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IMPACT OF RURAL WATER DISTRICTS ON LAND USE CHANGE IN OKLAHOMA

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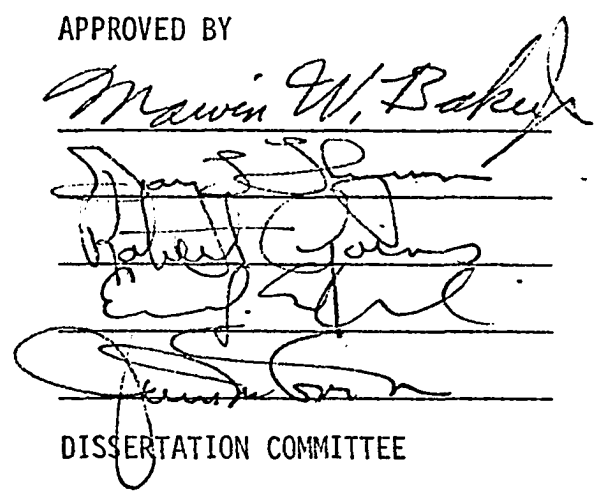

DISSERTATION COMMITTEE

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ABSTRACT

This research is concerned with land uses and land use change associated with rural water districts in Oklahoma. The objectives are: (1) to establish the land uses of selected areas of Oklahoma existing prior to the organization of rural water districts; (2) to establish current land uses of the same selected areas; (3) to compare land use changes of rural water district areas to land use changes of associated control areas; and, (4) to recommend appropriate approaches to reduce the conversion of present agricultural land to non-agricultural purposes.

Aerial photographs for time periods prior to rural water district development compared with aerial photographs updated by means of field mapping of the same sampled areas revealed basic changes have occurred in the land uses of rural Oklahoma. Land use change analysis indicates that the traditional rural character of Oklahoma is slowly changing, especially where rural water districts have made potable water supplies for domestic purposes available. In these areas population is increasing as new housing units are being constructed. At the same time, other land uses are also changing, at least in part, as a result of this population growth, and potential for future population growth. These population increases and resulting urban-like growth have created major and uncoordinated changes in the land use patterns or

rural Oklahoma. The major source of land for this urban-like expansion has been agricultural in nature. A sequence from cropland to pasture (idle in many cases) to residential is well developed in rural water districts.

FOREWARD

The rural landscape is ever changing. Not too many years ago this change was relatively slow and rather homogenous. More recently, and especially near the nation's urban areas, this change has taken on a greater heterogenous character. To say the least, the rural landscape is more dynamic today than ever before.

A major cause of such change is directly related to urban growth itself. Several aspects of urban growth bear on rural land uses. The actual physical expansion of residences requires increasingly large acreages of once rural land. Other forms of urban growth are likewise evident, such as: reservoirs for urban water supply; transportation facilities; recreation areas, etc. An additional type of suburban sprawl, "leapfrogging," has also become more widespread. This involves scattered housing developments or even individual homes of non-farm populations separated from the urban center by an expanse of land not used for urban functions.

Associated with these visually obvious urban land uses are the unseen competitions for land use. Land prices rise everywhere urban land uses compete or even potentially compete with traditionally rural land uses. Often taxes are affected by this competition. The result of such competition and tax structure might be to allow land to be

idled. Speculation, likewise, contributes to the idling of such land units. The idea is to invest the minimum capital possible until the land parcel may be sold to a developer for housing additions or some other such urban use.

This study is a descriptive analysis of the extent and types of land use changes occurring in association with rural water districts in Oklahoma. Samples representative of the state were taken both along and some distance from rural water districts lines of service to compare the land use changes occurring. Aerial photographs are used to identify the land uses prior to rural water district development for each set of samples. Field analysis along with more recent aerial photographs was utilized to determine present land uses in these same samples. The results allow a comparison of change in the water districts across the state and between water districts and rural areas without these institutions.

IMPACT OF RURAL WATER DISTRICTS ON LAND USE CHANGE IN OKLAHOMA

CHAPTER I

INTRODUCTION TO THE PROBLEM

The rural water district is today a standard organization for administering water in rural areas. Typically, it is a public entity that can enter into contracts and hold public funds; in some cases it may even have taxing powers. For the past seventeen years, there has been a "rural water district movement" in the United States. This movement reached a milestone in 1976 with the establishment of a National Rural Water Association.

This movement basically began in Oklahoma, in 1962, when that state passed legislation allowing such districts to be formed if two or more residents could receive a hearing and obtain the necessary order from the county governing body.[1] Once established, the district was authorized to operate community water systems and was eligible for Farmers Home Administration (FmHA) loans and grants.

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[1] Oklahoma Statutes at Large, "Rural Water District Act." Laws 1963, c. 266, Sec. 1.

This research is concerned with land use and land use changes associated with rural water districts in the state of Oklahoma. Sufficient time has elapsed to yield any observable impacts that have occurred. Although a large body of literature is available regarding urban growth and rural land use as well as their changing patterns, only scant attention has been afforded rural water districts (RWD).

In rural America today a number of land use changes are evident. On a national scale, however, little change is expected to occur between major land use categories. Change within each land use is likely to be more important. The area of land used for agriculture, for example, will change relatively little, but the intensity of its use will change greatly. Generally, the same situation prevails for all land uses.[2]

This scale of analysis, though, is not overly meaningful when one considers the more basic changes that in reality are taking place in rural America. Rex Campbell[3] pointed out, for example, that the trademark of rural communities, homogeniety, has largely disappeared. No longer are rural inhabitants, or rural land uses of the same general area basically similar. Today the situation quite often is one of vastly different land uses found side-by-side. At the same time, the inhabitants of these land areas may be virtually worlds apart from a socio-economic standpoint. The change that has taken place to yield

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[2]Marion Clawson, Policy Directions for U.S. Agriculture (Baltimore: Resources for the Future, by Johns Hopkins Press, 1968), pp. 90-92.

[3]Rex Campbell, "Beyond the Suburbs: The Changing Rural Scene," in Amos Hawley and Vincent Rock, Metropolitan America in Contemporary Perspective (N.Y.: John Wiley and Sons, 1975), p. 119.

this increasingly more heterogeneous landscape has not ceased--indeed, if anything, it has accelerated.

Clawson, et al[4] in 1960 predicted that acreages used for urban purposes would more than double, as would acreage for specialized recreation purposes, by the year 2000. In addition, they predicted increases in such land uses as transportation, water management, and wildlife preservation areas. It was also predicted that acreage decreases would occur in the following: cropland, forestry and pasture. Omitted from these still rather generalized categories is rural residential usage apart from urban extension. No hint of change is indicated in Clawson's analysis.

The United States Department of Agriculture (U.S.D.A.) has also prepared a set of land use projections.[5] These projections were made to 1980. This report estimated gross shifts, or shifts in land into and out of each use, as well as net shifts. It estimated that 17 million acres would be added to cropland between 1969 and 1980, while 68 million acres would be taken out--or a net outward shift of 51 million acres. Similar figures were presented for a number of other agricultural categories. These projections, then, were higher than those discussed earlier for Clawson.

The U.S.D.A., also, did not speak to changes associated with rural residences. One of the few such references is made by Clawson,[6]

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[4]Marion Clawson, et al., Land for the Future (Baltimore: Resources for the Future, by Johns Hopkins Press, 1960), p. 477.

[5]Land and Water Resources--A Policy Guide (Washington, D.C.: United States Department of Agriculture, May 1962).

[6]Clawson, Policy Directions for U.S. Agriculture, loc. cit., p. 287.

by default. As a side note in describing the decrease in farm numbers and increase in their sizes due to consolidation, he notes that farmsteads will be abandoned, and even though other farmhouses will continue to be lived in, while the occupants work elsewhere, it is doubtful that they will be replaced. In a later redeeming statement Clawson does acknowledge that near urban areas this may not be the case.[7] He points out that rural areas within 25 miles of cities with a population of 2500 or more will experience quite different changes. He even suggests that this 25-mile limit might be pushed back due to a willingness of commuters to drive farther to their jobs. Clawson has obviously not, in these passages, grasped the full dynamics of rural land use change and especially the degree to which rural residences are increasing in many parts of the nation.

The continued loss of lands well suited to the production of food, forage, fiber, and timber, and the probable degradation of the environment resulting from those losses, is a matter of growing concern to the American people. Major concern revolves around good agricultural land and the long-range need to retain their productive capacities. Practices that result in irreversible land use change represent a loss of a valuable natural resource. The process is large scale in some local areas. Nationally, individual losses seem small, but aggregately they may adversely impact domestic and international production.

At all levels of analysis there is growing concern that a large proportion of the best land for farming in the United States is already

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[7] Ibid., p. 288.

under cultivation. A recently completed study of potential cropland by the Soil Conservation Service (SCS)[8] indicated that the United States has only about 111 million acres of potential cropland left--land that is in other good uses but is well suited and available for conversion to farming if needed.

This total is considerably lower than recent estimates by others[9] and far below the estimate derived from the 1967 Conservation Needs Inventory conducted by the United States Department of Agriculture.[10]

A large proportion of the best farmland in the United States is already under cultivation. William Johnson[11] argues in response to optimistic testimonies that there is need for concern, substantiating his statement he makes three points. First, current studies suggest that average crop yields may be enhanced over the next 20 years--but not to the same extent of the past 20 to 30 years. Secondly, he argues that there is evidence that the United States population growth is slowing down, but total population will continue to grow for some time. At the same time, per capita income will increase. Rising population

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[8]U.S. Department of Agriculture, S.C.S. Finds 111 Million More Acres Could Be Converted to Crops, Press release #1832-76 (Washington, D.C., 1976).

[9]Economic Research Service, U.S. Department of Agriculture, Farmland: Will There Be Enough? ERS-584 (Washington, D.C., 1975).

[10]U.S. Department of Agriculture, Basic Statistics, National Inventory of Soil and Water Conservation Needs, 1967, Stat. Bult. 401 (Washington, D.C., 1971).

[11]William Johnson, "What Has Been Happening in Land Use in America and What Are the Projections," Journal of Animal Science, Vol. 45, #6 (1977), pp. 1469-1475.

and large income are easily translated into increased demand for food and for higher-quality food. Finally, he feels that demand for North American food from developing countries will continue to rise.

Johnson additionally argues that we will be facing a crisis in productive capability in only a few years. He says that ". . . we have a very few years in which to build a protective fence around a precious potential cropland reserve, or lose it for all time."[12]

Most authorities, then, agree that preservation of agricultural lands should be a central goal of the American nation. Those concerned with removal of prime agricultural lands from production see a weakening of the agricultural economy at least regionally if not nationally, creation of upward pressures on food and fiber prices, and the dislocation of individual farmers and ranchers. Some also view the preservation of prime lands as a means of avoiding dependence on other countries for basic necessities, containing urban sprawl, and maintaining resource conservation areas.[13]

The Environmental Protection Agency[14] is likewise concerned. Officials have recently expressed their fears regarding the environmental costs of taking good agricultural land out of production, since it requires less chemical treatment and is the land least prone to erosion.

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[12] Ibid., p. 1472.

[13] David Hansen and Seymour Schwartz, "Prime Land Preservation: The California Land Conservation Act," Journal of Soil and Water Conservation (September-October, 1976), p. 198.

[14] Tom Jorling, "Protecting Land Resources for Food and Living," Journal of Soil and Water Conservation (September-October, 1978), p. 213.

Perhaps the most compelling justification for increased concern about the conversion of agricultural land to other uses comes not from the national perspective, but from the state and local perspective. Maintenance of land in agricultural uses may serve important public purposes which are not readily apparent when viewing the situation from the national perspective. Agriculture is crucial to the economy of many states and municipalities. In addition, continued use of land for agriculture may be helpful in maintaining air and water quality in many areas.

A sequence may generally be identified to describe the fear many have about the lack of preservation of agricultural land. Farmers on the urban fringe observe development occurring, discover the selling price of the land, hope to sell their land at the same price, and hold off making costly new investments.[15] Allee, et al., noted that ". . . too many farmers may decide against new real estate investments that would maintain their competitiveness and increase productivity and current incomes with which to pay holding costs."[16] Libby[17] maintained that ". . . far more land is affected by the possibility of development potential when land allocation relies entirely on a land market replete with misinformation."

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[15]R. F. Vogel and A. J. Hahn, "On the Preservation of Agricultural Land," Land Economics, Vol. 8 (1972), pp. 190-193.

[16]David Allee, et al., Toward the Year 1985: The Conversion of Land to Urban Use in New York State, Special Series #8 (Ithica: New York State College of Agriculture, Cornell University, 1970).

[17]Lawrence Libby, "Land Use Policy: Implications for Commercial Agriculture," American Journal of Agricultural Economics, Vol. 56 (1974), pp. 1143-1152.

Melvin Cotner summed up this argument by making the following point:

> First, there is an increasing amount of interdependence between land uses and among regions in the use of land. Second, the traditional market system may not always be sufficient in providing for the wise use of our lands. Third, land use planning and the coordination of programs at the national, state, and local levels are essential if we are to make wise use of our lands. Fourth, efforts to limit the unwise conversion of agricultural lands to other uses are in the public interest. Our most productive lands should not be withdrawn from agriculture without full consideration of the impact of such actions.[18]

It is apparent from an analysis of the literature, that the greatest concern of those working with rural land use and land use change is the loss of agricultural land, and that the major concern is loss to urban encroachment. There have been many attempts, since as early as 1960, to explain and control inefficient patterns in suburban land use. These land use patterns are the result of many factors operating at different levels of government.

The sources of urban encroachment into rural America are diverse, and a number of trends may be identified. Nationally, for example, programs of the Federal Housing Administration, Veterans Administration, and Department of Housing and Urban Development contribute to such encroachment.[19] The Federal Government, through these agencies, has supported the home-building industry and helped citizens to buy homes, greatly stimulating the rate of suburbanization.

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[18]Melvin Cotner, "Why Preserve Agricultural Lands?" Journal of Soil and Water Conservation (September-October, 1976), p. 203.

[19]Marion Clawson, Suburban Land Conversion in the United States, (Baltimore: Johns Hopkins Press, 1971).

Local growth, likewise, is the result of many factors: access to highway facilities;[20] decisions by bankers, credit firms, and private citizens;[21] and access to sanitary sewer facilities.[22] These far ranging services, then, constitute the basic framework around which local urban expansion is based. Without the services suggested above, and others, urban expansion would be greatly decreased or non-existent. Other avenues for housing the urban population would have to be found.

An even more fundamental and yet encompassing rationale for urban expansion is given by Zimolzak and Stansfield. "Yet suburbia continues to expand because the attractions of single-family houses set in landscaped grounds with private yards, off-street parking, newer schools, and easily accessible shopping and leisure activities far outweigh commuting and financial strains for many."[23] This statement, then, either states or infers many of the reasons for urban growth.

Urban expansion, sprawl,[24] does not denote a single, homogeneous land use--indeed, a variety of forms are

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[20]Richard Twark, A Predictive Model of Economic Development at Non-Urban Interchange Sites on Pennsylvanian Interstate Highways, (University Park: Department of Business Logistics, Pennsylvania State University, 1967).

[21]Clawson, Suburban Land Conversion, loc. cit.

[22]Jeffery Stansbury, "Suburban Growth: A Case Study," Population Bulletin, Vol. 28, #1 (1972), p. 42.

[23]Chester Zimolzak and Charles Stansfield, Jr., The Human Landscape: Geography and Culture (Columbus, Ohio: Charles Merrill Publishing Co., 1979), p. 248.

[24]Sprawl is defined by Raymond Murphy (The American City: An Urban Geography, 2nd ed., N.Y.: McGraw-Hill, 1974, p. 499) as "The continuous expansion that goes on around the average large city with a belt of land always in the process of conversion from rural to urban use.

evident.[25] The two most often discussed are the low-density continuous development of the urban fringe and ribbon-developments. A third form, less often described in the literature, but nevertheless vital to understanding the changing land use patterns of rural America, is exurban, or leapfrogging, expansions.

This latter form of land use is of growing concern to rural land users because of its direct relationship to land availability. Murphy[26] points out that "leapfrog" expansion consists of discontinuous though compact patches of urban uses in an essentially rural matrix. Robert Huefner et al,[27] in discussing suburban expansion in the valleys of the Wasatch Front along the Great Salt Lake, pointed out that it was the spotting of subdivisions ". . . through these valleys in a scattered pattern that commits at least twice as much land as necessary to urban development, overruns the states' most productive farmland, and forces the spreading of inadequate and poorly financed services across vacant fields to serve the scattered developments"[27] (emphasis added).

Exurbia is expected to increase in importance with a greater impact on the rural landscape.[28] For the most part, exurbia is composed of non-farm populations thinly settled in either the most

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[25]Raymond Murphy, The American City: An Urban Geography, 2nd ed. (New York: McGraw-Hill, 1974), p. 499.

[26]Ibid.

[27]Robert Huefner et al, "Utah's Support for Land Use Planning: Fragile as the Landscape," Journal of Soil and Water Conservation (May-June, 1975), pp. 112-225.

[28]Clawson, Suburban Land Conversion, loc. cit., p. 54.

rural parts of the suburban fringe or past this fringe into rural America. Either in groups, such as subdivisions, or as individual residences, exurbia is expanding and taking up larger acreages of land that were often in formerly agricultural capacities. Characteristic of this form of urban expansion, farmers in evolving exurban areas tend to sell off road frontages, piece by piece, retaining ownership of the bulk of the acreage much longer,[29] resulting in the evolution of a linear exurban pattern amid a rural background. Land away from the road system often is kept in the same land use as prior to exurban intrusion. As this exurban growth continues, these interior land parcels may be subdivided for residential purposes--suburbia would have then overtaken exurbia. Exurbia then moves farther afield and the process continues.

Rural land uses and suburban expansion, or more appropriately exurban expansion, are vitally linked. There is a growing concern as to what the outcome might hold for the American public, even in the near future. Any new programs that would have an impact on the outcome of this land use evolution should be thoroughly studied and understood. One such program is the rural water district (RWD). The increasing availability of good quality water in sufficient quantities for domestic use makes those rural water districts especially attractive to the potential exurban resident.

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[29]Zimolzak, loc. cit.

Statement of the Problem

The rural water system program in Oklahoma was initiated in 1964, and as of January, 1975, there existed 318 rural water districts. Most of these systems have been built primarily to meet the water needs of the local residents, with some expansion allowance for future population growth. In 1975 Oklahoma ranked third among the states in total number of rural water districts. These systems serve small towns, rural communities, or both.[30] Since their inception, ample time has elapsed for some basic land use changes to have occurred in the rural areas served by these water systems.

This study's primary concern is to investigate the land use characteristics and some implications of rural water district development in Oklahoma. More specifically, this study seeks to determine the major trends in, and the extent of, land use change within rural water districts and to compare these to land use changes away from the rural water district lines of service.

Objectives

The objective of this study was to determine if land use change within rural water districts has generally differed from change along rural water district lines of service. Specifically, an attempt has been made to study, and to quantify where possible, changes in identified land use categories and changes in the number of housing units of the study area.

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[30]Daniel Badger and Gordon Sloggett, Economics and Growth of Rural Water Systems in Oklahoma, Bulletin B-17 (Stillwater, Oklahoma: Oklahoma State University Experiment Station, 1974).

A number of specific objectives were identified:

1. To establish the land uses of selected areas of Oklahoma existing prior to the organization of rural water districts.

The intent here was to provide a base from which to measure change within and away from rural water districts.

2. To establish current land uses of the same selected areas.

The intent here was to gather data to be compared to previously gathered information regarding land uses of the sampled areas. This data was gathered in 1978, some eighteen years after the first information source.

3. To compare land use changes of RWD areas to land use changes in associated control areas.

The intent here is to measure the differences in land uses within and away from rural water districts sampled.

4. To recommend appropriate approaches to reduce the conversion of present agricultural land to non-agricultural purposes.

The intent is to provide legislative agencies, and others, insights into how the flow of agricultural land to other uses may be reduced where deemed necessary.

Methodology

Within three sub-state planning districts[31] a sampling of water districts were chosen by the author to be representative of the

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[31] A sub-state planning district is a cluster of counties grouped together for the purpose of greater than local planning efforts.

character of the state of Oklahoma and to provide the basis for land use analysis (see Figure 1-1). These three are: District #1, Northeastern Counties of Oklahoma (NECO), representing northeastern Oklahoma; District #3, Kiamichi Economic District of Oklahoma (KEDO), representing southeastern Oklahoma; and District #9, Association of South Central Oklahoma Governments (ASCOG), representing western Oklahoma.

The sample was subjected to certain limitations. First, since the focus is on rural land use change, the districts from which samples were to be chosen had to be predominantly rural; i.e., all rural water districts serving incorporated towns, whether in total or where the town was the major user of the water system, measured in miles of water line, were eliminated. Secondly, only those districts in operation prior to 1971 were considered. Districts developed since that time were felt to show too little land use change due to their recent development. The year 1971 is the earliest possible date that will insure inclusion of all three sub-state planning districts since some sections of Oklahoma have only recently begun to acquire rural water district services.

Within the rural water districts under study, attention was focused on an area one-half mile either side of the main trunk water lines. The Oklahoma Rural Water Association considers a distance of one-fourth mile either side of the main trunk lines as serviceable, the cost of supplying water to homes beyond this limit being prohibitive.[32]

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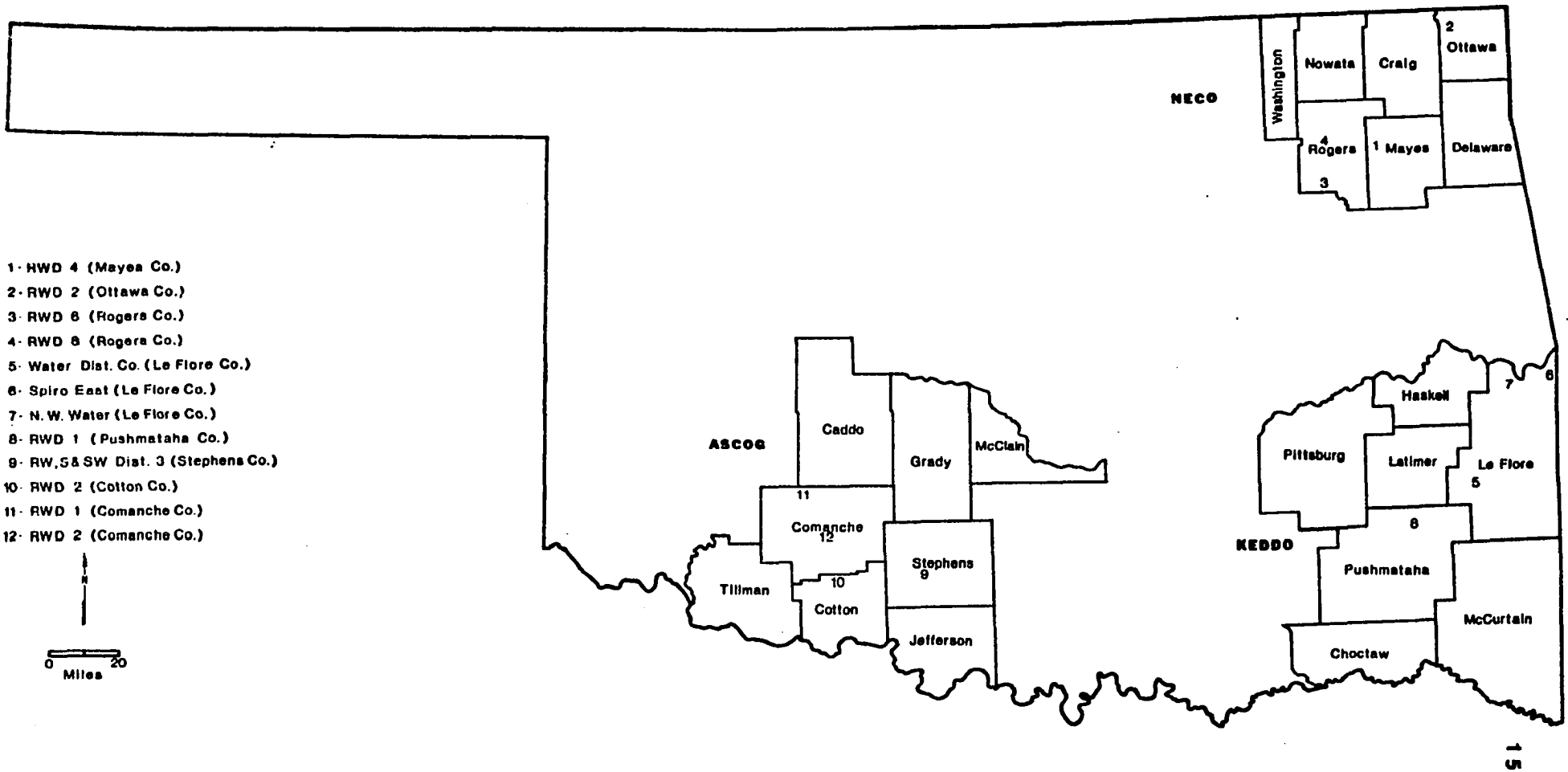
[32]R. K. Johnson, Oklahoma Rural Water Report, Phase I (Duncan, Oklahoma, 1975), p. 23.

Figure 1.1
Oklahoma Sub-State
Planning Regions



By extending the study area another one-fourth mile, any indirect impacts or exceptions to the one-fourth mile limit may be incorporated. The districts were then divided into one mile squares for sampling purposes.

In accordance with the above limitations, a random sample of forty land use units, each one mile square (one-half mile either side of the main trunk water line) was chosen from each selected sub-state planning district. A total of one hundred and twenty square miles of rural water district land was studied to determine land use change.

An associated control area was needed to insure that differential land uses found could be attributed, for the most part, to the presence of the rural water district. A similar random sample of the remaining (after all rural water district areas have been omitted) contiguous land use units was extracted to undergo the same analysis as the rural water district sample. (These are denoted in the text to follow as associated control areas.)

More specifically, samples were drawn in the following manner. Using a map of the county road system for each selected study area, the location of each rural water district line of service was plotted. Each square mile subject to sampling (one-half mile either side of the water line mains) was numbered and subject to random selection for analysis. The RWD samples were then extracted. Also, within each rural water district all mile land units (one-half mile either side of existing county roads) not numbered for possible selection as RWD units were then enumerated for random sampling of the associated control area. These units were all greater than one-half mile away from RWD

lines of service and therefore not subject to the same developmental influences as land units in the RWD lines of service. A number of sample units equal to that extracted for each RWD was chosen.

The collection of basic data from the sampled study areas for land use change analysis was then undertaken. Two sources of data were acquired. For the most current land use information, analysis of the most recent aerial photographs available from county Agricultural Stabilization and Conservation Service (A.S.C.) offices of the U.S.D.A. were updated and corrected by automobile reconnaissance, field mapping, and by records of the County Assessor's offices for land ownership.

Historical information for the pre-rural water district period was also needed. This information was also extracted from aerial photographs acquired from the Agricultural Stabilization and Conservation Service (A.S.C.) and from the Soil Conservation Service (SCS) offices of the U.S.D.A. of each study county. In addition, some photographs of the appropriate time period were found in the map library in the Oklahoma State University library.

Each land unit sampled was then submitted for land use analysis, based on nine identifiable land use types: rural residential, cultivated land, pasturage, woodland, extractive, transportation, commercial, recreational, and urban residential. Each different land use type was identified from the aerial photograph and measured by means of a planimeter, using standard procedures for error elimination. Again, this data was supplemented by automobile reconnaissance at which time each sample unit was field mapped for updating purposes.

The sample units for each study area were analyzed in a before and after method. Since nine possible land use classes were employed, there was the chance of 81 land use category changes; i.e., cropland to residential, pasture to cropland, woodland to cropland, etc. This research provides information regarding net land use in each of the nine categories and detailed movements of land between categories.

An estimation of impact of rural water district construction requires the determination of land use change. An efficient method by which this may be approached is through transition matrix analysis.[33] This requires summarizing the change from each land use category to every other category for the two time periods, with final analysis consisting of a summation of the sampled areas.

Three levels of analysis are possible by the construction of such a transition matrix for each stage of accumulative progression; i.e., the individual rural water district, the set of rural water districts within each sub-state planning area, and finally, the total of all sampled areas. These transition matrices indicate actual direction of land use change on each of these levels.

Organization of the Study

The results of this study are found in the following chapters. Chapter II presents a background discussion of water usage and water problems, and describes the development of the rural water district institution both nationally and in Oklahoma. Chapter III describes the

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[33]Kathryn Zelmetz, et al., Dynamics of Land Use in Fast Growth Areas, Economic Research Service (United States Department of Agriculture, Agricultural Economic Report No. 325, 1976).

data regarding actual land uses of the period prior to RWD development and the present period, in both the RWD areas and the control areas. Chapter IV consists of an analysis of the land use changes discovered in the description of characteristics of the two time periods. Chapter V summarizes the observed land use change patterns and presents recommendations regarding future policy for the Oklahoma Rural Water Association and other agencies concerned with rural planning.

CHAPTER II

WATER SUPPLY IN RURAL AMERICA

Rural water service has often not been perceived as one of the pressing needs of America. It was perhaps assumed by government officials and planners alike that these necessities had adequately been made available long ago. Today, rural community development has been receiving much higher precedence as a matter of national and state priority.[1] Rural interest has become quite the fashion on many levels. At the national level, there is now a Rural Caucus in the Congress; and at least two cabinet departments, Agriculture and Labor, are actively promoting rural development. This trend also extends to the subcabinet level. In the United States Department of Agriculture (U.S.D.A.), the position of Assistant Secretary for Rural Development has been formed (1963), and it now looms as a position of importance for the first time. The nation now seems to be serious about rural development.

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[1] An excellent example of this new found interest is the report of the National Demonstration Water Project, Drinking Water Supplies in Rural America (Washington, D.C., 1978). This report is the result of the Safe Drinking Water Act of 1974 (P.L. 93-523) which required the U.S. Environmental Protection Agency to conduct a survey of the quantity, quality, and availability of rural water supplies.

At this time no one really knows the status of water service development in rural America. The 1970 Census was the most extensive ever completed; however, it gives only partial information regarding such service and development. No comprehensive water survey has as yet been completed which one might consult for such basic information.

Rural America[2]

Population

"Rural" according to the United States Bureau of the Census includes all incorporated or unincorporated communities with populations less than 2,500, plus scattered individual dwellings.[3] There were then, based on this definition, some 53,886,996 people living within rural areas in 1970.[4] This accounts for approximately 26.5 percent of the total United States population.

Table 2-1 gives a breakdown of the rural and urban population for each of the states, and Table 2-2 gives a breakdown of the rural and urban population for each census region. In 1970 there were a total of 68,679,030 housing units in the United States, of which 18,536,429 (27%) were defined by the United States Bureau of the Census as being located in rural areas.[5]

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[2]Much of this section is based on Drinking Water Supplies in Rural America: An Interim Report, prepared by the National Demonstration Water Project under a grant from the U.S. Environmental Protection Agency, January, 1977.

[3]U.S. Bureau of the Census, Census of the Population: Summary, Vol. 1, (Department of Commerce, 1970).

[4]Ibid.

[5]"Domestic Water Use from Non-Central Systems," 1975 National Water Assessment, (U.S. Department of Agriculture, Soil Conservation Service, Special Projects Division, 1975).

TABLE 2-1

POPULATION BY STATE (1970)

State	Total	Urban	%	Rural	%
Alabama	3,444,165	2,011,941	58.4	1,423,224	41.3
Alaska	300,392	145,512	48.4	154,870	51.6
Arizona	1,770,900	1,408,864	79.6	362,036	20.4
Arkansas	1,923,295	960,865	50.0	962,430	50.0
California	19,953,134	18,136,045	90.9	1,817,089	9.1
Colorado	2,207,259	1,733,311	78.5	473,948	21.5
Connecticut	3,031,709	2,345,052	77.4	686,657	22.6
Delaware	548,104	395,569	72.2	152,535	27.8
Florida	6,789,443	5,468,137	80.5	1,321,306	19.5
Georgia	4,589,575	2,768,074	60.3	1,821,501	39.7
Hawaii	768,561	638,683	83.1	139,878	16.9
Idaho	712,576	385,434	54.1	327,133	45.9
Illinois	11,113,976	9,229,821	83.0	1,884,155	17.0
Indiana	5,193,669	3,372,060	64.9	1,821,609	35.1
Iowa	2,824,376	1,616,405	57.2	1,207,971	42.8
Kansas	2,246,578	1,484,870	66.1	761,708	33.9
Kentucky	3,218,706	1,684,053	52.3	1,534,653	47.7
Louisiana	3,641,306	2,406,150	66.0	1,235,156	33.9
Maine	992,048	504,157	50.8	487,891	49.2
Maryland	3,922,399	3,003,935	76.6	918,464	23.4
Massachusetts	5,689,170	4,810,449	84.6	878,721	15.4
Michigan	8,875,083	6,553,773	73.8	2,321,663	26.2
Minnesota	3,805,069	2,527,308	66.4	1,277,663	33.6
Mississippi	2,216,912	986,642	44.6	1,230,270	55.5
Missouri	4,676,501	3,277,662	70.1	1,398,839	29.9
Montana	694,409	370,676	53.4	323,733	46.6
Nebraska	1,483,493	912,598	61.5	570,895	38.5
Nevada	488,738	395,336	80.9	93,402	19.1
New Hampshire	737,681	416,040	56.4	321,641	43.6
New Jersey	7,168,164	6,373,405	88.9	794,759	11.1

TABLE 2-1 (Continued)

State	Total	Urban	%	Rural	%
New Mexico	1,016,000	708,775	69.8	307,225	30.2
New York	18,236,979	15,602,480	85.6	2,634,481	14.4
North Carolina	5,082,059	2,285,168	45.0	2,796,891	55.0
North Dakota	617,761	273,442	44.3	344,319	55.7
Ohio	10,652,017	8,025,775	75.3	2,626,242	24.7
Oklahoma	2,559,229	1,740,137	68.1	819,092	31.9
Oregon	2,091,385	1,402,704	67.1	688,681	32.9
Pennsylvania	11,793,909	8,430,410	71.5	3,363,499	28.5
Rhode Island	946,725	824,930	87.1	121,795	12.9
South Carolina	2,590,516	1,232,195	47.6	1,358,321	52.4
South Dakota	665,507	296,628	44.6	368,879	55.4
Tennessee	3,923,687	2,305,307	58.8	1,618,380	41.2
Texas	11,196,730	8,920,946	79.7	2,275,784	20.3
Utah	1,059,273	851,472	80.4	207,801	19.6
Vermont	444,330	142,889	32.2	301,441	67.8
Virginia	4,648,494	2,934,841	63.1	1,713,653	36.9
Washington	3,409,169	2,476,468	72.6	932,701	27.4
West Virginia	1,744,237	679,491	40.1	1,064,746	59.9
Wisconsin	4,417,731	2,910,418	65.9	1,507,313	34.1
Wyoming	332,416	201,111	60.5	131,305	39.5
Total	202,176,609	148,289,610	73.3	53,886,996	26.7

Source:

U.S. Bureau of the Census, 1970 Census of Housing, Special Reports (Department of Commerce, 1970).

