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**COMMUNITY AND SOCIO-ECONOMIC ANALYSIS
OF COLORADO'S HIGH PLAINS REGION**

by
Robert Burns

February 1982

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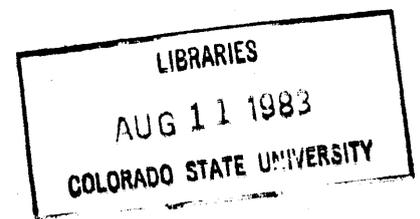
Technical Report No. 31

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COMMUNITY AND SOCIO-ECONOMIC ANALYSIS
OF COLORADO'S HIGH PLAINS REGION

by

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February 1982

This report was prepared in partial fulfillment of the Colorado portion of a six-state study of the Ogallala Aquifer. Funding was provided by the U. S. Economic Development Administration through the firm of Camp Dresser and McKee, Inc.

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PREFACE

This publication is one of six technical reports prepared by Colorado State University, the Colorado Office of Energy Conservation, the Colorado Division of Water Resources, and the Colorado Department of Local Affairs as part of the six-state High Plains-Ogallala Aquifer Study. The study was authorized by Congress in 1976 under Public Law 92-587 to investigate the extent of groundwater depletion of the Ogallala Aquifer to project its future depletion to 2020 A.D. and the associated economic impacts upon the High Plains region of the United States and to develop recommendations for action to minimize economic disruption in the region.

The six technical reports listed below make up the Colorado portion of this study:

Technical Report No. 29. McKean, John, et al. An Economic Input-Output Study of the High Plains Region of Eastern Colorado.

Technical Report No. 30. McBroom, Emm. Energy Production and Use in Colorado's High Plains Region.

Technical Report No. 31. Burns, Robert. Community and Socio-Economic Analysis of Colorado's High Plains Region.

Technical Report No. 32. Longenbaugh, Robert. Hydrologic and Pumping Data for Colorado's Ogallala Aquifer Region, 1979.

Technical Report No. 33. McKean, John. Projected Population, Employment, and Economic Output in Colorado's Eastern Plains, 1979-2020.

Technical Report No. 34. Young, Robert, et al. Energy and Water Scarcity and the Irrigated Agricultural Economy of the Colorado High Plains: Direct Economic-Hydrologic Impact Analysis.

Copies of the Colorado technical reports may be purchased at \$7.00 each from: Colorado Water Resources Research Institute, Bulletin Room, 171 Aylesworth Hall SW, Colorado State University, Fort Collins, Colorado, 80523 (Telephone: 303/491-6198). Prepayment requested for orders under \$25.00. An abstract of any of the reports will be sent upon request.

In addition to these technical reports, a 12-page newspaper published in November 1982 summarizes research results for the Colorado portion of the study and describes possible options for action. Copies are available at no cost upon request from: Resource Analysis Section, Colorado Department of Agriculture, 1525 Sherman Street, Denver, Colorado, 80203, telephone (303) 866-3219.

The studies on which these reports are based were financed in part by the Economic Development Administration of the U. S. Department of Commerce under Contract No. EDA-78-2550 with the State of Colorado. The statements, findings, conclusions, recommendations, and other data contained therein are solely those of the authors and do not necessarily reflect the views of the Economic Development Administration or the U. S. Government in general.

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The author and the Colorado Division of Planning would like to express appreciation to the many people and organizations who contributed generously of their time and efforts to provide information for this study. Their names are listed at the end of this report.

We would also like to thank the other participants in the Colorado part of the Six-State Ogallala-High Plains study for their cooperation. These include Colorado State University, the Colorado Department of Agriculture, the Colorado Division of Water Resources, and the Colorado Office of Energy Conservation. Meetings organized by the Colorado Department of Agriculture to examine the problems of agricultural land use were especially helpful in understanding the concerns of High Plains residents.

The final analysis and conclusions are based on the contributions of all these people and organizations, but the author is solely responsible for their inclusion and interpretation, and for any errors in this report.

