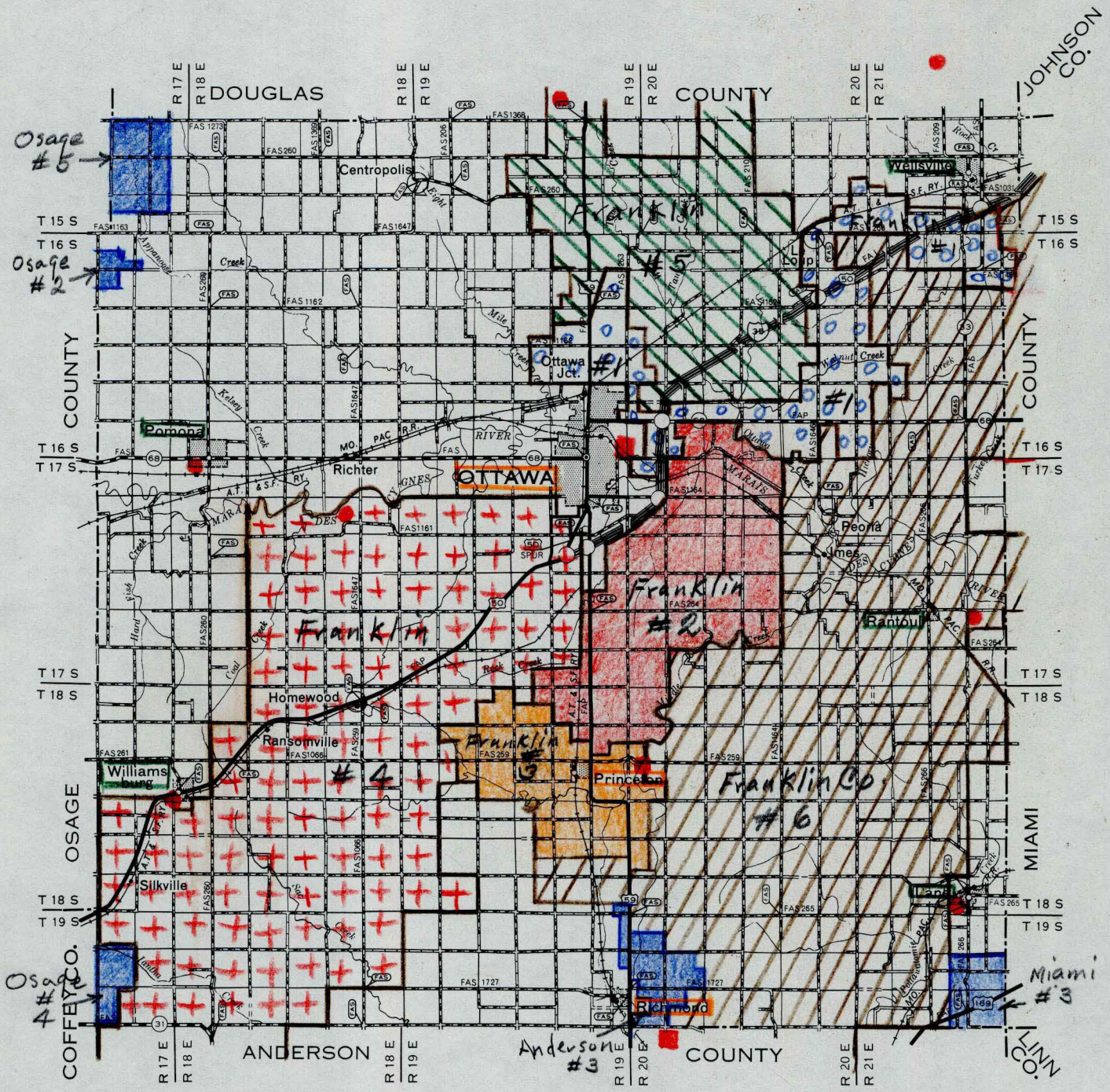
KEY TO COUNTIES

SCALE
MILES

1966

223

Fig. 20 —


DOUGLAS COUNTY
JOHNSON CO.
OSAGE COUNTY
FRANKLIN COUNTY
MIAMI CO.
COFFEY CO.
ANDERSON COUNTY
LINN CO.
Osage #5
Osage #2
Osage #4
Centropolis
Wellsville
Ottawa Jct.
Pomona
Richter
OTTAWA
Peoria
Rantoul
Homewood
Ransomville
Williamsburg
Princeton
Silkville
Richmond
Franklin #1
Franklin #2
Franklin #3
Franklin #4
Franklin #5
Franklin Co. #6
Anderson #3
Miami #3
R 17 E
R 18 E
R 19 E
R 20 E
R 21 E
T 15 S
T 16 S
T 17 S
T 18 S
T 19 S
A.T. & S.F. RY.
MO. PAC R.R.
MARAIS DES CYGNES RIVER
Appanoose Creek
Kriser Creek
Fish Creek
Hard Coal Creek
Rock Creek
Miller Creek
Williams Creek
Lottie Creek
Wolf Creek
Pottawatomie Creek
Marais des Cygnes River
Middle Creek
Parker Creek
Ottawa Creek
Rock Ct.
FAS 1273
FAS 1163
FAS 1360
FAS 260
FAS 1368
FAS 206
FAS 1647
FAS 1162
FAS 1161
FAS 1066
FAS 259
FAS 1727
FAS 265
FAS 266
FAS 1364
FAS 264
FAS 263
FAS 209
FAS 1031
FAS 210
FAS 1640
FAS 261
FAS 262
FAS 268
FAS 269
FAS 1165
FAS 1166
FAS 1167
FAS 1168
FAS 1169
FAS 1170
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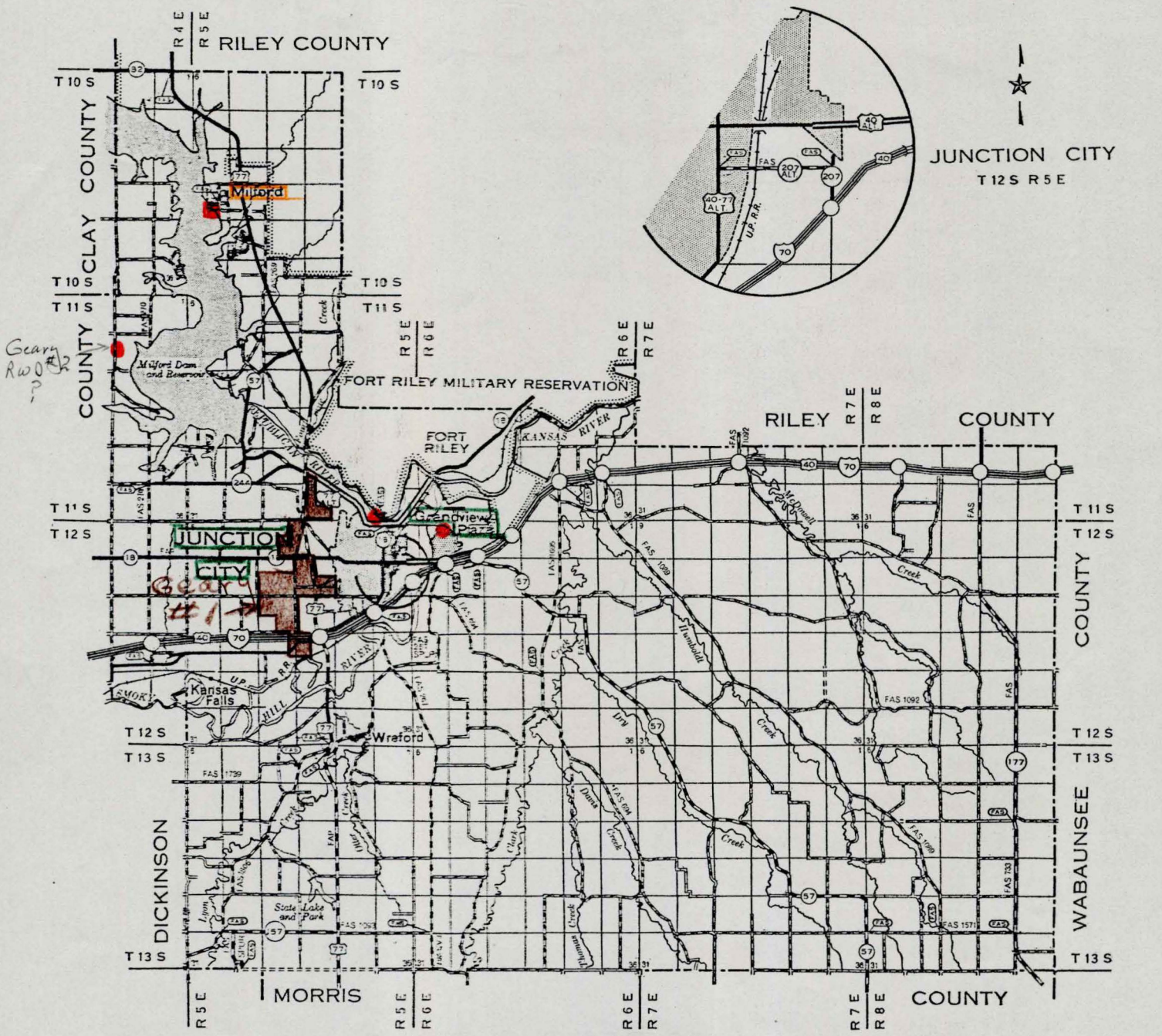
FAS



GENERAL HIGHWAY MAP

GEARY COUNTY
KANSAS

PREPARED BY THE
STATE HIGHWAY COMMISSION OF KANSAS
PLANNING AND RESEARCH DEPARTMENT
IN COOPERATION WITH THE
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