TABLE 2-2

POPULATION BY CENSUS REGION WITH URBAN/RURAL BREAKDOWN*
(See Figure 2-1)

Region	Total	Urban	%	Rural	%
Northeast	49,040,703	39,449,818	80.4	9,590,885	19.6
North Central	56,571,663	40,480,760	71.6	16,090,903	28.4
South	62,795,367	40,539,961	64.6	22,255,406	35.4
West	34,804,193	28,854,391	82.9	5,949,802	17.1

*Rural includes all communities up to 2,500 people under the Census definition.

Source:

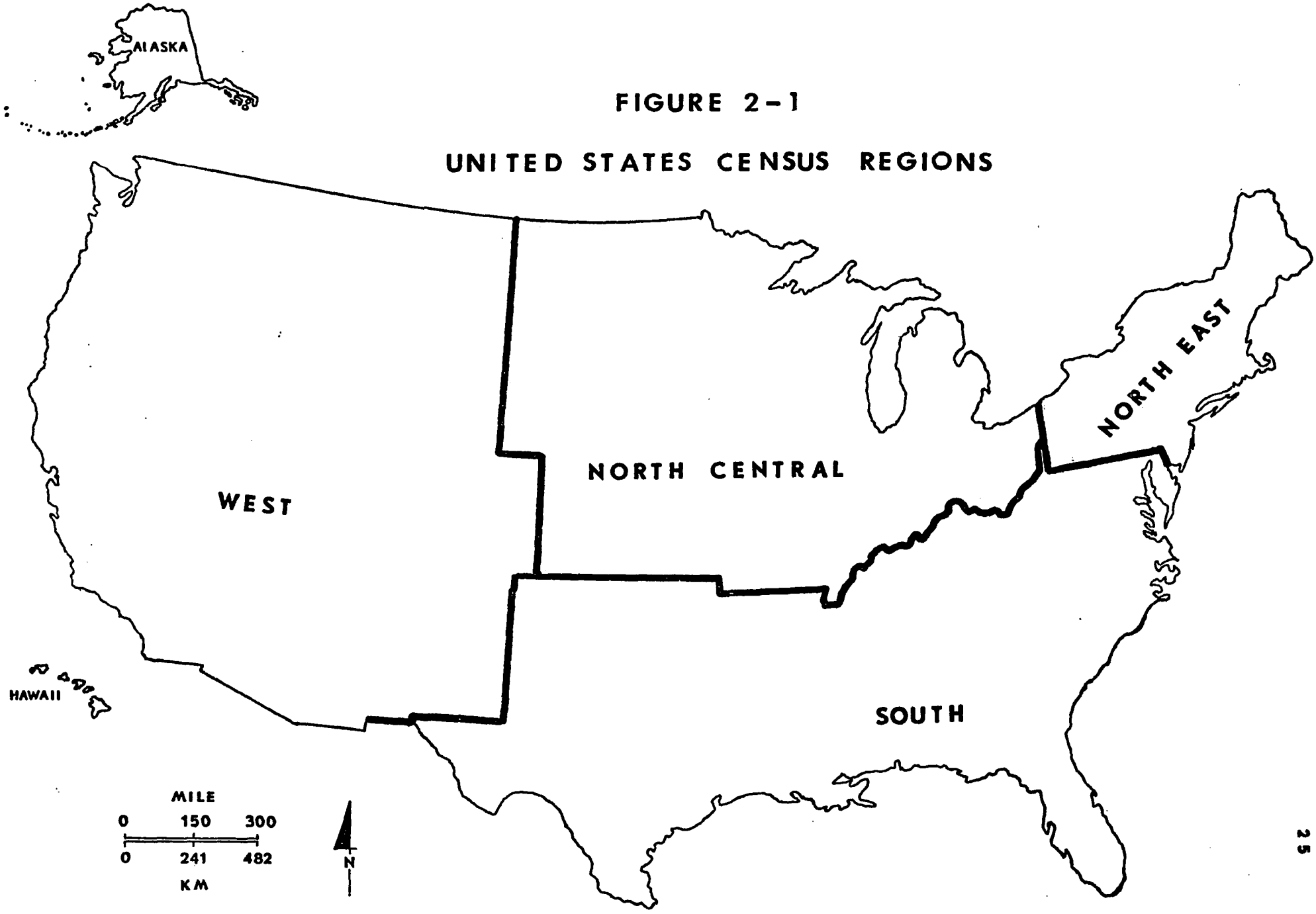
U.S. Bureau of the Census, 1970 Census of Housing, Special Reports (Department of Commerce, 1970).

Based on 1970 tabulations, the largest regional rural population in the nation, 22,255,406 people, is found in the South, as defined by the U.S. Bureau of the Census (Figure 2-1). This accounted for over 41 percent of the southern population. The North Central region also included a high rural population. The Census indicated some 16,090,930 in rural population. Smaller numbers were found in the West and Northeast. Some states in these latter regions, however, have relatively high percentages of rural population, such as Vermont and Alaska.

A definition of rural which differs from that of the Census Bureau is employed by the Farmers Home Administration (FmHA), under its rural community facilities program. This agency defines "rural" as

FIGURE 2-1

UNITED STATES CENSUS REGIONS



including communities up to 10,000 in population. Under this definition there are approximately 75,000,000 Americans living in rural areas. This represents about 37 percent of the total United States population.[6]

Rural Water Situation

The 1970 Census gives some estimates regarding certain characteristics of the rural water situation. This survey reported that there were 1,152,531 housing units in the United States without running water facilities. The vast majority of these, over 91 percent, were located in Census Bureau defined rural areas, i.e., communities with less than 2,500 population. A total of 3,572,846 people lived in housing without running water; of this total, only 300,423 lived in urban areas.[7]

The Soil Conservation Service (U.S.D.A.) in 1975 estimated the number of people inhabiting housing without running water as closer to 6 million, the vast majority of these in rural areas.[8] Converting these figures to correspond to the Census Bureau definition of rural, approximately 5.5 million rural residents do not live in housing with running water.

An additional characteristic surveyed by the 1970 Census had to do with plumbing facilities. The Census Bureau defines housing with

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[6]U.S. Bureau of the Census, loc. cit.

[7]U.S. Bureau of the Census, 1970 Census of Housing, Subject Reports, Geographic Aspect of Housing Inventory (Department of Commerce, 1970).

[8]"Domestic Water Use from Non-Central Systems," loc. cit.

inadequate plumbing as that which lacks running water, a flush toilet, or a shower (or both). Housing units lacking any one of these facilities were described as having incomplete plumbing.

Table 2-3 gives totals for the number of housing units in each state, and provides a breakdown of the number of urban and rural housing units that lack complete plumbing. In 1970 there were a total of 53,886,996 people living in rural America, of which 9,106,902 were without complete plumbing facilities.[9]

It is apparent that lack of plumbing is a problem of rural America. Only 3.4 percent of urban housing units lack adequate plumbing, while almost 17 percent of rural housing units lack adequate plumbing. Rural America comprises only 26.5 percent of total United States population, yet 64 percent of the housing without complete plumbing is located in rural areas.[10] If the broader Farmers Home Administration definition of rural (less than 10,000 population) were used, this figure would be even higher.

In 1975 the Economic Research Service of the U.S.D.A. estimated that there were 274,550 housing units in communities of 2,500 to 10,000 persons that lacked complete plumbing.[11] When this figure is added to the Census figure, a total of 3,256,739 housing units in rural areas

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[9]U.S. Bureau of the Census, 1970 Census of Housing, Special Reports, Plumbing Facilities and Estimates of Dilapidated Housing (Department of Commerce, 1970).

[10]Ibid.

[11]Ronald E. Kampe, "Household Income - How It Relates to Substandard Housing in Rural and Farmers Home Administration Areas, by State and Race, 1970," Agricultural Economic Report No. 287 (U.S. Department of Agriculture, Economic Research Service, 1975).

TABLE 2-3

HOUSING UNITS LACKING COMPLETE PLUMBING
1970

State	Number Housing Units	Without Complete Plumbing	%
Alabama	1,114,845	188,363	16.9
Urban	657,617	46,767	7.1
Rural	457,228	141,596	31.0
Alaska	88,555	15,162	17.1
Urban	43,752	1,152	2.6
Rural	44,803	14,010	31.3
Arizona	579,573	30,196	5.2
Urban	461,718	11,497	2.5
Rural	117,855	18,699	15.9
Arkansas	672,967	123,694	18.4
Urban	339,016	28,981	8.5
Rural	333,951	94,713	28.4
California	6,976,261	143,676	2.1
Urban	6,325,287	107,443	1.7
Rural	650,974	36,233	1.0
Colorado	742,858	36,721	4.9
Urban	573,399	16,795	2.9
Rural	169,459	19,926	11.8
Connecticut	968,815	25,842	2.7
Urban	761,598	19,893	2.6
Rural	207,217	5,949	2.9
Delaware	174,990	8,856	5.1
Urban	123,513	2,215	1.8
Rural	51,477	6,641	1.3
Florida	2,490,838	127,423	5.1
Urban	2,016,393	75,739	3.8
Rural	474,445	51,794	10.9
Georgia	1,466,687	193,748	13.2
Urban	896,203	57,049	6.4
Rural	570,484	136,699	24.0

TABLE 2-3 (Continued)

State	Number Housing Units	Without Complete Plumbing	%
Hawaii	215,892	12,041	5.6
Urban	178,814	6,231	3.5
Rural	37,078	5,810	15.7
Idaho	238,293	12,619	5.3
Urban	129,662	3,679	2.8
Rural	108,631	8,940	8.2
Illinois	3,692,447	176,955	4.8
Urban	3,017,884	106,465	3.5
Rural	620,563	70,490	1.1
Indiana	1,711,896	110,681	6.5
Urban	1,126,139	44,860	4.0
Rural	585,757	65,821	11.2
Iowa	954,975	71,820	7.5
Urban	550,247	27,747	5.0
Rural	404,728	44,073	10.9
Kansas	787,508	43,855	5.6
Urban	513,453	13,942	2.7
Rural	274,055	29,913	10.9
Kentucky	1,060,689	220,646	20.8
Urban	557,295	28,067	5.0
Rural	503,394	192,579	38.3
Louisiana	1,146,105	132,191	11.5
Urban	769,530	44,305	5.8
Rural	376,575	87,886	23.3
Maine	339,440	52,015	15.3
Urban	167,484	12,994	7.8
Rural	171,956	39,021	22.7
Maryland	1,234,680	54,770	4.4
Urban	958,566	16,263	1.7
Rural	276,114	38,507	13.9
Massachusetts	1,839,019	65,721	3.6
Urban	1,568,745	55,531	3.5
Rural	270,274	10,190	3.8

TABLE 2-3 (Continued)

State	Number Housing Units	Without Complete Plumbing	%
Michigan	2,845,448	123,827	4.4
Urban	2,079,439	47,614	2.3
Rural	766,009	76,213	9.9
Minnesota	1,219,591	99,460	8.2
Urban	812,248	33,352	4.1
Rural	407,343	66,108	16.2
Mississippi	697,271	169,362	24.3
Urban	320,081	34,350	10.7
Rural	377,190	135,012	35.8
Missouri	1,665,506	161,867	9.7
Urban	1,141,001	49,408	4.3
Rural	524,505	112,459	21.4
Montana	240,755	21,746	9.0
Urban	128,414	6,606	5.1
Rural	112,341	15,140	13.5
Nebraska	511,473	31,305	6.1
Urban	309,243	9,651	3.1
Rural	202,230	21,654	10.7
Nevada	171,658	5,485	3.2
Urban	137,367	2,855	2.1
Rural	34,291	2,630	7.7
New Hampshire	248,799	17,403	7.0
Urban	136,063	5,482	4.0
Rural	112,736	11,921	10.6
New Jersey	2,305,293	57,917	2.5
Urban	2,048,505	47,971	2.3
Rural	256,788	9,946	3.9
New Mexico	322,294	34,226	10.6
Urban	228,078	7,586	3.3
Rural	94,216	26,640	28.3
New York	6,159,314	195,165	3.2
Urban	5,323,904	137,898	2.6
Rural	835,410	57,267	6.9

TABLE 2-3 (Continued)

State	Number Housing Units	Without Complete Plumbing	%
North Carolina	1,619,548	252,319	15.6
Urban	732,436	44,909	6.1
Rural	887,112	207,410	23.4
North Dakota	200,465	27,635	13.8
Urban	84,032	4,235	5.0
Rural	116,433	23,400	20.1
Ohio	3,447,860	178,108	5.2
Urban	2,646,606	75,185	2.8
Rural	801,254	102,923	12.8
Oklahoma	937,815	66,426	7.1
Urban	633,445	18,885	3.0
Rural	304,370	47,541	15.6
Oregon	735,631	26,425	3.6
Urban	504,493	14,180	2.8
Rural	231,138	12,245	5.3
Pennsylvania	3,880,102	198,605	5.1
Urban	2,822,127	90,084	3.2
Rural	1,057,975	108,521	10.3
Rhode Island	307,309	9,646	3.1
Urban	272,685	7,569	2.8
Rural	34,624	2,077	6.0
South Carolina	804,858	149,300	18.5
Urban	389,180	38,207	9.8
Rural	415,678	111,093	26.7
South Dakota	221,636	30,059	13.6
Urban	96,158	4,863	5.1
Rural	125,478	25,196	20.1
Tennessee	1,297,000	192,543	14.8
Urban	763,626	35,984	4.7
Rural	533,374	156,559	29.4
Texas	3,890,086	291,383	7.5
Urban	2,965,688	132,715	4.5
Rural	843,398	158,668	18.8

TABLE 2-3 (Continued)

State	Number Housing Units	Without Complete Plumbing	%
Utah	311,982	8,557	2.7
Urban	250,362	4,068	1.6
Rural	61,620	4,489	7.3
Vermont	149,762	12,454	8.3
Urban	46,834	1,737	3.7
Rural	102,928	10,717	10.4
Virginia	1,484,952	199,317	13.4
Urban	939,375	32,272	3.4
Rural	545,577	167,045	30.6
Washington	1,204,092	41,510	3.4
Urban	878,748	22,623	2.6
Rural	326,154	18,887	5.8
West Virginia	592,845	108,678	18.3
Urban	243,118	9,664	4.0
Rural	349,727	99,014	28.3
Wisconsin	1,416,427	101,372	7.2
Urban	932,147	34,407	3.7
Rural	484,280	66,965	13.8
Wyoming	114,572	6,719	5.9
Urban	69,107	1,760	2.5
Rural	45,465	4,959	10.9

Source:

U.S. Bureau of the Census, 1970 Census of Housing, Special Reports, Plumbing Facilities and Estimates of Dilapidated Housing (Department of Commerce, 1970).

lack complete plumbing. This would be almost 70 percent of the total deficient housing in the United States.

Table 2-4 ranks the states by number of households lacking complete plumbing. North Carolina leads all states in households lacking complete plumbing with 207,410. This is followed by eleven other states, each with in excess of 100,000 units lacking complete plumbing facilities. Most of these high ranking states are in the South, Midwest and Appalachia (Table 2-4).

When states are ranked by percentage, as in Table 2-5, Southern and Appalachian states again rank consistently at the top. North Carolina, however, drops from first to twelfth position, and Kentucky has the highest percentage of rural residents living in substandard (for plumbing) housing--over 36 percent.

In October of 1968 the U.S.D.A. completed a survey to identify the long-range needs for water and water disposal systems in the United States.[12] This survey covered a large number of communities of more than 25 inhabitants and classified those communities by size and availability of community-wide water and sewer facilities. Table 2-6 presents some results of this survey, and shows that most communities lacking adequate facilities are the smaller communities. This survey estimated that the total population living in communities not served by public water facilities is around 40 million.

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[12] L. H. Beverly, Status of Water and Sewer Facilities in Communities without Public Systems, Economic Research Service, Agricultural Economic Report No. 143 (U.S. Department of Agriculture, October, 1968), pp. 7 and 16.

TABLE 2-4

RURAL HOUSING UNITS WITHOUT COMPLETE PLUMBING
RANKING BY STATES
(By Number of Units)

1.	North Carolina	207,410	26.	Maryland	38,507
2.	Kentucky	192,579	27.	California	36,233
3.	Virginia	167,045	28.	Kansas	29,913
4.	Texas	158,668	29.	New Mexico	26,640
5.	Tennessee	156,559	30.	South Dakota	25,196
6.	Alabama	141,596	31.	North Dakota	23,400
7.	Georgia	136,699	32.	Nebraska	21,654
8.	Mississippi	135,012	33.	Colorado	19,926
9.	Missouri	112,459	34.	Washington	18,887
10.	South Carolina	111,093	35.	Arizona	18,699
11.	Pennsylvania	108,521	36.	Montana	15,140
12.	Ohio	102,923	37.	Alaska	14,010
13.	West Virginia	99,014	38.	Oregon	12,245
14.	Arkansas	94,713	39.	New Hampshire	11,921
15.	Louisiana	87,886	40.	Vermont	10,717
16.	Michigan	76,213	41.	Massachusetts	10,190
17.	Illinois	70,490	42.	New Jersey	9,946
18.	Wisconsin	66,965	43.	Idaho	8,940
19.	Minnesota	66,108	44.	Delaware	7,641
20.	Indiana	65,821	45.	Connecticut	5,949
21.	New York	57,267	46.	Hawaii	5,810
22.	Florida	51,794	47.	Wyoming	4,959
23.	Oklahoma	47,541	48.	Utah	4,489
24.	Iowa	44,074	49.	Nevada	2,630
25.	Maine	39,021	50.	Rhode Island	2,077

Source:

U.S. Bureau of the Census, 1970 Census of Housing, Special Reports, Plumbing Facilities and Estimates of Dilapidated Housing (Department of Commerce, 1970).

TABLE 2-5

RURAL HOUSING UNITS WITHOUT COMPLETE PLUMBING
RANKING OF STATES
(By Percentage of Units)

1.	Kentucky	38.2	26.	Delaware	13.0
2.	Mississippi	35.8	27.	Ohio	12.9
3.	Alaska	31.3	28.	Colorado	11.9
4.	Alabama	31.0	29.	Illinois	11.4
5.	Virginia	30.7	30.	Indiana	11.2
6.	Tennessee	29.3	31.	Florida	10.9
7.	Arkansas	28.3	31.	Kansas	10.9
7.	New Mexico	28.3	31.	Iowa	10.9
7.	West Virginia	28.3	31.	Wyoming	10.9
10.	South Carolina	26.7	35.	Nebraska	10.7
11.	Georgia	24.0	35.	New Hampshire	10.7
12.	North Carolina	23.4	37.	Vermont	10.5
13.	Louisiana	23.3	38.	Pennsylvania	10.3
14.	Maine	23.0	39.	Michigan	10.0
15.	Missouri	21.5	40.	Idaho	8.2
16.	North Dakota	20.1	41.	Nevada	7.7
16.	South Dakota	20.1	42.	Utah	7.3
18.	Texas	18.8	43.	New York	6.9
19.	Minnesota	16.3	44.	Rhode Island	6.1
20.	Arizona	15.9	45.	Washington	5.8
21.	Hawaii	15.7	46.	California	5.6
22.	Oklahoma	15.6	47.	Oregon	5.3
23.	Maryland	14.0	48.	New Jersey	3.9
24.	Wisconsin	13.9	49.	Massachusetts	3.8
25.	Montana	13.5	50.	Connecticut	2.9

Source:

U.S. Bureau of the Census, 1970 Census of Housing, Special Reports, Plumbing Facilities and Estimates of Dilapidated Housing (Department of Commerce, 1970).

TABLE 2-6

THE AVAILABILITY OF COMMUNITY WATER AND SEWER FACILITIES BY COMMUNITY SIZE

Size of Community	No. with Public Water Facilities	No. without Public Water Facilities	No. with Public Sewer Facilities	No. without Public Sewer Facilities
26 - 99	12,080	34,550	3,803	42,827
1000 - 2499	4,336	134	3,079	1,391
2500 - 5500	2,297	79	2,027	349
over - 5500	3,037	31	9,926	142
Total	21,750	34,794	11,835	44,709

Source:

L. H. Beverly, Status of Water and Sewer Facilities in Communities without Public Systems, Economic Research Service, Agricultural Economic Report No. 143 (U.S. Department of Agriculture, October, 1968), pp. 7 and 16.

An additional aspect of the rural water situation is the type of service received. Water service may be divided into two distinct types: the "centralized" system, where water service is provided to homes through a public or private utility company, and the "non-centralized" system, or self-supplied water service, where water service is supplied to five or fewer households from an individual source. In 1975 it was estimated that 36.4 million Americans, primarily in rural areas, were served by non-central or self-supply water systems.[13] Table 2-7 presents the percentage of the total population served by non-central water supply systems for each of the nation's twenty water resource regions.

[13]"Domestic Water Use from Non-Central Systems," loc. cit.

TABLE 2-7

PERCENT OF TOTAL POPULATION SERVED BY NON-CENTRAL WATER SUPPLY SYSTEMS, 1975 BY WATER RESOURCE REGION

Region	Percentage	Region	Percentage
Souris - Red - Rainy	36	Missouri	18
Tennessee	31	Great Lakes	17
South Atlantic Gulf	26	Middle Atlantic	14
Alaska	26	New England	14
Ohio	24	Rio Grande	14
Lower Mississippi	21	Texas Gulf	11
Upper Mississippi	21	Great Basin	9
Columbia - North Pacific	20	Lower Colorado	7
Upper Colorado	20	California	4
Arkansas - Red - White	19	Hawaii	2

Source:

"Domestic Water Use from Non-Central Systems," 1975 National Water Assessment (U.S. Department of Agriculture, Soil Conservation Service, Special Projects Division, 1975).

The Souris-Red-Rainy region had the highest percentage of non-central systems with 36 percent, due to the sparse population and large supplies of good quality water. The Tennessee Basin has the next highest percentage, with 31 percent of its residents on self-supply systems, probably due to remoteness from major urban centers. Other regions, in order, are the South Atlantic Gulf, Alaska, the Ohio Basin, the lower and upper Mississippi Basins, the upper Colorado, the Columbia Basin, the Arkansas Basin, the Missouri Basin, and the Great Lakes regions, all of which have above 17 percent of their total population served by self-supply water systems.

Another way of viewing water supply systems is whether they are owned and operated by a public governmental organization or private

utility company. The Environmental Protection Agency has conducted a national inventory of all centralized water systems with 15 connections or more by EPA regions (Figure 2-2).[14] Table 2-8 presents the data for those systems serving from 25 to 2,500 people and for those serving 2,500 to 10,000 people. Forty-four percent of the small systems are publicly owned while 85 percent of the larger systems are publicly owned. As the population served increases, system ownership shifts from predominantly private to predominantly public.

TABLE 2-8

OWNERSHIP OF CENTRALIZED WATER SYSTEMS

EPA Region	Number of Systems Serving 25-2,500		Number of Systems Serving 2,500-10,000	
	Public	Private	Public	Private
I	328	1,162	189	48
II	939	2,112	326	46
III	1,148	3,709	416	178
IV	3,192	4,539	867	149
V	2,600	2,906	720	46
VI	2,353	1,981	433	50
VII	2,409	663	300	12
VIII	1,222	250	157	5
IX	772	1,844	224	109
X	766	1,127	138	15
Total	15,729	20,293	3,770	658

Source:

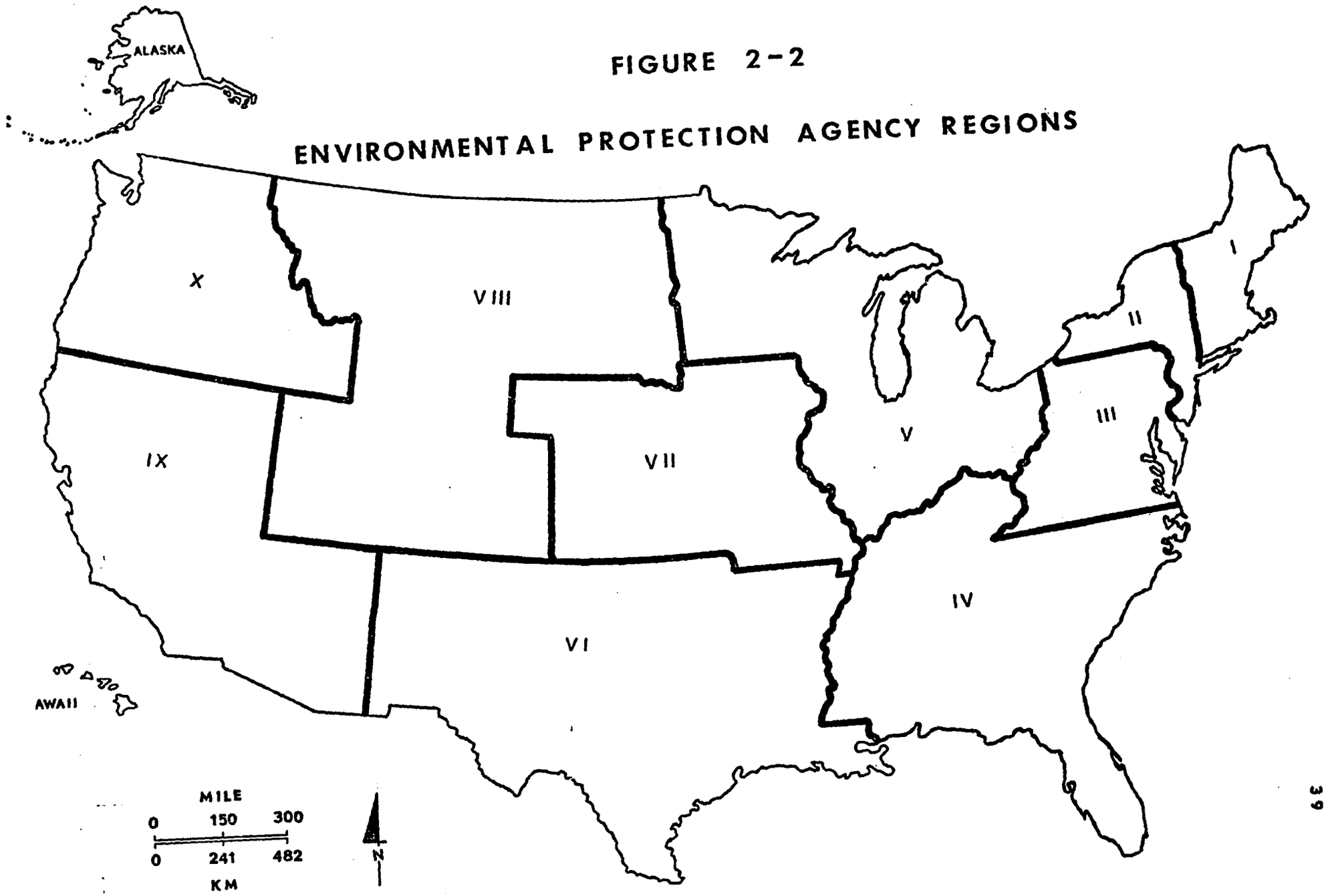
U.S. Environmental Protection Agency, Inventory of Water Supply Systems (Washington, D.C., January, 1979).

One final method of classifying water systems is by their source of water. The United States Geological Survey estimated the

[14]U.S. Environmental Protection Agency, Inventory of Water Supply Systems (Washington, D.C., January, 1976).

FIGURE 2-2

ENVIRONMENTAL PROTECTION AGENCY REGIONS



amount of water used in the United States in 1970.[15] Table 2-9 presents a breakdown of the estimated population served by self-supply and central supply systems by source of water. Ninety-five percent of the people served by self-supply systems obtain their water from groundwater sources while only 37 percent of the people served by

TABLE 2-9

ESTIMATED POPULATION SERVED BY SOURCE OF WATER (1970)
(Population in Thousands)

	Central Supplies		Self Supply	
Water Resource Region	Ground Water	Surface Water	Ground Water	Surface Water
New England	2,720	7,360	1,410	30
Middle Atlantic	8,670	24,900	4,811	20
South Atlantic Gulf	7,960	6,560	8,735	190
Great Lakes	4,000	19,400	5,500	203
Ohio	4,710	10,300	4,444	555
Tennessee	532	1,550	1,130	22
Upper Mississippi	6,350	4,530	1,765	88
Lower Mississippi	3,170	1,260	1,828	7
Souris/Red/Rainy	192	209	405	2
Missouri	2,850	3,860	1,617	162
Arkansas/White/Red	1,780	3,160	1,625	105
Texas Gulf	3,970	3,950	1,579	0
Rio Grande	876	499	234	8
Upper Colorado	80	116	174	34
Lower Colorado	1,220	576	427	0
Great Basin	546	558	107	2
Columbia/North Pacific	1,840	2,800	1,615	213
California	8,030	10,700	1,193	86
Alaska	62	64	130	46
Hawaii	662	32	15	61
Total U.S.	60,220	102,284	38,744	1,834

Source:

Estimated Use of Water in the United States in 1970. Circular 676 (U.S. Department of the Interior, Geological Survey, 1972).

[15] Estimated Use of Water in the United States in 1970. Circular 676 (U.S. Department of the Interior, Geological Survey, 1972).

central systems obtain their water from that source. Groundwater, then, is the primary source of water for rural communities. The existing rural water facilities in terms of type are summarized in Table 2-10.

TABLE 2-10

SUMMARY OF CURRENT RURAL WATER FACILITIES

	Self-Supplied Systems	Central Systems Serving 25-2,500	Central Systems Serving 2,500-10,000
Number of facilities	8,450,000	36,022	4,428
Population served	40,578,000	15,494,000	21,317,000
Population served by groundwater	28,744,000	12,150,000	12,800,000
Population served by surface water	1,834,000	1,922,000	5,307,000
Population served by more than one source	-0-	1,422,000	3,210,000
Number of public facilities	*	15,729	3,770
Number of private facilities	8,450,000	20,293	658

*All self-supplied systems were assumed to be privately owned. No data could be found, however, to substantiate this assumption.

Source:

Estimated Use of Water in the United States in 1970. Circular 676 (U.S. Department of the Interior, Geological Survey, 1972).

Farmers Home Administration

Since 1939 the United States Department of Agriculture has been authorized to provide financial assistance for the building of both

water supply and waste disposal facilities to needy rural communities. This authority was first given through the Farm Security Administration and, since 1946, through the Farmers Home Administration (FmHA).[16]

The original program involved only long-term loans to applicant communities, but in 1965 Congress added a grant program to the existing loan program in order to provide assistance to communities whose needs could not be met entirely by loans. This legislation and the latest amending legislation, the Rural Development Act of 1972, expanded the coverage in terms of community size to make more rural communities eligible for assistance.[17]

From 1965 through 1975, some 7,500 rural water and sewer systems, ranging in coverage from small local communities to inter-community or multicounty areas, received commitments of financial assistance. The FmHA now provides for about 1,400 new systems or system improvements each year.[18]

The legislation authorizing the FmHA grant program, a program to provide funds to appropriate communities for water and sewer system development, includes three specific constraints: first, eligible projects must serve "rural" areas; second, FmHA grant funds may not be used to pay more than 50 percent of the development costs of any

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[16] FmHA Management Capability. Joint Hearing before the Subcommittee on Rural Development of the Committee on Agriculture and Forestry, United States Senate, and the Subcommittee on Conservation and Credit, Committee on Agriculture, U.S. House of Representatives. 94th Congress, 2nd Session. January 27-29 and February 4-5, 1976, p. 259.

[17] Ibid.

[18] Ibid.

project; and third, grants to all such projects in any given year may not exceed $300 million.[19]

When one reviews the legislative history applicable to the grant provisions, it can be seen that Congress had several long-term objectives in mind. First, grants were to help rural communities maintain sanitary and healthful living conditions. Congressman Redlin in House Hearings in 1965 said that:

> . . . the importance of maintaining sanitary and healthful living conditions is well understood by my colleagues. Recent legislation to facilitate these conditions has been aimed primarily at urban and suburban areas. As a representative of one of the most rural congressional districts, I wish to voice my support for new programs tailored for the specialized conditions of rural agricultural areas.[20]

A second objective was to help needy rural communities realize their full economic potential, by improving water and sewer facilities. Congressman Bandstra of Iowa, testifying at Senate Hearings in 1965, said:

> S. 1766, in addition to expanding the existing loan program, would provide the FmHA with the authority to make Federal grants for the development of water systems in rural areas to non-profit corporations and public or quasi-public agencies. These grants would be an excellent investment. Water is a basic necessity for any community, but it is also essential for economic growth. Lacking a good water supply, many rural communities are without a sound financial base; and, lacking a sound financial base, they are without the economic resources to obtain a good water supply system. A program of federal grants for rural water development is the most promising method of solving the dilemma.[21]

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[19] P.L. 92-419, Title I, Sec. 108.

[20] Water Supply Systems and Insured FHA Loans, Hearings, Senate Committee on Agriculture and Forestry, 1965, p. 10.

[21] Loans for Water Supply and Sewage Disposal, Hearings, House Committee on Agriculture, 1965, pp. 25-26.

A third objective was urban-rural parity. The House Report accompanying the Rural Facilities Act of 1965 includes this declaration:

> The Congress has approved legislation providing Federal Assistance to urban political bodies to provide adequate water and sanitation facilities for city people. Rural citizens have the same need and are entitled to the same kind and degree of assistance and the purpose of this bill is to provide substantially the same kind and degree of assistance to rural areas in developing adequate water and sanitation facilities as is now available to citizens of urban areas.[22]

A final objective was to make the cost of rural water-sewer services affordable. In fact, the specific rationale offered to Congress for the grant program since its inception in 1965 has been that it was to provide assistance to communities that could not afford to pay the entire cost of needed water and sewerage systems.[23] Repeatedly, Congress has endorsed FmHA assurances that these grant funds would be utilized with the objective of establishing water and sewer facilities at an affordable cost to rural users.[24]

Under this legislation, the Farmers Home Administration may make grants and loans for construction of works for development, storage, treatment, purification or distribution of water. Eligibility, according to the legislation, is restricted to associations, including non-profit corporations, Indian tribes, and public and quasi-

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[22] House Report No. 847, Committee on Agriculture, U.S. House of Representatives, August 24, 1965, p. 2.

[23] 1968 U.S. Congress and Administrative News, p. 3369.

[24] Hearings, Subcommittee of Committee on Appropriations, U.S. House of Representatives, 93rd Congress, 2nd Session, Part 3, p. 604.

public agencies. Agency regulations are somewhat more specific and interpret the law relating to eligibility as including municipalities, counties, other political subdivisions of a state: districts, cooperatives, and corporations operated on a non-profit basis.[25]

The facilities funded by FmHA must serve, and be located in, a rural area, as defined earlier. Even though facilities must be rural, projects serving both rural and urban populations may be proposed, in which case funding is limited to the rural portion of the project.