R. Burns
26 March, 1981

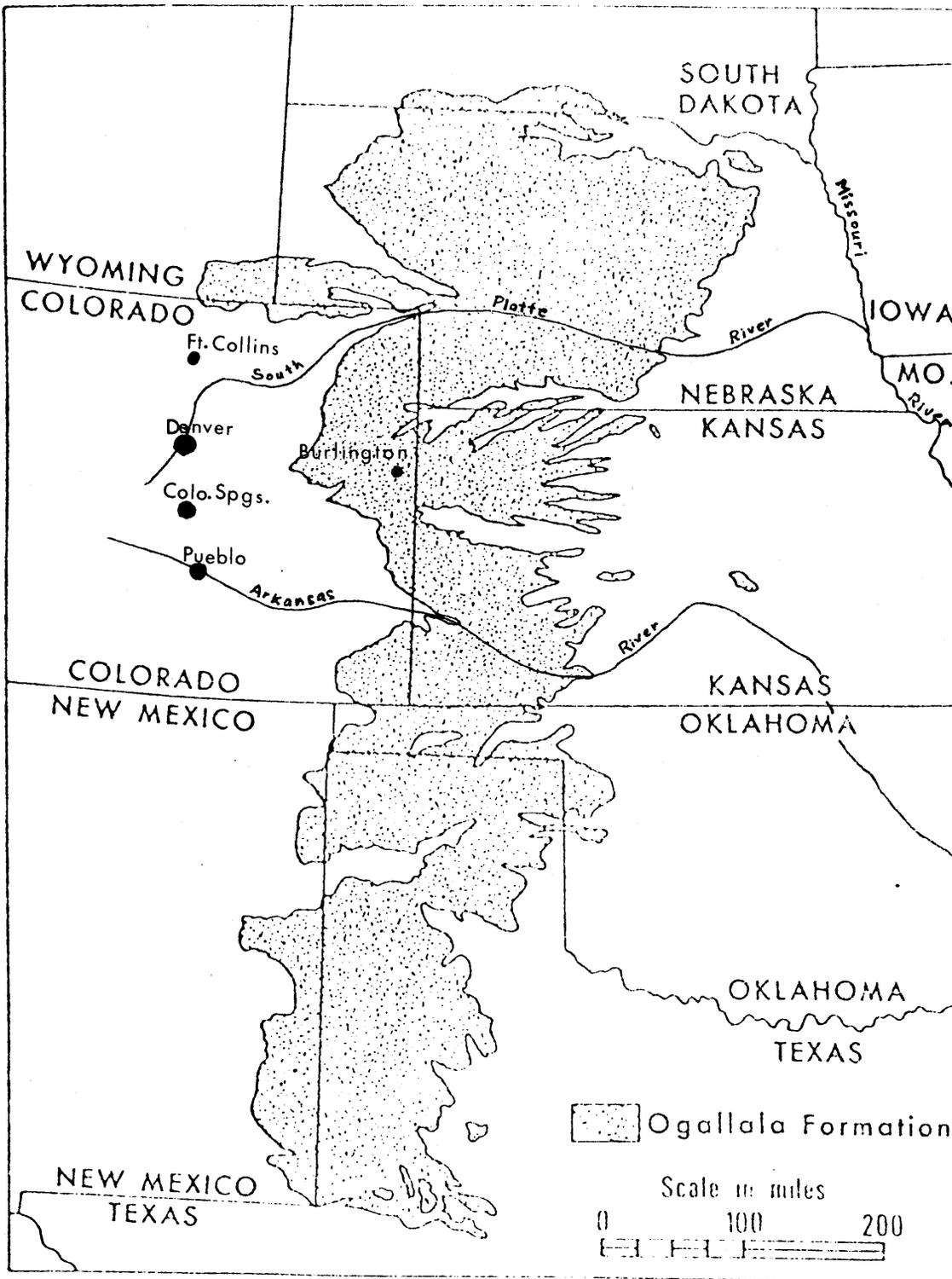
CHAPTER ONE
INTRODUCTION

The purposes of this part of Colorado's contribution to the Six-State Ogallala Study are as follows:

- (1) to describe the socio-economic characteristics of the Colorado part of the High Plains Region;
- (2) to understand the effects of possible changes in the region's economic base;
- (3) to understand the potential for additional economic development in the region; and
- (4) to investigate possibilities for improvements to mitigate identified problems in the region.

The study describes the resource base, and analyzes the geographic structure of the region, its economic development, its population and settlement patterns, and its communities. This provides a basis for analyzing the local economy and services available to the region's residents, to determine their adequacy and their susceptibility to changes in the economic base. This, in turn, suggests needs and opportunities to maintain or improve living conditions in the region's communities.