SCALE

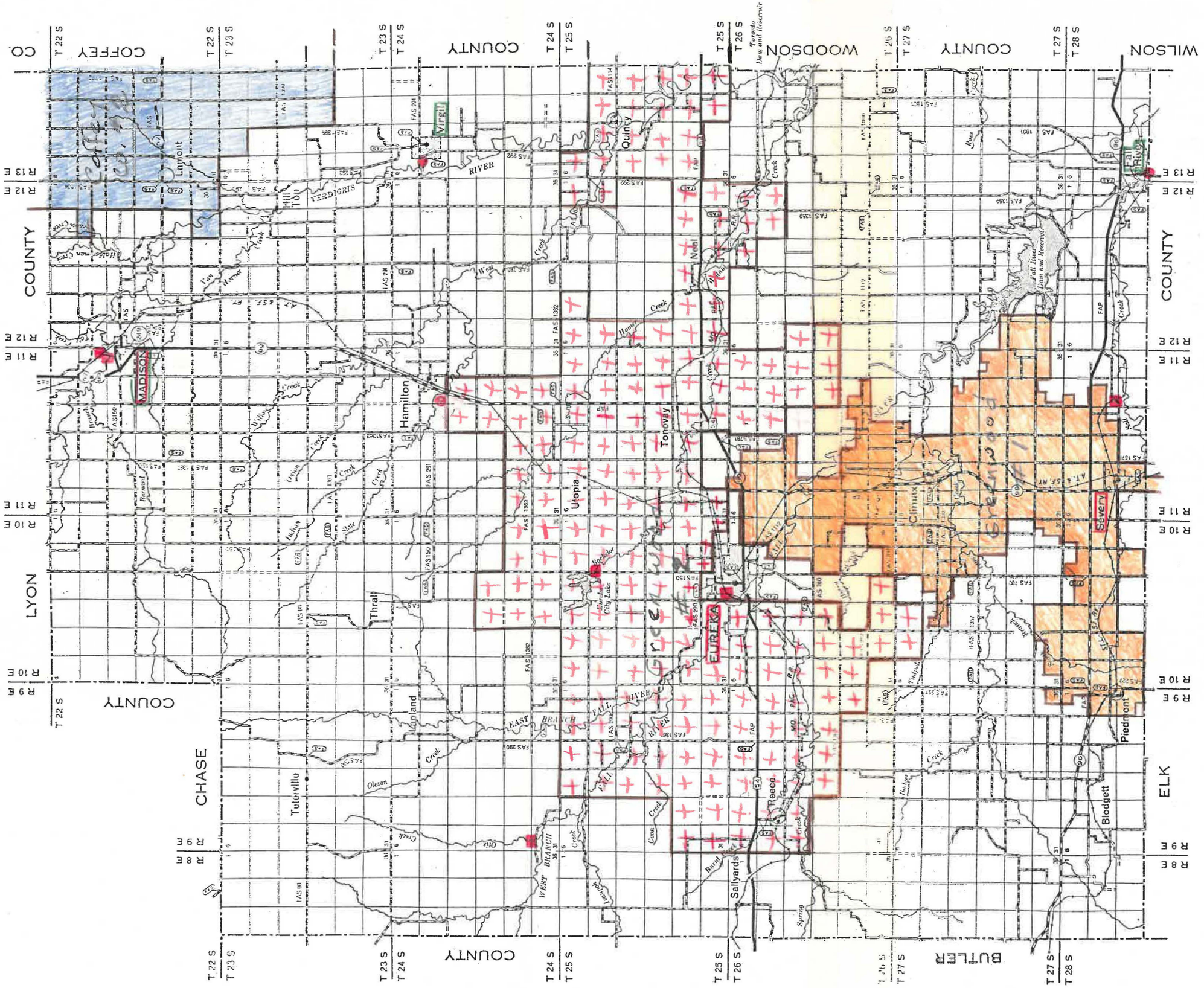
1967

POLYCONIC PROJECTION

KEY TO COUNTIES

225

Fig. 22 –

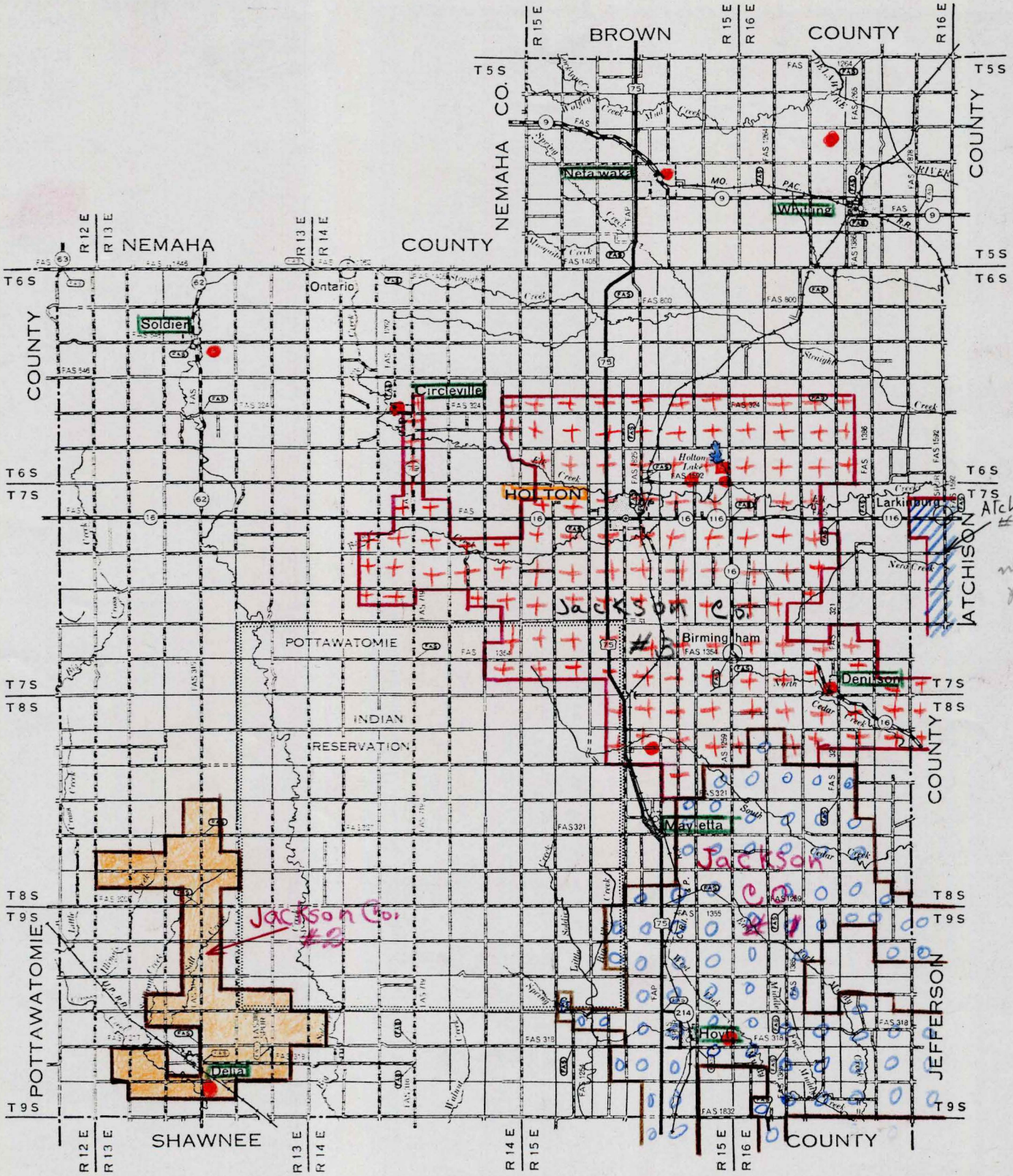


GREENWOOD COUNTY
KANSAS

SCALE 1965

Fig. 23 —

226



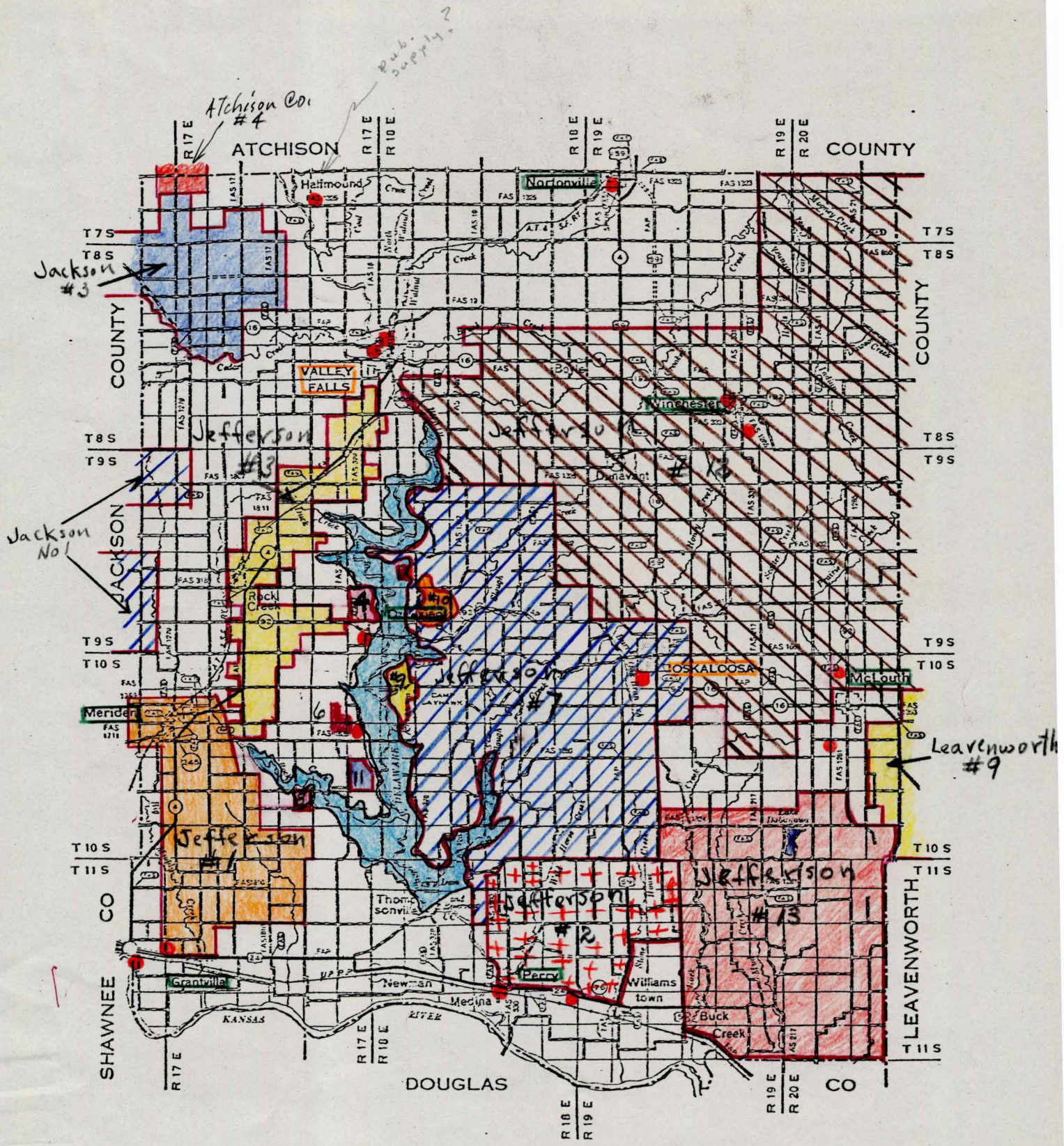
JACKSON COUNTY
KANSAS

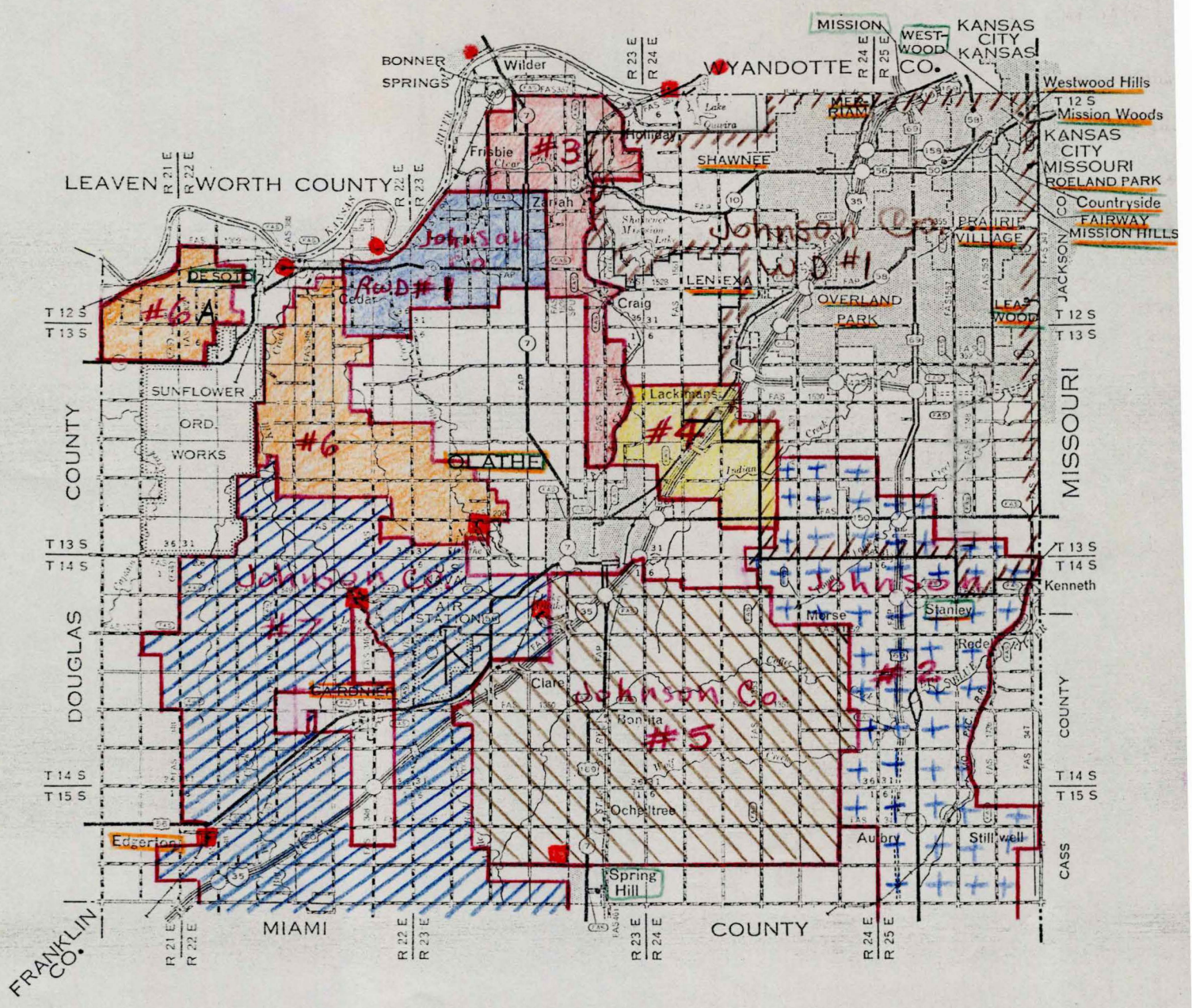
1964

SCALE

Fig. 24 —

227

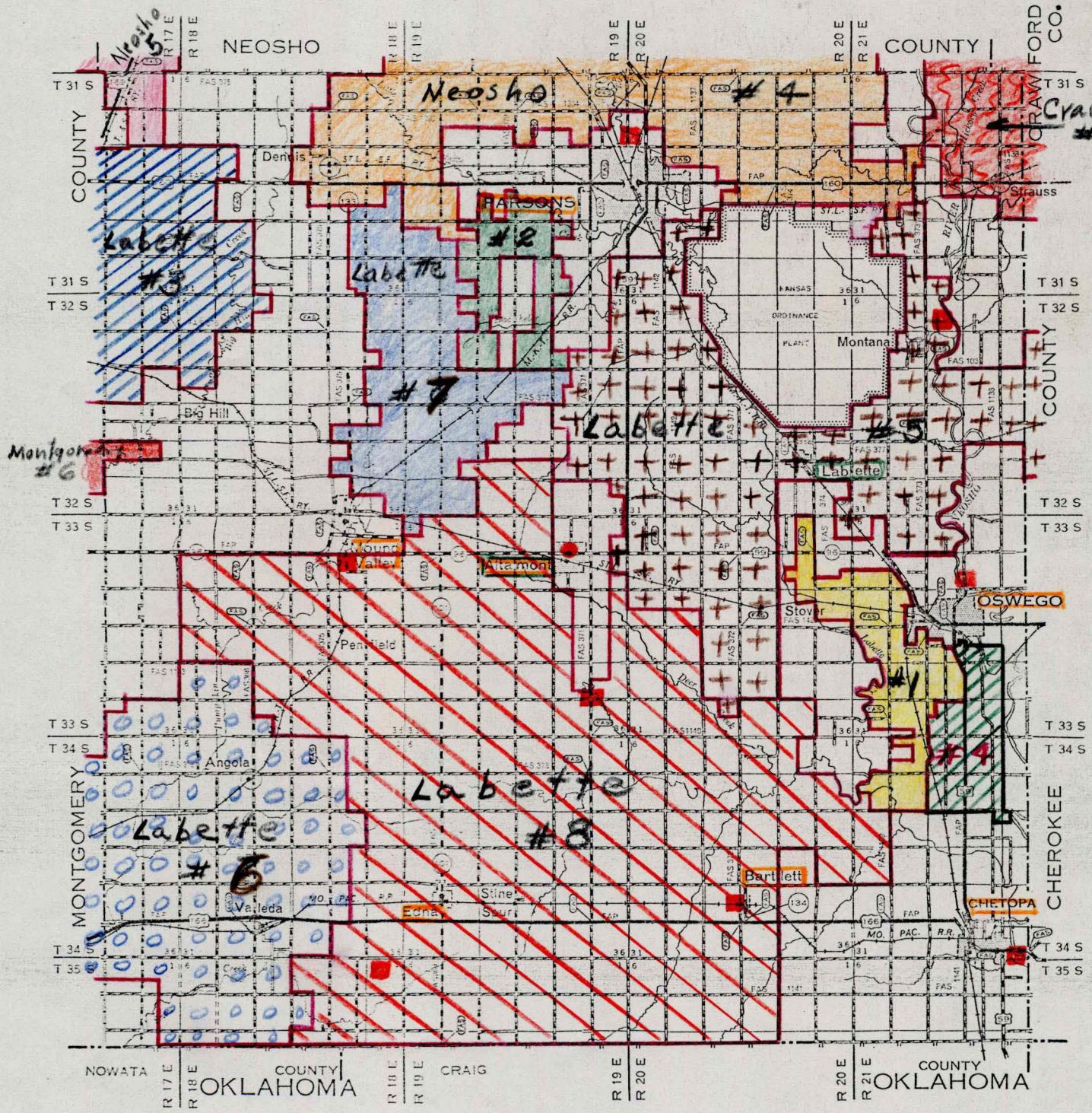

Atchison Co #4
Pub. supply?
ATCHISON COUNTY
Jackson #3
JACKSON COUNTY
Jackson No!
Jefferson #3
Jefferson #7
Jefferson #1
Jefferson #2
Jefferson #13
Leavenworth #9
SHAWNEE CO
LEAVENWORTH CO
DOUGLAS CO
Hiawatha
Horton
Netawaka
Whiting
Everest
Morrill
Sabetha
Goff
Bern
Corning
Baileyville
Wetmore
Fairview
Powhattan
Reserve
Denison
Muscotah
Atchison
Effingham
Lancaster
Huron
Kickapoo Reservation
Kickapoo Nation
Kickapoo Creek
Kickapoo Lake
Kickapoo Trail
Kickapoo Cemetery
Kickapoo Township
Kickapoo Township Hall
Kickapoo Township Cemetery
Kickapoo Township Hall
Kickapoo Township Cemetery
Kickapoo Township Hall
Kickapoo Township Cemetery