According to the statutes, funded water projects may include facilities providing central service, service to individuals, or both. Under current FmHA regulation, the applicant project must propose central domestic water facilities; however, it is not clear whether these regulations allow for FmHA funding of non-central systems.

Applicant projects for grant funds must also be designed so that they are consistent with a comprehensive community water, waste disposal, or other development plan. They must not be inconsistent with any planned development provided in any approved state, multi-jurisdictional county, or municipal plan. No loan funds may be made available to a project which is inconsistent with any multijurisdictional planning and development district's area-wide plan. The FmHA may also make grants to public bodies, and other agencies having the authority to prepare comprehensive plans for the development of water or wastewater disposal systems in rural areas. A rural area is, again,

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[25]Norman C. DeWeaver and Helen Lichtenstein, "Federal Financing of Rural Water-Sewer Facilities," (unpublished study by National Demonstration Water Project, Washington, D.C., 1977), p. 7.

defined as an area which does not contain a city or town larger than 10,000 persons.

In order to qualify for planning grants, the applicant organization must not have the resources immediately available to finance the planning for which the grant is proposed. As a prerequisite to awarding the grant, the state FmHA director must examine the application to determine also that the area in question is the logical one for treatment as a comprehensive area. Provision is made in the regulations for coordination with, and consideration of, relevant comprehensive and special use plans for the area.

Rural Water Districts

The first rural water system loan in Oklahoma was made by FmHA in 1964 to Rural Water District No. 1, Nowata County. Since then the Oklahoma Rural Water Program has accelerated at an incredible pace, as of 1977 the FmHA making loans and grants to 521 rural water districts, non-profit companies and public trusts within the state, totaling $127,229,650.[26]

The 1974 Field Survey Records of the Oklahoma Rural Water Association reflect the following facts:[27]

(1) In 1974, there were 261,356 rural water users on rural water systems (more than 10% of Oklahoma's total populations).

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[26]Glenn E. Laughlin and Sidney D. Williams, 1977 Oklahoma Rural Water Report, Phase II (Duncan, Oklahoma, 1977), p. 12.

[27]R. K. Johnson, Oklahoma Rural Water Report, Phase I (Duncan, Oklahoma, 1975), p. 23.

(2) More than 13,870 miles of rural water transmission and distribution lines had been constructed throughout Oklahoma rural areas.

In addition, the 1974 report indicated that rural water systems were experiencing an average annual growth rate of over 12 percent. These statistics indicate that the Oklahoma Rural Water Program has stimulated an insatiable demand for financing and construction of these projects, as well as producing a significant drain upon the water resources of the state.[28]

Figure 2-3 depicts a characteristic rural water system. This is Rural Water District No. 1 of Comanche County, Oklahoma consisting of approximately 120 square miles. Within this RWD are found almost fifty miles of main trunk line and an additional 150 miles of lateral water line. There are approximately 700 billing units represented, serving some 2000 residents. The water source for this district is Lake Latonka located in the south central portion of the district. (Other water districts in the state utilize wells and even tap onto urban water systems for their water sources.) A single water storage tower is located almost two miles to the north of the lake.

Rural water districts in Oklahoma are non-profit organizations for the purpose of providing water to rural communities and small towns. The primary purpose of such an organization is to finance, construct, and operate a public water system for members of the district. The system is owned and operated by the membership,

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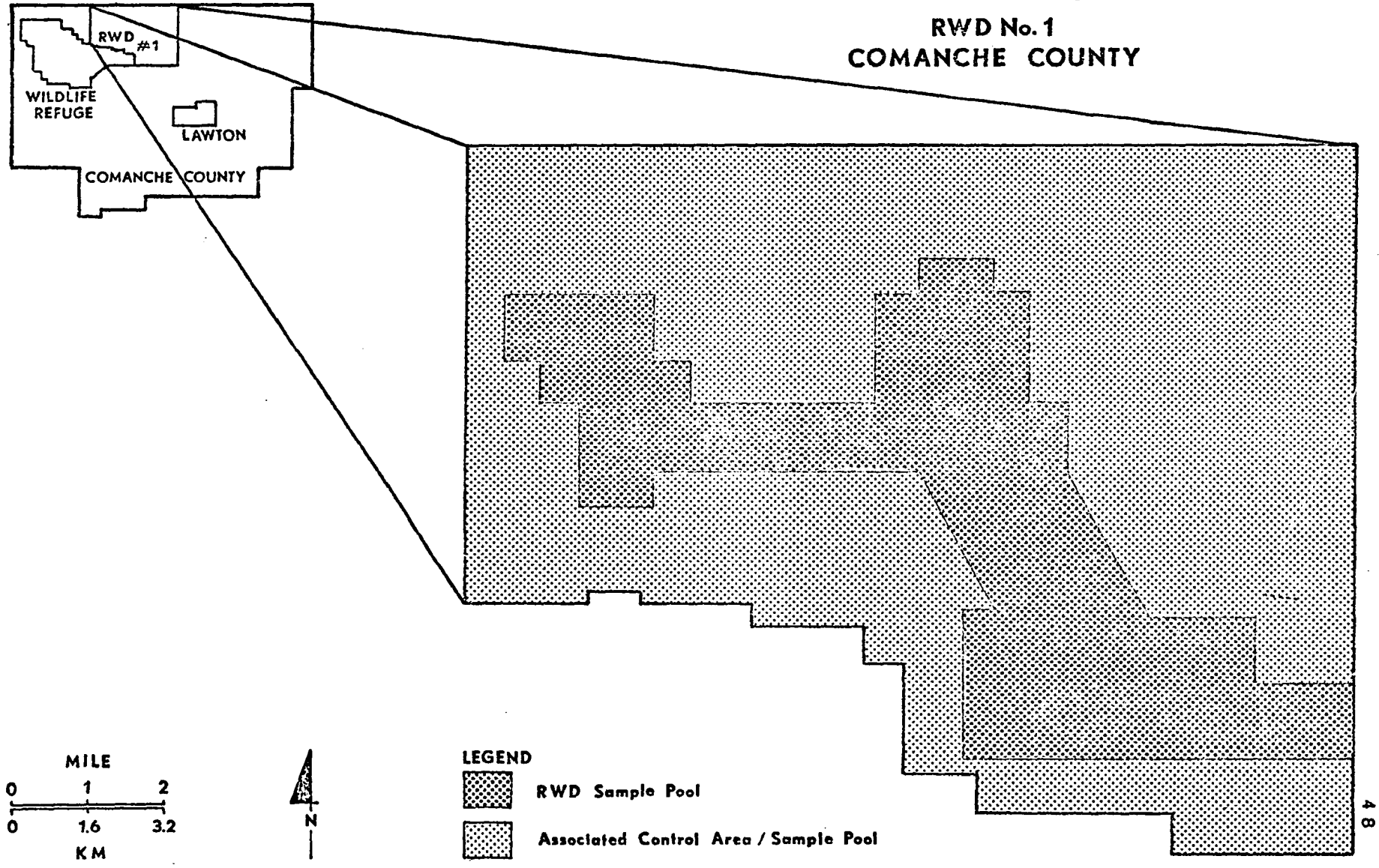
[28]Laughlin, loc. cit.

FIGURE 2-3
RWD No. 1
COMANCHE COUNTY



comprised of persons living within the district who purchase a benefit unit (a metered hook-up to a water district transmission line).

A rural community wishing to establish a rural water district first must meet and select a steering committee to direct the initial efforts of establishing the district. They must first determine the number of potential members and establish the initial feasibility of the water district. The committee, upon conferring with the FmHA, must then hire the services of an engineer to prepare a preliminary engineering report showing estimated cost of construction, a tentative design, and an estimated water rate schedule. This report is then submitted to the Farmers Home Administration.

The committee then employs an attorney and circulates a petition among local land owners to organize a water district. This petition is then filed with the Board of County Commissioners which holds a hearing, and incorporates the district as a legally constituted public body. Interested land owners then elect directors and prepare a body of by-laws. The directors replace the steering committee and request the engineer to prepare a final set of plans of the proposed water system. They advertise for construction bids, seek application from prospective membership, and formally apply for loans from the FmHA to finance the system. Once the FmHA closes the loan and deposits the funds in a construction account for the district, the contractor may begin construction. Residents who choose not to join the water district initially may petition to join at some later date, providing the district is not by then overloaded.

Operation costs and loan payments are paid from revenue obtained through the sale of water district memberships (ranging from as little as $20 to as much as $1,000), and through sale of water to members. Water sold in the district is metered at each user establishment. Occasionally, water is sold to an adjacent water district or in a few rare cases to other water users, such as small towns.

A member may purchase as many "benefit units" as he likes, but is expected to pay a minimum monthly fee for each unit he owns as well as a fee for the total amount of water used.

The rural water district has no lien on the land of the members for their share of the cost of operation, and the members are not personally liable for the debts of the district until initial, and any subsequent, loans are paid.

Water lines are normally laid on private property, by agreement with the land owners, where they will not be disturbed by other county or state projects. Where this is impossible they are permitted to construct such lines in the dedicated streets in towns and along section lines in rural areas. Occasionally, payment for property easement to build water towers or other large surface units is made to land owners.

Rural water district development in Oklahoma is a well founded component of the rural landscape. The following chapters will describe, based on a sampling from representative areas of the state, present and past land uses both within RWD areas and non-RWD areas. Land use changes for each will be documented.

CHAPTER III

OKLAHOMA LAND USE PATTERNS

Oklahoma has a total land area of some 44,020,800 acres. This area consists of a wide range of land uses, varying in nature from agricultural to urban. For much of the state a great deal of competition among these potential land uses exists.

In order to understand and plan for orderly development within the state a basic knowledge of present land use is needed. It is unfortunate, however, that adequate data regarding present and past land uses in Oklahoma have been poorly recorded. Little basic research has, as yet, been conducted that would reveal the trends of land use now existent. A number of periodic reports speak to such narrow topics as agricultural production[1] and economic development,[2] but information is needed to describe other land uses within the state so that planning for orderly development may continue.

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[1]See for example, Oklahoma Agricultural Statistics, compiled annually by the Oklahoma Crop and Livestock Reporting Service, Oklahoma City, Oklahoma.

[2]See for example, Gerald M. Lage et al., A Profile of Oklahoma: Economic Development 1950-1975 (Frontiers of Science Foundation of Oklahoma, Inc., Oklahoma City, Oklahoma, 1977).

As will be discussed more fully in Chapter IV, the land use pattern in Oklahoma is changing and much of this change corresponds to trends found throughout the nation. Other trends, however, seem to be more unique to the state of Oklahoma, or at least to the region in which this state is located. For example, the total area devoted nationally to cropland is a relatively stable percentage of the total land area,[3] but in Oklahoma the quantity of land devoted to crops has actually declined in recents years.[4]

As a necessary step in the research at hand, land uses were sampled for two time periods in areas representing the northeast, southeast, and western portions of Oklahoma. The west differs physically from the east. Its terrain is flatter and it receives less precipitation than the east. Eastern Oklahoma varies also from north to south: northeastern Oklahoma is generally less timbered and more gently rolling than is southeastern Oklahoma. One would expect that within these three general zones there would be different approaches to land use, and as a result, differences in the types and degrees of land use change.

Samples were drawn from two types of situations within each of the three state regions. First, samples were extracted from the rural water districts (RWD) of basic concern in this research. From those districts meeting the criteria for analysis set forward in Chapter I,

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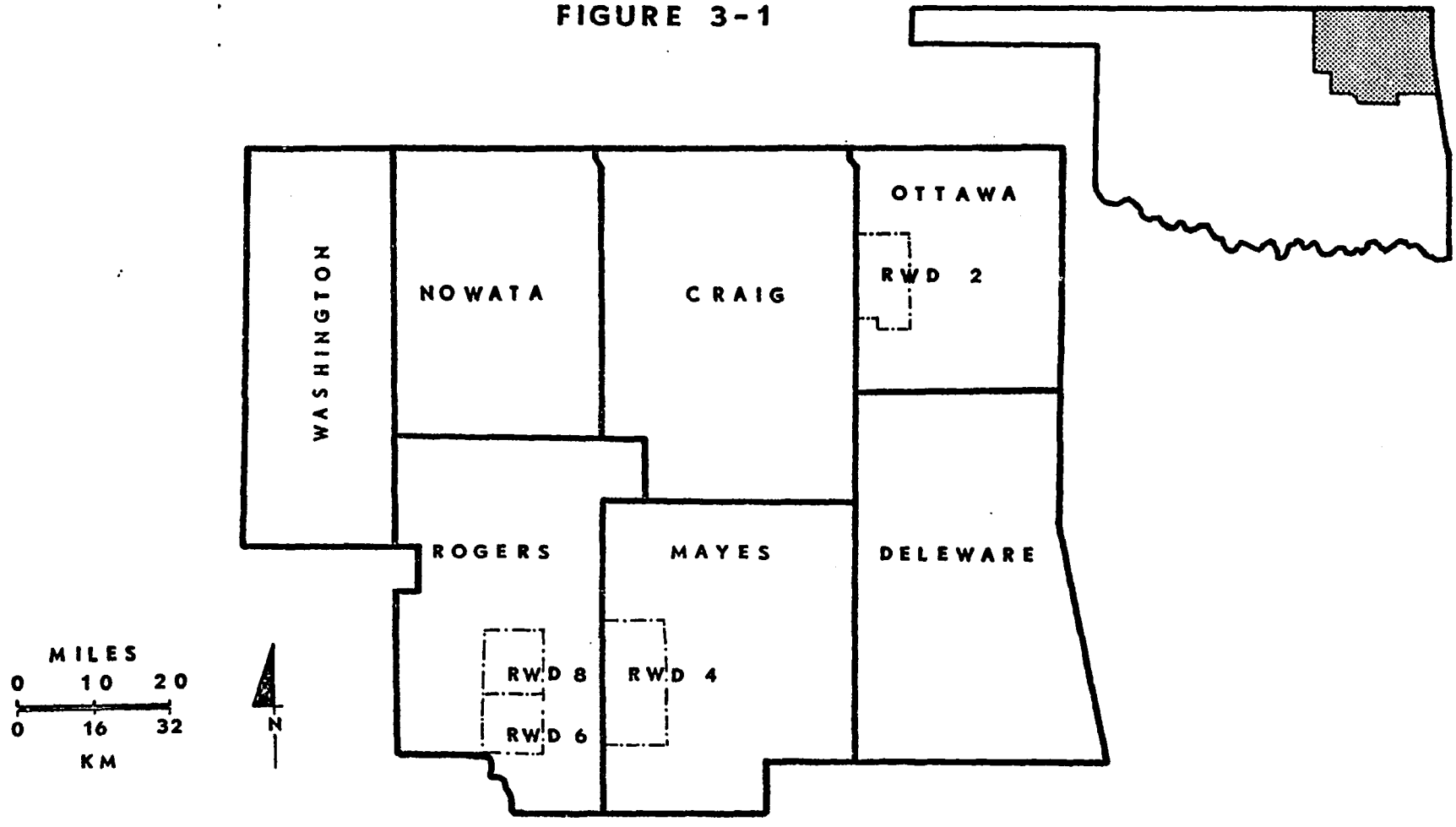
[3]U.S. Department of Agriculture, Major Uses of Land in the U.S.: Summary for 1974 (Economic Research Service, Agriculture Economics Report #274, December, 1977).

[4]Oklahoma Agricultural Statistics, 1976 (Oklahoma Crop and Livestock Reporting Service, Oklahoma City, Oklahoma, 1977), p. 3.

twelve rural water districts (four from each of the three regions) were randomly selected by the author for analysis. Figures 3-1 through 3-3 indicate the locations of each water district sampled. Land uses along existing water supply lines were then sampled according to the procedure established in Chapter I. Secondly, within each of the selected rural water districts a comparable set of samples were drawn from land uses remote from the actual water supply lines. After all existing water district lines of service were located for sampling purposes, all land areas not included were subject to this second sampling. This latter sampling, drawn as a control area, was to produce a set of data to compare to the results of RWD data. These two sets of samples are equally represented at all levels of concern, i.e., state total, regional total and sub-regional (RWD) total.

Aerial photographs were analyzed for a pre-water district development period. These photographs ranged in age from 1955 to 1964 with 1960 being the average date of photography. Similar photographs were used for the post development period analysis. These photographs were taken between 1969 and 1972. In order to make this final analysis as current as possible, these latter photographs were corrected by an automobile reconnaissance for all survey areas. The total area sampled equalled some 153,600 acres for each time period. It is then possible, based on this sampling, to extract a basic impression of past and present patterns of Oklahoma land use.

FIGURE 3-1



NORTHEAST COUNTIES OF OKLAHOMA

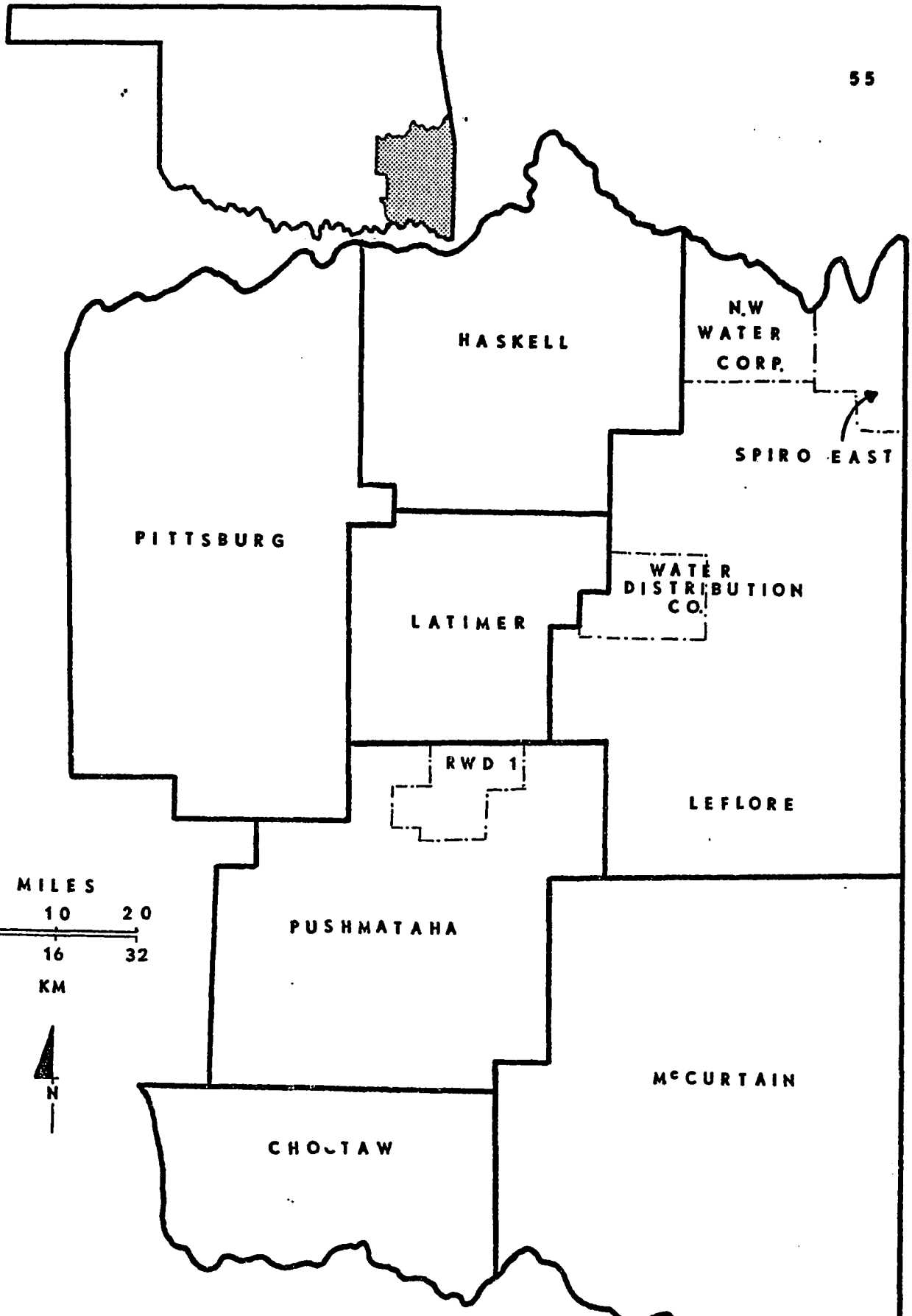


FIGURE 3-2

KIAMICHI ECONOMIC DEVELOPMENT
DISTRICT OF OKLAHOMA

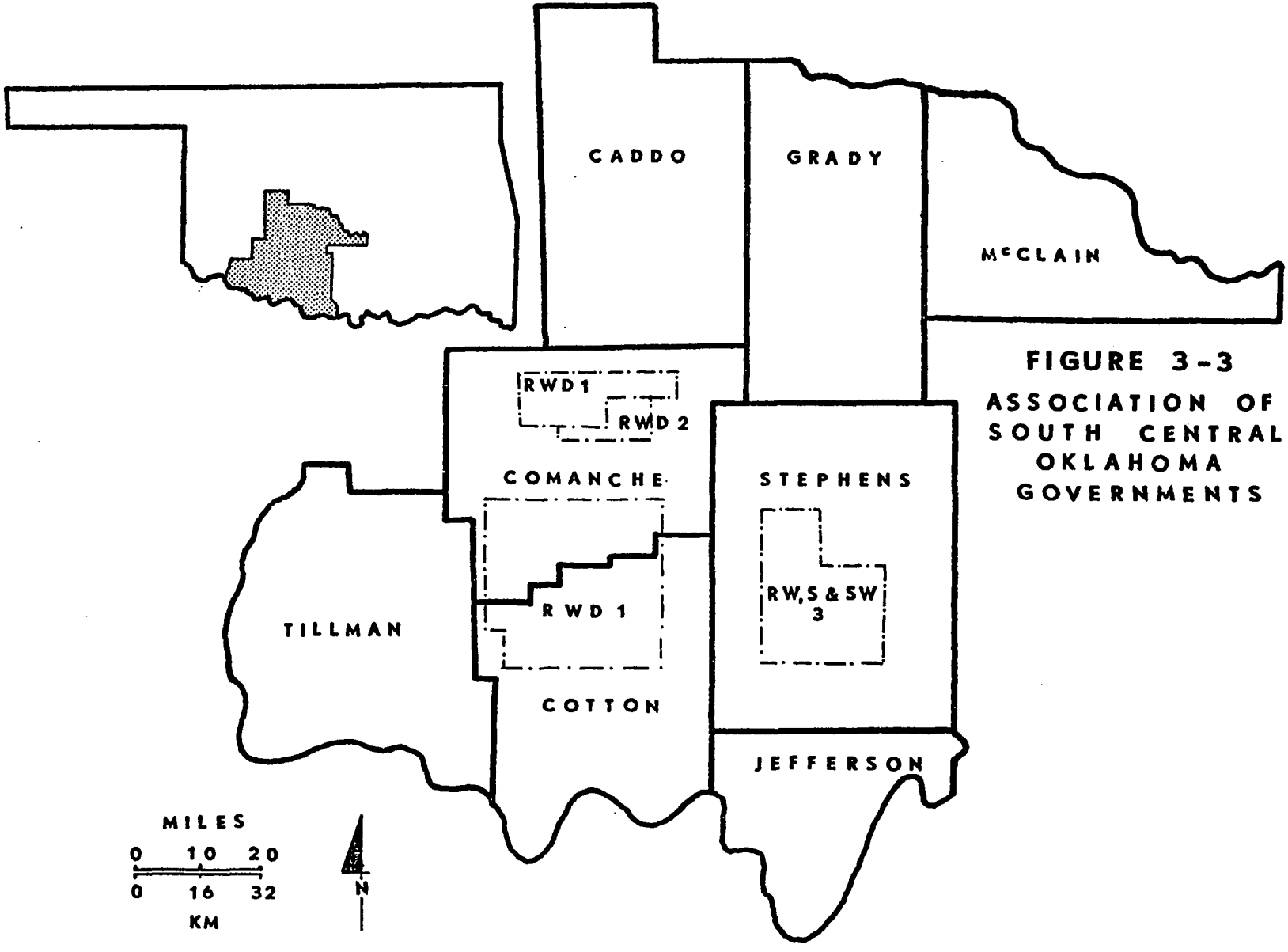


FIGURE 3-3

ASSOCIATION OF SOUTH CENTRAL OKLAHOMA GOVERNMENTS

Statewide Land Use Patterns

Present Land Uses

The somewhat physically diverse area of Oklahoma may be grouped into nine broad use categories:

CROPLAND	- land at the time of analysis either planted in crops or in cultivation
PASTURE	- land exhibiting native or planted grasses
WOODLAND	- land with a predominant tree cover, either commercial or non-commercial
RURAL RESIDENTIAL	- all dwelling complexes and corresponding acreages found in a rural setting
URBAN RESIDENTIAL	- all built-up areas corresponding to incorporated agglomerations
COMMERCIAL	- land on which establishments for the production or exchange of manufactured merchandise are located
TRANSPORTATION	- all transportation facilities exclusive of normal section line routes
RECREATION	- all natural and man-made facilities for the purpose, either primarily or in part, of recreational enjoyment
EXTRACTION	- areas devoted primarily to the extraction of minerals

A large amount of land in Oklahoma is seemingly not being used at present, and may have several different vegetative covers, usually giving the appearance of woodland or grassland usage. Since land uses are here identified by visual analysis, either from aerial photographs or field analysis, it is often impossible to distinguish this unused land from other types of land use.

Overall, agriculture utilized 123,656.8 acres (80.5 percent) of the area sampled. This total includes land in crop rotation or otherwise cultivated, as well as all types of pasture and ranges

(Table 3-1). The difference between state and national trends may be seen by comparing Table 3-1 to 3-2.

A great majority of the land sampled was found to have a grassland cover. For the most recent period of analysis (1978), land devoted to pasture and range totaled 99,632 acres, or 64.9 percent of available land area. This percentage seems rather high when viewed against national statistics; however, it may not be far out of line with actual land uses in Oklahoma. Daryll Ray and Glenn Collins, writing for the Oklahoma Experiment Station Bulletin in 1975 explain, in part, this trend:

> Agriculture in Oklahoma is continually adjusting to changes in the productivities and prices of imputs (capital investments) and to changes in demand for its products. Changes in productive techniques, relative to imput prices and government program provisions alter the demand for agriculture imputs, the resource mix and the optimum farm size in Oklahoma agriculture. Demand for Oklahoma's agriculture (agricultural products) changes with consumer preferences, income growth, and export markets.
>
> Oklahoma farmers have made substantial adjustments in response to these economic forces. Adjustments have included large scale substitution of capital for labor, farm numbers and operators, and greater emphasis on livestock production relative to crop production.[5] (emphasis added)

In any event, pasture and range in Oklahoma make up the highest percentage of land use. This conclusion is further substantiated by a 1976 Oklahoma Crop and Livestock Reporting Service publication suggesting that almost forty-two percent of Oklahoma is in either pasture or range.[6]

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[5]Daryll E. Ray and Glenn S. Collins, Structural Changes in Oklahoma Agriculture (Agricultural Experiment Station, Oklahoma State University, Bulletin B-720, May, 1975).

[6]Oklahoma Agricultural Statistics, 1976, loc. cit.

TABLE 3-1

TOTAL LAND USE
RURAL WATER DISTRICT AND ASSOCIATED CONTROL AREA SAMPLES - 1978

Major Land Use	Acreage	Percentage of Total
Cropland	24,024.8	15.6
Pasture	99,632.0	64.9
Rural Residence	7,377.6	4.8
Woodland	19,073.1	12.4
Urban Residence	935.6	0.6
Transportation	575.4	0.4
Recreation	930.3	0.6
Commercial	369.5	0.2
Extractive	681.7	0.4
Total Sample	153,600.0	99.9

TABLE 3-2

NATIONAL AND STATE LAND USE ESTIMATES - 1974
(in 1,000 Acres)

Land Use	U.S.[1]		Oklahoma[2]	
	Acres	%	Acres	%
Total Area	2,264,000	100.0	44,021	100.0
Cropland (in crops)	363,000	16.0	14,667	33.3
Cropland (idle)	20,000	0.9	NA[3]	NA
Pasture-Grassland	682,000	30.1	18,449	41.9
Forest	718,000	31.7	2,152	4.9
Special Use[4]	184,000	8.1	NA[3]	NA[3]
Other	304,000	13.1	10,938	19.9

[1]Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstracts of the United States, 1977, (1978), p. 676.

[2]Source: Oklahoma Crop and Livestock Reporting Service, Oklahoma Agricultural Statistics, 1976, (1977), p. 3.

[3]NA - There was no data available to estimate these land use categories.

[4]Special Use includes Urban and Transportation, Federal and State uses for Recreation and Wildlife Preserves, Military and Farmsteads.

Land in crop production constitutes the second largest land use category. In 1978 only 15.6 percent, or 24,024.8 acres, showed any evidence of being used as cropland.

Forest or woodland is the dominant non-agricultural use of sampled land. No attempt is made in this research to distinguish between commercially productive and other forested land areas. Obviously, some overlap occurs in practice between woodland and pasture since timbered regions are often used for grazing. These differences in use, however, are not detectable from aerial photographs. Some 19,073.1 acres (12.4 percent) of this sample were identified in 1978 as having a woodland cover.

Rural residences accounted for only a fraction of total area sampled, but, as will be discussed later, is one of the fastest growing land use categories. At present, rural residences and associated acreages occupy 7,377.6 acres or 4.8 percent of sampled land, and constitute the fourth largest land use category under consideration.

Other land uses for which identification was made total 3,492.5 acres, or 2.2 percent of the total area sampled. Of these five remaining land use categories, urban residential and recreation are the largest with 935.6 and 930.3 acres respectively. These constitute 0.6 percent each when rounded to the nearest tenth. Both transportation and extractive uses account for 0.4 percent each and commercial land uses for only 0.2 percent.

Trends in Major Land Uses

Changes in sampled land use totals and percentages between 1960 and 1978 are presented in Table 3-3. Pasture and range land increased

TABLE 3-3

TOTAL LAND USE - RURAL WATER DISTRICT PLUS SAMPLES
OF ASSOCIATED CONTROL AREA LAND USES
1960 and 1978

Major Land Use	1960		1978		Percentage Change
	Acreage	Percentage	Acreage	Percentage	
Cropland	33,570.6	21.9	24,024.8	15.6	-6.3
Pasture	88,472.1	57.6	99,632.0	64.9	+7.3
Rural Residential	2,948.4	1.9	7,377.6	4.8	+2.9
Woodland	25,720.7	16.8	19,073.1	12.4	-4.4
Urban Residential	481.9	0.3	935.6	0.6	+0.3
Transportation	545.3	0.4	575.4	0.4	-0-
Recreation	930.3	0.6	930.3	0.6	-0-
Commercial	276.7	0.2	369.5	0.2	-0-
Extractive	688.8	0.4	681.7	0.4	-0-
TOTALS	153,600.0	100.1	153,600.0	99.9	

by 11,204.9 acres between the two periods of analysis. In 1960 this grassland accounted for 57.6 percent of the area, while in 1978, this percentage increased to 64.9 and constituted a substantial change of 7.3 percent.

Land devoted to crops actually declined between the periods in question. A decrease of 9,545.8 acres was recorded, constituting a percentage decrease of 6.3, from 21.9 percent in 1960 to 15.6 percent in 1978.

Woodland areas of the state also experienced a decline in total acreage. In the early 1960's some 25,730.9 acres were wooded, but only 19,073.1 acres could be identified in 1978, a 4.4 percent reduction, from 16.8 percent to 12.4 percent.

Of the remaining land uses identified, only urban residential (contiguous portions of urban landscape outside official corporate boundaries) showed any significant statewide trend. A near doubling of the area devoted to urban residential use was recorded in this sampling. The earlier period produced 481.9 acres or 0.3 percent devoted to this land use, whereas the later period found 935.6 acres for 0.6 percent of the total land area. All other land use categories indicated either no change in area or only a moderate decrease.

These trends are consistent with those generally found on the national level where certain rural land uses are sequentially giving way to less rural directed land uses.[7] Urbanization, either directly

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[7]Marion Clawson, Suburban Land Conversion in the United States: An Economic and Governmental Process (Baltimore: Resources for the Future, 1971).

or indirectly, is growing rapidly. The fact that rural residential land area is increasing, whereas the numbers of farms are declining, suggests that this population is largely non-rural in occupation. At the same time, the growth of pasture and range land uses fits the nationally identified trend of holding lands idle awaiting buyers and developers for non-rural types of expansion. Likewise, the clearing of woodland areas, and especially their non-crop orientation, is suggestive of similar speculation.[8]

If these trends continue, it is foreseeable that a rather large portion of the State's cropland, and to a lesser extent woodland, will be converted to non-rural land uses, or at best, be held in extensive land uses as a means of speculation.

Regional Land Use Patterns

Land used primarily for agricultural production (cropland and grazing land) accounted for over 80 percent of Oklahoma's sampled land area in 1978. Woodland accounted for another 12.4 percent and all other land uses for the remaining 7.9 percent. Of this remaining 7.9 percent, rural residential constituted the majority (4.8 percent). The proportions of these land uses, however, vary greatly across the state. Within the distributional patterns of these broad groups, variable proportions of land are cropped, grazed and idled. Other land uses are dual or multiple, as when woodland is used simultaneously for timber production and other purposes such as grazing or recreation. As a framework for considering the variable characteristics and distribution

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[8] Ibid.

of important land use components, aggregate regional acreages for each land use identified during sampling are presented in Table 3-4.

Pasture

A predominant grassland cover was found on 99,632 acres or 64.9 percent of the total area sampled. This total includes acreages in two major types--grassland and other nonforested land used more or less exclusively for grazing.

The proportion of total pasture sampled for both time periods differs substantially among the three regions under analysis. At the earlier period (1960) the southeastern study region exhibited the smallest amount of land devoted to this land use, 22,271 acres or 43.5 percent of the total area sampled. Even there, however, pasture was still the predominant form of land use. At this same time the western study area produced the largest total devoted to this land use, 35,843.3 acres, or some 70 percent of the total. The northeastern study region was intermediate and closer to the statewide percentage with 59.2 percent or 30,312.8 acres.