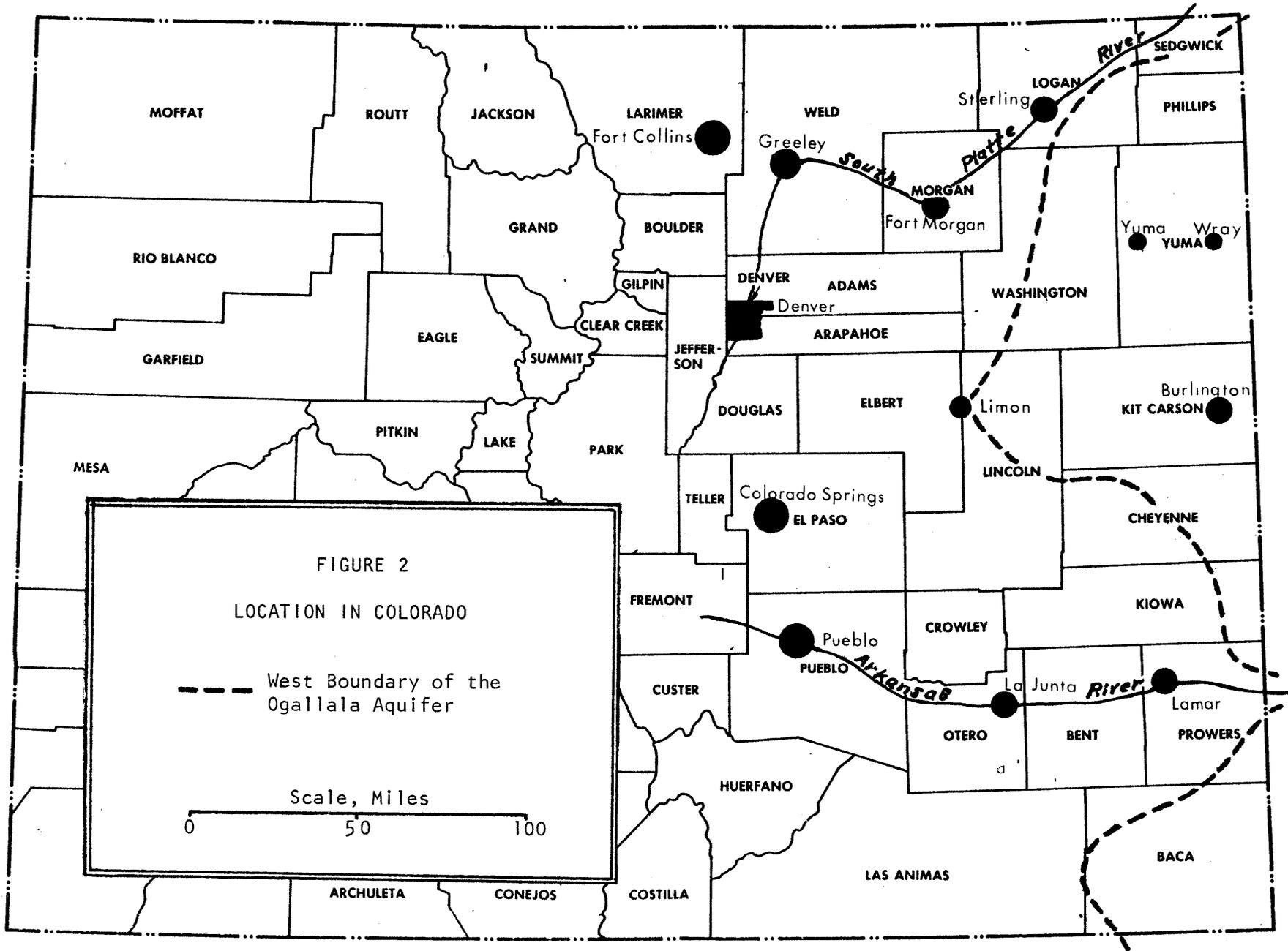
The High Plains Region of Colorado is a small westerly part of the larger High Plains Region extending throughout larger areas of Nebraska, Kansas and Texas, and smaller areas of other states (Figure 1). For the Six-State Study of which this study is a part, the region of concern has been defined as the part of the High Plains overlying the Ogallala Formation, a ground-water