JOHNSON COUNTY
KANSAS

Fig. 26

229



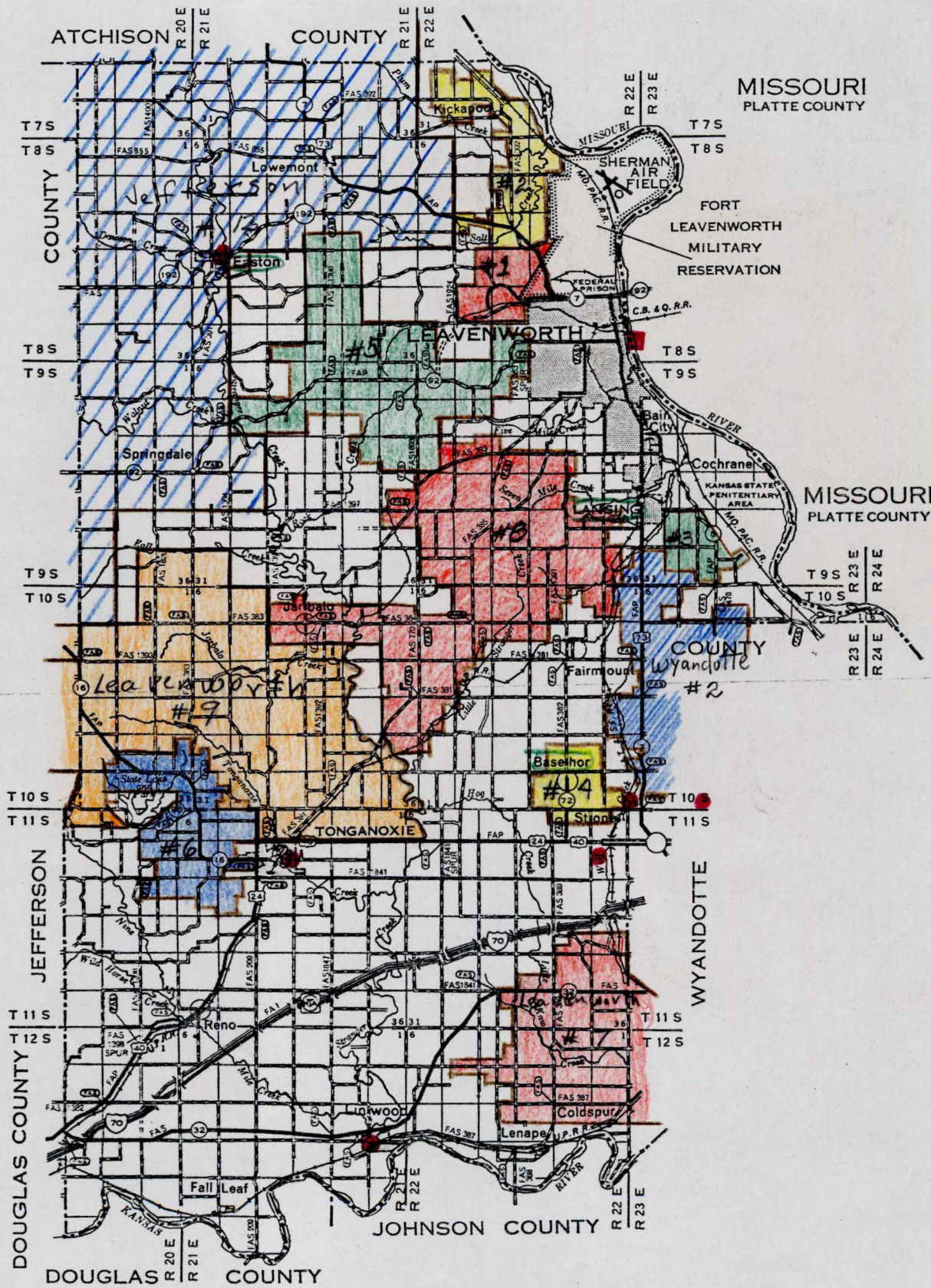
LABETTE COUNTY
KANSAS

SCALE 0 1 2 3 4 MILES

1965

230

Fig. 27 —

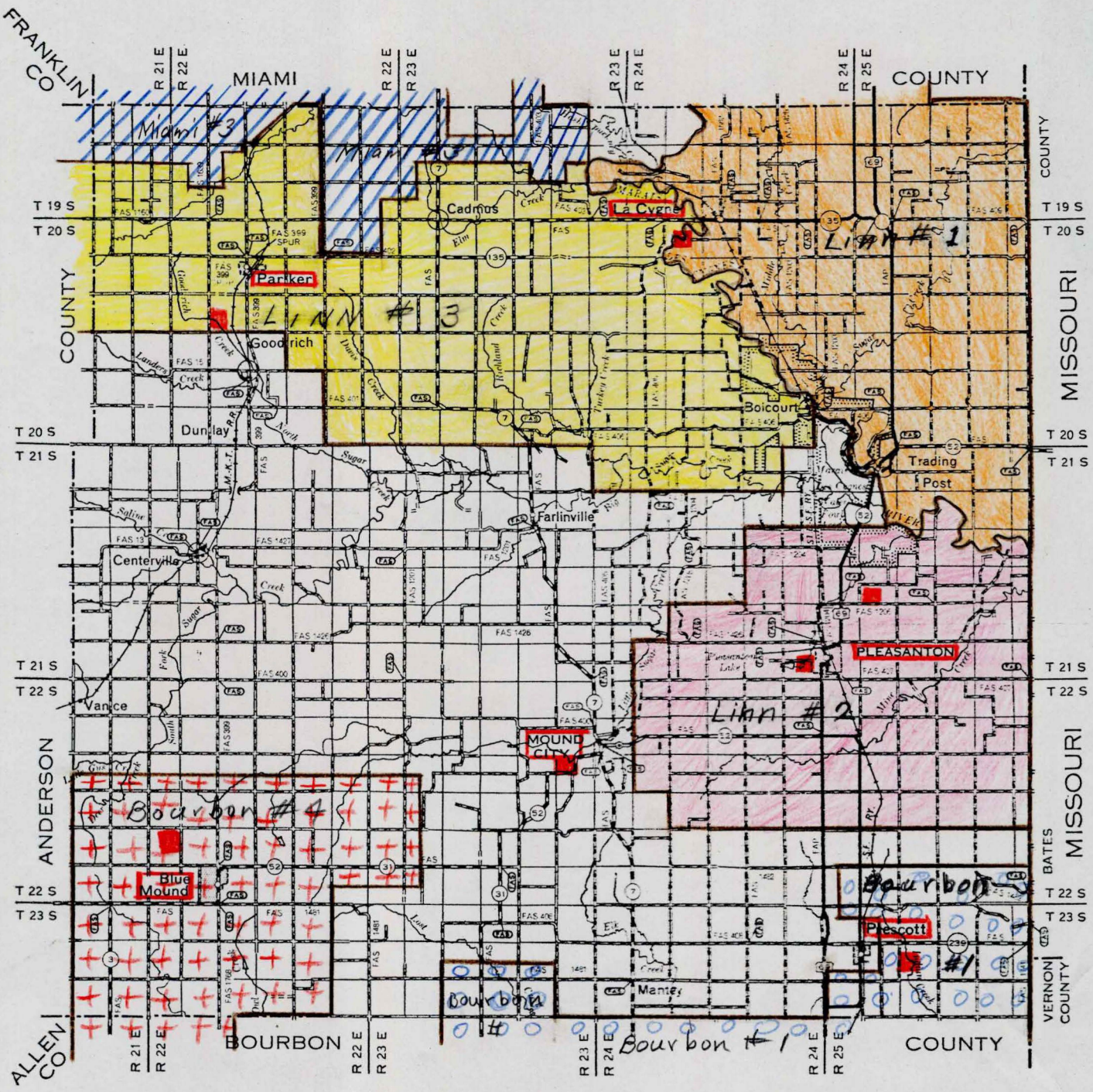


LEAVENWORTH COUNTY
KANSAS

SCALE 1966

231

Fig. 28 —



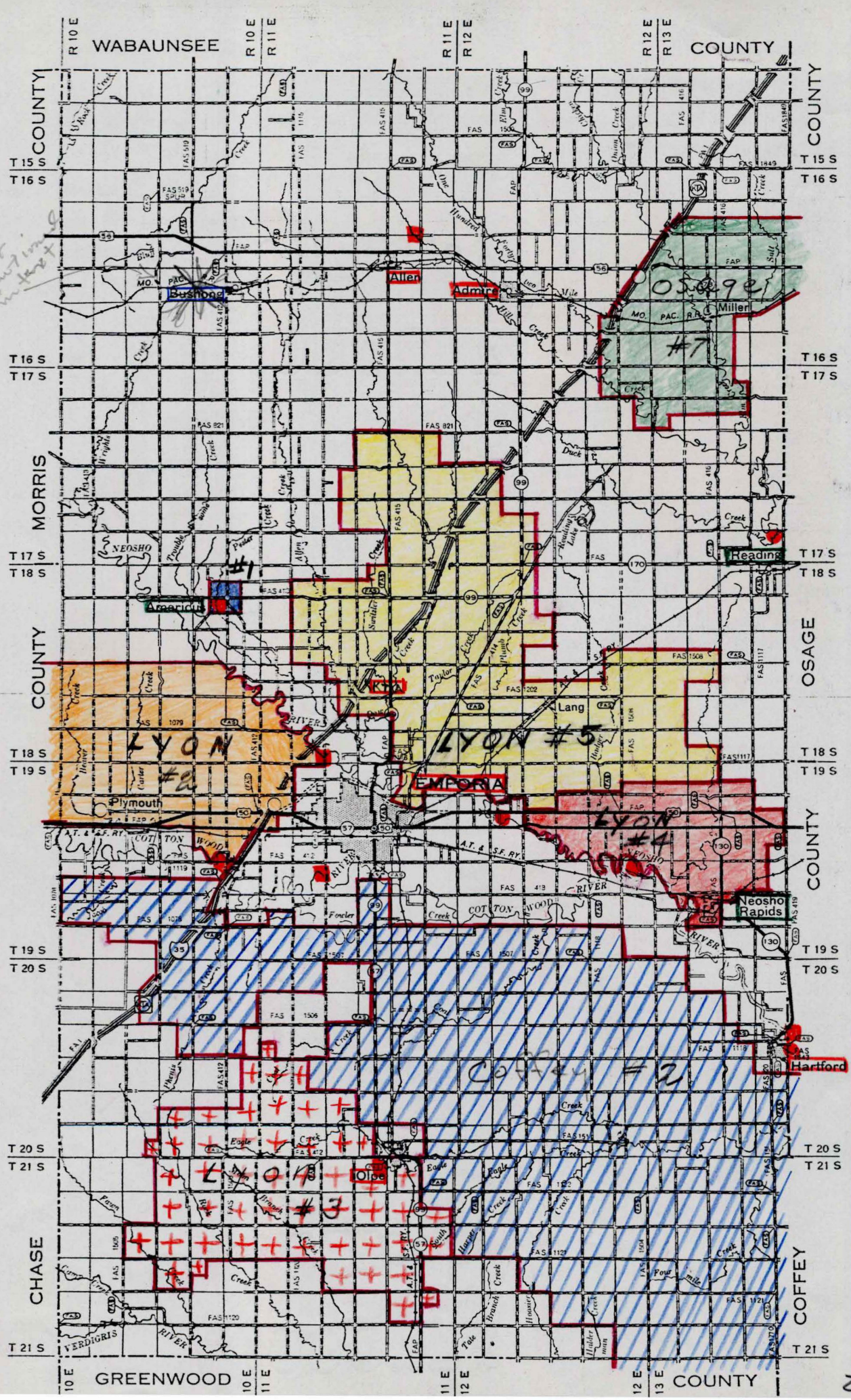
LINN COUNTY
KANSAS

1964

SCALE

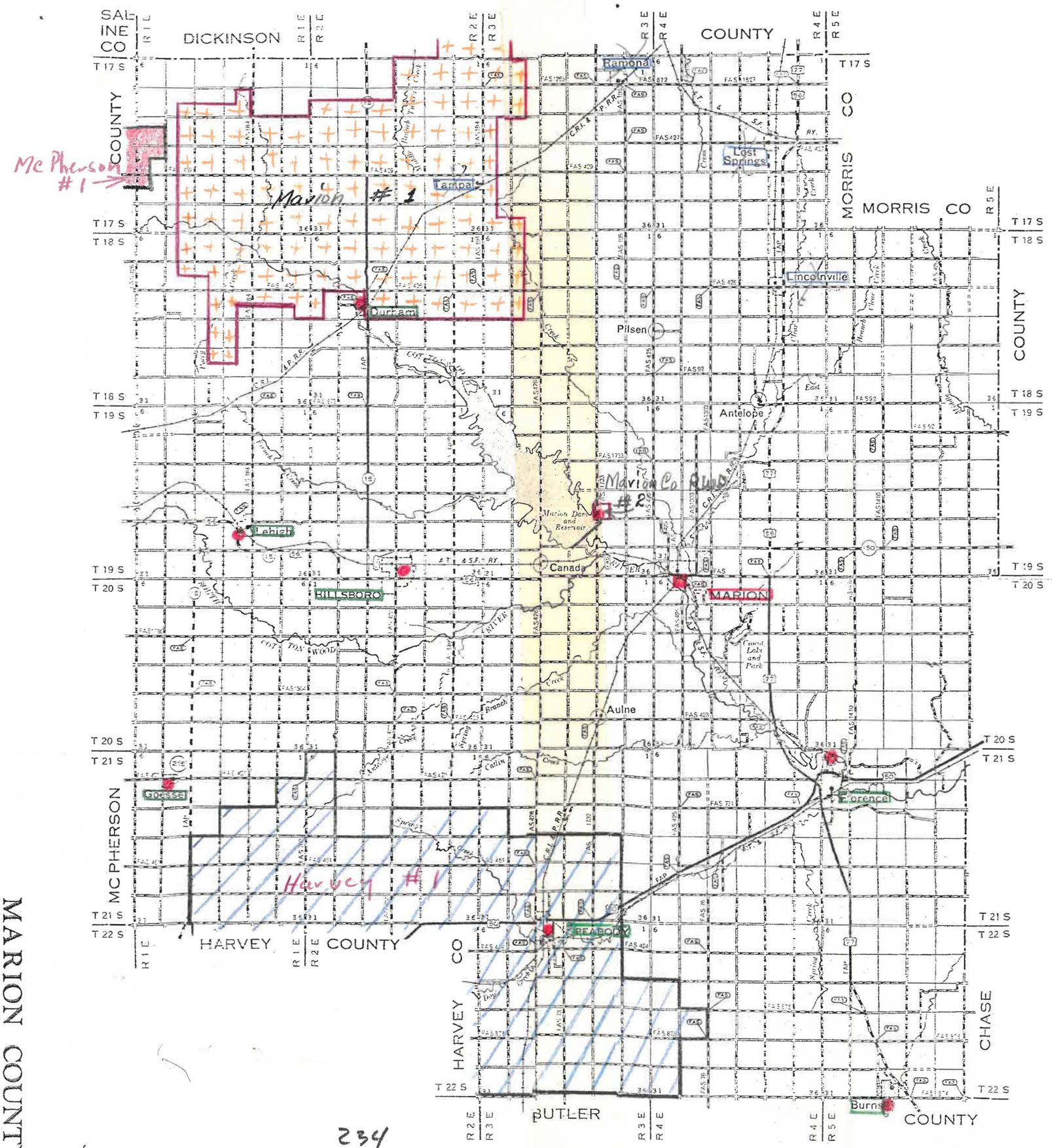
232

Fig. 29—



LYON COUNTY
KANSAS

Fig. 30 –



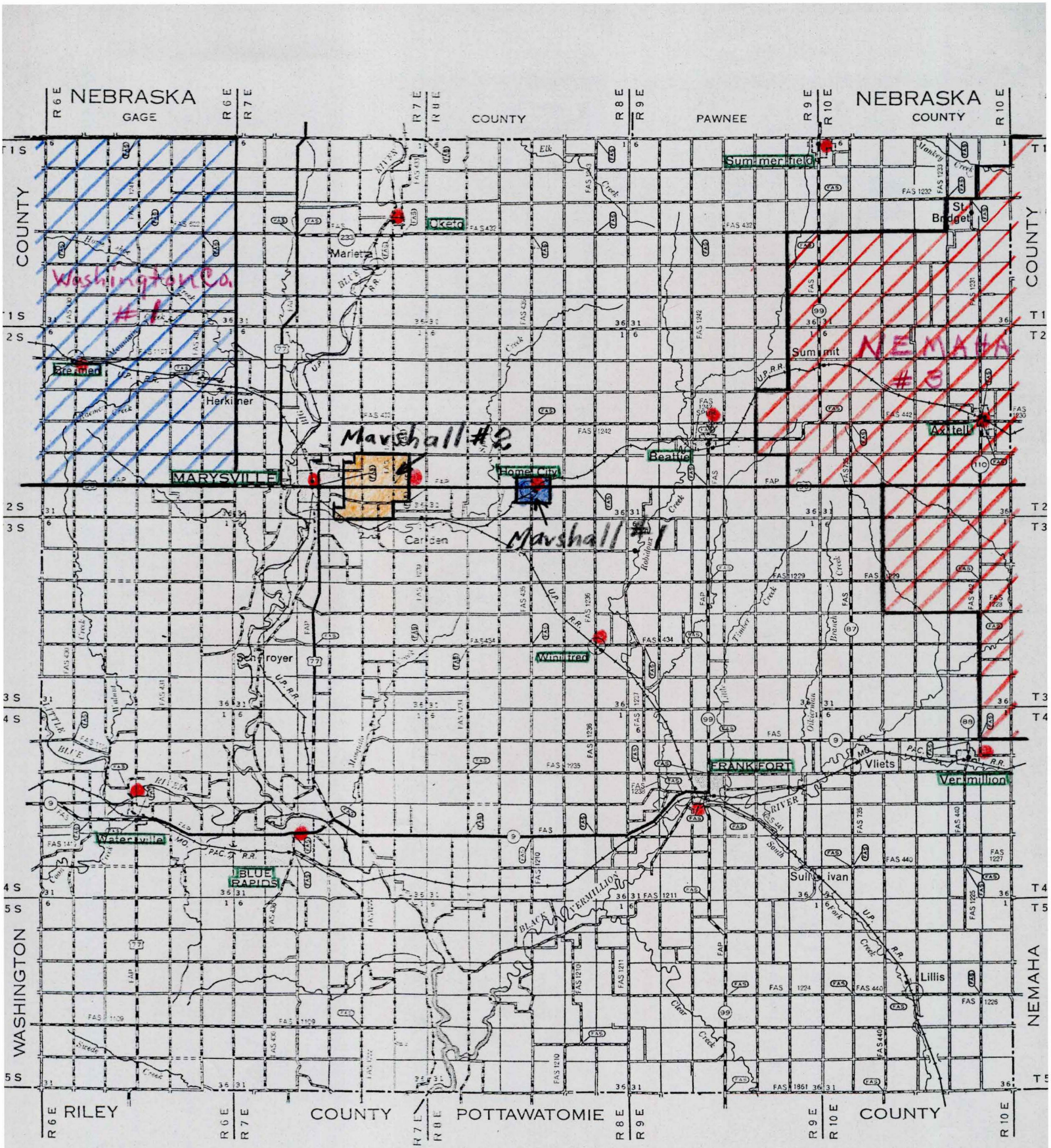
MARION COUNTY
KANSAS

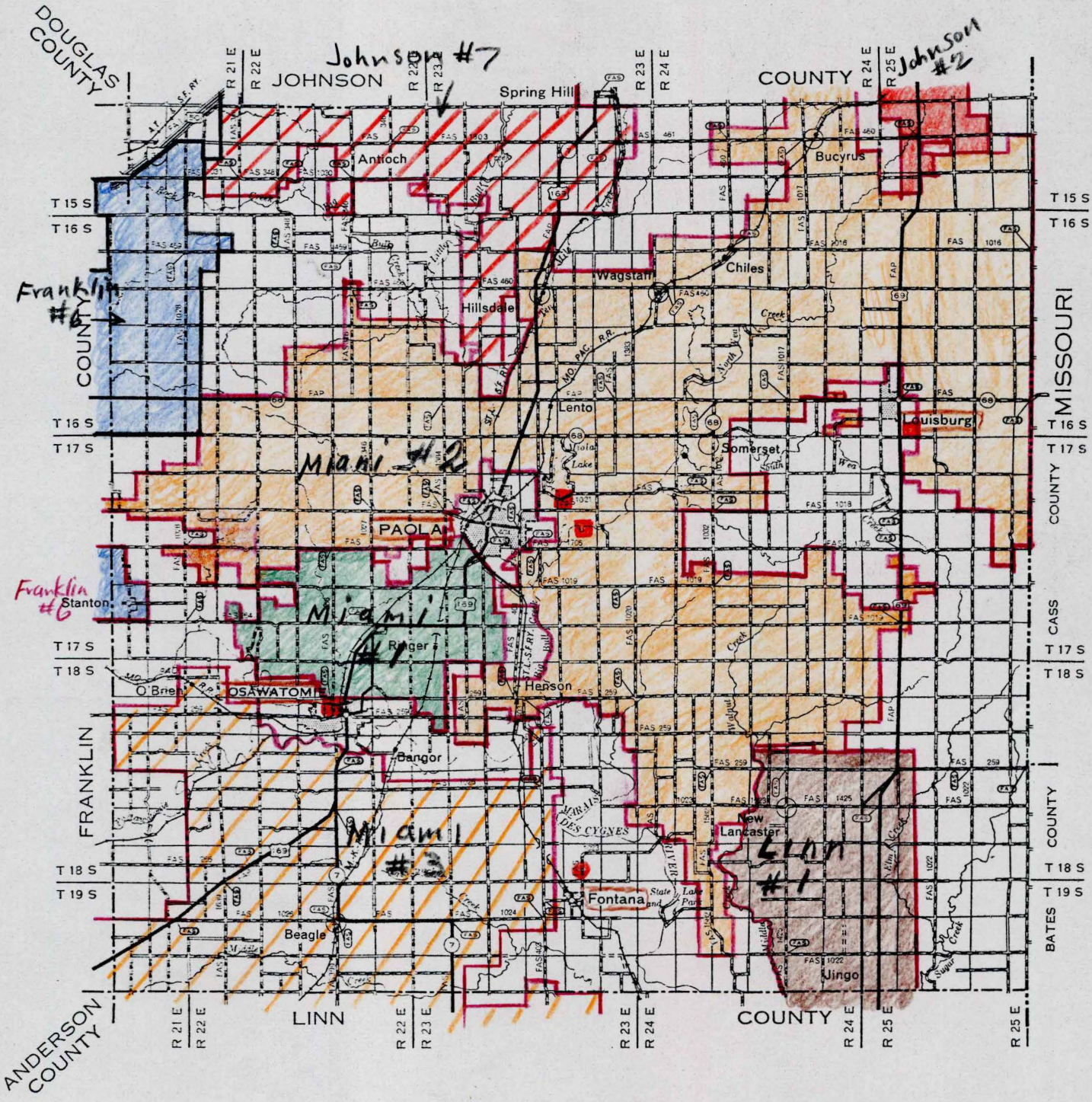
SCALE 1965

234

Fig 31

57


NEBRASKA
GAGE
COUNTY
PAWNEE
NEBRASKA
COUNTY
WASHINGTON
COUNTY
NEMAHA
COUNTY
RILEY
COUNTY
POTTAWATOMIE
COUNTY
Washington Co. #1
Marshall #2
Marshall #1
NEMAHA #3
MARYSVILLE
Oketo
Marietta
Summerfield
St. Bridget
Bremen
Herkimer
Summit
Axtell
Beattie
Home City
Winifred
Schroyer
Frankfort
Vliets
Vermillion
Waterville
Blue Rapids
Sullivan
Lillis
Clear Creek
Black Vermillion River
Big Blue River
Little Blue River
Elk Creek
Hanley Creek
Home Creek
Mill Creek
Robidoux Creek
Timber Creek
Oketo Branch
Peppermint Creek
Wolf Creek
Spring Creek
Turkey Creek
Little Vermillion River
Mo. Pac. R.R.
U.P. R.R.
FAS 1232
FAS 1233
FAS 1231
FAS 1242
FAS 1229
FAS 1236
FAS 1235
FAS 1238
FAS 1227
FAS 1211
FAS 1210
FAS 1224
FAS 1226
FAS 1861
FAS 1109
FAS 1225
FAS 1230
FAS 1239
FAS 1240
FAS 1241
FAS 1243
FAS 1244
FAS 1245
FAS 1246
FAS 1247
FAS 1248
FAS 1249
FAS 1250
FAS 1251
FAS 1252
FAS 1253
FAS 1254
FAS 1255
FAS 1256
FAS 1257
FAS 1258
FAS 1259
FAS 1260
FAS 1261
FAS 1262
FAS