For the more recent period of analysis (1978), quite different statistics were evident and even a change in regional order occurred. The southeast study area still maintained the lowest total area devoted to pasturage with 51.2 percent of that sample and 26,237 acres. The northeastern section, however, now had the higher proportion of its area devoted to pasture, 38,416.4 acres or some 75 percent. Increase in pasture acreage for this region was basically the result of removal of underproductive wooded areas, as well as a general decline in cropped land. The northeast study area, however, replaced the western

TABLE 3-4

TOTAL LAND USE - RURAL WATER DISTRICTS PLUS ASSOCIATED CONTROL AREAS
1978 and 1960

Land Use	Southeast Region		West Region		Northeast Region		TOTALS	
	1978	1960	1978	1960	1978	1960	1978	1960
Cropland								
Acres	4,703.7	5,715.8	11,586.3	12,491.6	7,734.8	15,363.2	24,024.8	33,570.6
Percent	9.2	11.2	22.6	24.4	15.1	30.0	15.6	21.9
Pasture								
Acres	26,237.0	22,271.0	34,978.6	35,843.3	38,416.4	30,312.8	99,632.0	88,423.1
Percent	51.2	43.5	68.3	70.0	75.0	59.2	64.9	57.6
Rural Residential								
Acres	1,772.1	623.8	2,812.5	1,092.9	2,793.0	1,231.7	7,377.6	2,948.4
Percent	3.5	1.2	5.5	2.1	5.5	2.4	4.8	1.9
Woodland								
Acres	17,359.8	21,694.6	120.5	349.4	1,592.8	3,086.9	19,073.1	25,730.9
Percent	33.9	42.4	0.2	0.7	3.1	7.2	12.4	16.8
Urban Residential								
Acres	456.1	218.7	479.5	265.5	---	---	935.6	481.9
Percent	0.9	0.4	0.9	0.5	---	---	0.6	0.3
Transportation								
Acres	218.7	218.7	173.6	143.5	183.1	183.1	575.4	545.3
Percent	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.4
Recreation								
Acres	145.0	145.0	446.8	446.8	338.5	338.5	930.3	930.3
Percent	0.3	0.3	0.9	0.9	0.7	0.7	0.6	0.6
Commercial								
Acres	13.5	13.5	214.6	179.4	141.4	83.8	369.5	276.7
Percent	0.03	0.03	0.4	0.4	0.3	0.1	0.2	0.2
Extractive								
Acres	294.1	301.2	387.6	387.6	---	---	681.7	688.8
Percent	0.6	0.6	0.8	0.8	---	---	0.4	0.4
TOTALS: Acres	51,200.0	51,200.0	51,200.0	51,200.0	51,200.0	51,200.0	153,600.0	153,600.0
Percent	100.03	100.03	99.9	100.1	100.1	100.0	99.9	100.1

region primarily because the latter experienced an overall decrease in land devoted to pasture. Pasture acreage declined from 70 percent recorded in 1960 to 68.3 percent in 1978, or some 864.7 acres. Much of this decline was the result of residential growth to be discussed below. Again, though, this intermediate percentage is comparable to the sampled state figure of 64.9 percent.

Cropland

The second largest land use category is cropland. Nationally, nearly 21 percent of the nation's land areas are devoted to cropping purposes,[9] accounting for some 472 million acres. This total represents neither the acreage actually used in crop production each year nor the acreage that could be used for crops, rather, it represents the acreage presently in crop rotation. This figure, then, can be directly compared to results of the research at hand.

For the earlier sampling period (1960), 21.9 percent of the area was found to be in crop rotation. This declined substantially by 1978, when only 15.6 percent of the area showed evidence of being used for cropping purposes.

A large disparity in the amount of land devoted to crop production was found to exist among the three areas sampled. In 1960 the southeast study area maintained only 5,715.8 acres, or 11.2 percent of its total area, in this form of agriculture. The northeastern zone, however, employed nearly one-third of its land area for crop

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[9]U.S. Department of Agriculture, Our Land and Water Resources (Economic Research Service, Miscellaneous Publication #1290, May, 1974), p. 2.

production--15,363.2 acres or 30 percent of its total. The western study area was intermediate with 24.4 percent and 12,491.6 acres.

By the more recent period of analysis (1978), cultivated land for all three regions had declined, the greatest decline occurring in the northeastern study area. Sampled cropland totals decreased there by almost one-half. In 1960 some 15,363.2 acres (30 percent) were sampled, whereas in 1978 only 7,734.8 acres (15.1 percent) were identified as cropland. As a result of this major decline, the northeast fell behind the western study area in percent of area devoted to cropland usage. The southeast region still produced the smallest acreage, only 4,307.7 acres (9.2 percent) attributed to the production of crops.

As mentioned earlier, this statewide conversion of cropland to other uses may have far-reaching effects on Oklahoma's economy--especially that involving rural occupations. This state still has a large agriculture component, and rapid changes in the agricultural economy may not be adequately offset by increasing non-rural economic growth. The obvious result would be the greater dependence of this state on others for basic food resources. An imbalanced trade situation would evolve between Oklahoma and other food producing states, as well as an increase in food prices.

Woodland

The sample results indicate that wooded areas of Oklahoma have declined between the two study periods. Almost 17 percent of the area was forested in 1960, whereas only 12.4 percent was identified as such in 1978. This decline may be due to a number of influences, not the

least of which is increased clear-cutting activities in southeast Oklahoma and the clearing of woodland for crop, pasture, and other purposes elsewhere.

Nationally, as much as one-third (754 million acres) of the United States is forested. About one-sixth of this area is in Alaska, where little timber is harvested at present for wood products.[10] It may also be observed that total forested areas, especially in the plains region of which western Oklahoma is a part, are decreasing.[11]

Regional differences in the amount of area devoted to woodland purposes are obviously related to the differences among physical environments within the state. The eastern portion of Oklahoma, and especially the southeastern area, is heavily forested and is more representative of the eastern portion of the nation. The western study areas, where the natural vegetation has been allowed to remain and grasslands predominate, are more indicative of the Great Plains.

In the early 1960's, 21,694.6 acres (42.4 percent) of the southeastern study area were devoted to woodland. In 1978 a still large 33.9 percent or 17,359.8 acres were identified. At the same time, the western region, in both time periods, exhibited low percentages of woodland, 0.7 percent in 1960 and 0.2 percent in 1978, accounting for only 349.4 acres and 120.5 acres respectively. All the woodland found in the samples for western Oklahoma occurred in Stephens

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[10] U.S. Department of Agriculture, The Outlook for Timber in the United States (U.S. Forest Service, Forest Research Report #20, October, 1973).

[11] Kathryn A. Zeimetz, et al., Dynamics of Land Use in Fast Growth Areas (U.S. Department of Agriculture, Economic Research Service, Agriculture Economics Report #325, April, 1976), p. 7.

County, a portion of the western margins of the "cross-timbers" of Oklahoma. This is a zone of underproductive scrub oak and black jack timber stands. The northeastern study area likewise experienced a substantial decline in woodland uses. This decline was primarily the result of tree removal projects designed to increase the productivity of the areas by removing underproductive woodland vegetation and replacing it with more productive rangeland and cropland.

Rural Residential

Although the above three land use categories (pasture, cropland and woodland) combine to account for over 90 percent of the total sampled land use in Oklahoma for both time periods, the land use category with the greatest percentage of change is rural residential. In the earliest time period (1960), only 1.9 percent of the area sampled could be depicted as rural residential. The later sampling of the same areas (1978), however, found almost 5 percent of the area in this category.

A substantial amount of this increase can not be accounted for as functionally rural population: i.e., those occupationally involved in agriculture, livestock raising or other forms of primary production. The growth of rural residences, therefore, must be the result of other than primary production oriented populations.

The smallest proportion of land devoted to rural residences was found in the southeastern portion of the study area. In 1960 only 623.8 acres or 1.2 percent of the area was found to be representative of this category. In 1978, however, this had increased to a substantial 1,772.1 acres, or 3.5 percent of the total. The

northeastern region exhibited twice as much land devoted to rural residences in the early 1960's as did tne southeastern section (1,231.7 acres, or 2.4 percent of the total). The western section was only slightly behind with 1,092.9 acres (2.1 percent).

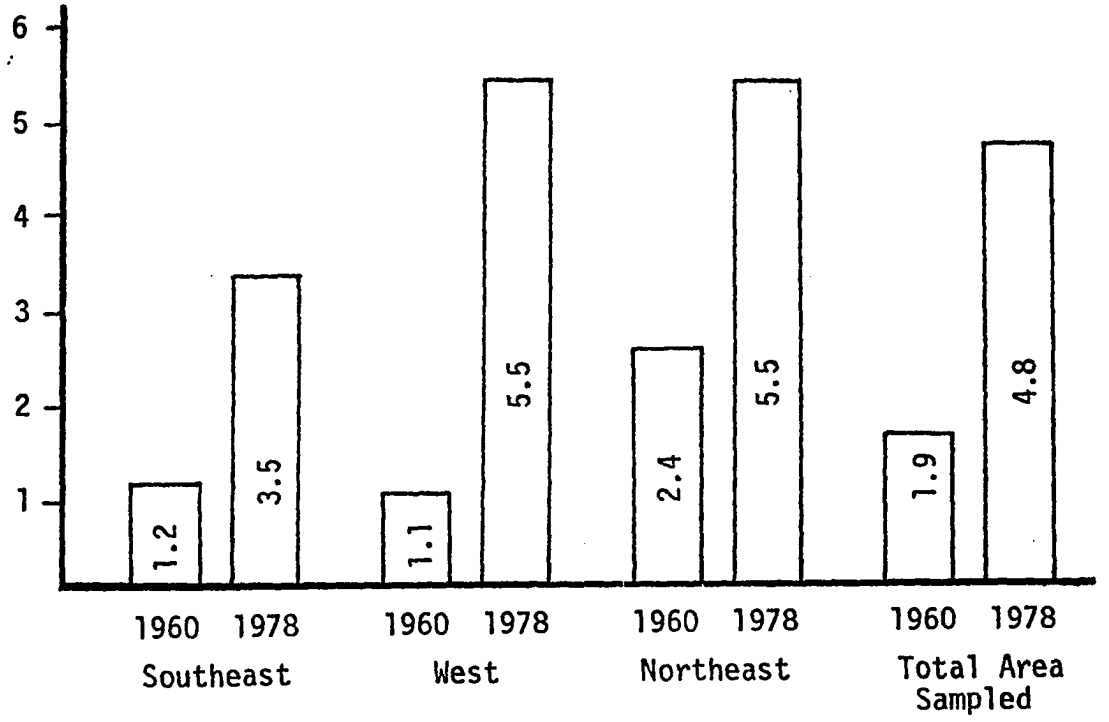
In 1978, both the northeastern and the western study regions showed exceptional growth in the rural residential category. The west had the greatest increase, finally matching the northeast with 5.5 percent of their respective areas. A total of 2,812.5 acres were recorded in the west, whereas the northeast was only slightly smaller with 2,793 acres. Both these regions were well above the total state figure of 4.8 percent.

An important comparison between the two time periods for the three regions can be made. The highest sampled percentage of rural residences for the earliest survey period was well below even the lowest sample percentages for the more recent study period (see Figure 3-4), indicating a substantial change in this type of land use in Oklahoma. More will be said about this in Chapter IV.

As the rural non-farm residential sector increases, a number of increasing costs (often excessive) may be predicted for the rural community. A list of such rural liabilities would include road maintenance, school bus services to existing public schools, liquid and solid waste disposal and such protective services as police and fire. At present the rural community is not prepared to provide these increased needs, indeed, most rural communities have traditionally done a poor job of providing such services with much smaller rural populations and therefore a smaller demand. If such growth is to

FIGURE 3-4

PERCENTAGE OF THE SAMPLED AREAS FOUND
TO BE IN RURAL RESIDENTIAL LAND USES



continue unabated, a basic restructuring of state expenditures must occur. In addition, a greater concern for rural planning must evolve to facilitate orderly development.

Other Land Uses

The only other land use category showing any substantial change is urban residential. Growth of urban agglomerations in Oklahoma is important. Sample results show a doubling of land area attributed to this land use. In the earlier period (1960), 0.3 percent of the area was in urban land use. In the later sampling (1978), however, this had increased to 0.6 percent. Again, this is comparable to the national growth of such areas.

Both the southeastern and western sampled portions of Oklahoma exhibited some urban land use. In both cases the amount of increase was substantial, at least doubling the amount for the earlier period. In both areas were found some 0.9 percent of the total area devoted to urban land uses by the late 1970's. This amounted to 456.1 acres for the southeastern Oklahoma sample and 479.5 acres for the western sample. In no samples drawn from the northeastern study area could there be found evidence of urban land use. It should be remembered, however, that the focus of this research is toward rural Oklahoma and that samples for analysis were drawn to measure land uses in that sector of the state. Although urban areas were initially excluded from the study, some urban expansion was found as a result of the dynamic growth of urban agglomerations. That any urban development at all was found in these samples attests to the rapid change occurring in this sector,

but does not give a fair representation of total urban land use within the state of Oklahoma.

The other four land use categories in this sample--transportation, recreation, commercial and extractive--also represented small percentages of total land use in Oklahoma, and showed no change in overall percent of total area represented. Transportation accounted for only 0.4 percent of the total land area, as did extractive land uses. Recreation was larger with 0.6 percent, and commercial smaller with only 0.2 percent.

The southeastern portion of the state presented the smallest total land area devoted to commercial usage with only 13.5 acres or 0.03 percent of the total area. The larger amount, however, was found in western Oklahoma where 179.4 acres in 1960 and 214.6 acres in 1978 were found. Still, these amounted to only 0.4 percent of the totals. Northeastern Oklahoma experienced a major increase between the two periods of analysis. In the earlier, only 83.8 acres (0.1 percent) were found; however, 141.4 acres (0.3 percent) were evident in 1978.

Summary

Several land uses in rural Oklahoma predominate. Pasture (64.9 percent), cropland (15.6 percent) and woodland (12.4 percent) combine for a total of 92.9 percent of all land sampled within the state. When rural residential land usage (4.8 percent) is added to this total, very little sampled land remains to be divided among the other five surveyed land uses.

As would be expected from national trends, pasture, rural residential, and urban residential land uses increased during the study

period, while cropland and woodland decreased. The other four land use categories surveyed remained constant.

Regional variations in Oklahoma were found to exist in all land use categories. The widest variations appeared in the land use types with greater acreages. Not all regions, however, were found to be changing in the same direction. For example, the northeast and southeast gained pasture land, while the western study area experienced a decline in pasture lands.

The trends in land use noted above will have the impact of changing the economic situation of at least rural Oklahoma. A predominantly agriculture-oriented state, Oklahoma will experience a reduction of that economic base as more land is taken from agriculture and placed into either more extensive land uses or converted to some form of urban usage, including the various forms of land speculation.

The following chapter will more precisely discuss the particular changes in land uses identified above. The exact direction and magnitude of these changes as they pertain to RWD and associated control areas will be evaluated.

CHAPTER IV

PATTERNS OF LAND USE CHANGE IN RURAL OKLAHOMA

From Chapter III it is evident that land use changes are occurring in rural Oklahoma. In some places, and especially in the rural water districts, there are indications that this change is of a large magnitude. Chapter IV will identify and discuss certain basic trends of this land use change.

Of first concern in this analysis is the development of broad land use profiles of the three levels of analysis thus far discussed. At the state level may be an analysis of all samples, as well as a division into RWD samples and those extracted from areas contiguous to but remote from RWD lines of service. This allows for a comparison of land use changes occurring in RWD and associated control area samples. In addition, for the rural residential categories, number of residences is discussed to lend credence to any residential trend discovered.

A next lower level of analysis deals with regional land use patterns. The same basic approach as above is used; however, analysis is focused on the three region breakdown described earlier. These include: the northeast, the southeast, and the western areas of the state (see Figures 3-1 to 3-3, Chapter III).

Finally, this analysis will focus on the individual rural water districts of the study and their associated control areas. Analysis of these individual districts and control areas will be structured along regional lines but comparison between regions will also be employed where necessary.

The second land use analysis concern discussed in this chapter involves the use of transition matrices. The transition matrix is a tool for discerning actual changes among particular uses being examined. This approach is necessary to document and analyze the detailed transfers among the various uses. Again, the hierarchical approach is employed, with discussion focusing, in turn, on the state, regional and individual rural water district levels.

The final aspect of this chapter deals with observed trends in land use change of the sampled data. The samples, and their results, are aggregated in a zonal fashion of increasing units of commuting distance from urban agglomerations. Comparison, again, is made on the basis of RWD and associated control area samples.

Land Use Profiles

Sample results indicate that the overall pattern of land use did not change dramatically between the two time periods of analysis (Table 4-1 and Figure 4-1). The focus of this research, though, is with land use change within, or as a result of, rural water districts. As has been discussed earlier, two sets of land use samples were extracted. The first set was drawn from along rural water district lines of service within the three study regions. The second set was extracted from areas at some distance from but contiguous to these RWD

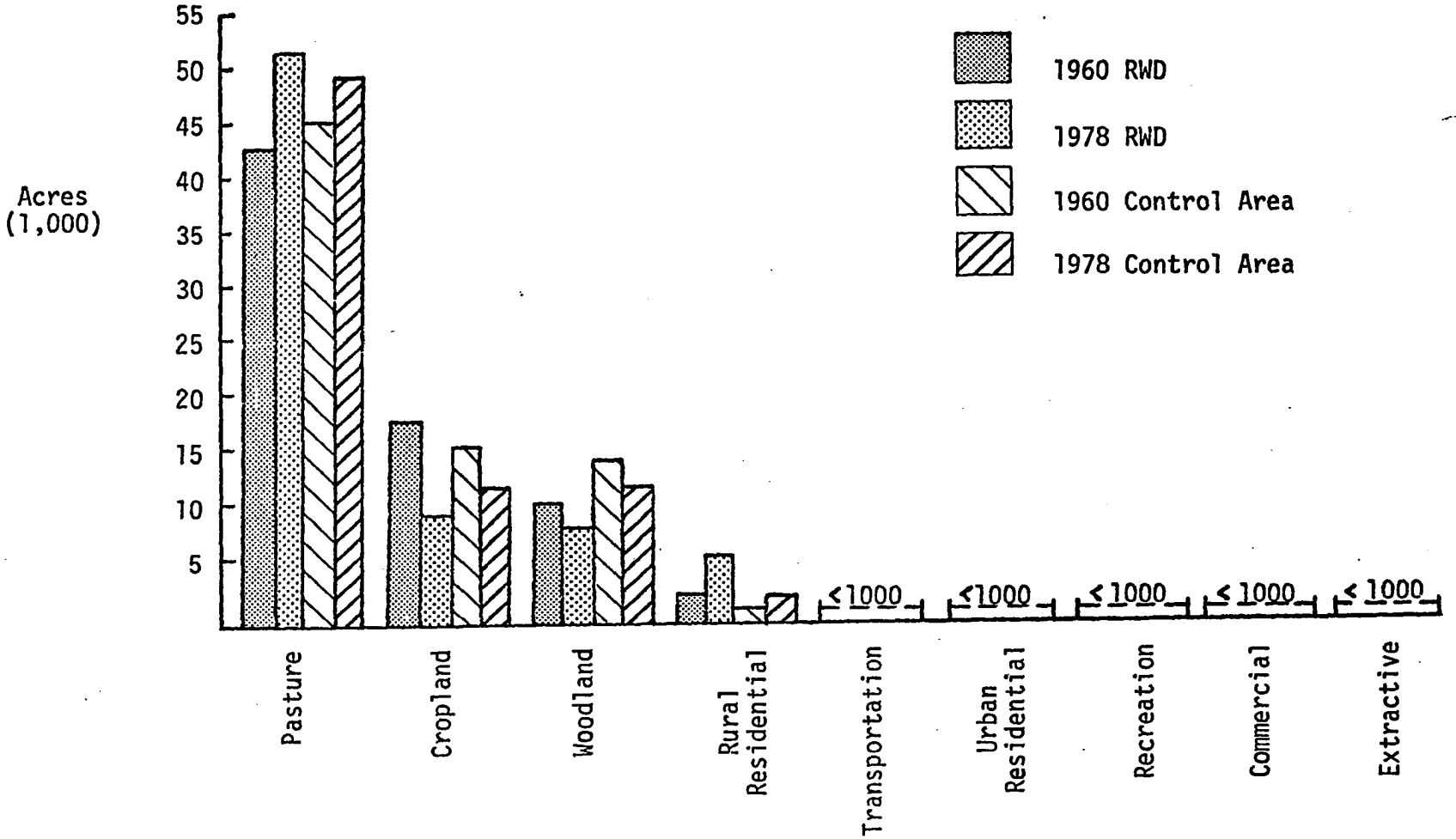
TABLE 4-1

LAND USE OF STUDY AREA BY REGION, 1960 AND 1978
(by percent)

Land Use	Southeast	West	Northeast	Total
Cropland				
1960	11.2	24.4	30.0	21.9
1978	9.2	22.5	15.1	15.6
Pasture				
1960	43.5	70.0	59.2	57.6
1978	51.2	68.3	75.0	64.9
Rural Residential				
1960	1.2	2.1	2.4	1.9
1978	3.5	5.5	5.5	4.8
Woodland				
1960	42.4	0.7	7.2	16.8
1978	33.9	0.2	3.1	12.4
Urban Residential				
1960	0.4	0.5	---	0.3
1978	0.9	0.9	---	0.6
Transportation				
1960	0.4	0.3	0.4	0.4
1978	0.4	0.3	0.4	0.4
Recreation				
1960	0.3	0.9	0.7	0.6
1978	0.3	0.9	0.7	0.6
Commercial				
1960	0.03	0.4	0.1	0.2
1978	0.03	0.4	0.3	0.2
Extractive				
1960	0.6	0.8	---	0.4
1978	0.6	0.8	---	0.4

FIGURE 4-1

SAMPLED LAND USE TOTALS
1960 and 1978



service lines and represent control area land uses. Samples of this second set were, likewise, equally extracted from the three study zones of the state. The purpose of the second set of samples, the control areas, was to provide a control data set to measure the differences in land use change occurring between these two sets of areas. The difference between the two can, in part, be attributed to the presence of the RWD.

Table 4-2 presents the accumulated statewide results of land use analysis for the two time periods for both the RWD samples and for the control samples. As can be seen from this figure, a number of significant changes in land use have occurred, and, the variation between RWD samples and control samples is often pronounced.

Excluding urban residential land uses of the control areas, the category with the greatest absolute percentage change at the state level is rural residential. For both samples this land use had the greater overall change, with rural water district samples experiencing a major increase, of some 203.7 percent, between 1960 and 1978. The control area samples were considerably smaller but higher than any other control area change except urban residential.

Housing units, likewise, experienced an abrupt growth during this time frame. In 1960 only 935 rural residential housing units could be identified (Table 4-3), but by 1978, this figure had rocketed to 2,268 units. This amounted to a 142.6 percent increase over 1960, and a total increase of 1,339 rural residential housing units.[1] Only

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[1]Housing unit figures for the earlier (1960) time period in cases where several residences were clustered together must be considered only as estimates due to the difficulty in identification

TABLE 4-2

SAMPLED LAND USE TOTALS FOR BOTH RWD's AND ASSOCIATED CONTROL AREAS, 1960 AND 1978

Land Use	Rural Water Districts			Associated Control Areas		
	1960 Acres	1978 Acres	% Change	1960 Acres	1978 Acres	% Change
Pasture	43,647.0	51,227.7	17.36	44,043.7	49,039.9	11.34
Crop	18,874.0	10,854.1	-57.50	15,343.5	12,458.4	-18.81
Woodland	10,694.9	7,057.7	-65.99	15,138.4	12,100.7	-20.07
Rural Residential	1,844.6	5,602.3	203.71	1,022.8	1,716.5	67.82
Urban Residential	478.7	743.2	55.25	11.7	186.3	1492.30
Transportation	494.8	524.7	6.04	109.7	109.7	--
Recreation	446.8	446.8	--	483.5	483.5	--
Commercial	276.7	325.3	17.56	-0-	41.5	--
Extractive	42.7	18.2	-42.62	646.7	663.5	2.59
Totals	76,800.0	76,800.0		76,800.0	76,800.0	

TABLE 4-3

NUMBER OF RURAL RESIDENTIAL UNITS, 1960 AND 1978

Rural Water District	Southeast 1960	1978	Change	Rural Water District	West 1960	1978	Change	Rural Water District	Northeast 1960	1978	Change
Pushmataha Co. RWD #1				Comanche Co. RWD #1				Ottawa Co. RWD #2			
RWD	7	60	+ 53	RWD	48	121	+ 73	RWD	88	185	+ 97
Control Area	3	5	+ 2	Control Area	13	9	- 4	Control Area	31	35	+ 4
LeFlore Co. Water Dist. Company				Comanche Co. RWD #2				Mayes Co. RWD #4			
RWD	25	54	+ 39	RWD	29	254	+225	RWD	71	142	+ 71
Control Area	12	31	+ 19	Control Area	29	30	+ 1	Control Area	30	49	+ 19
LeFlore Co. NW Water Inc.				Cotton Co. RWD #2				Rogers Co. RWD #6			
RWD	40	83	+ 43	RWD	27	37	+ 10	RWD	40	138	+ 98
Control Area	14	41	+ 27	Control Area	16	15	- 1	Control Area	120	142	+ 22
LeFlore Co. Spiro East				Stephens Co. RW S & SW Dist. #3				Rogers Co. RWD #8			
RWD	75	217	+142	RWD	53	188	+135	RWD	57	190	+133
Control Area	18	34	+ 16	Control Area	46	66	+ 20	Control Area	43	132	+ 19
Totals				Totals				Totals			
RWD	147	424	+277	RWD	157	600	+443	RWD	250	655	+405
Cont. A.	47	111	+ 64	Cont. A.	104	120	+ 16	Cont. A.	224	358	+134
Grand Totals RWD/Cont. A.	194	535	341	Grand Totals RWD/Cont. A.	261	720	459	Grand Totals RWD/Cont. A.	474	1013	539

438 units of this increase were found in control area samples. The difference between the RWD and control sampled areas is important. The fact that RWD regions have had a rural residential growth of over three times that of the control areas and an increase of nearly two and a half times in housing units indicates the importance of the ready availability of water resources as at least one major force affecting the pattern of land use within rural environments.

On a regional basis, rural residential land uses again displayed rather excessive changes (Table 4-4). Appendix A shows the total acreages found to exist at each of the time periods sampled, for RWD and control samples. While both RWD and control samples all had regional increases, the greater increases occurred in the water districts. Indeed, even the smallest regional increase for the RWD samples, 115.2 percent for northeastern Oklahoma, was almost as great as the largest increase of the control areas, 157.1 percent for the southeast. The largest increase for the RWD samples was found in the western study region, a 244.4 percent change from 1960 to 1978. Housing units, likewise, exhibited substantial changes (Table 4-3), with the rural water district samples having a much greater increase than did the non-water district samples. The largest regional increase was found in the western area, with an increase of only 157 residences. In 1978, however, this number increased to an even 600 units, an increase of 443 housing units. Although not to the same extent, both the northeast and southeast regions also saw substantial growths in

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from aerial photographic sources. The more recent (1978) figures, however, are considerably more accurate since aerial photographic techniques were corrected by field analysis.

TABLE 4-4

RWD AND CONTROL AREA LAND USE BY REGION, 1960 AND 1978
PERCENT CHANGE BY REGION

Land Use	Southeast Region	West Region	Northeast Region
Crop			
RWD	-14.3	-13.4	-59.4
Control Area	-18.2	2.6	-33.0
Pasture			
RWD	18.2	-5.9	35.3
Control Area	17.2	0.4	19.7
Rural Residential			
RWD	183.3	244.4	155.2
Control Area	157.1	13.3	75.0
Woodland			
RWD	-36.0	0	-23.1
Control Area	- 8.0	-100.0	-76.1
Urban Residential			
RWD	25.0	90.0	0
Control Area	1500.0	0	0
Transportation			
RWD	0	20.0	0
Control Area	0	0	0
Recreation			
RWD	0	0	0
Control Area	0	0	0
Commercial			
RWD	0	14.3	33.3
Control Area	0	0	0.2
Extractive			
RWD	-65.0	0	0
Control Area	10.0	0	0

residential units. The control samples, on the other hand, exhibited a much weaker tendency to increase. The samples drawn from the western region, for example, showed an increase of only sixteen units.

Within the various rural water district samples (Table 4-5) and adjacent control areas (Table 4-6) similar variation is evident. Increase in rural residential uses was everywhere high in the RWD samples (Table 4-5). In almost every case this land use type was twice as great in 1978 as in 1960. In many cases, at least a tripling of the 1960 percentage was found to have occurred. The largest increase was found in Pushmataha County RWD #1, with a 760 percent increase between the two sampling periods. Another large increase occurred in Comanche County RWD #2, some 504.8 percent growth, mainly associated with a number of rural subdivisions, the largest of which is the Wichita Mountain Estates development. Figure 4-2 is a sample square mile drawn from that development area. Notice especially the north half section where most of the land has been converted from pasture (P) to rural residential (R).

Again, the change in the number of rural residential housing units (Table 4-3) substantiates the acreage figures. Notice, for example, Comanche County RWD #2. In 1960 only 29 housing units were found; however, this leaped to over 250 units in 1978. Again, most of this increase can be attributed to the Wichita Mountain Estates development. As in the case of acreage, the greater change in housing units identified were within the RWD segment of samples. In addition to the Comanche County RWD #2 example cited, others produced some substantial growth figures: see for example, Stephens County, RW., S. and S. W. District #3; LeFlore County, Spiro East Water District; and

TABLE 4-5

RWD LAND USE BY RWD, 1960-1978: PERCENTAGE CHANGE IN ACREAGE SAMPLED

Land Use 1960-1978	Southeast				Northeast				West			
	Pushmataha Co. RWD #1	LeFlore Co. N.W. Water Association	LeFlore Co. Spiro East	LeFlore Co. Water Distribution Co.	Rogers Co. RWD #6	Rogers Co. RWD #8	Ottawa Co. RWD #2	Mayes Co. RWD #4	Comanche Co. RWD #1	Comanche Co. RWD #2	Cotton Co. RWD #2	Stephens Co. RW, S & SW #3
Crop	-25.0	-25.5	-15.62	35.5	-72.6	-52.2	-61.3	-54.4	6.2	-37.7	13.7	-47.0
Pasture	760.0	6.0	- 6.18	9.6	9.9	-02.0	244.0	80.4	-10.5	- 1.9	-15.9	3.9
Rural Residential	725.0	131.6	182.40	113.3	227.8	231.0	107.5	110.7	212.1	504.8	41.2	207.9
Woodland	-45.2	-18.2	NC	-22.4	-35.0	- 9.5	NC	-17.5	NC	NC	NC	NC
Urban Residential	NC*	NC	NC	69.2	NC	NC	NC	NC	NC	500.0	NC	50.0
Transportation	NC	NC	NC	NC	NC	NC	NC	NC	NC	38.5	NC	NC
Recreation	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Commercial	NC	NC	NC	NC	NC	NC	NC	NC	100.0	NC	NC	18.18
Extractive	NC	-57.14	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

*NOTE: NC = No change was recorded between 1960 and 1978.

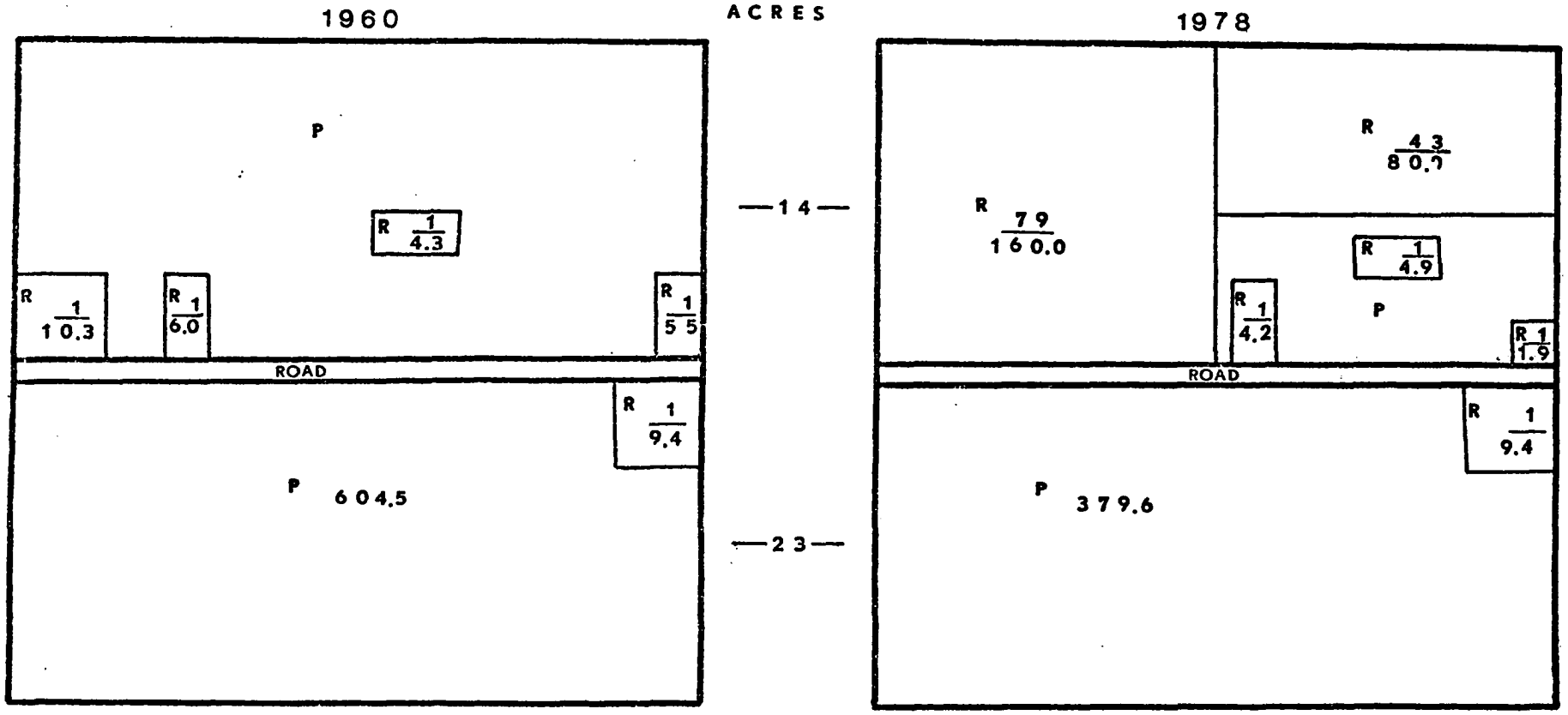
TABLE 4-6

CONTROL AREA LAND USE BY RWD, 1960-1978: PERCENTAGE CHANGE IN ACREAGE SAMPLED

Land Use 1960-1978	Southeast				Northeast				West			
	Pushmataha Co. RWD #1	LeFlore Co. N.W. Water Association	LeFlore Co. Spiro East	LeFlore Co. Water Distribution Co.	Rogers Co. RWD #6	Rogers Co. RWD #8	Ottawa Co. RWD #2	Mayes Co. RWD #4	Comanche Co. RWD #1	Comanche Co. RWD #2	Cotton Co. RWD #2	Stephens Co. RW, S & SW #3
Crop	-58.8	-28.5	-7.9	-64.3	5.9	-35.4	-41.3	-15.4	44.3	29.8	-11.1	-9.0
Pasture	53.7	17.7	17.2	9.2	-1.4	-3.3	91.0	50.4	-2.8	-6.6	6.5	5.9
Rural Residential	NC*	260.0	112.5	240.0	35.5	200.0	28.6	46.2	-20.8	8.3	-12.5	18.9
Woodland	-2.2	-19.6	-36.1	-4.5	NC	NC	-100.0	-74.8	NC	NC	NC	-100.0
Urban Residential	NC	NC	100.0	NC	NC	NC	NC	NC	NC	NC	NC	NC
Transportation	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Recreation	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Commercial	NC	NC	NC	NC	NC	100.0	NC	NC	NC	NC	NC	NC
Extractive	NC	NC	50.0	NC	NC	NC	NC	NC	NC	NC	NC	NC

*NOTE: NC = No change was recorded between 1960 and 1978.