From: John C. Frye, "The Ogallala Formation: A Review," 1970
 Ogallala Aquifer Symposium, Texas Tech University

FIGURE 1

LOCATION OF THE OGALLALA AQUIFER



aquifer which has been extensively used as a source of water for a highly developed irrigated agricultural economy. In Colorado, the boundaries of this aquifer coincide with the uppermost parts of the drainage basins of the Republican River in the northern, and the Cimarron River in the southern, part of the state. The region of concern in this part of the Colorado study, however, includes the total area of the eleven counties lying partially within the boundaries just described (Figure 2). Changes in the agricultural economies within the Ogallala Aquifer areas of these counties could presumably affect the entire counties.

This study includes an analysis of the natural resources and economic potential of the Colorado High Plains, in the regional context of eastern Colorado as a whole. It examines functional geographic relationships, transportation, economic base, population, employment, local services, settlement patterns, social organization, infrastructure, and investment in the region. This is the basic information included in Chapter Two, "Regional Description and Analysis". Chapter Three, "Regional Problems", focuses on the details of the regional economy which have been of particular concern, such as education, medical services, transportation, and other services. Chapter Four, "Effects of Projected Scenarios", analyzes the changes in the local and regional economy that may be expected to follow possible changes in the agricultural economic base. Chapter Five, "Economic Alternatives", explores the possibilities of new developments in agriculture and other economic base activities.

RESEARCH PROCEDURE

Research for this report included the following sources of information:
--literature on the U. S. agricultural economy, the Great Plains, non-

metropolitan industrialization, and regional economics. (See References.)

- reports and other documents in the files of the Colorado Division of Planning and other state agencies. (Partially included in Reference.)
- meetings on agricultural land use and on the High Plains Study organized by the Colorado Department of Agriculture.
- meetings with members of the Colorado State University Cooperative Extension Service, University of Colorado Community Development Specialists, USDA and Extension Service field officers, local businessmen and officials, farmers, farm organizations, and state agencies.
- continuous communication with Colorado State University researchers investigating and analyzing agricultural prices, water resources, and the regional agricultural economic base.
- Colorado Agricultural Statistics and Census reports on population, business and agriculture.
- direct observations of communities and agricultural practices in the High Plains during 12 days of travel in the region for meetings with groups and individuals.

From this information, material has been selected, organized and analyzed to assess the results of current trends in the region and their implications. A large amount of well-supported information about agricultural and economic conditions in the High Plains Region is available in the publications of the USDA Cooperative Extension Service, Economic Research Service and university researchers. Census sources provide considerable information about population, economic conditions, and agriculture in the region. Discussions with extension

agents and USDA officers provided insights about problems and possibilities. The literature on regional economic development provided a basis for assessing alternative economic base possibilities. Finally, discussions with local farmers, businessmen and elected officials, revealed a range of viewpoints about the region, its economy, and its alternatives.

CONCLUSIONS

The part of the High Plains of Colorado which lies above the Ogallala Formation contains about 33,000 people in parts of eleven counties. This area is part of the larger eastern Colorado region containing 141,000 people in sixteen counties. The High Plains region thus defined contains about one percent of the state's population, while eastern Colorado (east of the metropolitan counties) includes about seven percent of the state's population.

The economy of the High Plains is almost exclusively agricultural, while the South Platte and Arkansas valleys have developed somewhat more diverse economies in their four largest population centers. The relative advantage of the High Plains has long been in unirrigated wheat production and cattle ranching, but in the last several decades the development of ground water resources has given rise to a thriving feed-grain and cattle-feeding economy in several areas of the region. Changes in the costs of electricity and natural gas for irrigation pumping, and the possibility of exhaustion of ground water resources, have caused considerable concern about the future of agriculture in the region. This concern has increased in recent years, culminating in the Six-State High Plains-Ogallala Aquifer Study, of which this study is a part. In general, the results of the Colorado part of the study have been encouraging. Research at Colorado State University forecasts a

moderately-growing agricultural economic base for the Colorado High Plains during the period 1980 to 2020, assuming current agricultural practices and water-using techniques. If more efficient techniques can be instituted, water may be conserved or the regional income from agriculture may be greater than forecast. Conversely, if expected price increases for feed grains are smaller than expected, production and incomes in the region will be less than forecast, but water use will be less and water resources will be extended. Large increases or declines, however, appear unlikely. Thus, the agricultural economic base of the Colorado High Plains appears generally stable, at least for the 1980-2020 planning period.