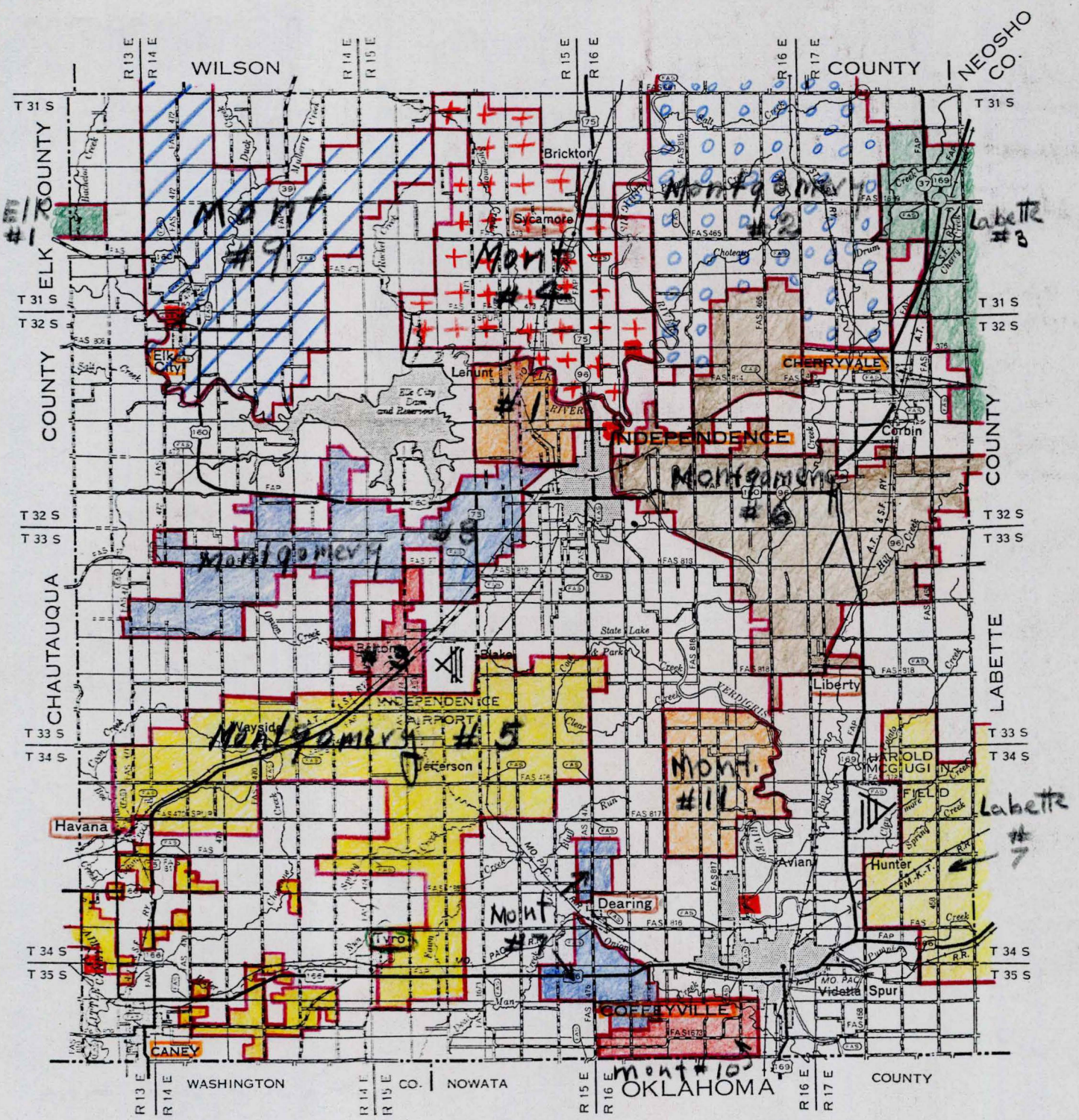
MIAMI COUNTY
KANSAS

1964

SCALE

236

Fig. 33 —



MONTGOMERY COUNTY
KANSAS

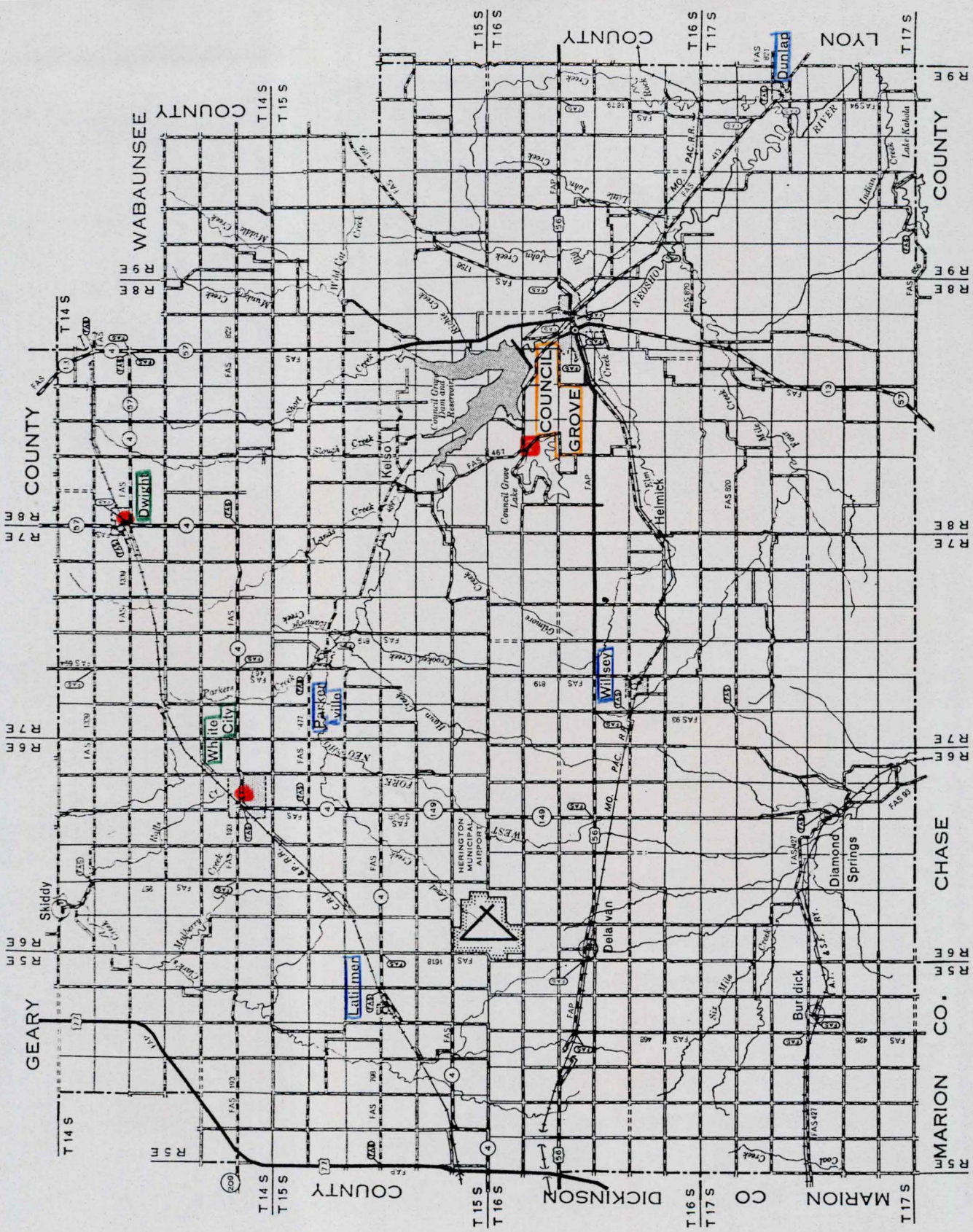
1964

SCALE

63

237

Fig. 34—



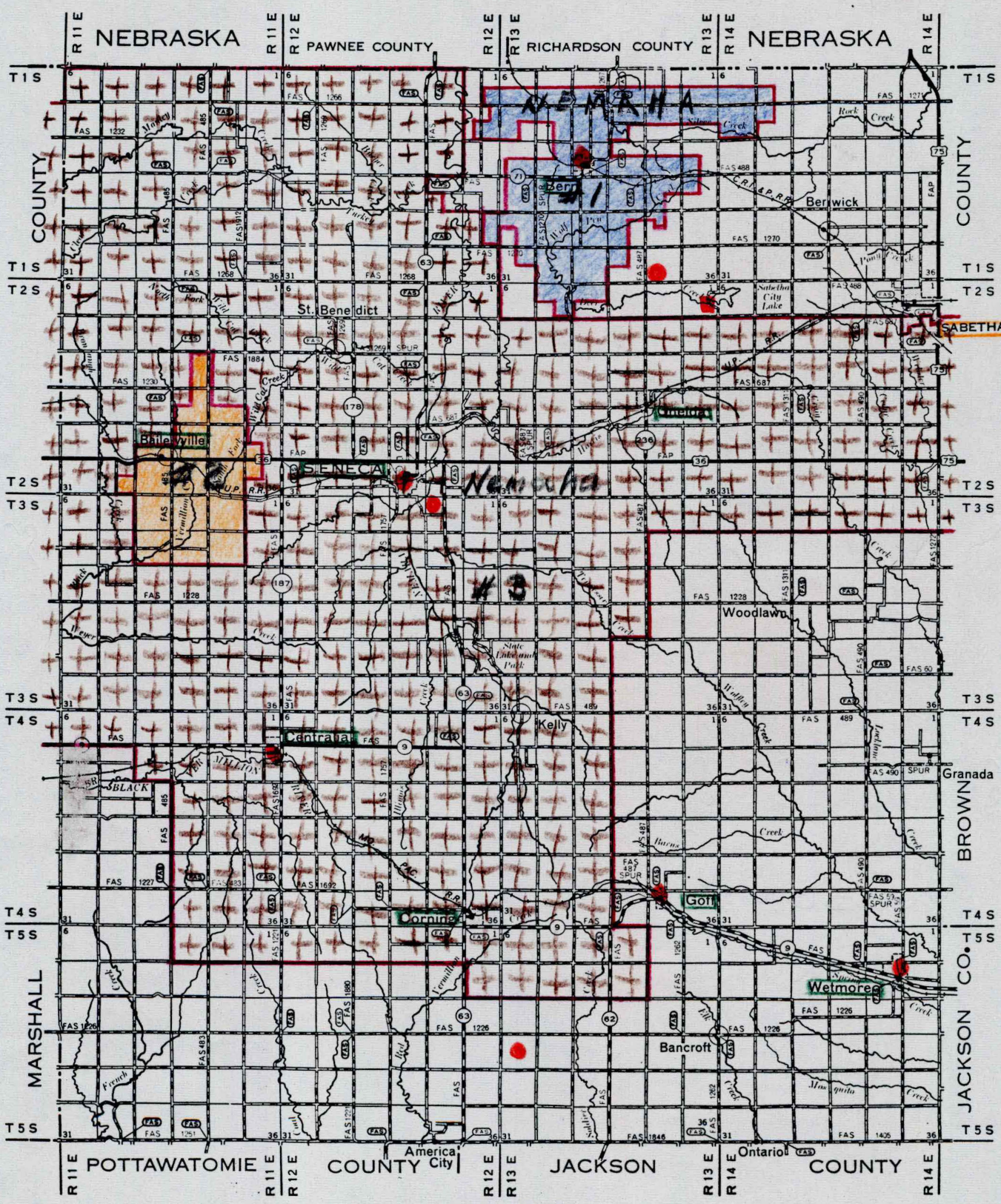
MORRIS COUNTY
KANSAS

1963

SCALE

238

Fig. 35—

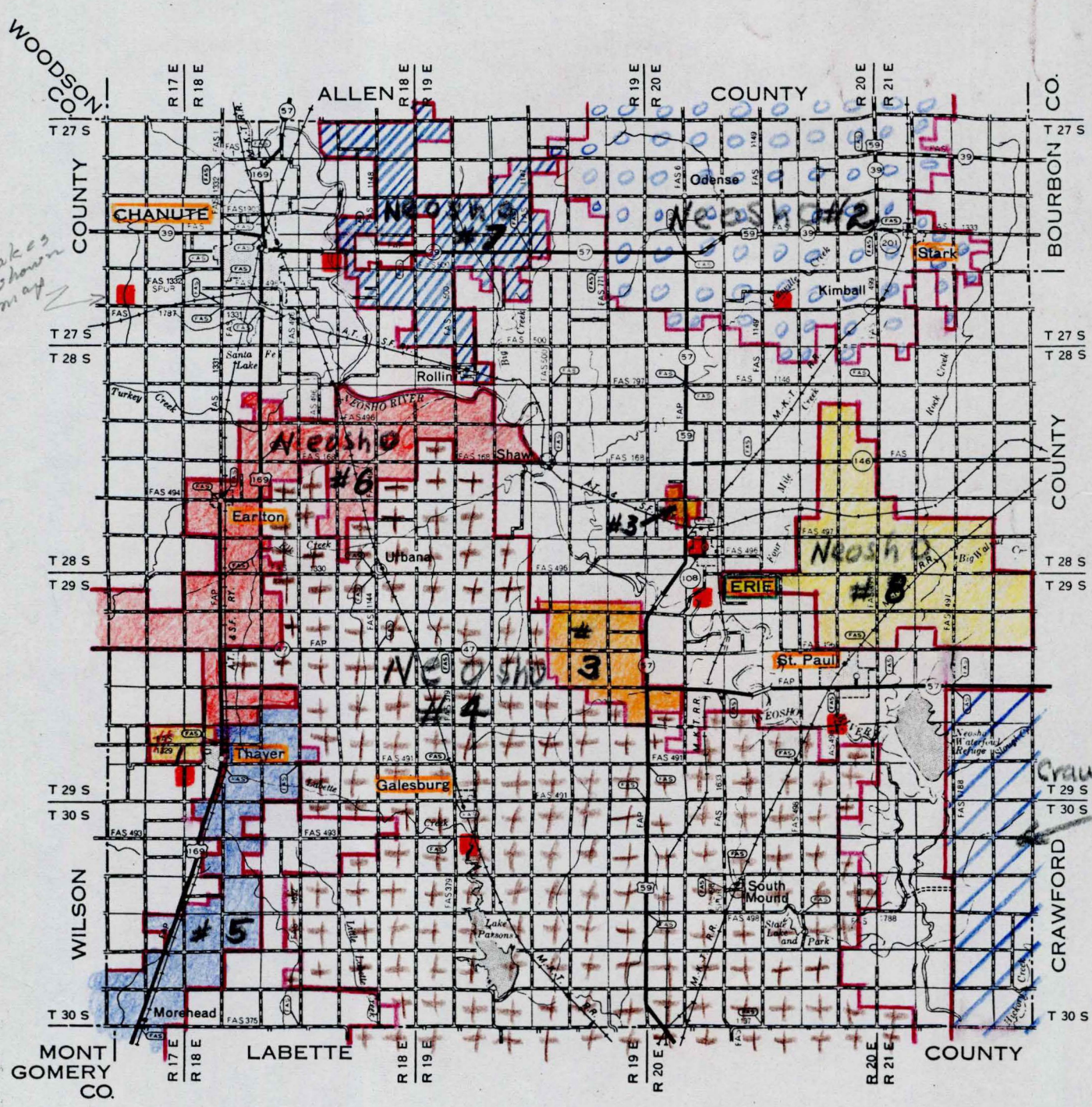


NEMAHA COUNTY
KANSAS

SCALE
1965

239

Fig. 36 —



NEOSHO COUNTY
KANSAS

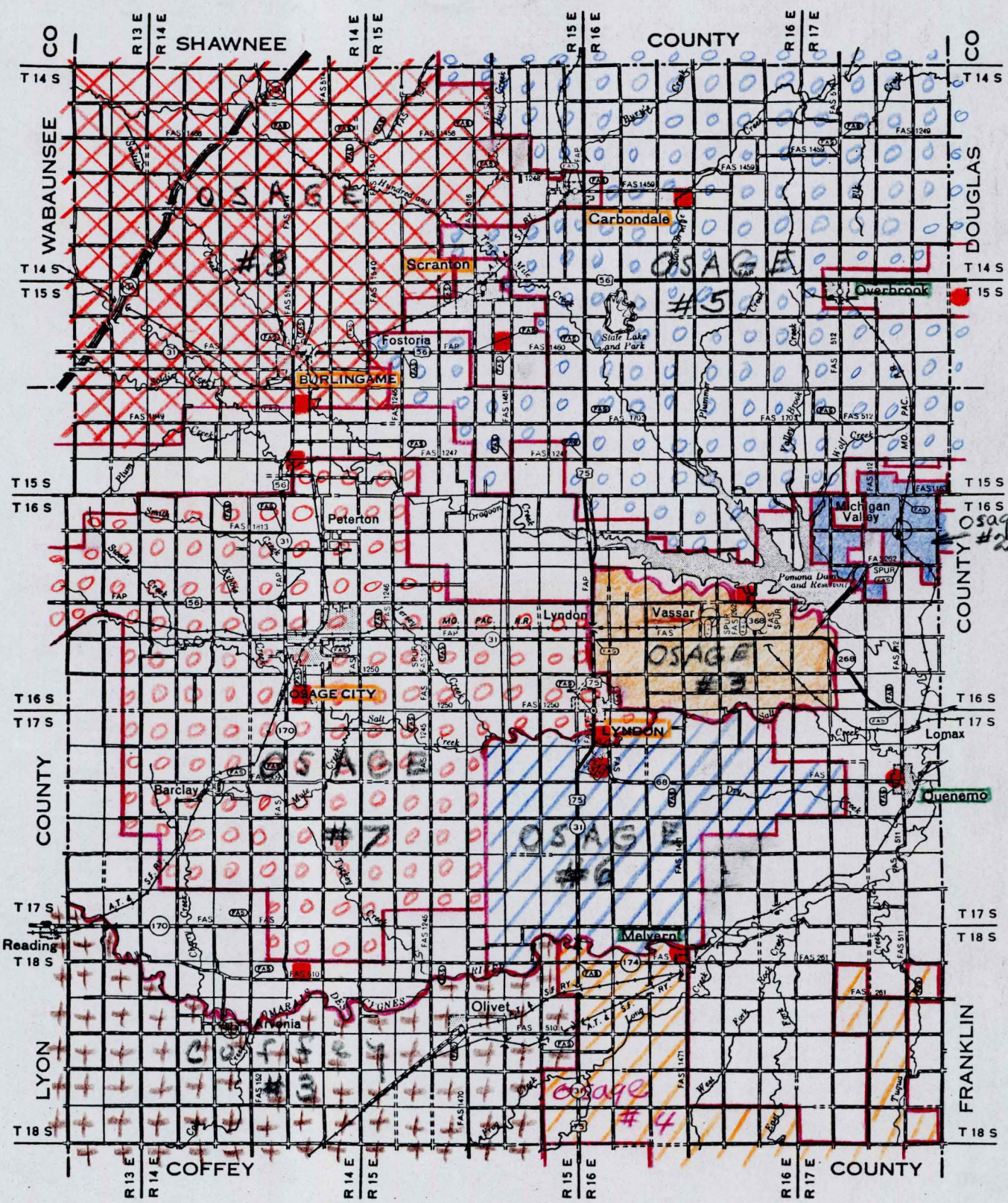
1964

SCALE

67