FIGURE 4-2
RWD No2, COMANCHE COUNTY
T3N R12W SECTIONS 14 and 23



MILE
0 1/8 1/4
0 0.2 0.4
KM

LEGEND

C - CROPS
P - PASTURE
R - RURAL RESIDENT
No. UNITS / ACREAGE

NORTH

all four RWD cases in the northeastern samples. Most of the control samples, however, showed very little or only modest increases in rural housing units, with one sample area actually experiencing a decline: Comanche County's RWD #1 adjacent area samples. In this sample area was found thirteen housing units in 1960; however, in 1978 only nine such units could be located. This is predominantly rangeland and wheat production land where a steady consolidation of ranches and farms into larger units has taken place, the former land owners migrating out of this area.

Similar conclusions may be drawn regarding other land use types. Cropland, for example, experienced a major decrease in total sampled land area. Samples drawn from RWD's indicate a decline of 57.5 percent of the total area, or a loss of some 8,019 sampled acres, while control samples experienced only an 18.8 percent decrease. Although the earlier control area percentage is smaller than for the RWD samples, 18.8 percent as opposed to 57.5 percent for the water districts, the most recent samples depict control areas as being more cropland oriented. Associated control area cropland uses accounted for 16.4 percent of the total.

On a regional basis, similar cropland patterns prevail (Table 4-4) but not all control samples experienced a decrease in cropland. The western portion of the study actually had an increase of 2.5 percent. The other two regions, however, showed some decline, as the southeast dropped 18.2 percent and the northeast declined by 33 percent. The RWD samples, on the other hand, all saw a decline in cropland usage, with the western region having the smallest loss (13.4 percent) and the northeast with the highest (59.4 percent).

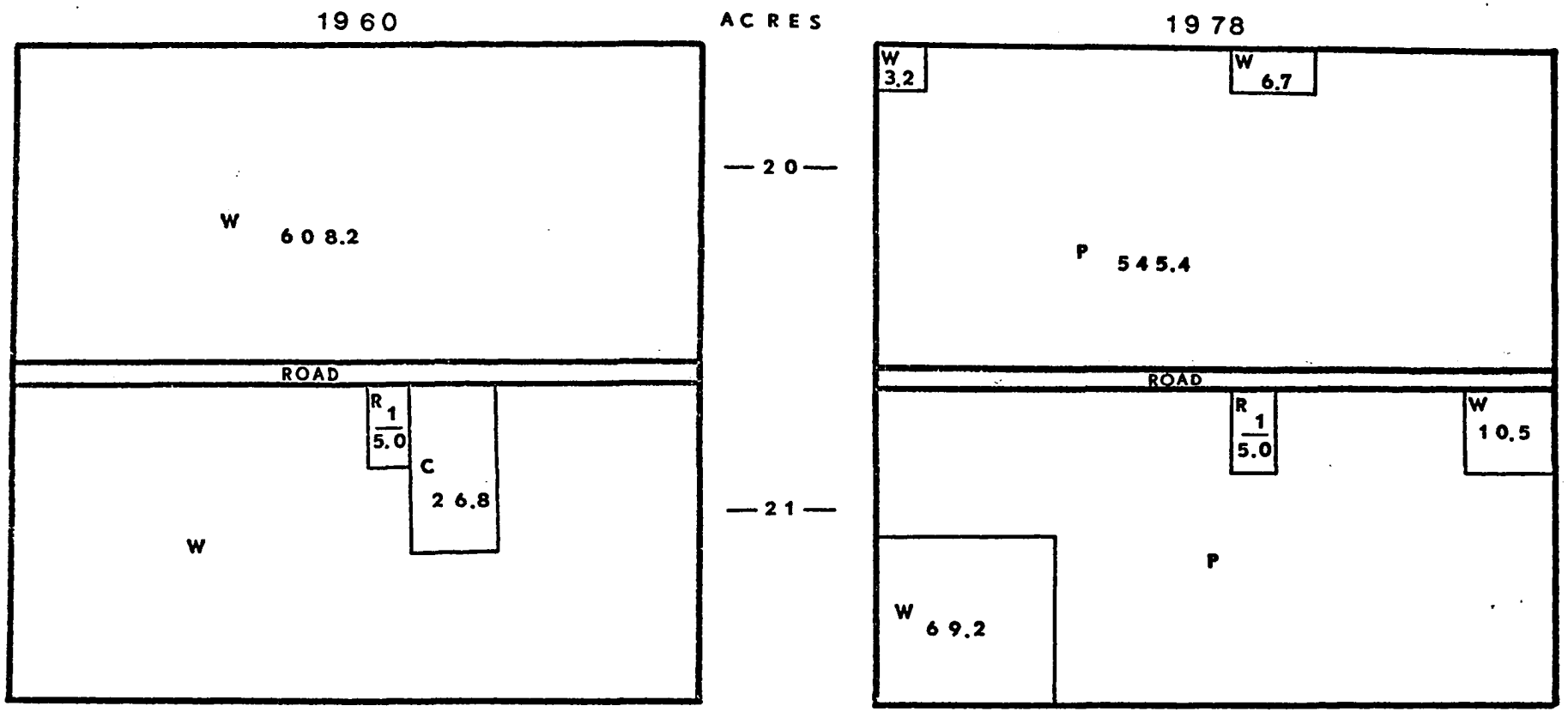
While cropland, for the most part, was found to be declining in each water district sampled, a few had increases (Table 4-5). LeFlore County's Water Distribution Company had an increase of some 35.5 percent, but was the only district outside the western region to do so. Two of the western region districts, Comanche County Rural Water District #1 and Cotton County Rural Water District #2, each had increases. Figure 4-3 is a sample from Cotton County's RWD #2 indicating the trend in cropland increase in the western study area.

Pasturage also followed expected trends in that the general direction of change was an increase in acreage. On a state level, though, pasture usage does not exhibit a great difference between RWD and control study areas (Table 4-2), but both samples are large. Rural water districts do produce the greater change, with a gain of 17.36 percent and a total area of 7,580.7 acres. The water district and control area samples were similar in total area at the earlier sampling; the control samples, however, experienced only an 11.34 percent gain in land area or some 4,996.2 acres.

On a regional basis (Table 4-4) pasture did not always experience an increase in area. For example, the western region of RWD samples experienced a decline of 5.9 percent. The other regions, for both the water district and the control samples, showed an increase in land devoted to this use and, again, the greater increases occurred generally in the water district samples, with the northeast leading.

On a more local basis, increases in land attributed to pasture was again most often the case, but in a few districts decreases were found (Tables 4-5 and 4-6). In every region at least one such district

FIGURE 4-3
RWD No 1, PUSHMATAHA COUNTY
T2N R19E, SECTIONS 20 and 21



06

was found, with the western region having three, but for the most part, these declines were small.

The only other rural land use that was found to vary to any large extent between the two time frames was woodland. On a state basis (Table 4-2) the RWD samples experienced a decrease of 65.99 percent, while the control samples decreased by only 20.07 percent.

Regionally (Table 4-4) the woodland classification consistently showed a decrease in total land area. The only exception to this was for the western region of the RWD samples where no change occurred. The largest change was found in the western control area section where all woodland found in 1960 had disappeared by 1978. The northeastern areas of the control sample also had a rather large decline of 76.1 percent.

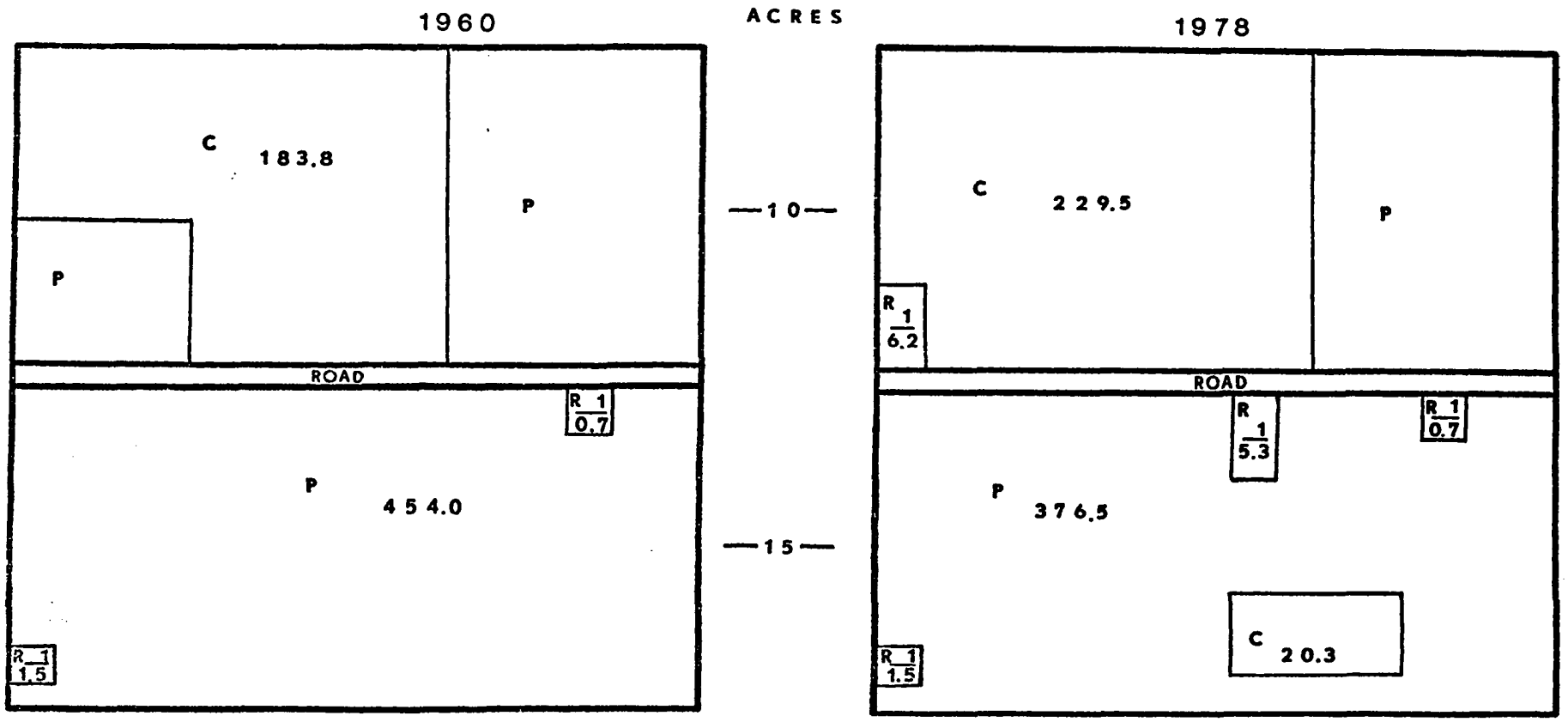
Locally (Tables 4-5 and 4-6) there was not a single district with an increase in woodland acreage, however, several districts remained constant between the two periods. At the same time, though, a number of counties lost a substantial amount of their original forest cover. Ottawa County RWD #2 associated control area, for example, lost all cover tabulated in 1960, and Pushmataha County RWD #1 also had a substantial decrease of over 45 percent. Figure 4-4 also indicates the trend in woodland decline in this area. Most of this loss went to pasture where an increase of 760 percent was recorded.

Only small amounts of land were devoted to the remaining rural land uses, with only small changes in acreage occurring. From a percentage change standpoint, however, some major variations were recorded, especially for urban residential. In these cases the earlier

FIGURE 4-4

RWD No 2, COTTON COUNTY

T1S R12W, SECTIONS 10 and 15



LEGEND

C CROPS

P – PASTURE

R – RURAL RESIDENT

No UNIT / ACREAGE

MILE

0 1/8 1/4

0 .2 0.4

K.M.

NORTH

figures (1960) were extremely small, therefore, any change at all would be statistically substantial.

In summary, it is evident that more land use change is taking place in rural Oklahoma than originally suggested. However, stability still is to be found overall. The trends identified may be generally associated with similar nation-wide changes, with highest rates of growth in rural Oklahoma being directed toward an extended suburban type of land use. Rural residential uses have shown exceptional growth patterns, especially in association with rural water districts. The non-rural water district samples, likewise, produced some rather large changes in this category, but a major gulf exists between these and their RWD counterparts.

Other land uses also followed expected trends of change. Both cropland and woodland areas identified in 1960 experienced declines by 1978, whereas areas devoted to pasture were found to have increased in most cases. A few exceptions to these general trends were found, most of which may be explained by local situations of physical and socio-economic environments.

Transition Matrices

The previous examination of land use and net changes in major uses for the two periods of analysis suggests that the overall pattern was relatively stable, although analysis of housing unit increases indicates a much more dynamic, if not complex, rural situation. The actual dynamism of change is better appreciated if specific changes among particular uses are examined. To best grasp the intricacy and magnitude of ongoing land use shifts, it is necessary to document and

analyze the detailed transfers among the various uses. Land use transfers among the nine categories for the total study area are summarized in a series of land use transition matrices. The dynamics and fluidity of change within each use category are examined as are patterns of change evidenced by the different groups.

Analysis of Statewide Data

A gross analysis of the land use changes taking place within the state may be made from Table 4-7. This table sums all sampled land uses, both RWD and control areas, for this study, and along with others to follow, should be read in a "from to" format. It depicts the amount of land of a certain use in the 1960 time period that had shifted to another use by 1978. The table should be read in a row-column manner. The rows represent land uses in 1960, whereas the columns represent land uses in 1978. For example, row number two (pasture) and column number one (cropland) should be interpreted as follows: in 1960 there were 5,762 acres in pasture that had shifted to cropland by 1978. Row number four (woodland) and column number two (pasture) may be read similarly; in 1960 there were 6,457.4 acres devoted to woodland uses that by 1978 had shifted to pasture.

A number of important land use changes may be observed from Table 4-7. In 1978 there were measured some 23,312.5 acres of land devoted to cropland, as compared to 34,217.9 acres in 1960. This suggests a simple decrease of 10,905.4 acres of cropland between these two periods. The matrix, however, reveals that of the original 34,217.9 acres of cropland only 17,417.2 acres (row number one, column number one) actually remained intact, a difference of 16,800.7 acres. Even

TABLE 4-7

LAND USE TRANSITION MATRIX, 1960 AND 1978

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	1960 TOTALS
Cropland	17,417.2	15,561.3	950.1	66.7	174.4	30.1	0	18.1	0	34,217.9
Pasture	5,726.0	78,160.5	3,279.1	174.8	260.3	0	0	72.0	17.4	87,690.7
Rural Residential	6.1	63.9	2,797.4	0	0	0	0	0	0	2,867.4
Woodland	163.2	6,457.4	291.6	0	0	0	0	0	0	25,833.3
Urban Residential	0	0	0	0	490.6	0	0	0	0	490.6
Transportation	0	0	0	0	0	604.3	0	0	0	604.3
Recreation	0	0	0	0	0	0	903.3	0	0	930.3
Commercial	0	0	0	0	0	0	0	276.7	0	276.7
Extractive	0	24.5	0	0	0	0	0	0	664.3	688.8
1978 TOTALS	23,312.5	100,267.6	7,318.8	19,158.4	929.5	634.4	130.3	366.8	681.7	153,600.0

though these 16,800 acres were lost to the other eight land uses, there was a corresponding shift of some 5,895.3 acres from these same land uses, primarily pasture to cropland.

Most of the land use change away from cropland went to pasture. Indeed, an amount almost equal to the cropland acreage left unchanged was transferred to pasture usage, some 15,561.3 acres. This corresponds generally with the national conversion of cropland to pasture. Rural residential land uses accounted for most of the remaining loss of cropland, a transfer of 950.1 sampled acres. Growth of rural residential land also corresponds with a major national trend, that of suburban growth. Not all such suburban growth need necessarily be contiguous to urban areas.

The corresponding transfer of land to cropland was primarily away from pasture usage, involving over 5,700 acres. Much of this is land that at an earlier time had been cropped and therefore was easier to convert back to cropland. Only woodland, with 163.2 acres and rural residential with 6.1 acres contributed additional acreage to this shift. While it was observed that cropland decreased in acreage during the period of this study, pasture usage increased in acreage within the area sampled, from 87,690.7 to 100,267.6 acres. Whereas most of this was the result of a decline in cropland acreage, a large amount was also transferred from woodland uses, some 6,457.4 acres. At the same time, some previous pasture acreages were converted to other land uses. As was pointed out above, 5,726 acres of pasture land were converted to cropland. In addition, a large amount of pasture was converted to rural residential, some 3,279.7 sampled acres; and another 260.3 acres

was converted to urban residential land use. It should be remembered, however, that idle land was especially combined with pasturage for this analysis due to difficulties in identification of that form of land use from aerial photographs. Therefore, much of this shift may be attributed to a transfer from idle to some form of residential usage, rather than from lands used primarily for the production of livestock. This again corresponds to a broader sequence of conversion to suburban usage, or from woodland or the more intensively cropped to less extensive pasture (speculation) and finally to an urban usage--rural residential.

When the above data are divided into rural water districts (Table 4-8) and associated control areas (Table 4-9), even more explicit changes may be recognized. It is evident, from even this level of gross analysis, that a greater amount of change away from traditional land use is occurring in RWD areas than elsewhere. Of the 15,561.3 acres converted from cropland to pasture, for example, 9,772.7 acres were found in RWD samples as compared to only 5,788.6 acres found in control samples. At the same time, though, only 2,664.6 acres reverted to cropland from pasture in the RWD samples; whereas over three thousand acres of former pasture became cropland in the control samples.

Of the 18,874 RWD acres identified as cropland in 1960, only 8,153.3 remained in cropland in 1978, the largest loss being attributed to pasturization but in part being held in a less intensive form for speculative purposes. Rural residence also expropriated a sizeable amount, some 894.8 acres, which is by far the majority of the total

TABLE 4-8

LAND USE TRANSITION MATRIX, 1960 AND 1978: RWD SAMPLES

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	1960 TOTALS
Cropland	8,158.3	9,772.7	894.8	0	0	30.1	0	18.1	0	18,874.0
Pasture	2,664.6	27,964.5	2,638.5	88.6	260.3	0	0	30.5	0	43,647.0
Rural Residential	2.4	0	1,842.2	0	0	0	0	0	0	1,844.6
Woodland	28.8	3,466.0	226.8	6,969.1	4.2	0	0	0	0	10,694.9
Urban Residential	0	0	0	0	478.7	0	0	0	0	478.7
Transportation	0	0	0	0	0	494.6	0	0	0	494.6
Recreation	0	0	0	0	0	0	446.8	0	0	446.8
Commercial	0	0	0	0	0	0	0	276.7	0	276.7
Extractive	0	24.5	0	0	0	0	0	0	18.2	42.7
1978 TOTALS	10,854.1	15,227.7	5,602.3	7,057.7	743.2	524.7	446.8	325.3	18.2	76,800.0

TABLE 4-9

LAND USE TRANSITION MATRIX, 1960 AND 1978: CONTROL SAMPLES

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	1960 TOTALS
Cropland	9,258.9	5,788.6	55.3	66.7	174.4	0	0	0	0	15,343.9
Pasture	3,061.4	40,196.0	641.2	86.2	0	0	0	41.5	17.4	44,043.7
Rural Residential	3.7	63.9	955.2	0	0	0	0	0	0	1,022.8
Woodland	134.4	2,991.4	64.8	11,947.8	0	0	0	0	0	15,138.4
Urban Residential	0	0	0	0	11.9	0	0	0	0	11.9
Transportation	0	0	0	0	0	109.7	0	0	0	109.7
Recreation	0	0	0	0	0	0	483.5	0	0	483.5
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	646.1	646.1
1978 TOTALS	12,458.4	49,039.9	1,716.5	12,100.7	186.3	109.7	483.5	41.5	663.5	76,800.0

sample (RWD plus control areas) conversion from cropland to rural residence of 950.1 acres (see Table 4-7). Only 55.3 acres of control area cropland was found to have been converted to rural residence.

Perhaps the most glaring difference between RWD land use shifts and those occurring elsewhere involves the shift from pasture to rural residence, the end stage of the urban conversion sequence for rural areas. A total of 3,279.7 acres shifted in this way for the total sample (Table 4-7), and again, the vast majority of this occurred in RWD samples (2,638.5 acres). At the same time, only 641.2 acres were found to have experienced a similar type of change in the control samples. Likewise, corresponding transfers from woodland to rural residence is more pronounced for the RWD samples, 226.8 acres, as compared to control samples of only 64.8 acres. Overall, the RWD samples showed an increase of 3,757.7 acres, from 1,844.6 acres in 1960 to 5,602.3 acres in 1978. The control samples fell considerably short of these figures with an increase of only 693.7 acres, from 1,022.8 acres in 1960 to 1,716.5 acres in 1978.

The only other noteworthy land use shift observed involved the conversion of woodland areas to pasture. Here, though, little difference between RWD and control samples was found. RWD conversions were slightly higher at 3,466 acres, while control area change produced some 2,991.4 acres. It should be noted that a smaller amount of land was devoted to woodland uses at either time period for the RWDs than for the control samples. The RWDs experienced a decline of 3,637.2 acres, from 10,694.9 acres in 1960 to 7,057.7 acres in 1978; at the same time, the control samples experienced a decline of 3,037.7 acres, from 15,138.4 acres in 1960 to 12,100.7 acres in 1978.

A related aspect of this shift is the change in actual number of residential units observed as land use conversion took place. Table 4-10 presents the number of housing units found in 1978 that were occupying space used for other purposes in 1960: in this case former cropland, pasture or woodland space.

Overall, in former (1960) cropland areas an increase of some 282 housing units was found (grand totals for the three study regions). Likewise, former woodland use areas in 1978 exhibited a total of ninety-nine new residential units with the larger gain in the conversion of former pasture lands, some 982 new units. An increase of 1,363 rural residential housing units in areas formerly devoted to cropland, pasturage or woodland in the sampled areas was then recorded.

Regional Analysis

Important regional differences exist regarding changing land use patterns within the state. The three study areas surveyed for this research each exhibit differing patterns of land use development.

Northeast

Both RWDs and control areas experienced a decline in cropland between the two time periods of analysis (Tables 4-11 and 4-12) with the greater decline within the RWD samples. This portion of the study area experienced a decrease of 5,735.8 acres, such that of the original 9,641.3 acres, only 3,283.2 acres remain in cropland uses. Again, as discussed on the state level, the greater loss can be attributed to conversion to pasturage, some 6,068.6 sampled acres. But also, an important 273.4 acres shifted to rural residences during this time

TABLE 4-10

NUMBER OF HOUSING UNITS IN 1978 THAT WERE IN OTHER LAND USES IN 1960

Rural Water District	Southeast			Rural Water District	West			Rural Water District	Northeast		
	Cropland	Pasture Land	Woodland		Cropland	Pasture Land	Woodland		Cropland	Pasture Land	Woodland
Pushmataha Co. RWD #1				Comanche Co. RWD #1				Ottawa Co. RWD #2			
RWD	1	0	52	RWD	17	64	0	RWD	76	21	0
Control Area	1	0	1	Control Area	0	1	0	Control Area	6	3	0
LeFlore Co. Water Dist. Company				Comanche Co. RWD #2				Mayes Co. RWD #4			
RWD	2	34	4	RWD	30	195	0	RWD	37	19	17
Control Area	0	15	3	Control Area	1	4	0	Control Area	2	5	12
LeFlore Co. N.W. Water Inc.				Cotton Co. RWD #2				Rogers Co. RWD #6			
RWD	2	37	3	RWD	7	14	0	RWD	6	90	1
Control Area	4	19	4	Control Area	3	1	0	Control Area	8	13	0
LeFlore Co. Spiro East				Stephens Co. RW, S & SW Dist. #3				Rogers Co. RWD #8			
RWD	4	139	0	RWD	62	68	0	RWD	10	125	0
Control Area	2	12	2	Control Area	0	19	0	Control Area	1	84	0
Totals				Totals				Totals			
RWD	9	210	59	RWD	116	341	0	RWD	129	255	18
Control Area	7	46	10	Control Area	4	25	0	Control Area	17	105	12
Grand Totals RWD & Control Area	16	256	69	Grand Totals RWD & Control Area	120	366	0	Grand Totals RWD & Control Area	146	360	30

TABLE 4-11

LAND USE TRANSITION MATRIX, 1960 AND 1978: NORTHEAST RWD SAMPLES

	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	3,283.2	6,068.6	273.4	0	0	0	0	16.1	0	9,641.3
Pasture	622.3	12,218.1	852.5	0	0	0	0	0	0	13,692.9
Rural Residential	0	0	730.4	0	0	0	0	0	0	730.4
Woodland	0	274.5	48.5	1,032.1	0	0	0	0	0	1,328.1
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	123.5	0	0	0	123.5
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	83.8	0	83.8
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	3,905.5	18,534.2	1,904.8	1,032.1	0	123.5	0	83.8	0	25,600.0

TABLE 4-12

LAND USE TRANSITION MATRIX, 1960 AND 1978: NORTHEAST CONTROL SAMPLES

	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	2,949.0	2,731.3	41.6	0	0	0	0	0	0	5,721.9
Pasture	830.0	15,431.7	316.7	0	0	0	0	0	0	16,619.9
Rural Residential	0	0	501.3	0	0	0	0	0	0	501.3
Woodland	50.3	1,719.2	28.6	0	0	0	0	0	0	2,358.8
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	59.6	0	0	0	59.6
Recreation	0	0	0	0	0	0	338.5	0	0	338.5
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	3,829.3	19,882.2	888.2	560.7	0	59.6	338.5	0	0	25,600.0

period, accounting for an increase of 129 rural residential housing units (Table 4-10). At the same time, some 622.3 acres shifted from pasture to cropland. In addition to speculation, the greater shift to pasture is also the result of higher cattle prices in the past few years in association with rather low returns on cropped land, especially land devoted to wheat production.

Control area cropland figures are somewhat smaller, and a decline of only 1,892.6 acres was noted. Of the initial 5,721.9 acres, some 2,949 acres remained intact, with, as before, the greatest loss going to pasturage, 2,731.3 acres. However, rural residence increased by only 41.6 acres at the expense of cropland losses, and an increase of only 17 rural residences could be found, the result of inadequate services, especially water. Cropland gained acreage from both pasture and woodland uses, with 832 acres being converted from pasture to cropland and another 50 acres from woodland.

The RWD samples gained a large amount of pasture area between the two periods of analysis. In 1960, grassland accounted for some 13,692.9 acres, but increased to 18,543.2 acres in 1978, an increase of 4,841.3 sampled acres. Again, most of this gain was at the expense of cropland, which is more capital intensive than pasture, and woodland also contributed 240 acres. This shift to pasture, especially from cropland, is again, in part, the effect of speculation. Nearness to Tulsa is a major factor encouraging land owners to sell lands to developers and real estate agents who hold the land until an appropriate time for development, or to take this land out of capital intensive uses and put it into less intensive uses to await selling

opportunities. Pasture also lost some of its initial (1960) area. In addition to the loss to cropland noted earlier, an additional 852.5 acres were converted to rural residential usage, accounting for an increase of 255 individual housing units.

A similar, although somewhat smaller, gain was found in the control samples. In 1960 a total of 16,619.9 acres were found in pasture usage, but increased to 19,882.2 acres in 1978, a gain of 3,262.3 acres. Most of this gain was at the expense of cropland, noted earlier. However, a major amount, 1,719.2 acres, was converted from woodland usage. Pasture losses were primarily found in two land use categories: cropland and rural residential. Eight-hundred and thirty acres were converted from pasture to cropland and another 316.7 acres to rural residential. A rather large number of rural residences (105) were recorded in this conversion from pasture usage.

Rural residential land usage experienced an overwhelming increase in the RWD samples. In 1960 only 730.4 acres were identified as rural residential, but in 1978 this had increased to 1,904.8 acres. All 730.4 initial acres were intact, but conversion from cropland (273.4 acres), pasture (852.5 acres), and woodland (48.5 acres) inflated the total to over two and a half times the 1960 sampled figures. A total of 402 new rural housing units were recorded, again attesting to the impact available water has on rural suburban growth.

Even though the control samples experienced some increase in rural residential usage, the increase was not as great as in the RWD samples. In 1960 just over 500 acres were found in this land use category, but by 1978, an increase of 386.9 acres could be identified,

thus expanding the total to 888.2 acres. Again, this category gained from previous cropland (41.6 acres), pasture (316.7 acres), and woodland (28.6 acres) uses, and accounted for an increase of only 134 rural housing units. At the same time, no loss in rural residential land use or housing units was anywhere recorded in the northeastern study region.

West

Western Oklahoma also experienced some major variations between land sampled from RWDs (Table 4-13) and control areas (Table 4-14). By far the majority of the land in this region was devoted to either cropland or pasture uses. For both RWDs and the control areas a loss in cropland was noted, but the loss was much more pronounced within the RWD samples than in control samples. In the 1960 RWD samples, 8,173.1 acres were found to have been devoted to cropland. In 1978 this had decreased to 6,024.6 acres, a loss of 2,112.5 acres. Of the initial acreage, only 4,538 remained intact, with most of the 3,599.1 acres being converted to pasture, some 3,015.3 acres in total. Rural residence gained a significant amount of the loss from cropland, 551.7 acres, and an increase of 116 new rural housing units was found to have occurred in this category. Transportation (30.1 acres) and commercial land uses (2.0 acres) accounted for the remaining acreage. An important increase in cropland, at the expense of pasturage, was also noted. This conversion accounted for a 1,484.2 acre increase.

Declining pasture acreage for control areas totaled only 14.5 acres, from 4,863.9 acres in 1960 to 4,848.4 acres in 1978. The loss

TABLE 4-13

LAND USE TRANSITION MATRIX, 1960 AND 1978: WEST RWD SAMPLES

	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	4,538.0	3,015.3	551.7	0	0	30.1	0	2.0	0	8,137.1
Pasture	1,484.2	12,705.3	1,180.0	0	205.3	0	0	30.5	0	15,605.3
Rural Residential	2.4	0	656.4	0	0	0	0	0	0	658.8
Woodland	0	0	0	120.5	0	0	0	0	0	120.5
Urban Residential	0	0	0	0	274.2	0	0	0	0	274.2
Transportation	0	0	0	0	0	177.9	0	0	0	177.9
Recreation	0	0	0	0	0	0	449.4	0	0	446.8
Commerical	0	0	0	0	0	0	0	179.4	0	179.4
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	6,024.6	15,720.6	2,388.1	120.5	479.5	208.0	446.8	211.9	0	25,600.0

TABLE 4-14

LAND USE TRANSITION MATRIX, 1960 AND 1978: WEST CONTROL SAMPLES

	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	2,878.7	1,981.9	3.3	0	0	0	0	0	0	4,863.9
Pasture	1,954.7	17,651.6	127.2	0	0	0	0	0	0	19,733.5
Rural Residential	3.7	63.9	310.5	0	0	0	0	0	0	378.1
Woodland	12.3	196.2	3.8	0	0	0	0	0	0	212.3
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	24.6	0	0	0	24.6
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	387.6	387.6
1978 TOTALS	4,849.4	19,893.6	444.8	0	0	24.6	0	0	387.6	25,600.0

of 1,981.9 acres to pasture was nearly offset by a conversion of 1,954.7 acres from pasture to cropland. In a similar fashion, a loss of 3.3 acres to rural residence was offset by a conversion of 3.7 former rural residence acres to cropland, and a small increase of only 4 rural housing units was found. The remaining difference was a 12.3 acre shift from woodland to cropland.

Similarly, both RWDs and control areas gained pasture land. In 1960 some 15,605.3 acres were recorded in this land use category for the RWD samples, and increased to 15,720.6 acres in 1978, a gain of only 115.3 acres. Pasture was lost to cropland (1,484.2 acres), rural residential (1,180 acres), and commercial (30.5 acres) land uses. Former pasture areas produced the largest regional gain in rural housing units. In former pasture areas some 341 new housing units were discovered with the only gain in pasture acreage at the expense of cropland. However, this was a sizeable gain of 3,015.3 acres, more than offsetting the noted losses.

Basically, the same pattern exists for control samples. The initial total of 19,733.5 acres of pasture land had increased to 19,893.6 acres by 1978. Major losses were again to cropland (1,954.7 acres) and to rural residential (127.2 acres) but only 25 new housing units were found. Acreage gains in pasturage, however, came at the expense of former cropland (1,981.9 acres), woodland (196.2 acres), and, surprisingly, rural residential uses (63.9 acres) where 16 former housing units were abandoned to pasture use.

Some rather large land use conversions were taking place in this portion of the state in the rural residential category. An

increase of 66.7 acres was recorded in the control samples, but, as noted above, some surprising losses in rural residential acreage were identified. The trend depicted thus far suggests that rural residential acreages here should be increasing rather than decreasing, but of the original 378.1 acres recorded, only 310.5 acres remained intact through the period under analysis. Loss of this acreage was to cropland (3.7 acres) and to pasture (63.9 acres), with gains coming at the expense of cropland (3.3 acres), woodland (3.8 acres), and pasturage (127.2 acres).

In the RWD samples, however, only 2.4 acres of the initial 658.8 acres devoted to rural residential use were lost. These few acres were converted to cropland. Gains, however, more than made up for this loss. Conversion from pasture alone totaled 1,180 acres, and cropland conversion contributed another 551.7 acres to the growth of rural residential acreages. A total of 366 new housing units were found but 20 former housing units were eliminated and the land converted to cropland and pasture.

Southeast

The third sample region, the southeast, showed, in some respects, a pattern similar to the other two regions; however, some notable differences are discernable. Some vast differences exist between RWD samples (Table 4-15) and control samples (Table 4-16) within the southeastern study area.