Economic alternatives to agriculture as a basis for expanding the regional economy were also investigated. The main possibility for non-agricultural economic expansion in the region appears to be an additional development of the local service economy. Industrial development, tourism and other economic activities appear unlikely to add much to the economy of the Colorado High Plains, owing to comparative advantages elsewhere. Possible exceptions are industries such as fuel alcohol production or sunflower oil processing, that could use large amounts of locally-produced raw material and produce large volumes of by-products that could be most economically used locally as cattle feed. There appears to be more probability of industrial development and of further expansion of the agricultural economy, in the more populated areas of the South Platte and Arkansas valleys. Development in these valleys could increase the economic opportunities available to the people of the entire eastern Colorado region. This could minimize the need for young people of the region to migrate to metropolitan areas or out of

eastern Colorado, even though opportunities might be limited in the High Plains communities.

The towns and agricultural communities of the irrigated areas of the High Plains are characterized by stable economies that appear unlikely to be severely affected by any probable change in their agricultural economic bases. However, there appear to be opportunities for expanding local service economies, strengthening the multiplier effects of the agricultural economic base, and providing desired local services more effectively. Identified needs include commercial goods and services, medical services, school system improvements, and improvements in housing. The large proportion of elderly people in the region makes medical services and housing especially important public concerns.

The agricultural economies of the unirrigated areas of the Colorado High Plains--based on wheat and cattle--have stabilized at levels that support only very scattered, small, populations. In these areas, the populations of most towns have already declined below the levels needed to maintain most commercial services, and have continued to decline during the past decade. As the operators of the large farms and ranches of this region live on widely scattered farmsteads or in the larger towns, the decline of the smaller towns in the unirrigated area appear to be a rational adaptation to the economic base, which may continue.

In summary, the conclusions of this study are as follows.

1. The economic base of the Colorado High Plains region is overwhelmingly agricultural and will remain so.

2. This economic base is essentially stable, and only marginal adjustments are expected in response to changing water supplies, production costs, and prices for products, at least until the year 2020.
3. The communities of the irrigated area have reached stable equilibrium with the agricultural economy, and can be expected to remain stable or to increase slightly in population and services.
4. The communities of the unirrigated area have uncertain futures because their populations have declined below the level at which they can support adequate regional services. They may survive as residential settlements with minimal local services, however.
5. Alternative economic base activities, such as manufacturing or tourism, have very limited possibilities in the High Plains, but somewhat greater possibilities in the larger towns of the South Platte and Arkansas valleys.
6. For regional development purposes, eastern Colorado should be considered as a whole, to take advantage of possibilities specific to its four largest population centers in the South Platte and Arkansas valleys.
7. For community development in High Plains towns attention should be focused on the agricultural economic base and on development of community services, rather than on alternative economic base activities.

The following chapters present the information on which these conclusions are based.

CHAPTER TWO
REGIONAL DESCRIPTION

Socio-economic conditions are largely a result of regional characteristics-- location, resources, economic base, population, cultural development, and environmental characteristics. These all affect socio-economic conditions in various ways. This regional description, then, is organized on the basis of the following characteristics:

- resources
- economic base
- location
- population and employment
- settlement patterns
- community conditions

RESOURCES

The main natural resource of the Colorado High Plains is agricultural land. Its use is dependent on water, which is related to climate and accumulated ground water deposits. Less important resources include oil and gas, wildlife, and scenic and environmental qualities. Cultural resources include the towns of the region, and its farms, irrigation systems, and transportation systems. Together these natural and cultural resources determine the region's potential and future development. Resources vary throughout the larger High Plains Region, and even through the Colorado High Plains.

These variations affect the possibilities of growing alternative crops in different parts of the Region, the effects of higher water costs or depleted

water supplies, and the costs of production in general. Thus, conclusions about the effects of declining water resources or increasing production costs, and the resulting socio-economic consequences, cannot be uniformly applied throughout the High Plains nor even through the Colorado High Plains.

A major characteristic of semi-arid climates is that mean total precipitation is not only lower than in humid regions, but that annual variation is greater. In eastern Colorado, droughts lasting several years occur at ten to twenty year intervals, with serious crop losses and wind erosion.