240

Fig. 37 —

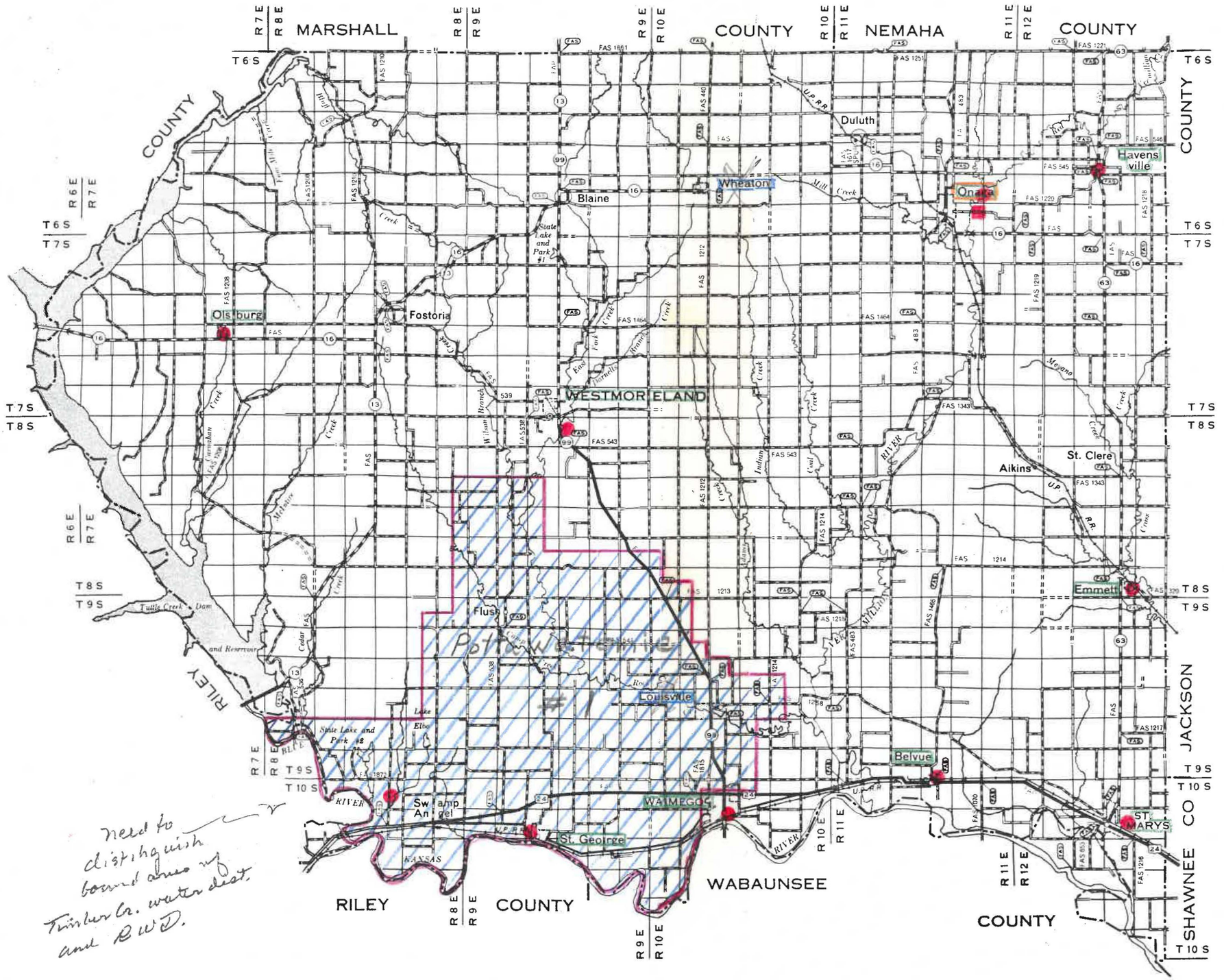


OSAGE COUNTY
KANSAS
1963

SCALE

Fig. 38

241



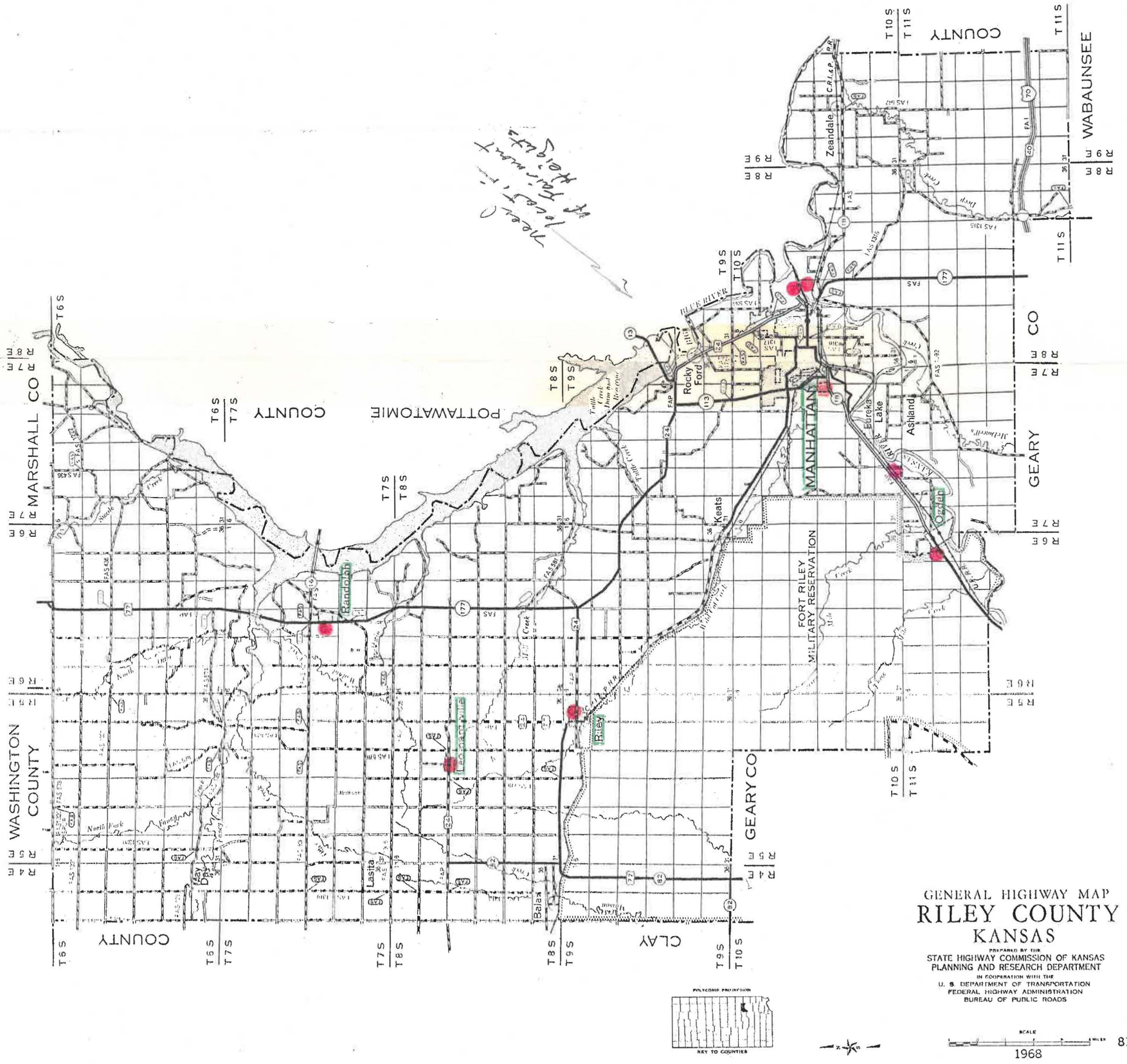
need to distinguish boundaries of Tuttle Cr. water dist. and RWD.

POTTAWATOMIE COUNTY
KANSAS

1963

242

Fig. 39-



GENERAL HIGHWAY MAP

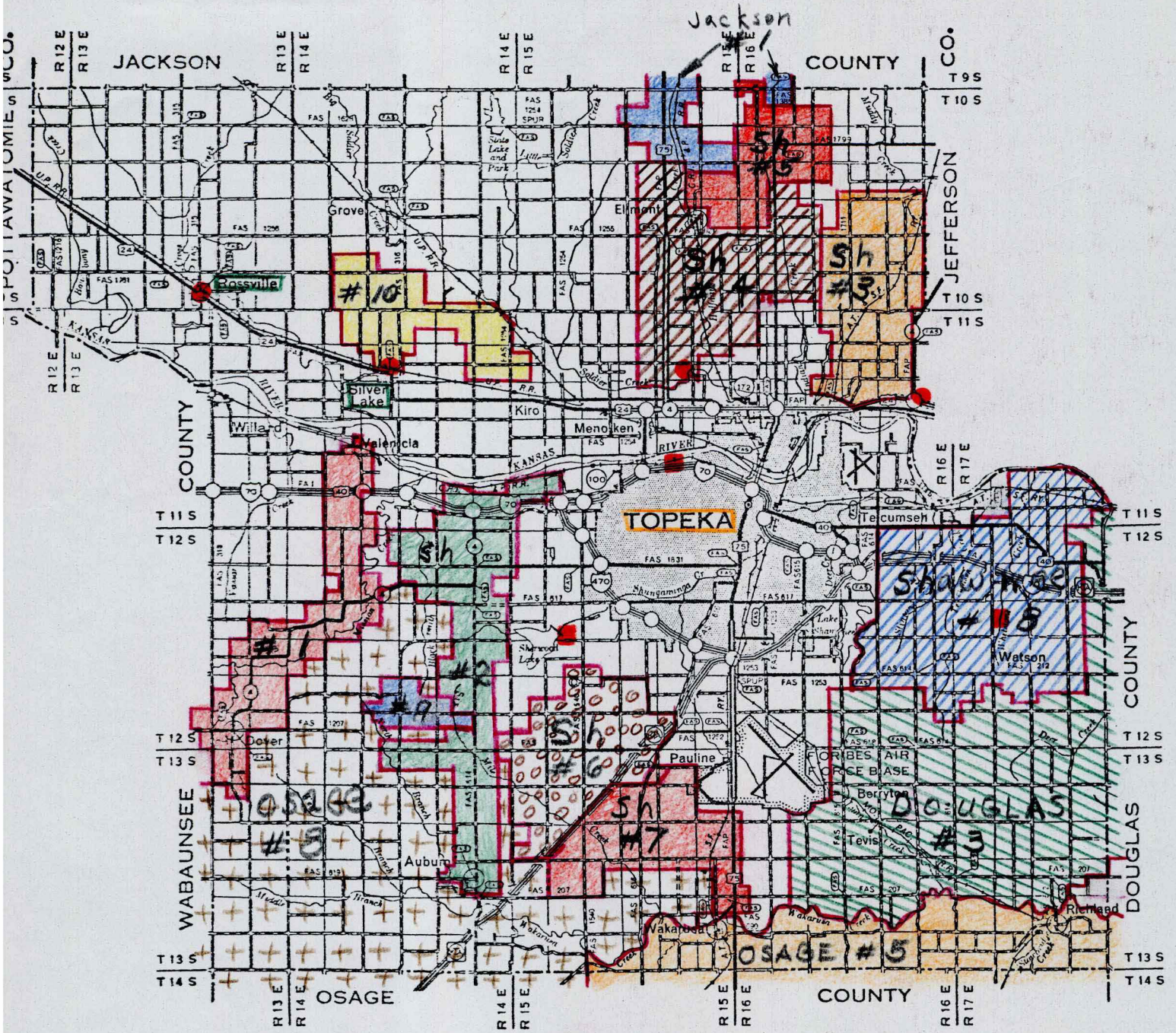
RILEY COUNTY KANSAS

PREPARED BY THE
STATE HIGHWAY COMMISSION OF KANSAS
PLANNING AND RESEARCH DEPARTMENT
IN COOPERATION WITH THE