As in the other regions and for similar reasons, cropland experienced an overall decline in total acreage for both the RWD

TABLE 4-15

LAND USE TRANSITION MATRIX, 1960 AND 1978: SOUTHEAST RWD SAMPLES

	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	337.1	688.8	69.7	0	0	0	0	0	0	1,095.6
Pasture	558.1	13,041.1	606.0	88.6	55.0	0	0	0	0	14,348.8
Rural Residential	0	0	455.4	0	0	0	0	0	0	455.4
Woodland	28.8	3,218.5	178.3	5,816.5	4.2	0	0	0	0	9,246.3
Urban Residential	0	0	0	0	204.5	0	0	0	0	204.5
Transportation	0	0	0	0	0	193.2	0	0	0	193.2
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	13.5	0	13.5
Extractive	0	24.5	0	0	0	0	0	0	18.2	42.7
1978 TOTALS	924.0	16,972.9	1,309.4	5,905.1	263.7	193.2	0	13.5	18.2	25,600.0

TABLE 4-16

LAND USE TRANSITION MATRIX, 1960 AND 1978: SOUTHEAST CONTROL SAMPLES

	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	3,431.2	1,075.4	10.4	66.7	174.4	0	0	0	0	4,758.1
Pasture	276.7	7,112.7	197.3	86.2	0	0	0	0	17.4	7,690.3
Rural Residential	0	0	143.4	0	0	0	0	0	0	143.4
Woodland	71.8	1,076.0	32.4	11,387.1	0	0	0	0	0	12,567.3
Urban Residential	0	0	0	0	11.9	0	0	0	0	11.9
Transportation	0	0	0	0	0	25.5	0	0	0	25.5
Recreation	0	0	0	0	0	0	145.0	0	0	145.0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	258.5	258.5
1978 TOTALS	3,779.7	9,264.1	383.5	11,540.0	186.3	25.5	145.0	0	275.9	25,600.0

samples and the control samples. In 1960, 1,095.6 acres devoted to cropland were recorded in the RWD samples, but only 924 such acres were found in 1978, a loss of 171.6 acres. More significant were the dynamic shifts occurring within the various categories of land use in relation to cropland. Of the initial 1,095.6 cropland acres, only 337.1 remained, a loss of 758.5 acres. As before, most of this loss can be attributed to the increase in pasturage, some 688.8 acres, and in rural residences (69.7 acres). At the same time, however, additional land was converted to cropland from pasture (558.1 acres) and woodland (28.8 acres). There was also an increase of nine rural residential housing units in former cropland areas.

A similar decline in cropland was found in the control samples. In 1960, 4,758.1 acres were identified, but only 3,779.7 acres were tabulated in 1978, a loss of 978.4 acres. In this case, however, a greater amount of the initial acreage remained in that land use, 3,431.2 acres, with the losses being accounted for by increases in pasture (1,075.4 acres), rural residential (910.4 acres), woodland (66.7 acres), and urban residential (174.4 acres) land uses. Only small gains were recorded, the largest occurring in pasture (276.7 acres). Additionally, a gain of seven housing units was found, only slightly less than for RWD samples.

Likewise, pasture land gained overall acreage in both categories. Pasture acreage in RWD's increased from 14,348.8 acres in 1960 to 16,972.9 acres in 1978, a gain of 2,624.1 acres. Most of this growth, however, can in this case be attributed to deforestation--often clear-cutting. Woodland areas experienced a conversion of 3,218.5

acres to pasture usage, but it should be noted that in the case of clear-cutting, the land may some day be replanted for future forest production. However, no evidence in the sampled areas could be found that replanting had taken place or was even forthcoming. Indeed, several such overcuts had scrub growth several years old. A second major increase in pasture land came from cropland (688.8 acres), usually land that has been allowed to return to natural grassland cover.

At the same time that pasture was gaining acreage, major conversions of former grasslands to other uses were occurring. The largest such conversion was to rural residences where 606 acres were identified along with an increase of 210 housing units. Other conversions involved former woodland (88.6 acres) and urban residential (55 acres) land uses.

Likewise, control areas increased their pasture holdings. A total of 1,555.8 acres were found to have been converted to pasture uses, with an almost equal acreage coming from cropland (1,075.4 acres) and woodland (1,076.0 acres). Losses of pasture land were small, with only 276.7 acres passing back into cropland and another 86.2 acres to woodland. Rural residential usage gained a total of 197.3 acres at the expense of pasturage, and only 46 new housing units were found in former pasture lands.

An important comparison between RWD and control samples can be found in the rural residence land use categories. While the RWD samples experienced a rather large increase of rural residential usage, control samples experienced a more modest growth. In 1960 some 455.4

acres were recorded as rural residential in the RWD samples, and while this acreage remained intact in 1978, an additionally large amount was added at the expense of former pasture land (606 acres), woodland (178.3 acres), and cropland (69.7 acres), and in addition, an increase in housing of 278 units was found.

The control area category retained all its 1960 total of 143.4 acres and gained some small acreages from previous cropland (10.4 acres), pasture (197.3 acres), and woodland (32.4 acres) uses. A total of only 63 new housing units were identified.

One final categorical change, only partially noted above, involves woodland uses. The RWD samples recorded a major loss of 3,341.2 acres, and as previously reported, most of this passed to pasture land uses (3,218.5 acres), with the balance going to cropland (28.8 acres), rural residential (178.3 acres), and urban residential (4.2 acres). In former woodland areas were found 59 new residential units with the only recorded gain coming at the expense of former pasture lands (88.6 acres).

Figures for control areas were much less variable. A total loss of only 127.3 acres was found to have occurred and almost all of this can be attributed to a conversion to pasturage (1,076.0 acres). Only ten new housing units were added in former woodland areas, but with only marginal gains in acreage at the expense of former cropland (66.7 acres) and pasture (86.2 acres) uses.

In summary, regional analysis of the land use matrices points out that some rather extreme land use conversions are taking place. The land use patterns are much more dynamic than previously reported.

The major shift occurring relates to the growth of rural residences. Former cropland, pasturage, and woodland areas have all contributed large acreages to the expansion of this form of suburban growth. Other land conversions may be interpreted as having some type of urban stimulus. The overall shift from woodland and the more intensive cropland to pasture can be seen as rural forms of speculation. Pasture usage is much less capital intensive than cropland and easier to sell to potential residential buyers if cleared of heavy woodland. Even though not all land converted to pasture from cropland or woodland will become residential, the growth of rural residential acreages indicates a sizeable quantity will be thus converted.

Analysis of Individual Rural Water Districts

The difference between land use change associated with RWDs and that associated with control areas becomes even more evident when individual water district and associated non-water district samples are analyzed in a transition matrix format. Appendix B, Tables 1-24, present the results of this analysis for each district from the standpoint of RWD and control area samples. Within each of the three study regions four rural water districts were chosen for analysis, and four corresponding samples were drawn from non-rural water district areas found within the same general region.

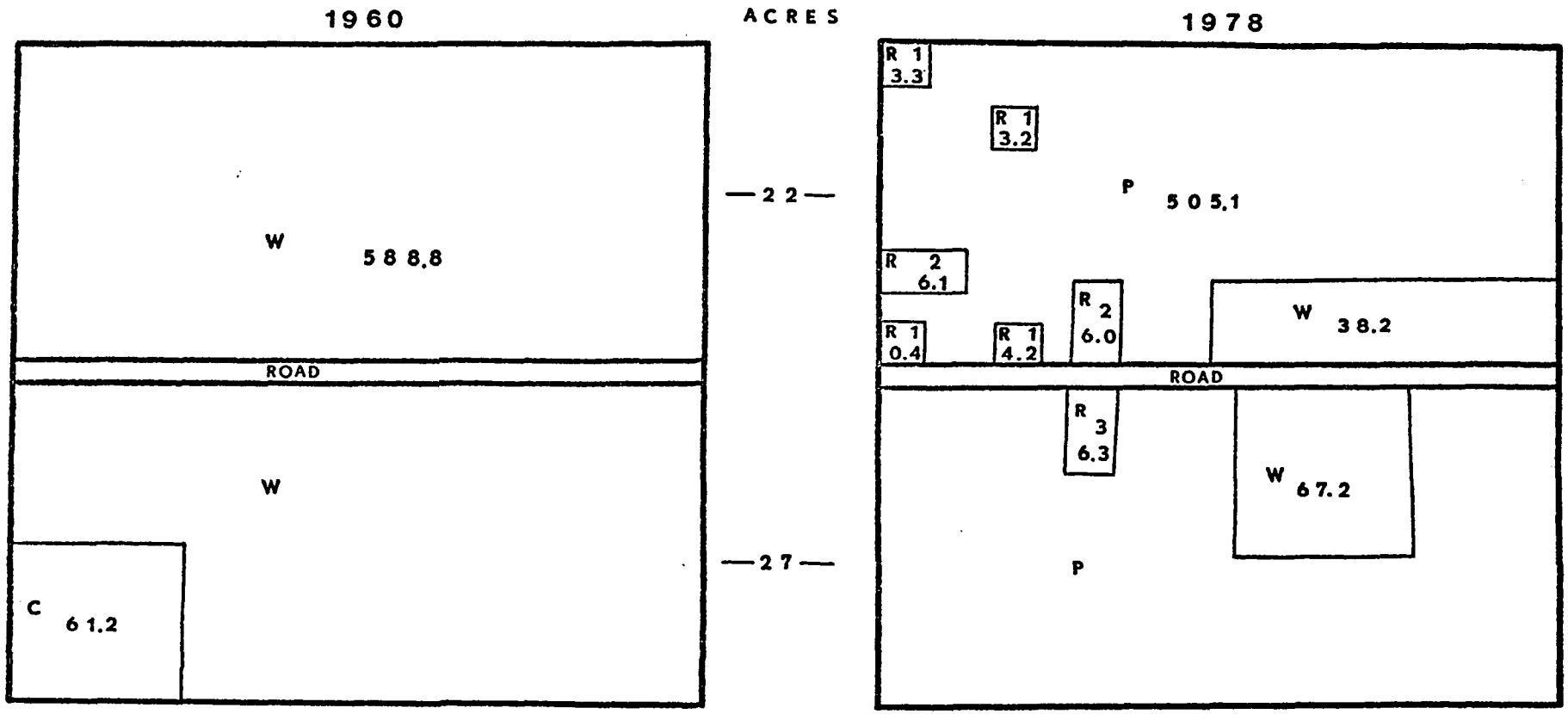
Southeast

Several important trends may be observed from the eight (four rural water district and four control area) samples selected in southeast Oklahoma. A major land use in this portion of Oklahoma is

woodland. In every surveyed case, woodland areas were found to be declining, and for the most part, this decline resulted in an increase in pasture land usage. In Pushmataha County's Rural Water District #1 (Appendix B, Table 1), for example, almost half the initial (1960) woodland cover had been removed and replaced by some form of grassland cover. Figure 4-5, for example, depicts such a case. This conversion may be the result of several forces occurring simultaneously in this portion of the state. First, as pointed out earlier, clear-cutting forest practices are obviously taking place, and again, there is little or no evidence to suggest any replanting of such cut over acres. The area is then left to grassland and brush regrowth as well as various erosional processes. Secondly, an increase in cattle prices in the last few years has made cattle grazing a more lucrative business. Some land, then, will be specifically cleared, or left in a cleared state after commercial forest removal, for livestock rearing purposes. Within the corresponding control samples (Appendix B, Table 2), however, a much smaller amount was thus converted.

Another familiar pattern is the increase in rural residential land uses of the RWD samples, again predominantly occurring at the expense of former cropland, pasture and woodland acreages. In LeFlore County's Spiro East sample (Appendix B, Tables 3 and 4), for example, rural residence land uses almost tripled in acreage and experienced an associated increase of some 143 housing units. Most of this growth, including 139 housing units, was at the expense of former pasture acreage. The corresponding control sample, however, experienced only a modest growth within this land use category. In every RWD sampled, at

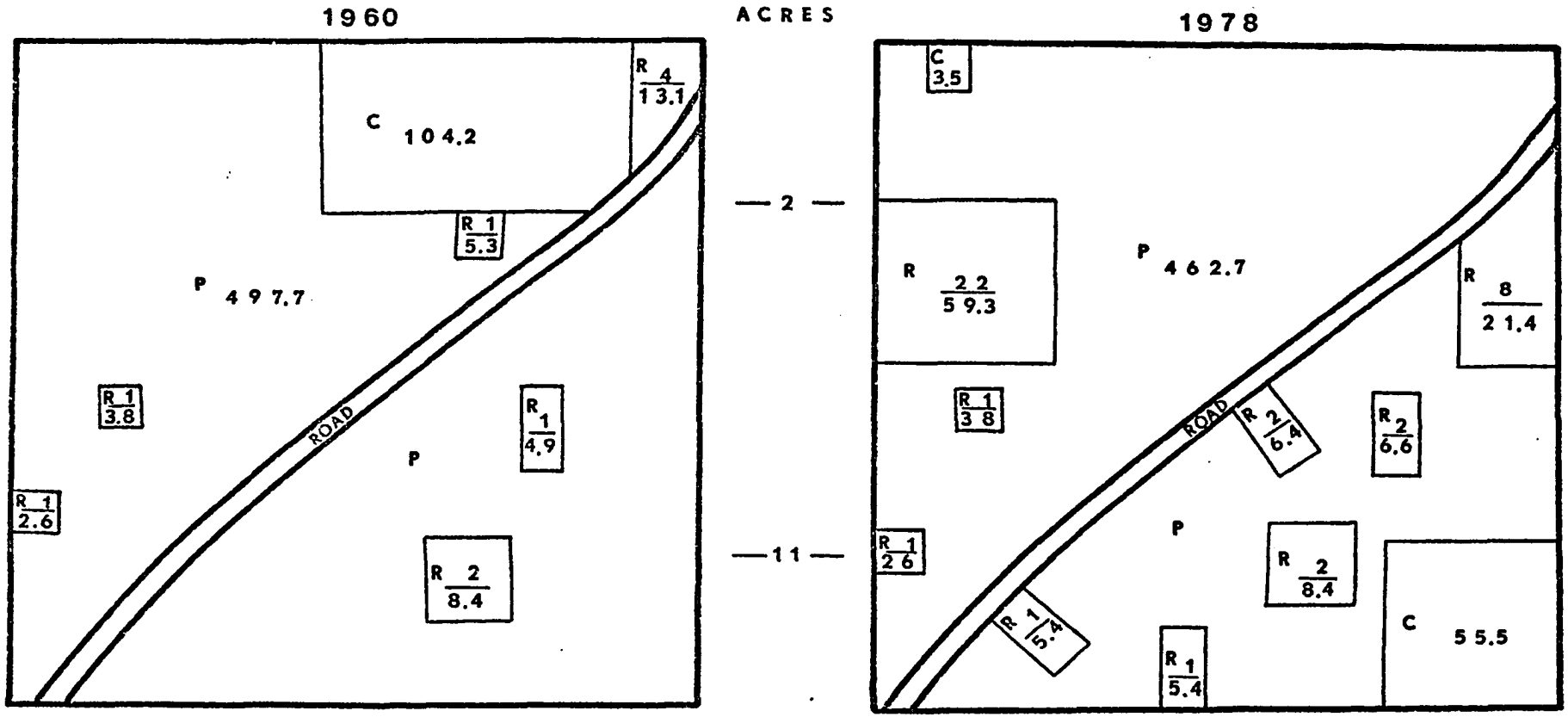
FIGURE 4-5
RWD No1, PUSHMATAHA COUNTY
T2N R19E, SECTIONS 22 and 27



least a doubling of the acreage in rural residences was observed, and in some cases, as in the case of LeFlore County's Northwest Water District (Appendix B, Table 5), much more than a doubling was identified. In most cases the increase in rural residential acreages was mainly at the expense of previous pasture land uses, again suggesting a process of transition whereby original woodland cover is first cleared and used for pasture purposes and later transferred to residential land uses. This is the traditional land use transition process often identified around urban areas.

Within this region, the only major change involving cropland occurred in the Spiro East Water District of LeFlore County (Appendix B, Table 3). Although the total acreage devoted to cropland did not change radically (from 205.6 acres in 1960 to 173.1 acres in 1978) some major internal transfers are evident. Of the initial 205.6 acres in 1960, only 30 remained intact, with over 170 acres being lost to pasture and an additional 4.5 acres to rural residence. However, only an increase of four (4) rural housing units was found. At the same time, though, 143.1 acres were converted from pasture to cropland to partially offset the lost acreage (see for example 4-6). A similar change in land use occurred within the corresponding control sample. In this case, though, urban residential also became a major recipient of former cropland area, but again, only a small number of rural residences, two (2), were identified. In addition, a large acreage was added to the cropland total from former woodland land uses.

FIGURE 4-6
SPIRO EAST RWD, LEFLORE COUNTY
T9N R26E, SECTIONS 2 and 11



LEGEND

C - CROPS
P - PASTURE
R - RURAL RESIDENT
No. UNITS / ACREAGE

MILE
0 1/8 1/4
0 0.2 0.4
KM

NORTH

West

The most conspicuous land use element of the western Oklahoma sample is the lack of woodland cover. Obviously, this is due to the physical environment more than to any contemporary land use change process. In the most eastern section of this sample, in Stephens County Rural Water, Sewage, and Solid Waste District #3, some woodland cover is evident in both RWD and control samples (Appendix B, Tables 11 and 12). In the RWD samples no change was found to occur regarding this category of land use, but in the control areas the 212.3 acres recorded in 1960 had been converted, for the most part, to pasture (Figure 4-7). A major trend, here, is to remove underproductive woodland cover and replace it with native or improved grasses for livestock production. In addition, a smaller loss of woodland cover was found that increased both cropland and rural residence uses.

In other land use categories, it seems a great deal of internal land use change is occurring. Cropland, for example, is in most samples losing significant amounts of area, but experiencing some major gains at the same time. A case in point might be Comanche County's Rural Water District #1 (Appendix B, Table 9). Here, 359.8 acres were transferred from cropland to pasture and an additional 50.9 acres to rural residential uses (Figure 4-8). This totaled 410.7 acres, almost one-half of the original 830.3 acres found in 1960, and in addition some 64 new housing units were identified. At the same time, though, 441.9 acres were converted from pasture to cropland purposes (Figure 4-9).

FIGURE 4-7

RURAL WATER, SEWER & SOLID WASTE DISTRICT
No 3, STEPHENS COUNTY
T1S R7W, SECTIONS 34 and 35

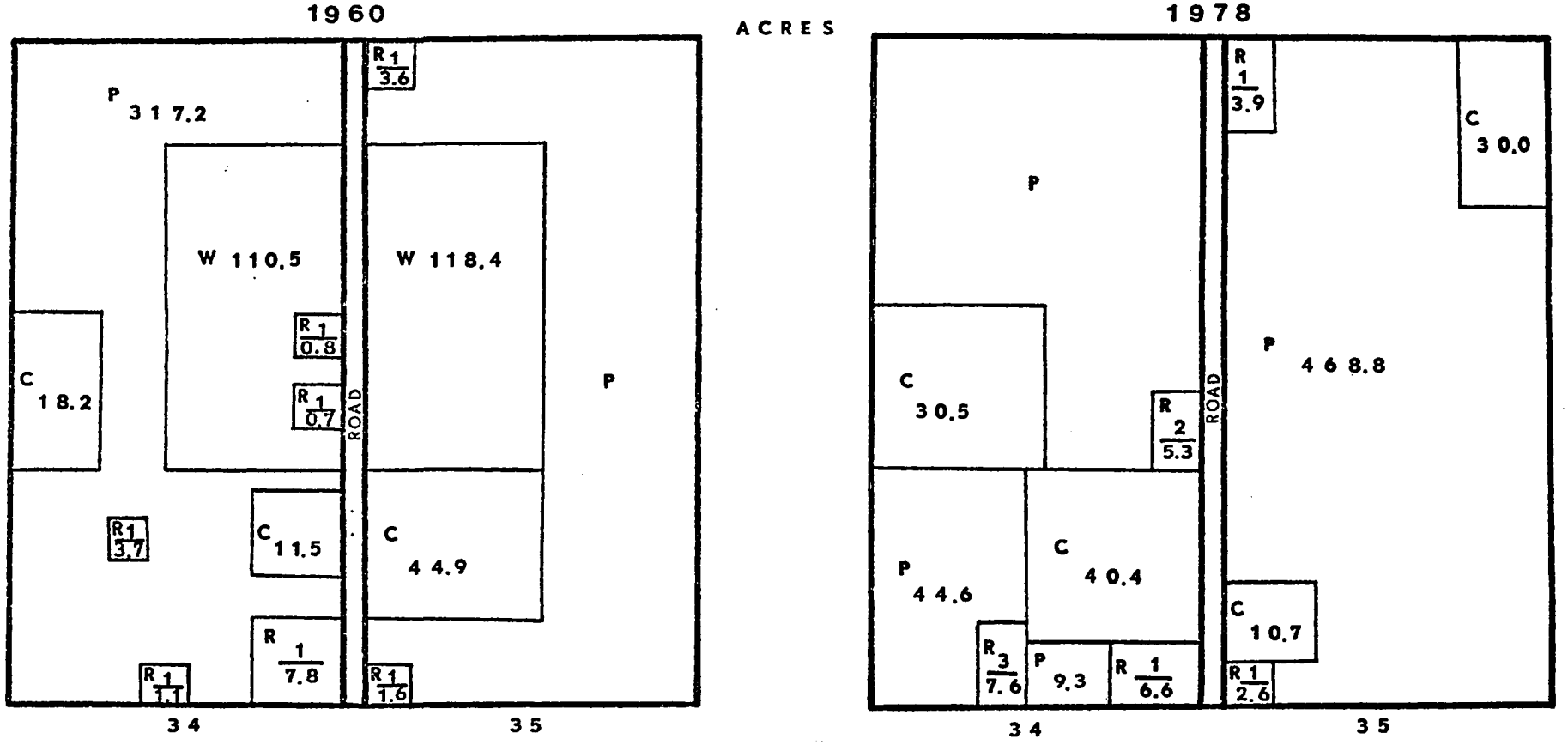
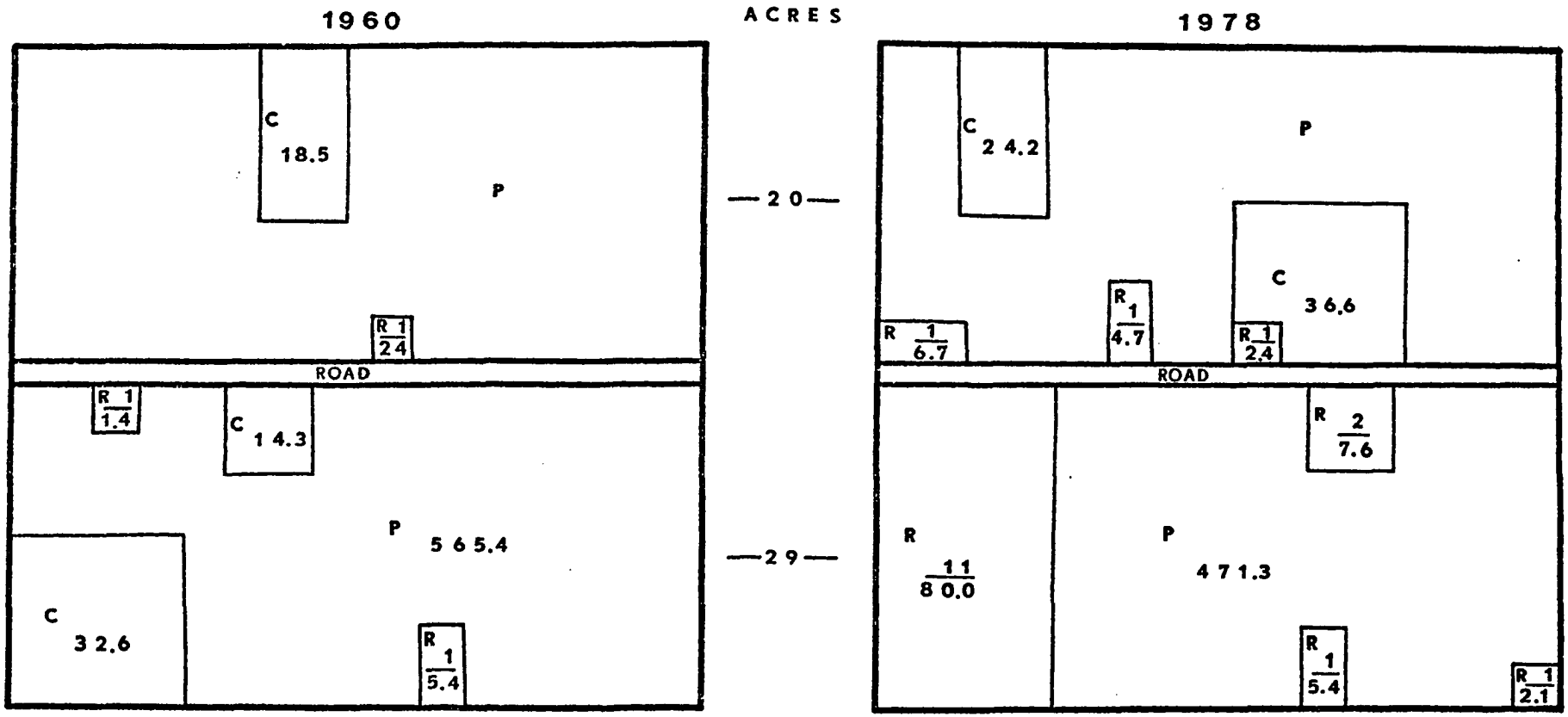


FIGURE 4-8
RWD No 1, COMANCHE COUNTY
T4N R13W, SECTIONS 20 and 29



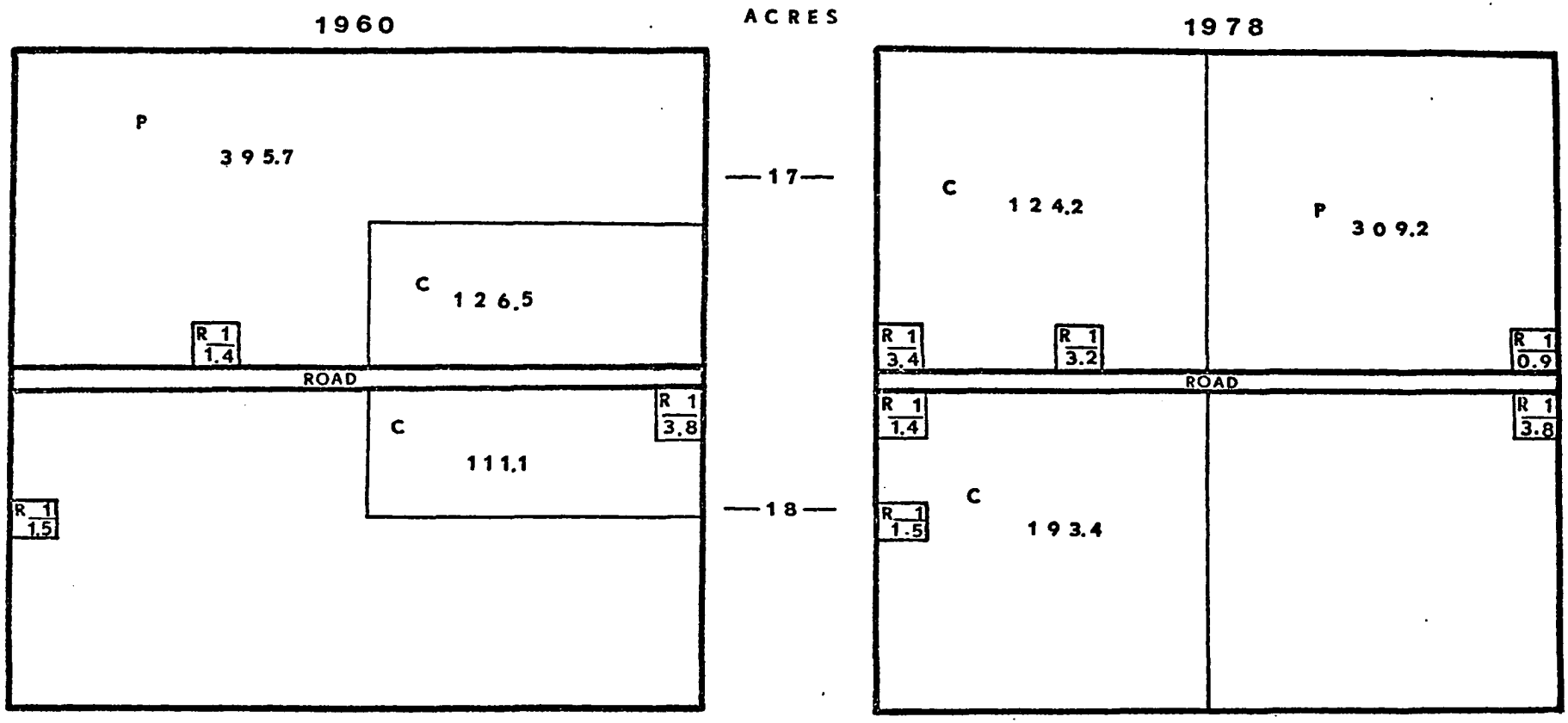
MILE
0 1/8 1/4
0 0.2 0.4
KM

LEGEND

C – CROPS
P – PASTURE
R – RURAL RESIDENT
No. UNITS / ACREAGE

NORTH

FIGURE 4-9
RWD No 1, COMANCHE COUNTY
T4N R11W, SECTIONS 17 and 18



MILE
0 1/8 1/4
0 0.2 0.4
KM

LEGEND

C – CROPS
P – PASTURE
R – RURAL RESIDENT

No. UNITS
ACREAGE

NORTH

Overall, this district experienced a net gain in cropland between 1960 and 1978, with an even greater gain being reported in the corresponding control samples (Appendix B, Table 10). The only other western Oklahoma sample to experience such a gain was Comanche County's Rural Water District #3, Control Area (Appendix B, Table 16). Here, also, the slight increase was due to a major conversion of pasture to cropland purposes that is in part due to recent relaxation of federal crop acreage constraints and to the need, on the farmers' part, to harvest larger acreages.

Due primarily to the large acreage found in pasture usage at the outset of this study, some major transitions also occurred in that category. As discussed above, some major conversions of pasture to cropland were noted in both RWD and control samples. At the same time, major gains to pasture totals were observed, especially at the expense of cropland, for both sets of samples. However, in this case, the greater conversion took place in the RWDs.

A most important trend found in western Oklahoma again concerned rural residences. In all RWD samples, the rural residence land use category experienced large increases in acreage. With the exception of Comanche County's Rural Water District #2 (Appendix B, Table 5), all districts experienced a near tripling of acreage, with this increase coming from former cropland and especially pasture uses. Figure 4-2, discussed earlier in this chapter, well illustrates this trend with the Wichita Mountain Estates example. Again, and for the most part as a result of this development, a rather large increase of 225 residential units occurred here.

Control area samples usually experienced only a modest increase in rural residence acreage. And, indeed, two samples, Comanche County's Rural Water District #2 Associated Control Area and Cotton County's Rural Water District #2 Associated Control Area (Appendix B, Tables 15 and 14) actually experienced a decline. Both lost some acreage to pasture and the Cotton County sample lost to cropland as well. There was a corresponding increase of only five and four housing units respectively in these two sample areas.

Northeast

One of the most glaring land use changes in the northeastern portion of the state is the decline in cropland. In every RWD sampled, at least a fifty percent reduction in cropland was observed. In Figure 4-10, for example, a 93.8 percent reduction in cropland was measured. Only small initial acreages remain, and usually, only modest additions to the cropland total were made. In every case, except Mayes County Rural Water District #4 (Appendix B, Table 23), the total added from former pasture uses was less than 50 acres, with over 500 acres being added in the Mayes County sample. In every case, though, more land was converted to pasture than was left in cropland. Rural residential land uses also gained a significant amount of acreage due to the loss of cropland, the greatest gain being in the Ottawa County sample (Appendix B, Table 19), over 200 acres (Figure 4-11). Here was found, in addition, an increase of 76 rural housing units.