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

1968

243

Fig. 40

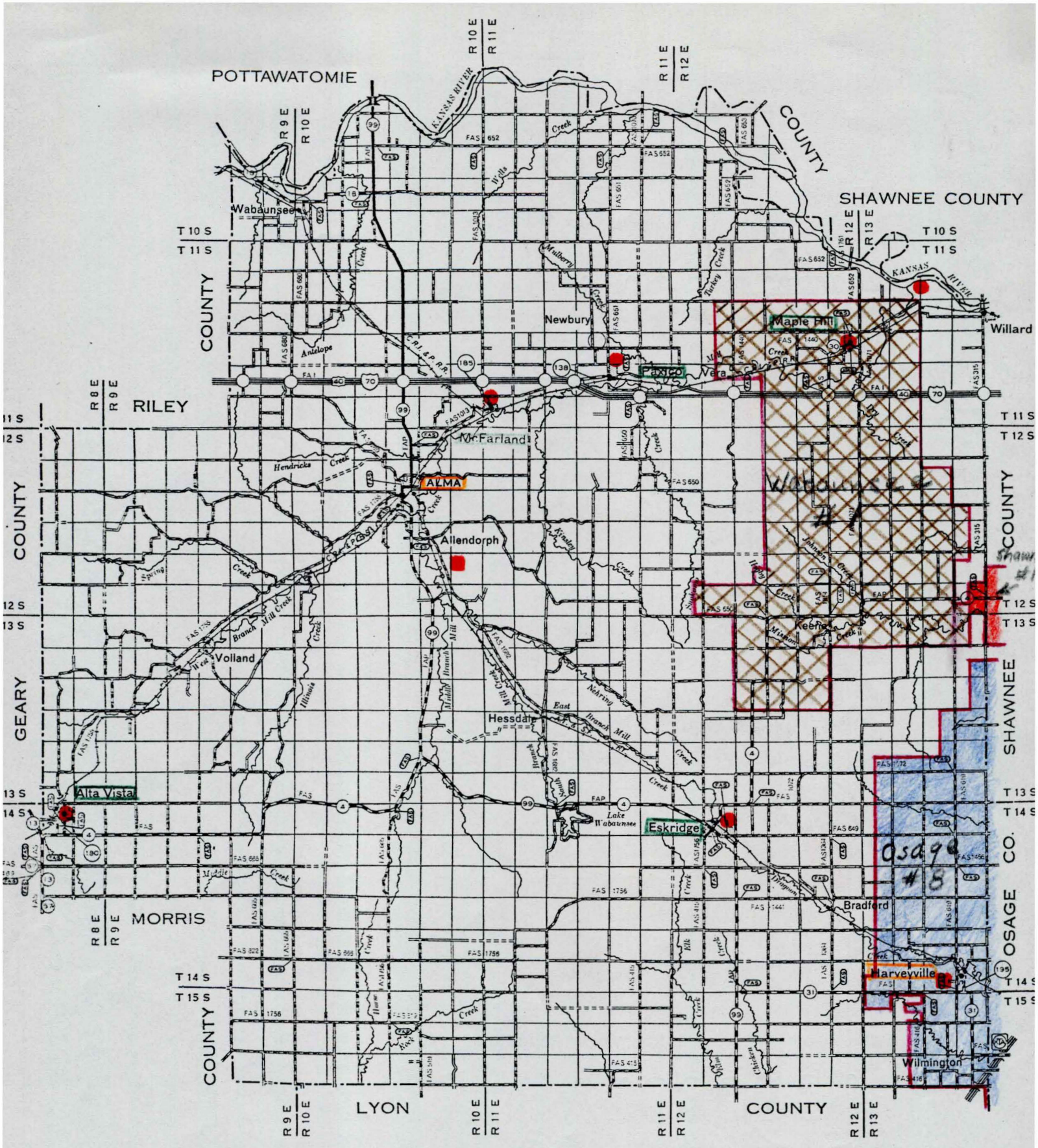


SHAWNEE COUNTY
KANSAS

89

Fig. 41

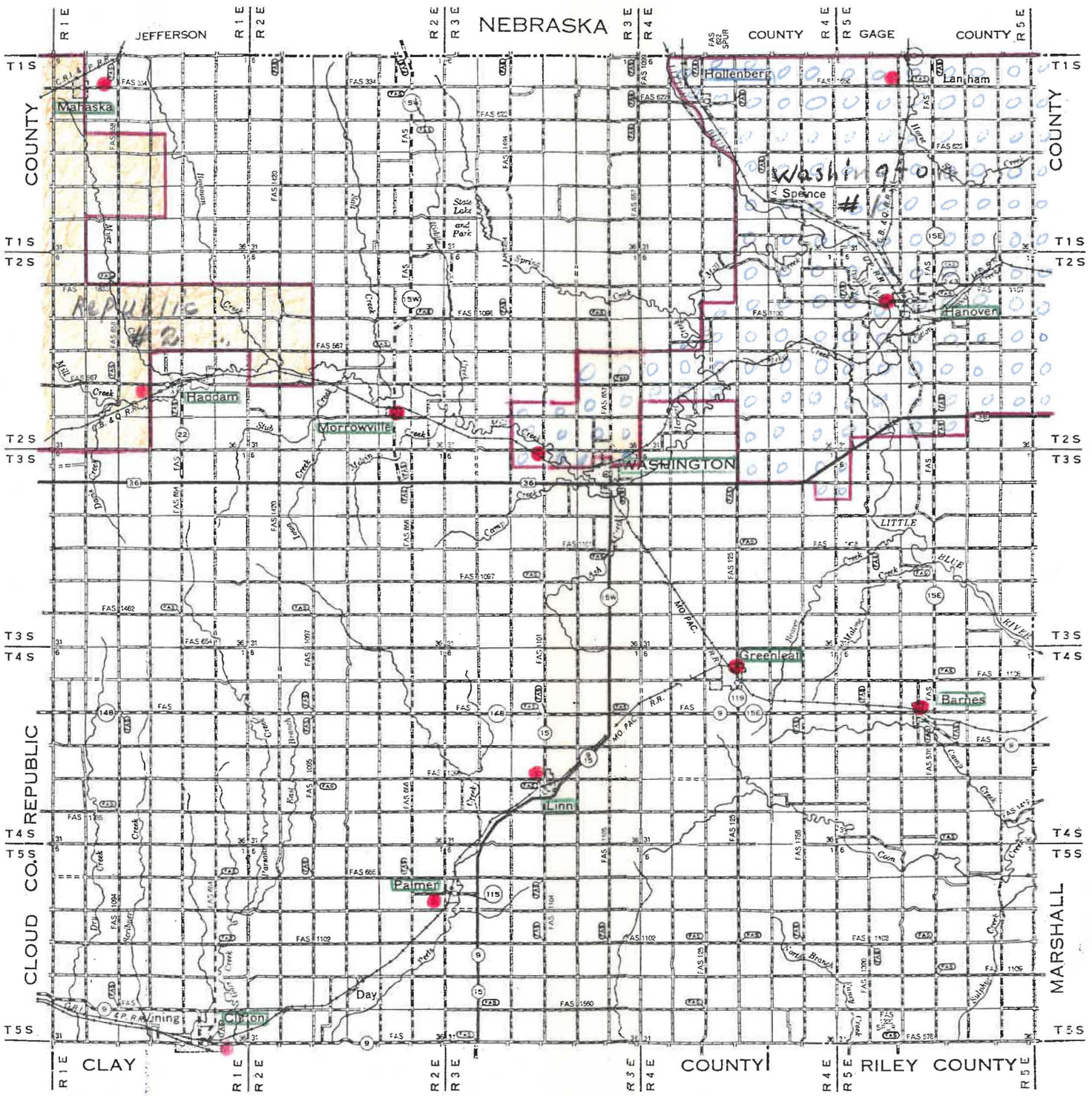
244



WABAUNSEE COUNTY
KANSAS
1963

99

Fig. 42



GENERAL HIGHWAY MAP

WASHINGTON COUNTY
KANSAS

PREPARED BY THE
STATE HIGHWAY COMMISSION OF KANSAS
PLANNING AND RESEARCH DEPARTMENT
IN COOPERATION WITH THE
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