With the exception of the Rogers County Rural Water District #6 Associated Control Area (Appendix B, Table 22), all control areas also

FIGURE 4-10
RWD No 2, OTTAWA COUNTY
T27N R22E, SECTIONS 34 and 35

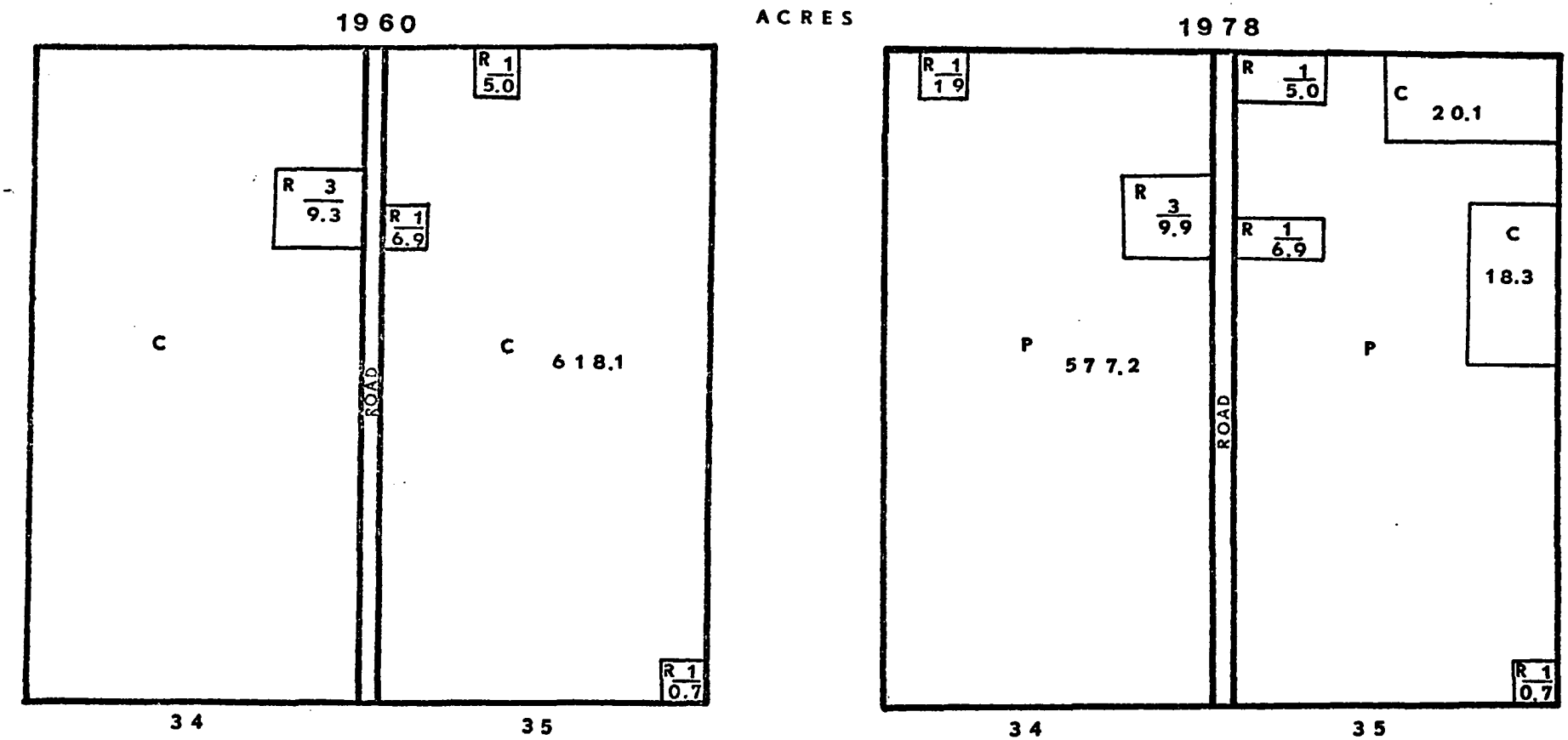
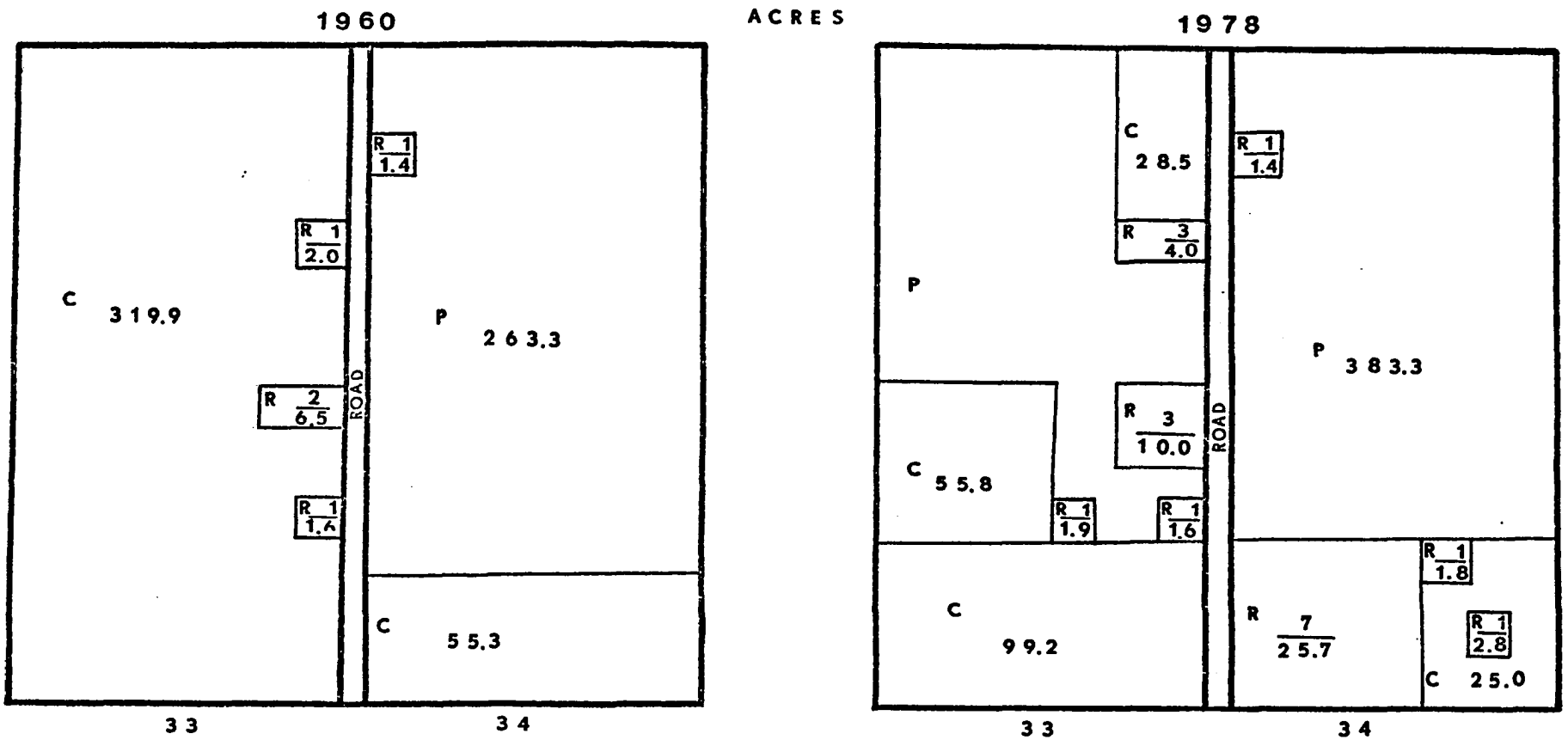


FIGURE 4-11
RWD No 2, OTTAWA COUNTY
T28N R22E, SECTIONS 33 and 34



lost cropland acreage. Losses here, though, were not as large as in the RWD samples. The major losses of cropland were to pasture, with small amounts going to rural residential land uses. In the case of Rogers County Rural Water District #8 (Appendix B, Table 17), no conversion to rural residential land use was recorded and only ten housing units were here added. Much larger conversions from pasture to cropland were found to have occurred in the control samples. Indeed, only one district, Rogers County Rural Water District #8 (Appendix B, Table 17), experienced less than a 200 acre conversion from pasture to cropland.

With the exception of Rogers County Rural Water District #8 (Appendix B, Table 17), all RWDs experienced an increase in pasturage. The decrease in Rogers County was primarily the result of an increase of rural residential land uses. Almost 400 acres were converted from pasture to rural residential uses with an associated increase of 125 housing units. Losses to rural residential land were large elsewhere as well. The other three samples, though, saw increases, with cropland and woodland losses adding large acreages to the pasturage totals.

Two of the control areas recorded decreases in pasture land uses: the two Rogers County samples (Appendix B, Tables 18 and 22). The Rogers County Rural Water District #8 Associated Control Area sample (Appendix B, Table 18) lost pasture acreage primarily to rural residential usage, (with a corresponding increase of 84 housing units) whereas the Associated Control Area #6 (Appendix B, Table 12), lost most of its acreage to cropland, with rural residential use adding only a modest amount and only 13 housing units.

Rural residential expansion within the RWD samples was, as in other regions, exceptionally large. In every case at least a doubling of acreage was recorded, the majority of which resulted from pasture loss. The sample drawn from Ottawa County (Appendix B, Table 19), however, saw a greater addition from cropland (201 acres) than from pasture (79.9 acres). The greatest conversion to rural residential came in Rogers County Rural Water District #8 (Appendix B, Table 17), almost 400 acres, with cropland contributing only 38.2 acres.

As in the other regions, the increase of rural residential land acreage was much smaller for the control samples. The only exception being Rogers County Rural Water District #8 Associated Control Area.

In the Mayes County samples (Appendix B, Tables 23 and 24), woodland also experienced some significant changes in land use. In the RWD portion, woodland acreage declined by nearly 150 acres. Most of this was converted to pasture, but 48.5 acres were converted to rural residential land uses, accommodating an increase of 18 housing units.

In the control sample, 2,051.3 acres were found to be under woodland cover in 1960, but only 517.2 remained in 1978. As there were no additions to woodland acreage during this period, all conversions were to other land uses, most going into pasture (1,455.2 acres). But cropland also saw an increase of 50.3 acres and rural residential grew by 28.6 acres.

Locally, land use change is considerably more variable than at either the regional or state scale. Much of this has to do with variations in the physical environment between sampled areas; however, some is the result of non-physical situations, such as declines in

prices for certain cropped products and the rise in cattle prices. Again, though, a major trend identified was the increasing growth of rural residences, especially in relation to rural water district samples. Associated with this trend is the general decline in woodland and cropland while grassland is experiencing overall growth. Especially as it pertains to RWD areas, this is in part the result of a shift toward active land speculation and a desire to minimize capital outlays while expecting to sell eventually to homeowners or developers. Although not all such conversions fit this model, enough evidence has been found to warrant such a conclusion.

Transition Patterns

As the samples discussed above reflect, land uses are changing in rural Oklahoma, and certain trends are easily identified--some of which have been identified nationally. For example, transition matrix analysis indicated that a major shift from cropland to pasture has occurred while an increase in rural residential land use is taking place at the expense of former pasture land use. This was shown both from the standpoint of acreages and the increase of residential units.

This trend is of particular importance when one views such changes as a component of suburbanization or exurbanization; that is, the expansion of urban type land uses into rural areas. It has been well documented that the demand for land in suburban and rural areas has been increasing. Both Beale and Vining, for example, point out that this demand is the result of regional growth and the creation of new families, and that this urban to rural population flow is first to

the suburbs, later to the "exurbs," and in recent years to small towns and areas beyond.[2]

The burden of guilt for spreading urbanization into formerly rural areas, however, should not be borne by the urbanite alone. The farmer or otherwise rural land owner makes a choice between maintaining traditionally rural land uses or selling for residential or other types of urban land use. In market terms, selling to residential users is more lucrative. The incentive of land owners to realize profits is strong and will often bring about the conversion of rural land to urban usage. The cost of cropland retention as compared to urban conversion may well influence the land owner to sell or convert his land to other uses--even irreversable uses--although conversion to reversable non-crop uses such as pasture, forestry or simply idling, may precede urbanization. Even John F. Hart, who has expressed doubt that this trend is anything to worry about in the near future, has pointed out that the idling of farmland after farming has ceased to be economically viable and for long periods of time before development takes place is common.[3] Regarding Hart's lack of concern of rural land loss to urban

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[2]Calvin Beale, The Revival of Population Growth in Non-Metropolitan America, Report ERS-605 (U.S. Department of Agriculture, Washington, D.C., 1976); and, Daniel R. Vining, Jr., and Ann Strauss, A Demonstration That Current Deconcentration Population Trends Are A Clean Break with Past Trends, Discussion Paper Series #90 (Regional Science Institute, Philadelphia, Pa., 1976).

[3]John F. Hart, "Loss and Abandonment of Cleared Farmland in the Eastern United States," Annals of the Association of American Geographers, 58:417-440.

uses, an analysis of a few statistics, especially as they pertain to prime agricultural land, might prove interesting.[4]

Of particular importance is the shift in type of farming as a prelude to urbanization. Such a shift has been found to involve at least two factors: a shortened planning horizon with a consequent shift to farming requiring less investment, and a reduction in the amount of time available for farming as the land owner or members of his family take up at least part-time urban employment. The farmer may begin disinvesting, e.g., not making the necessary investment to maintain structures or to keep fields in good condition, and watching the value of his land appreciate when the possibility of urban development increases.[5]

Another concern of the planner is the conversion pattern within individual land samples. At first analysis, perhaps only one general trend is evident: residential units within rural environments tend to be found largely near transportation routes. This is especially true where the rural water lines parallel roads and highways. A good example of this is shown in Figure 4-12 taken from RWD number 1 in Mayes County. In this example, two different road systems are

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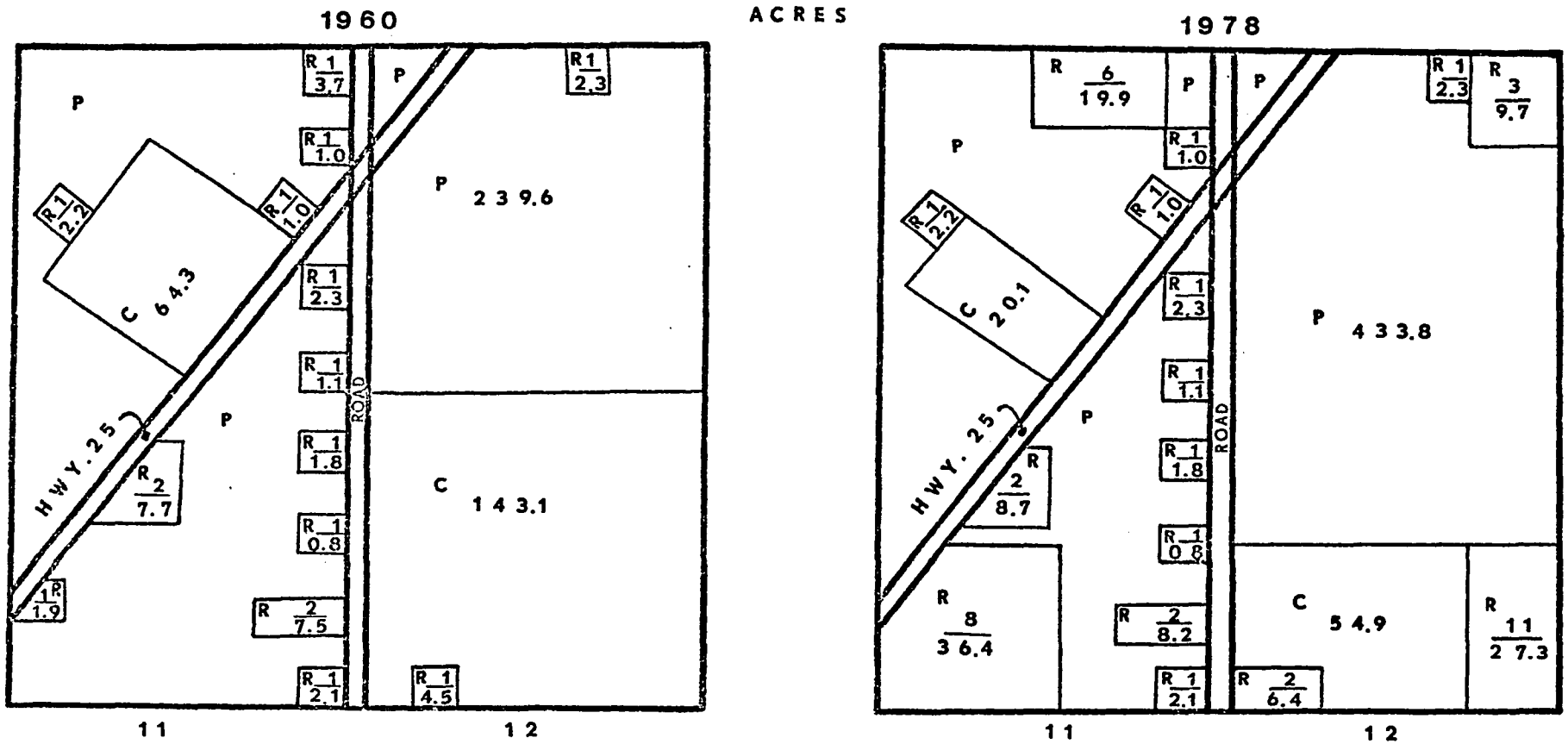
[4]The Soil Conservation Service in its Potential Cropland Study (1975, U.S. Department of Agriculture, Washington, D.C.) points out that the annual loss of prime agricultural land to urbanization in the United States is as much as 760,000 acres. By the year 2000 this could mean up to 5.8% of the total amount of prime agricultural land identified in 1975.

[5]This situation is described, for example, in two studies found in the geographical literature: David E. Berry, "The Sensitivity of Dairying to Urbanization," Professional Geographer (1979), 31(2):170-176; and, Robert Sinclair, "von Thunen and Urban Sprawl," Annals of the Association of American Geographers, 57:72-87.

FIGURE 4-12
RWD No 1, OTTAWA COUNTY
T27N R22E, SECTIONS 11 and 12



represented. First is the section-line system of county roads and secondly, cutting across diagonally from the southwest to the northeast, is Highway 25 connecting Vinita and Miami, Oklahoma. Notice the large increase in acreage converted to rural residence, especially along Highway 25. Much less was added to the rural residential system along the county road. An important increase in residential units is also indicated along Highway 25. It should be pointed out, in addition, that an increase in residential land use did occur along the county roads marking the southern and northern borders of this particular sample. Notice also the decrease in land under crops and the increase in pasturage. This might, again, suggest the farmers' desire to disinvest due to the potential sales to urban type land uses.

Road construction itself consumes valuable agricultural land for such purposes as roadways, paved shoulders, medians, drainage facilities and interchanges. Spaulding and Heady have pointed out that the 40,000-plus miles of interstate roadway completed by 1975 used an average of 40 acres per mile of right-of-way.[6]

Secondary impacts of road construction are of equal importance. Construction often results in stimulation of urban land uses, especially residential. Around interchanges even greater urbanization is probable. Retailers of fuel, food and lodging tend to congregate first. This may then be followed by other retail and office space users.[7]

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[6]Brent H. Spaulding and Earl O. Heady, "Future Use of Agricultural Land for Non-Agricultural Purposes," Journal of Soil and Water Conservation (1977), 32(2):89-91.

[7]Barton-Aschman Associates, Highway and Land-Use Relationships in Interchange Areas (Chicago, Illinois, 1968).

Other less visible trends in land use pattern change are also occurring. Analysis of acreage shifts between land uses from the standpoint of commuting distances to nearest urban area[8] reveals distinct patterns of change.

Since no samples for this research were drawn from areas farther than 12 miles from an urban agglomeration, as defined in Footnote 8, four commuter zones of three miles width each were analyzed around each agglomeration. This sampling procedure, then, allows a comparative framework to be developed that will indicate any patterned change occurring between the two drawn sets of samples (RWD versus control area samples). At the same time, it allows the formulation of a typical sample for each of the three levels of analysis; i.e., state, regional and local water district.

As noted above, shifts in agricultural types are identified as a result of suburbanization. These shifts include a decline in cropland and forest areas, but an increase in pasture and urban types, including residential. The Soil Conservation Service in 1979, for example, pointed out that as much as three million acres of rural land each year is converted to urban, built-up and urban water supply uses, and that some 69 million acres are expected to be lost in this manner by the year 2000.[9]

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[8]Here urban area is taken to mean any agglomeration with a population in excess of 2,500 people at the time of analysis.

[9]Soil Conservation Service, SCS National Resource Inventories, 1977, Final Estimates (U.S. Department of Agriculture, Washington, D.C., 1979), and, Daniel Vining, Jr., and Thomas Plaut, and Kenneth Bieri, "Urban Encroachment on Prime Agricultural Land in the United States," International Regional Science Review (1977), 2(2):143-156.

Cropland and forest areas fare less well from competition with other land uses and, near urban areas, are found to be declining in acreage. These same land uses, however, are found to be increasing with increasing distance from these same urban agglomerations. Other uses, such as pasture (with low capital input and the possibility of conversion to some form of urban land use), residential, commercial, etc., can more easily compete, and thus will often present a pattern of decreasing acreages with distance from an urban agglomeration.

On the state level, both RWD and associated control area samples (Tables 4-17 and 4-18) generally displayed the above outlined pattern. The RWD samples, however, more closely approximate the expected, although not every land use change category bears this out. Notice, for example, the large amount of cropland remaining intact for the RWD samples in the zone nearest the urban agglomeration than found farther afield. But, also observe the more expected tendencies of cropland to pasture conversion and both cropland and pasture to rural residential conversions. These, and others, support the expected situation as outlined.

Likewise, the increase in rural residential units as a result of the loss of acreage formerly in other land uses supports this same contention. Table 4-19 again compares RWD and associated control area sample findings. In almost every case the average number of rural residential units decreased with increasing distance from urban agglomerations. The same is true for the total number of housing units in 1960 and 1978 (right-hand columns of Table 4-19). Whereas the same

TABLE 4-17

STATE LEVEL - RWD SAMPLES
SELECTED AVERAGE LAND USE CHANGE
BY COMMUTER DISTANCE FROM NEAREST URBAN AGGLOMERATION
(Acres)

Commuter Zone Miles	Cropland to Cropland	Cropland to Pasture	Cropland to Rural Residential	Cropland to Commercial	Pasture to Pasture	Pasture to Cropland	Pasture to Rural Residential	Pasture to Woodland	Pasture to Commercial	Woodland to Woodland	Woodland to Pasture	Rural Residential to Rural Residential	Woodland to Rural Residential
L3[1]	82.4	74.0	7.8	0.5	300.4	28.5	35.3	-0-	0.1	41.5	41.5	19.6	2.5
3- 6[2]	39.3	86.5	11.8	0.1	332.6	12.8	22.5	-0-	0.7	53.1	39.1	14.7	2.8
6- 9[3]	75.7	89.0	2.8	0.1	322.6	26.5	11.5	0.6	0.1	68.2	17.4	12.5	0.7
9-12[4]	88.9	59.6	2.7	-0-	285.2	24.6	12.0	6.6	-0-	99.4	38.4	13.7	0.3

[1]Based on 34 sample units.

[2]Based on 41 sample units.

[3]Based on 35 sample units.

[4]Based on 10 sample units.

TABLE 4-18

STATE LEVEL - CONTROL SAMPLES
SELECTED AVERAGE LAND USE CHANGES
BY COMMUTER DISTANCE FROM NEAREST URBAN AGGLOMERATION
(Acres)

Commuter Zone Miles	Cropland to Cropland	Cropland to Pasture	Cropland to Rural Residential	Pasture to Pasture	Pasture to Cropland	Pasture to Rural Residential	Pasture to Woodland	Pasture to Commercial	Woodland to Woodland	Woodland to Cropland	Woodland to Pasture	Rural Residential to Rural Residential	Rural Residential to Pasture	Woodland to Rural Residential
<3[1]	44.0	12.8	0.3	325.3	35.9	8.9	-0-	2.6	145.5	1.4	19.8	10.9	0.1	-0-
3- 6[2]	70.6	27.7	0.1	384.6	18.9	4.2	2.5	-0-	89.4	0.4	34.1	9.9	1.0	1.0
6- 9[3]	50.7	75.3	0.5	345.6	6.5	8.2	-0-	-0-	122.7	-0-	16.3	6.5	0.5	0.6
9-12[4]	139.0	59.5	0.4	305.4	31.4	1.2	-0-	-0-	58.7	3.2	27.5	4.5	0.2	0.2

[1]Based on 16 sample units.

[2]Based on 35 sample units.

[3]Based on 38 sample units.

[4]Based on 31 sample units.

is generally true for the associated control area samples, the magnitude is less in all cases.

TABLE 4-19

AVERAGE STATE INCREASE IN RURAL RESIDENCES AT EXPENSE OF OTHER LAND USES, 1960-1978 BY COMMUTER DISTANCES FROM NEAREST URBAN AGGLOMERATION

Commuter Zone Miles	From Cropland	From Pasture	From Woodland	Total Number of Residential Units 1960	1978
3					
RWD	2.9	11.7	0.1	5.1	17.2
Control Area	0.3	2.4	0	3.4	6.3
3- 6					
RWD	1.5	6.8	0.7	5.3	16.5
Control Area	0.2	1.0	0.4	5.1	6.4
6- 9					
RWD	0.6	2.8	0.5	4.1	7.9
Control Area	0.2	2.5	0.1	2.3	5.4
9-12					
RWD	0.8	3.4	0.6	4.4	8.9
Control Area	0.2	0.3	0.1	1.7	2.0

Regionally, similar findings prevail (Tables 4-20 to 4-22). In every case the conversion to rural residence is very pronounced and closely follows that expected. And, likewise, the increase in rural residential units from former cropland, pasture and woodland uses supports this conclusion (Tables 4-23 to 4-25). Also, from the regional standpoint, associated control area samples follow this same general pattern, but again differ mainly in magnitude.

TABLE 4-20

WEST REGION AVERAGE LAND USE CHANGES
BY COMMUTER DISTANCES FROM NEAREST URBAN AGGLOMERATION
(Acres)

Commuter Zone Miles	Cropland to Cropland	Cropland to Pasture	Cropland to Rural Residential	Cropland to Commercial	Pasture to Pasture	Pasture to Cropland	Pasture to Rural Residential	Pasture to Commercial	Woodland to Woodland	Woodland to Cropland
<3										
RWD	156.1	71.4	11.0	-0-	282.8	31.1	41.7	0.2	-0-	-0-
Control Area	186.3	-0-	-0-	-0-	226.2	223.5	-0-	-0-	-0-	-0-
3- 6										
RWD	13.7	54.6	29.9	0.2	377.6	29.7	33.4	2.5	11.0	-0-
Control Area	69.3	34.0	0.1	-0-	490.0	24.4	4.6	-0-	-0-	0.7
6- 9										
RWD	120.5	91.6	2.8	0.2	332.2	50.2	14.8	0.1	-0-	-0-
Control Area	36.7	31.3	-0-	-0-	490.1	64.0	3.3	-0-	-0-	-0-
9-12										
RWD	300.1	121.9	4.9	-0-	160.9	44.0	4.8	-0-	-0-	-0-
Control Area	98.0	96.1	0.1	-0-	381.7	59.4	0.2	-0-	-0-	-0-

TABLE 4-20 (Cont'd)

Commuter Zone Miles	Woodland to Pasture	Rural Residential to Rural Residential	Commercial to Commercial	Recreation to Recreation	Transportation to Transportation	Urban to Urban	Pasture to Urban	Rural Residential to Cropland	Rural Residential to Pasture	Woodland to Rural Residential
<3										
RWD	-0-	22.7	0.8	8.2	11.9	-0-	-0-	-0-		
Control Area	-0-	2.2	-0-	-0-	-0-	-0-	-0-	-0-	1.8	-0-
3- 6										
RWD	-0-	16.3	15.0	15.8	-0-	21.2	-0-	-0-		
Control Area	10.9	8.9	-0-	-0-	-0-	-0-	-0-	-0-	8.9	0.2
6- 9										
RWD	-0-	10.9	0.2	12.5	-0-	-0-	3.4	0.1		
Control Area	-0-	10.1	-0-	-0-	0.2	-0-	-0-	-0-	10.1	-0-
9-12										
RWD	-0-	2.6	-0-	-0-	-0-	-0-	-0-	0.8		
Control Area	-0-	2.7	0.3	-0-	-0-	-0-	-0-	0.3	2.7	-0-

TABLE 4-21

SOUTHEAST REGION AVERAGE LAND USE CHANGES
BY COMMUTER DISTANCES FROM NEAREST URBAN AGGLOMERATION
(Acres)

Commuter Zone Miles	Cropland to Cropland	Cropland to Pasture	Cropland to Rural Residential	Cropland to Woodland	Pasture to Pasture	Pasture to Cropland	Pasture to Rural Residential	Pasture to Woodland	Woodland to Woodland	Woodland to Cropland
<3										
RWD	1.4	3.5	-0-	-0-	251.2	-0-	16.0	-0-	191.3	-0-
Control Area	72.7	6.9	0.6	8.7	183.5	9.8	3.1	-0-	326.4	3.2
3- 6										
RWD	3.7	10.2	1.3	-0-	371.7	9.6	17.1	-0-	97.3	-0-
Control Area	104.1	12.3	-0-	-0-	118.8	8.4	4.7	9.6	341.0	-0-
6- 9										
RWD	21.5	46.5	3.8	-0-	288.9	23.5	12.1	2.0	183.9	-0-
Control Area	13.5	18.5	0.4	-0-	212.4	2.1	7.6	-0-	333.2	-0-
9-12										
RWD	2.8	-0-	-0-	-0-	361.4	22.5	15.8	9.4	142.0	2.6
Control Area	195.0	71.5	0.6	-0-	178.6	10.3	3.1	-0-	136.3	-0-

TABLE 4-21 (Cont'd)

Commuter Zone Miles	Woodland to Pasture	Rural Residential to Rural Residential	Commercial to Commercial	Transportation to Transportation	Woodland to Rural Residential	Woodland to Urban	Urban to Urban	Cropland to Urban	Recreation to Recreation
<3									
RWD	122.9	7.7	1.9	14.1	12.2	0.6	17.2		
Control Area	7.6	6.2	3.6	-0-	-0-	-0-	-0-	-0-	-0-
3- 6									
RWD	100.6	11.8	-0-	3.3	4.3	-0-	5.6		
Control Area	43.3	2.5	-0-	-0-	0.9	-0-	-0-	-0-	-0-
6- 9									
RWD	43.0	9.6	-0-	2.8	2.2	-0-	-0-		
Control Area	36.5	2.4	-0-	-0-	1.8	-0-	0.9	-0-	10.4
9-12									
RWD	54.8	17.1	-0-	1.9	0.5	-0-			
Control Area	11.5	4.3	-0-	-0-	-0-	-0-	0.6	17.4	-0-

TABLE 4-22

NORTHEAST REGION AVERAGE LAND USE CHANGES
BY COMMUTER DISTANCES FROM NEAREST URBAN AGGLOMERATION
(Acres)

Commuter Zone Miles	Cropland to Cropland	Cropland to Pasture	Cropland to Rural Residential	Cropland to Commercial	Pasture to Pasture	Pasture to Cropland	Pasture to Rural Residential	Pasture to Commercial
<3								
RWD	37.5	118.4	8.3	1.3	351.1	41.9	38.5	-0-
Control Area	1.1	19.6	-0-	-0-	461.8	35.4	15.0	5.2
3- 6								
RWD	93.6	186.2	9.0	-0-	260.5	3.6	19.9	-0-
Control Area	36.1	26.8	-0-	-0-	445.9	18.4	2.7	-0-
6- 9								
RWD	80.7	125.2	1.7	-0-	343.9	5.4	7.7	-0-
Control Area	97.9	163.5	1.0	-0-	334.8	13.1	12.3	-0-
9-12								
RWD	258.0	352.4	17.4	-0-	-0-	-0-	-0-	-0-
Control Area	128.1	7.2	0.6	-0-	348.3	21.6	0.4	-0-

TABLE 4-22 (Cont'd)

Commuter Zone Miles	Woodland to Woodland	Woodland to Cropland	Woodland to Pasture	Rural Residential to Rural Residential	Commercial to Commercial	Transportation to Transportation	Woodland to Rural Residential	Recreation to Recreation
<3								
RWD	5.9	-0-	0.8	22.6	7.0	9.1	-0-	-0-
Control Area	5.4	-0-	33.0	16.1	-0-	5.1	-0-	42.3
3- 6								
RWD	39.9	-0-	6.7	16.4	-0-	1.0	1.0	-0-
Control Area	7.5	-0-	76.1	21.0	-0-	-0-	2.9	-0-
6- 9								
RWD	30.2	-0-	11.4	16.8	-0-	-0-	-0-	-0-
Control Area	-0-	-0-	7.9	8.2	-0-	1.3	-0-	-0-
9-12								
RWD	-0-	-0-	-0-	12.1	-0-	-0-	-0-	-0-
Control Area	45.7	5.0	73.7	9.0	-0-	-0-	0.5	-0-

TABLE 4-23

SOUTHEAST REGION AVERAGE INCREASE IN RURAL RESIDENCES
AT EXPENSE OF OTHER LAND USES, 1960-1978
BY COMMUTER DISTANCES FROM
NEAREST URBAN AGGLOMERATION

Commuter Zone Miles	From Cropland	From Pasture	From Woodland	Total Number of Residential Units 1960	1978
<3					
RWD	0	5.4	3.9	2.6	11.4
Control Area	0.1	0.7	0	1.9	3.0
3- 6					
RWD	0.4	6.4	1.4	4.3	14.8
Control Area	0.1	1.1	0.6	1.0	3.9
6- 9					
RWD	0.5	2.9	0.5	2.1	5.9
Control Area	0.1	1.8	0.3	0.9	3.1
9-12					
RWD	0	4.6	0.9	2.2	4.7
Control Area	0.4	0.6	0	1.2	2.2

TABLE 4-24

NORTHEAST REGION AVERAGE INCREASE IN RURAL RESIDENCES
AT EXPENSE OF OTHER LAND USES, 1960-1978
BY COMMUTER DISTANCES FROM
NEAREST URBAN AGGLOMERATION

Commuter Zone Miles	From Cropland	From Pasture	From Woodland	Total Number of Residential Units 1960	1978
<3					
RWD	4.9	13.0	0	7.1	25.1
Control Area	0.4	4.3	0	4.9	9.4
3- 6					
RWD	3.8	4.4	0.6	6.0	14.9
Control Area	0.6	0.6	1.1	13.9	16.4
6- 9					
RWD	0.6	2.8	0.8	6.3	9.8
Control Area	0.6	4.5	0	3.4	8.6
9-12					
RWD	6.0	0	0	6.0	12.0
Control Area	0.1	0.1	0.3	2.6	2.8

TABLE 4-25

WEST REGION AVERAGE INCREASE IN RURAL RESIDENCES
AT EXPENSE OF OTHER LAND USES, 1960-1978
BY COMMUTER DISTANCES FROM
NEAREST URBAN AGGLOMERATION

Commuter Zone Miles	From Cropland	From Pasture	From Woodland	Total Number of Residential Units 1960	1978
<3					
RWD	2.5	13.7	0	4.6	13.6
Control Area	0	0	0	2.0	2.0
3- 6					
RWD	6.0	10.5	0	5.6	21.0
Control Area	0.1	1.1	0	3.3	3.7
6- 9					
RWD	0.8	1.7	0	3.0	5.7
Control Area	0	0.7	0	2.9	3.9
9-12					
RWD	1.0	1.0	0	2.5	3.5
Control Area	0.2	0.2	0	1.3	1.1

Summary

General trends of land use change in Oklahoma fit very well that expected from national trends. While cropland and woodland are both found to be generally declining at all levels of analysis (state, regional and local), pasturage and rural residential uses are expanding.

When analyzed on the basis of rural water district samples and associated control area samples, greater conversion rates are found for the former. This is especially true for rural residential land uses. In the RWD samples, a much greater conversion of acreage to rural residential from cropland, woodland and pasture is occurring than in the control area samples. This RWD conversion is most often the result of the availability of potable water in sufficient quantities to warrant migration from urban or urban fringe areas to more rural

locations. Associated control areas, on the other hand, can not as often provide such water supplies.

The increase in pasture and declines in cropland and woodland acreages is likewise suggestive of at least the potential increasing incursion of urbanites into rural areas. As cropland is taken out of capital intensive production or land is cleared of timber, it is often allowed to remain in grassland cover and be used for grazing purposes (with a low capital input) until such land may be sold for development.

Transition matrix analysis of these same samples reveals an even greater dynamism than even the previous discussion indicates. The transferring of acreages among the several land use categories, and especially cropland, pasture and rural residential, is rampant in the RWD samples. And, while this same change is found in the control area samples, the magnitude of such a change is drastically reduced. In many instances only a small part of the original (1960) acreages were in the same land use in 1978 within the RWD samples. Regionally, and on the basis of individual rural water districts, some individual land use variations were observable. But, again, the greater overall difference occurred between RWD and control area samples.

Broad trends in land use change in relation to distances from urban agglomerations were noted. On each level of analysis, but more specifically on the state and regional levels, land use change followed a predictable pattern. It was found that certain land uses declined in acreage with increasing distance from urban agglomerations. These included rural residential, commercial and urban land uses especially. Rural residential housing units were also noted to decrease away from

urban agglomerations. At the same time, certain other uses such as cropland and woodland increased acreage with increasing distance from urban agglomerations. Again, the more distinct changes were found to occur in the RWD samples with the associated control area samples being more stable during the time frame of this analysis.