POLYCONIC PROJECTION

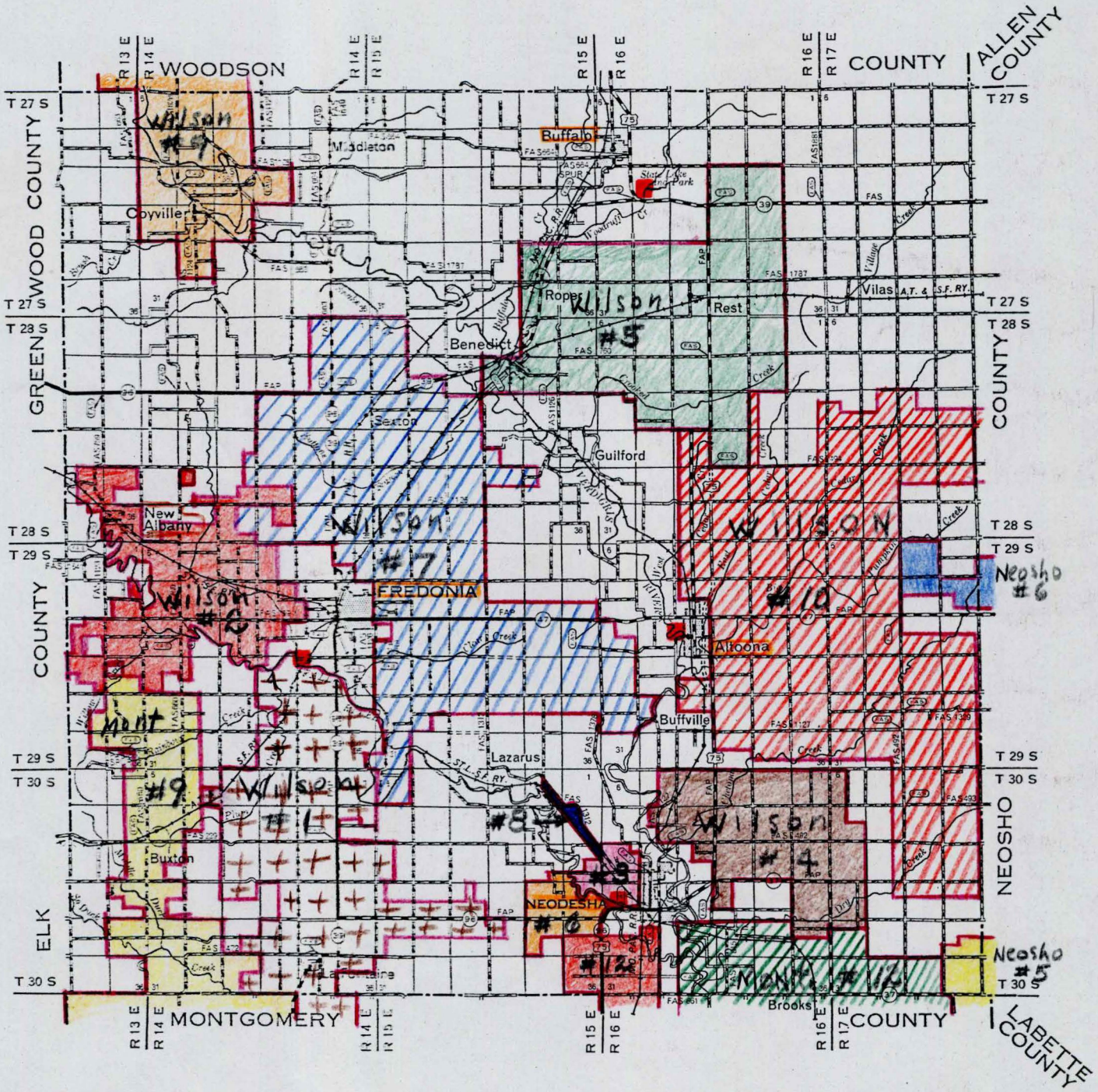
KEY TO COUNTIES

SCALE

1967

Fig. 43—

246

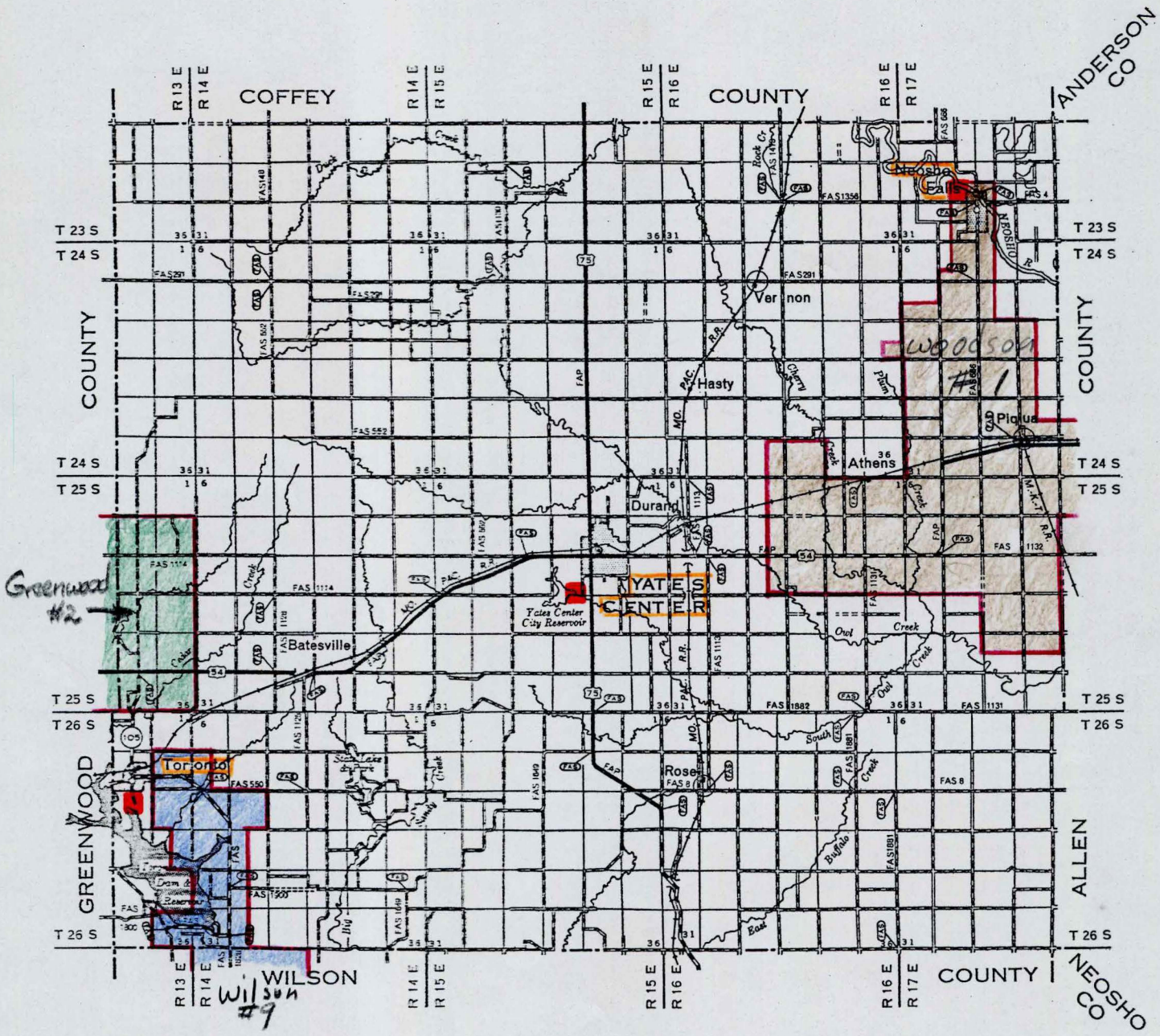


WILSON COUNTY
KANSAS

SCALE
1965

247

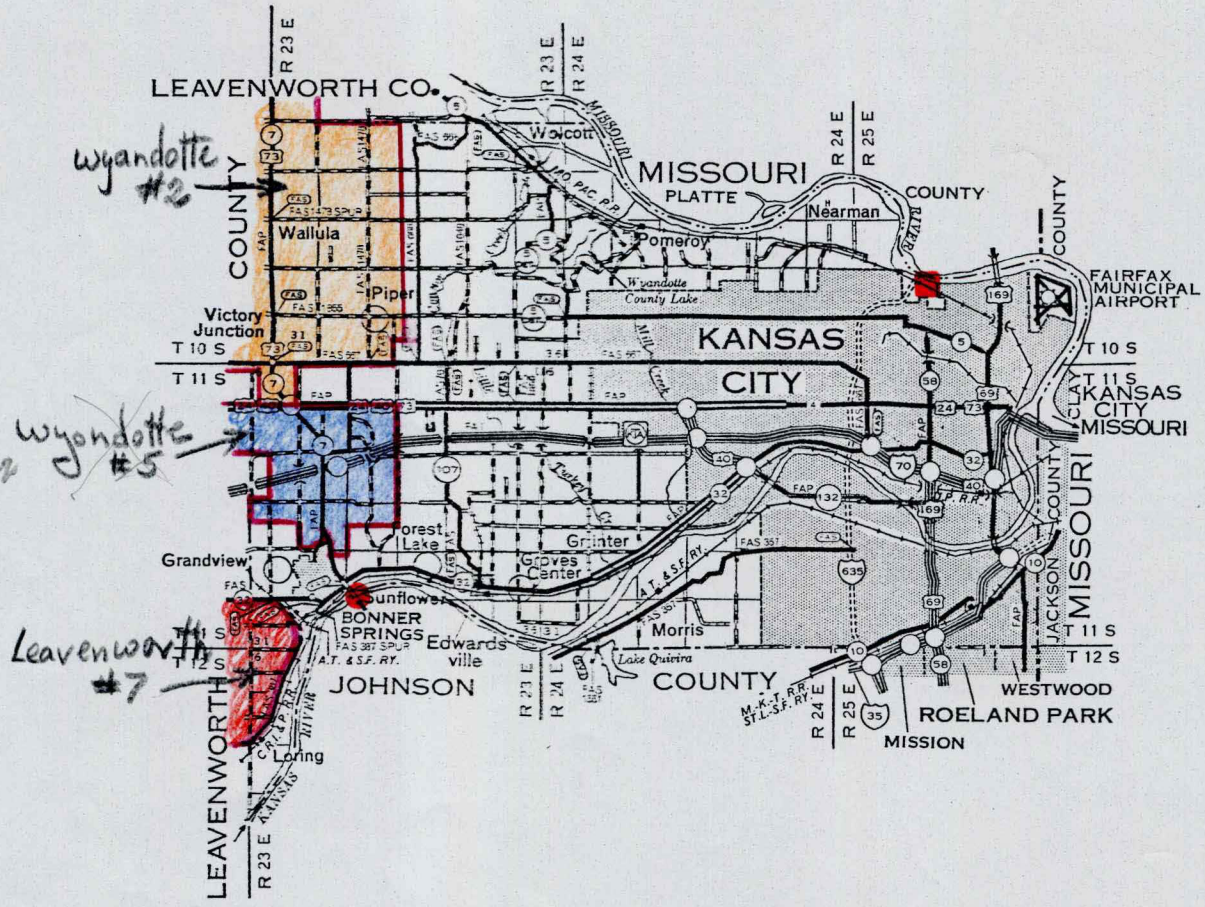
Fig. 44



WOODSON COUNTY
KANSAS

248

Fig. 45 —



WYANDOTTE COUNTY
KANSAS

249

Fig. 46, —