CHAPTER V

SUMMARY AND CONCLUSIONS

The Farmers Home Administration has funded 521 rural community water systems in Oklahoma since 1964. These systems constitute part of a national program to raise the living standards of rural inhabitants by financing quality water supplies and sewage disposal projects. Since 1964, these water systems have directly or indirectly resulted in a number of rural Oklahoma land use changes as almost a phenomenal rural water district growth has taken place.

Both rural water district (RWD) and adjacent non-rural water district areas (associated control areas) were sampled in three regions of the state for this research. It was found that the overall pattern of land use did not change drastically between 1960 and 1978, while the changes that did occur followed the national trends. The more capital intensive land uses, such as cropland, declined while rural residential and the more extensive pasture uses (including rural idle) both increased in acreage. Woodland, another major land use surveyed, was also found to have declined overall.

The rural residential land use was the most dynamic of those sampled. The RWD samples had a rather large increase of over 203 percent in acreage from 1960 to 1978. For all samples combined, the number of housing units identified increased by over 142 percent or 1,339 units, only 438 of which were found in the control area segment of the study. The fact that RWD's had a rural residential growth more than triple the control areas and almost a two and one-half times increase in housing units indicates the importance of the availability of good quality water as a force affecting the pattern of land use in rural areas.

Similar results are found when rural residences are identified on either a regional or local basis. For all regions and with only the exception of one control sample (associated with Comanche County RWD #1) all RWD and control samples had increases in both rural residential acreage and number of housing units. Regionally, the smallest increase for RWD samples was almost as large as the greatest growth for control samples (155.2 percent in the RWD samples in northeast Oklahoma and 157.1 percent in the control samples of southeast Oklahoma). Locally, several exceptional growth rates were recorded. Pushmataha County RWD #1 had in excess of a 760 percent increase, while Comanche County's RWD #2 recorded a 504 percent increase. In Comanche County this growth, as elsewhere, was largely associated with detached (from existing urban areas) suburban type growth, such as the Wichita Mountain Estates development.

Other land uses experienced similar predictable changes, but of lesser magnitude than rural residential uses. Cropland, for example,

declined overall; the major variation was between RWD samples (57.5 percent loss) and control samples (18.8 percent loss). Regionally, however, only two of the three control regions showed such a decline; the western section of the study experienced a growth of 2.5 percent. This growth is primarily the result of increasing wheat prices and the associated conversion of marginal lands to wheat production.

Pasture and woodland likewise followed expected trends closely. While pasture areas increased statewide, there were some regional exceptions. In the western section, as noted above, pasture lands were often cultivated and therefore experienced acreage declines. Woodland everywhere either decreased in acreage or experienced no overall change. In some cases all woodland acreage recorded in 1960 had been converted to other uses by 1978.

Simple comparisons of before and after totals mask much of the dynamics of land use change. In most cases as a particular land use, even at the most local scale, recorded either a gain or loss of acreage much more dynamic forces have actually taken place. For example, cropland recorded an overall loss of over 16,800 acres, but in addition gained over 5,895 acres. Most of the loss (15,561 acres) went to pasture lands while rural residential uses gained some 950 acres. At the same time, the majority of the acreage converted to cropland came from former pasturage (over 5,700 acres) and woodland (over 163 acres).

The only category that did not both lose and gain acreage on the state and regional level was rural residential. This category constantly gained acreage. Locally, however, in the western section of

the study, some losses were recorded for both acreage and housing units. These losses were associated with increased consolidation in the control area samples of both rangeland and cropland and the migration of former residents out of the area.

Shifts among rural uses was an important aspect of land use change in Oklahoma. Some new cropland was developed even in areas with rapidly expanding populations where the overall trend was for this land use to decline. Considering only net moves, the regional patterns of land use change were much more variable than the aggregate. The detailed movements among the various land uses exhibited even more regional differences.

Rural residential land use experienced the most dynamic change of any of the uses. Cropland, pasture and woodland were abandoned because of the general changes in farming production and the special negative pressure of urban-like growth.

Several patterns of land use change were generally identified by this research. The more obvious pattern is the alignment of rural residential units along transportation systems. Since rural water lines follow these same routes and are usually located in the county right-of-way, and since extending lines away from these routes is expensive, user residents have located as close as possible to tie-in points. The National Rural Water Association considers distances greater than one-fourth mile from a major line to be uneconomical. Almost all users, then are less than one-fourth mile from existing main water lines, and most are much closer.

Another pattern identified was of a distance decay nature. Those land uses least able to compete for space near incorporated agglomerations were found to increase in acreage with increasing distance from such agglomerations. Those land uses more able to compete were found to decrease in acreage with increasing distance from agglomerations. Both cropland and woodland, especially within the RWD samples, increased in acreage with increasing distance from incorporated agglomeration. This tendency, though, was not as well developed in the control samples. Likewise, both rural residential and even pasture land uses decreased in acreage with increasing distance from the agglomeration. Pasturage maintained large acreages near agglomerations in this case because of the inclusion of idle land. The major land uses near agglomerations were for the most part urban in nature. Again, the RWD samples followed these expected trends closely, especially where rural residential uses were concerned.

Land use change analysis indicates that the traditional rural character of Oklahoma is slowly changing, especially where rural water districts have made potable water supplies for domestic purposes available. In these areas population is increasing as new housing units are being constructed. At the same time, other land uses are also changing, at least in part as a result of this population growth, and potential for future population growth. These population increases and resulting urban-like growth have created major and uncoordinated changes in the land use patterns of rural Oklahoma. The major source of land for this urban-like expansion has been agricultural in nature.

A sequence from cropland to pasture (idle in many cases) to residential is well developed in rural water districts.

Other forces, however, are at work causing traditional land uses to be changed. There has been, in recent years, a migration from the urban, to the suburban, to the rural areas of the United States. This migration, although not replacing nor more extensive than the more traditional rural to urban migration, is, nevertheless, an integral part of today's rural scene. A number of reasons for this reverse migration can be found. These would include a growing economic decentralization, a growing preference for the rural life and the modernization of rural living.[1] Modernization would involve a wide range of technological advancements, such as the automobile and highway construction, electricity and convenience appliances, communication technology, including the telephone, television and radio and centralized sewer and water systems. Rural areas are no longer isolated and backward. Rural existence, then, may be as convenient as urban existence, but lack much of the perceived offensiveness of the latter. The image of "country life" is that it is more dignified, more respectable, it has a greater permanence, is more healthful and less stressful than urban life. Many have become disenchanted with the urban setting and its multitude of problems and have sought rural existence as an escape.

The type of land use change documented in earlier chapters exemplifies the generally accepted concept of exurbia. Exurbia is a

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[1]Calvin L. Beale, "Making a Living in Rural and Small Town America," ch. 1, Rural Development Perspectives, Economics, Statistics, and Cooperative Service (U.S. Department of Agriculture, Washington, D.C., 1978).

term applied to land use less closely tied to the city than suburbia.[2] Exurbia is urban in origin and nature, since capital for migration to the countryside as well as negative attitudes toward the city were acquired in the urban environment. With rising real incomes, more people can afford to live away from the city and even away from the suburb. Exurban living, then, can be expected to increase in importance and in its impact on the rural landscape.

The desire of the urbanite to migrate to the countryside is in itself insufficient to cause an increased suburban type growth in the rural landscape. The rural land owner must, in addition, be willing to sell land to this migrant. On the urban fringe, and beyond, a number of factors force the farmer's normal operating costs upward, and therefore, contribute to the probability he will sell all or part of his holdings. One of the more prominent of such forces is rising land prices.[3] Associated with increasing land costs are increasing property taxes. Many feel tax assessments, especially those made on value in the open market as opposed to actual land use, are too high. If property taxes were deferred until the land was sold, this would often

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[2]See for example, Hugh Johnson, Jr., Rural Residential Recreation Subdivisions Serving Washington, D.C. Area, AER-59, Economic Research Service (U.S. Department of Agriculture, 1964); and Hugh Johnson, Jr., et al., Exurban Development in Selected Areas of the Appalachian Mountains, ERS-111, Economic Research Service (U.S. Department of Agriculture, 1963).

[3]Howard Conklin and Richard Dymsza, Maintaining Viable Agriculture in Areas of Urban Expansion (New York State Office of Planning Services, Albany, 1972).

forestall such sales and maintain existing land uses longer.[4] However, even where land is assessed at use-value, demand for new public services, i.e., schools, sanitation facilities, roads, fire protection, etc., generated by growing communities, will cause tax rates to increase.

But even those agriculturists who desire to continue operation under such conditions find it difficult to expand successful operations. Due to increased urban competition for rural land, farmers cannot expand and purchase sufficient acreage to farm on a profitable scale. In some cases adjacent land has already been converted to these urban-like uses and is, therefore, unavailable for agricultural use. Urban-like expansion has caused a decline in farm productivity over a much larger area than has been physically occupied to date by urban-like uses, and probably a much larger area than will be occupied by these uses for some time in the future.[5]

Finally, these same high prices often awaken the speculative nature of the land owner. As land prices increase due to increasing demand for the land and as corresponding profit margins of agricultural production either do not change or increase more slowly, many farmers

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[4]Several states have instituted such tax policies. One such state is California under its California Land Conservation Act (Calif. Gov. Code, Sects. 51200-51295). Another state is Vermont. See for example, Jerome Ruse, "Vermont Uses the Taxing Power to Control Land Use," Real Estate Law Journal (Vol. 2, 1973), p. 602.

[5]This same situation exists in other states as well. See for example, Howard Conklin and Richard Dymsza, Maintaining Viable Agriculture in Areas of Urban Expansion (New York State Office of Planning Services, Albany, 1972).

are tempted to sell out at the higher profit and perhaps move their operation farther afield.

Other, less visible, forces may contribute to the farmer's decision to sell his land. Pressure from adjacent, non-agricultural neighbors may be strong. To these neighbors, agriculture may have some offensive associations. Agricultural practices such as the use of fertilizers, pesticides and herbicides, the operation of equipment either in early morning hours or late evening times, and even the air pollution associated with some forms of harvesting may be unacceptable.

These problems may culminate in the passage of local ordinances which may at least restrict if not totally prohibit traditional agricultural activities. This is especially likely if the non-agricultural population has reached sufficient size to cause a local political power shift to occur. In such a case, the farmers may be outvoted at the polls when local ordinances are proposed.[6]

In a different way, still other causes for increased suburbanization of rural America may be found. Federal projects designed to aid the rural resident, as well as those for urban assistance, often contribute to the indiscriminate conversion of farmland to non-farm activities. Directly related to the research undertaken here are federal projects and federally assisted projects for water resource development. These contribute to rural land conversion because of the additional development that may be stimulated by such major public works programs. "While the loss of some high quality farmland because

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[6]Conklin, Maintaining Viable Agriculture in Areas of Urban Expansion, loc. cit.

of such projects is inevitable, few agencies have factored farmland protection considerations into their planning process."[7] An excellent example of such conversion to non-agricultural activities as an indirect result of a major federal program is the rural water program of the Farmers Home Administration. Neither the FaHA nor the Rural Water Association has factored farmland protection considerations into any of their planning processes.

By funding highways, sewer systems, etc., as well as water projects, both federal and state governments determine to a large extent which areas become suitable for development. For the most part, though, only local governments exercise direct control over subdivision and land use, if any such authority exists.

The above mentioned forces, then, contribute to the conversion of rural land from traditionally agrarian to urban or suburban uses. A comparison of the 1977 National Resource Inventories[8] with the 1976 Conservation Needs Inventory[9] shows that about 29 million acres of rural land shifted to urban and built-up uses between 1976 and 1977. At the same time, population has increased both in the United States and world wide. This increased population, along with other factors, such as increased per capita incomes and international trade imbalances,

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[7] Max Schnepf, (ed.), Farmland, Food and the Future (Soil Conservation Society of America, Ankery, Iowa, 1979), p. 137.

[8] Soil Conservation Service, SCS National Resource Inventories, 1977, Final Estimates (U.S. Department of Agriculture, Washington, D.C., 1979).

[9] U.S. Department of Agriculture, Basic Statistics: National Inventory of Soil and Water Conservation Needs, 1967, Statistical Bulletin 461 (Washington, D.C., 1971).

has greatly increased the demand for agricultural production and especially American agricultural production.

The need for increased agricultural production, as major portions of America's agricultural lands are being converted to non-rural land uses, will result in some less than satisfactory land use choices. This conversion means that additional land, as a replacement, must be added to the cropland base on the extensive margin, or remaining cropland must be used more intensively. In either event, the tendency will be to use more erosive land where expansion is necessary and more erosive practices on existing agricultural lands. Expanded agricultural production, then, appears to be accompanied by excessive soil erosion losses and water runoff, severe cropland deterioration and environmental degradation.[10]

When prime agricultural land is analyzed, as opposed to rural land in general, an even bleaker picture, with urbanization the major "villan," may be presented. Metropolitan areas and their adjacent counties account for 51.7 percent of America's prime agricultural land, but only 43.2 percent of all the land in the United States.[11] The annual loss of prime agricultural land to urbanization has been estimated as high as 760,000 acres.[12] These losses projected to the

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[10]Dennis Cory and John Timmons, "Responsiveness of Soil Erosion Losses in the Corn Belt to Increased Demand for Agriculture Products," Journal of Soil and Water Conservation (1978), 33(5):221.

[11]Daniel Vining, et al., "Urban Encroachment in Prime Agricultural Land in the United States," International Regional Science Review (1977), 2(2):143-156.

[12]Soil Conservation Service, Potential Croplands Study (U.S. Department of Agriculture, Washington, D.C., 1975).

year 2000 suggest a further loss of 5.5 percent of all prime agricultural land identified in 1975. The result of these figures is that on a regional scale United States prime agricultural land is under greater pressure from urbanization than is the total stock of land. And, when analyzed on a longer basis, which should be the case for such an important resource, it becomes obvious that loss of prime land to urban usage presents a serious problem.[13]

Even the above situation, however, does not depict the entire impact of urban-suburban expansion into rural areas. It has been estimated, for example, that each acre of rural land taken for development isolates at least one additional acre that is lost to farm production.[14] In reality, then, this leapfrog manner of rural land conversion is even more extensive than the statistics indicate.

Simply bringing more land into production from America's "limitless" reserves is fringing upon the mythological. There is a definite limit to the amount of land that can be used for agricultural purposes. Only about 14 percent (135 million acres) of America's rural land has a high to medium potential for conversion to cropland.[15] The supposed vast reservoir of rural land available and suitable for cropping is indeed small.

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[13]Thomas Plant, Urban Growth and Agricultural Decline: Problems and Policies (Bureau of Business Research, University of Texas, Austin, 1978).

[14]Raymond Dideriksen and R. Neil Sampson, "Important Farmlands: A National View," Journal of Soil and Water Conservation (1976), 31:195-197.

[15]Soil and Water Conservation Service, SCS National Resource Inventories, 1977, loc. cit.

When evaluated over an extended period of time, it becomes evident that additions to the nation's cropland base will consist of more marginal or near marginal lands. Some low-yielding, erodable, wet, stony, shallow and droughty soils may need to be cropped. This, again, could cause environmental problems such as water pollution, both high energy and water use, and soil degradation due to erosion.

Rural water districts, because they encourage the conversion of rural agricultural land (and often this is prime agricultural land) to non-agricultural purposes, must be re-evaluated in light of their contribution to rural problems. It is evident from research presented here that there is a greater amount of non-agricultural development taking place within rural water districts than away from these water lines. These developments, often in the form of large scale real estate projects, result in the growth of rural population and suburban sprawl. This larger rural non-farm population brings with it demands which are traditionally urban in nature and difficult or costly to provide in such a rural setting, often long distances from existing urban service systems. Such demands would include more paved roads (with more maintenance than is traditionally the case in rural settings), school bus service to urban institutions (an increasingly expensive venture in light of recent energy cost escalations), expanded and more efficient police and fire protection (requiring additional hirings and again larger budgets for energy consumption), sanitation pick-up or distribution and expanded and higher quality medical services. Cost of such demanded services, since they are outside municipal areas, must be borne by county government. At the very

least, an increase in county-based taxes will result; one should remember that high taxes was a basic reason for migrating from the urban area originally. Other offensive characteristics of the urban landscape would follow as the "rural" population increased: crime congestion, pollution, etc. And, in addition, since most of these rural non-farm inhabitants work in the urban areas they must face the time consuming and increasingly expensive daily commute to work.

The development of rural water projects promised to better the life of the rural inhabitant--the farmer. But the real impacts are the changing land use pattern and specifically the loss of prime agricultural land, the suburbanization of rural areas, increases in taxes for many rural occupants, and higher costs to bring into production marginal or near marginal land reserves for increased agricultural demands.

The development of non-farm activities in rural areas will require rural residents (both agriculturally oriented and others) to face many of the same issues of reconciling conflicting uses for land that confront urban expansion. Expansion of population in rural areas, including both small towns and the countryside, will result in increased conversion of farmland for housing, commercial and associated uses. Multi-county planning must take place to insure this development is reasonable. All these uses will raise new problems for non-urban local governments and those responsible for land use planning.

Desired rural objectives may not always be possible without changes in existing institutions. One such example is the enactment of land use planning legislation at the state and county level. Municipal

governments have used land use planning for quite some time, but interest in land use planning on any other level is comparatively recent.

It is apparent that direct measures will be needed to control the use of rural land in the near future, if not at present. These measures will be designed, in part, to direct urban development. Measures of this sort should be regulatory under the police power of government and the purchase of rights in land.

Exclusive agricultural zoning is a common regulatory measure. This type is characterized by limitation of uses (restricted usually to agricultural activity and farm related dwellings), and large minimum lot sizes. This type of rural land regulation is most common in the western United States.

In the east, purchase of development rights is much more common. This measure is equivalent to the direct purchase and sale or lease of land with restrictions and has the advantage of depending more directly on the market for valuation.[16]

Direct measures such as these will not prevent the reduction of farming, but they will keep major portions of farmland undeveloped. Both farmland and farming must be maintained if values of environmental protection, retention of landscape heritage and energy conservation, as well as the production of food and fiber, are to be maintained.

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[16]Robert Coughlin and Thomas Plant, "Less-Than-Fee Acquisition for the Preservation of Open Space: Does It Work?," Journal of the American Institute of Planners (1978), 44(4):452-462.

It is now evident that programs based on direct and indirect controls are necessary. One example is Wisconsin's program of state income tax credits. The farmer's tax depends on his income and the degree to which a county commits itself to an agricultural preservation plan, exclusive agricultural zoning and other measures.[17]

Citizen participation in setting objectives for land use, and public acceptance of measures to achieve these objectives are vital to successful land use control. Economic criteria alone cannot resolve these issues, even though economic considerations are often uppermost in community and individual objectives for land use.

Citizen participation in setting and achieving the objectives for using land is an important factor to the institutional structure for making decisions about land use. Broad participation is required to address long term problems, such as the coordination of objectives for land use with objectives for economic growth, environmental quality, transportation, and soil and water conservation.

Projects such as those mentioned above utilizing both direct and indirect control measures and taking advantage of citizen participation, appear to be our best hope to save farmland and even to maintain farming.

We are living in an industrialized, urbanized society which extends its influence even into the most remote rural areas. We can no longer approach the various, and similar, development problems as if these were two, truly different societies: rural and urban. Many of

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[17]Peter Amato, "Wisconsin Hopes A New Law Will Preserve Its Farms," Planning (1979), 45(1):10-12.

the same approaches used in urban areas to deal with land use problems must now be applied to rural areas. The alternative is increased uncoordinated expansion of non-rural land uses and continued depletion of agricultural land resources. New legislation, both state and national, is needed to assure orderly development of our land resources. This legislation should at the same time assure continued and adequate agricultural production in the most suitable areas, provide for increased population growth of the future and maintain local citizen decision making processes. This legislation in many cases will seem revolutionary and must be accompanied by extensive education programs to affect the support of the American public. Such changes will be both difficult and time consuming, but the alternative is unacceptable.

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APPENDIX A

RWD AND CONTROL AREA LAND USE TOTALS, 1960-1978
(in acres)

Land Uses	Northeast		West		Southeast	
	1960	1978	1960	1978	1960	1978
Pasture						
RWD	13,692.9	18,534.2	15,605.3	15,720.5	14,348.8	16,972.9
Control Area	16,619.9	19,882.2	19,733.5	19,893.6	7,690.3	9,264.1
Crop						
RWD	9,641.3	3,905.5	8,137.1	6,024.6	1,095.6	924.0
Control Area	5,721.9	3,829.3	4,863.5	4,849.4	4,758.1	3,779.7
Woodland						
RWD	1,328.1	1,032.1	120.5	120.5	9,246.3	5,905.1
Control Area	2,358.8	560.7	212.3	0	12,567.3	11,540.0
Rural Residential						
RWD	730.4	1,904.8	658.8	2,388.1	455.4	1,309.4
Control Area	501.3	888.2	378.1	444.8	143.4	383.5
Transportation						
RWD	123.5	123.5	177.9	208.0	193.2	193.2
Control Area	59.6	59.6	24.6	24.6	25.5	25.5
Commercial						
RWD	83.8	99.9	179.4	211.9	13.5	13.5
Control Area	0	41.5	0	0	0	0
Urban Residential						
RWD	0	0	274.2	479.5	204.5	263.7
Control Area	0	0	0	0	11.9	186.3
Recreation						
RWD	0	0	446.8	446.8	0	0
Control Area	338.5	338.5	0	0	145.0	145.0
Extractive						
RWD	0	0	0	0	42.7	18.2
Control Area	0	0	387.6	387.6	258.5	275.9

APPENDIX B - TABLE 1

SOUTHEAST REGION: PUSHMATAHA COUNTY RWD #1 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	0	70.5	15.1	0	0	0	0	0	0	85.6
Pasture	56.1	256.0	0	0	9	0	0	0	0	312.1
Rural Residential	0	0	27.9	0	0	0	0	0	0	27.9
Woodland	0	2,428.5	157.0	3,157.9	4.2	0	0	0	0	5,757.6
Urban Residential	0	0	0	0	120.3	0	0	0	0	120.3
Transportation	0	0	0	0	0	96.5	0	0	0	96.5
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	56.1	2,428.5	210.0	3,157.9	124.5	96.5	0	0	0	6,400.0

APPENDIX B - TABLE 2

SOUTHEAST REGION: PUSHMATAHA COUNTY RWD #1 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	44.5	148.7	0	66.7	0	0	0	0	0	259.9
Pasture	0	77.6	0	0	0	0	0	0	0	77.6
Rural Residential	0	0	11.3	0	0	0	0	0	0	11.3
Woodland	0	306.7	3.5	5,741.0	0	0	0	0	0	6,051.2
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	44.5	533.0	14.8	5,807.7	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 3

SOUTHEAST REGION: LEFLORE COUNTY SPIRO EAST RWD SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	30.0	171.1	4.5	0	0	0	0	0	0	205.6
Pasture	143.1	5,372.2	392.6	0	0	0	0	0	0	5,907.9
Rural Residential	0	0	214.9	0	0	0	0	0	0	214.9
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	58.1	0	0	0	58.1
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	13.5	0	13.5
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	173.1	5,543.3	612.0	0	0	58.1	0	13.5	0	6,400.0

APPENDIX B - TABLE 4

SOUTHEAST REGION: LEFLORE COUNTY SPIRO EAST RWD CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	2,198.4	196.0	4.5	0	174.4	0	0	0	0	2,572.3
Pasture	97.4	2,250.7	50.6	0	0	0	0	0	17.4	2,416.1
Rural Residential	0	0	54.2	0	0	0	0	0	0	54.2
Woodland	71.8	390.4	0	832.2	0	0	0	0	0	1,294.4
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	25.5	0	0	0	25.5
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	37.5	37.5
1978 TOTALS	2,367.6	2,836.1	109.3	832.2	174.4	25.5	0	0	54.9	6,400.0

APPENDIX B - TABLE 5

SOUTHEAST REGION: LEFLORE COUNTY NORTHWEST WATER, INC. SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	187.4	373.8	44.6	0	0	0	0	0	0	605.8
Pasture	238.8	4,315.1	119.2	0	0	0	0	0	0	4,673.1
Rural Residential	0	0	118.7	0	0	0	0	0	0	118.7
Woodland	0	173.5	0	773.2	0	0	0	0	0	946.7
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	13.0	0	0	0	13.0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	24.5	0	0	0	0	0	0	18.2	42.7
1978 TOTALS	426.2	4,886.9	282.5	773.2	0	13.0	0	0	18.2	6,400.0

APPENDIX B - TABLE 6

SOUTHEAST REGION: LEFLORE COUNTY NORTHWEST WATER, INC. RWD CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	1,153.2	678.6	5.9	0	0	0	0	0	0	1,837.7
Pasture	179.3	2,994.4	82.1	0	0	0	0	0	0	3,255.8
Rural Residential	0	0	44.7	0	0	0	0	0	0	44.7
Woodland	0	106.5	21.0	913.3	0	0	0	0	0	1,040.8
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	221.0	221.0
1978 TOTALS	1,332.5	3,774.5	153.7	913.3	0	0	0	0	221.0	6,400.0

APPENDIX B - TABLE 7

SOUTHEAST REGION: LEFLORE COUNTY WATER DISTRIBUTION COMPANY SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	119.7	73.4	5.5	0	0	0	0	0	0	198.6
Pasture	120.1	3,097.8	94.2	88.6	55.0	0	0	0	0	3,455.7
Rural Residential	0	0	93.9	0	0	0	0	0	0	93.9
Woodland	28.8	616.5	11.3	1,885.4	0	0	0	0	0	2,542.0
Urban Residential	0	0	0	0	84.2	0	0	0	0	84.2
Transportation	0	0	0	0	0	25.6	0	0	0	25.6
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	268.6	3,787.7	204.9	1,974.0	139.2	25.6	0	0	0	6,400.0

APPENDIX B - TABLE 8

SOUTHEAST REGION: LEFLORE COUNTY WATER DISTRIBUTION COMPANY, RWD CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	35.1	53.1	0	0	0	0	0	0	0	88.2
Pasture	0	1,790.0	64.6	86.2	0	0	0	0	0	1,940.8
Rural Residential	0	0	33.2	0	0	0	0	0	0	33.2
Woodland	0	272.4	7.9	3,900.6	0	0	0	0	0	4,180.9
Urban Residential	0	0	0	0	11.9	0	0	0	0	11.9
Recreation	0	0	0	0	0	0	145.0	0	0	145.0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	35.1	2,148.7	105.7	3,986.8	11.9	0	145.0	0	0	6,400.0

APPENDIX B - TABLE 9

WEST REGION: COMANCHE COUNTY RWD #1 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	417.6	359.8	50.9	0	0	0	0	2.0	0	830.3
Pasture	441.9	4,186.4	409.2	0	0	0	0	4.6	0	5,042.1
Rural Residential	0	0	205.1	0	0	0	0	0	0	205.1
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	34.8	0	0	0	34.8
Recreation	0	0	0	0	0	0	273.2	0	0	273.2
Commercial	0	0	0	0	0	0	0	14.5	0	14.5
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	859.5	4,546.2	665.2	0	0	34.8	273.2	21.1	0	6,400.0

APPENDIX B - TABLE 10

WEST REGION: COMANCHE COUNTY RWD #1 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	295.0	97.4	0	0	0	0	0	0	0	392.4
Pasture	267.3	5,702.4	4.7	0	0	0	0	0	0	5,974.4
Rural Residential	0	11.9	21.3	0	0	0	0	0	0	33.2
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	562.3	5,811.7	26.0	0	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 11

WEST REGION: STEPHENS COUNTY RW, S AND SW DISTRICT #3 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	752.0	618.3	288.2	0	0	0	0	0	0	1,658.5
Pasture	194.7	3,454.9	205.1	0	106.5	0	0	25.9	0	3,987.1
Rural Residential	0	0	238.3	0	0	0	0	0	0	238.3
Woodland	0	0	0	120.5	0	0	0	0	0	120.5
Urban Residential	0	0	0	0	256.7	0	0	0	0	256.7
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	138.9	0	138.9
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	946.7	4,073.2	731.6	120.5	363.2	0	0	164.8	0	6,400.0

APPENDIX B - TABLE 12

WEST REGION: STEPHENS COUNTY RW, S AND SW DISTRICT #3, RWD CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	449.6	541.8	0	0	0	0	0	0	0	991.4
Pasture	501.1	4,372.9	93.8	0	0	0	0	0	0	4,967.8
Rural Residential	0	34.6	193.9	0	0	0	0	0	0	228.5
Woodland	12.3	196.2	3.8	0	0	0	0	0	0	212.3
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	963.0	5,145.5	291.5	0	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 13

WEST REGION: COTTON COUNTY RWD #2 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transporation	Recreation	Commercial	Extractive	TOTALS
Cropland	2,493.9	1,244.6	41.9	0	0	0	0	0	0	3,780.3
Pasture	585.1	1,887.9	64.7	0	0	0	0	0	0	2,537.7
Rural Residential	2.4	0	79.6	0	0	0	0	0	0	82.0
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	3,081.3	3,132.5	186.2	0	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 14

WEST REGION: COTTON COUNTY RWD #2 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	1,324.9	1,021.2	2.1	0	0	0	0	0	0	2,348.2
Pasture	667.0	3,330.6	5.0	0	0	0	0	0	0	4,002.6
Rural Residential	3.7	9.6	35.9	0	0	0	0	0	0	49.2
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transporation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	1,995.6	4,361.4	43.0	0	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 15

WEST REGION: COMANCHE COUNTY RWD #2 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	874.6	792.6	170.7	0	0	30.1	0	0	0	1,868.0
Pasture	262.5	3,176.1	501.0	0	98.8	0	0	0	0	4,038.4
Rural Residential	0	0	133.4	0	0	0	0	0	0	133.4
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	17.5	0	0	0	0	17.5
Transportation	0	0	0	0	0	143.1	0	0	0	143.1
Recreation	0	0	0	0	0	0	173.6	0	0	173.6
Commercial	0	0	0	0	0	0	0	26.0	0	26.0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	1,137.1	3,968.7	805.1	0	116.3	173.2	173.6	26.0	0	6,400.0

APPENDIX B - TABLE 16

WEST REGION: COMANCHE COUNTY RWD #2 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	809.2	321.5	1.2	0	0	0	0	0	0	1,131.9
Pasture	519.3	4,245.7	23.7	0	0	0	0	0	0	4,788.7
Rural Residential	0	7.8	59.4	0	0	0	0	0	0	67.2
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	24.6	0	0	0	24.6
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	387.6	387.6
1978 TOTALS	1,328.5	4,575.0	84.3	0	0	24.6	0	0	387.6	6,400.0

APPENDIX B - TABLE 17

NORTHEAST REGION: ROGERS COUNTY RWD #8 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	241.4	306.1	38.2	0	0	0	0	0	0	585.7
Pasture	38.0	4,972.6	391.9	0	0	0	0	0	0	5,402.5
Rural Residential	0	0	185.6	0	0	0	0	0	0	185.6
Woodland	0	15.7	0	120.0	0	0	0	0	0	135.7
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	90.5	0	0	0	90.5
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	279.4	5,294.4	615.7	120.0	0	90.5	0	0	0	6,400.0

APPENDIX B - TABLE 18

NORTHEAST REGION: ROGERS COUNTY RWD #8 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	118.1	189.1	0	0	0	0	0	0	0	307.2
Pasture	77.3	5,169.4	251.0	0	0	0	0	41.5	0	5,539.2
Rural Residential	0	0	130.5	0	0	0	0	0	0	130.5
Woodland	0	0	0	43.5	0	0	0	0	0	43.5
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	41.1	0	0	0	41.1
Recreation	0	0	0	0	0	0	338.5	0	0	338.5
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	195.4	5,358.5	381.5	43.5	0	41.1	338.5	41.5	0	6,400.0

APPENDIX B - TABLE 19

NORTHEAST REGION: OTTAWA COUNTY RWD #2 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	1,892.7	2,835.2	201.0	0	0	0	0	16.1	0	4,945.0
Pasture	20.2	1,019.0	78.9	0	0	0	0	0	0	1,118.1
Rural Residential	0	0	253.1	0	0	0	0	0	0	253.1
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	83.8	0	83.8
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	1,912.9	3,854.2	533.0	0	0	0	0	99.9	0	6,400.0

APPENDIX B - TABLE 20

NORTHEAST REGION: OTTAWA COUNTY RWD #2 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	2,078.0	1,883.7	19.2	0	0	0	0	0	0	3,980.9
Pasture	258.2	1,802.2	3.6	0	0	0	0	0	0	2,064.0
Rural Residential	0	0	91.1	0	0	0	0	0	0	91.1
Woodland	0	264.0	0	0	0	0	0	0	0	264.0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	2,336.2	3.949.9	113.9	0	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 21

NORTHEAST REGION: ROGERS COUNTY RWD #6 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	192.0	663.4	7.9	0	0	0	0	0	0	863.3
Pasture	43.8	4,737.2	257.6	0	0	0	0	0	0	5,038.6
Rural Residential	0	0	112.0	0	0	0	0	0	0	112.0
Woodland	0	137.0	0	249.1	0	0	0	0	0	386.1
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	235.8	5,537.6	377.5	249.1	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 22

NORTHEAST REGION: ROGERS COUNTY RWD #6 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	238.6	172.7	22.1	0	0	0	0	0	0	433.4
Pasture	212.9	5,508.5	45.8	0	0	0	0	0	0	5,767.2
Rural Residential	0	0	199.4	0	0	0	0	0	0	199.4
Woodland	0	0	0	0	0	0	0	0	0	0
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	451.5	5,681.2	267.3	0	0	0	0	0	0	6,400.0

APPENDIX B - TABLE 23

NORTHEAST REGION: MAYES COUNTY RWD #4 SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	957.1	2,263.9	26.3	0	0	0	0	0	0	3,247.3
Pasture	520.3	1,489.3	124.1	0	0	0	0	0	0	2,133.7
Rural Residential	0	0	179.7	0	0	0	0	0	0	179.7
Woodland	0	94.8	48.5	663.0	0	0	0	0	0	806.3
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	33.0	0	0	0	33.0
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	1,477.4	3,848.0	378.6	663.0	0	33.0	0	0	0	6,400.0

APPENDIX B - TABLE 24

NORTHEAST REGION: MAYES COUNTY RWD #4 CONTROL AREA SAMPLE

Land Uses 1960	Cropland	Pasture	Rural Residential	Woodland	Urban Residential	Transportation	Recreation	Commercial	Extractive	TOTALS
Cropland	514.3	485.8	0.3	0	0	0	0	0	0	1,000.4
Pasture	281.6	2,951.6	16.3	0	0	0	0	0	0	3,249.5
Rural Residential	0	0	80.3	0	0	0	0	0	0	80.3
Woodland	50.3	1,455.2	28.6	517.2	0	0	0	0	0	2,051.3
Urban Residential	0	0	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	18.5	0	0	0	18.5
Recreation	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Extractive	0	0	0	0	0	0	0	0	0	0
1978 TOTALS	846.2	4,892.6	125.5	517.2	0	18.5	0	0	0	6,400.0