The soils of the region are inherently fertile. Because of this and the climatic conditions, farmers in the Great Plains generally use less fertilizer and pesticides than the national average, although they use slightly more fuel for tillage, and large amounts of energy may be used for pumping irrigation water. (1)

Much of the area of the Colorado High Plains is grassland of various conditions and productivity. In the past this land has supported a large range cattle industry, but at present it may be understocked in some places, according to Extension Service livestock specialists. This probably reflects the present unprofitability of range livestock or "cow-calf" operations and the tendency of many farmers to specialize in crop production and cattle feeding.

Land use in the Colorado High Plains, then, consists mainly of cropland and rangeland. Cropland area is mainly unirrigated, but in several counties the smaller areas of irrigated cropland produce a majority of the crop value (Table 1). Most of the land irrigated with ground water is in four counties--

Table 1

Area and Value of Irrigated and Unirrigated Crops in the Six High Plains Counties Having Significant Areas of Irrigated Land, 1979.

	<u>Yuma</u>	<u>K.Car.</u>	<u>Phil.</u>	<u>Baca</u>	<u>Wash.</u>	<u>Chey.</u>	<u>Total</u>
Harvested Area (Thousands of Acres)	385	355	201	430	371	173	1915
Irrigated	213	118	89	108	53	25	606
Unirrigated	172	237	112	322	318	148	1309
Crop Value (Sales) (Millions of Dollars)	84	57	45	44	45	15	290
Irrigated	65	32	32	12	11	5	157
Unirrigated	20	25	14	31	35	10	135

Compiled from data on individual crops from Colorado Agricultural Statistics, 1980. Colorado Department of Agriculture.

Baca, Kit Carson, Phillips, and Yuma. Little land is irrigated in the other High Plains counties, or in the High Plains areas of counties that include surface irrigation in the South Platte and Arkansas valleys.

The other resources of this region--wildlife, scenic quality, and environmental characteristics--have contributed little to the regional economy, and are unlikely to do so.

ECONOMIC BASE

The economic base of the Colorado High Plains is almost entirely agriculture and ranching. The main limit to agricultural production is water. This limit has been temporarily transcended on about 600,000 acres of the region through irrigation. The irrigated area is less than one-third of the total harvested area of the Colorado High Plains, but in 1979 this area produced about \$157 million in crop value, or about half of the total value of crops produced in the region (Table 1).

Except for the irrigated area, which is only about five percent of the total area of the region (Table 2), land use is very extensive--producing high total value, but low value per acre.

Agriculture

According to the 1974 Census of Agriculture, the five most productive High Plains counties together produced about 17 percent of the total value of agricultural products and livestock sold in Colorado (Table 3). All of eastern Colorado, including the South Platte and Arkansas valleys, the High Plains, and the metropolitan counties, produced 86 percent of all the crop and livestock sales value in the state.

Table 2

Land Use--Colorado High Plains Counties, 1974

(thousands of acres)

	Area in Farms and Ranches					Total County Area
	Total	Cropland		Total	Pasture or Range	
		Irri- gated	Unirri- gated			
<u>Major Irrigation Counties</u>						
Yuma	1400	173	476	649	734	1523
Kit Carson	1374	124	605	729	602	1389
Baca	1400	86	621	707	668	1640
Phillips	467*	61	315	376	81	435
Total	4641	444	2017	2461	2085	4987
<u>Minor Irrigation Counties</u>						
Washington	1382	30	723	753	587	1616
Cheyenne	905	17	361	378	515	1134
Kiowa	1002	12	464	476	463	1131
Lincoln	1615	5	358	363	1210	1659
Total	4904	64	1906	1970	2775	5540

*Includes land outside Phillips County which is part of farms in the county.

Source: Census of Agriculture, 1974, Part IV. County Data.

Table 3

Market Value of Agricultural Products and Livestock Sold, Eastern
Colorado, 1974

(millions of dollars)

Colorado Total 1962.1 (100% of State)

High Plains Counties--Irrigated

Baca	44.9
Kit Carson	97.4
Phillips	45.0
Washington	49.1
Yuma	<u>90.7</u>
Total	326.7 (16.6% of state)

Metropolitan Counties

Adams	54.4
Arapahoe	12.6
Boulder	20.6
Douglas	6.1
Elbert	15.1
El Paso	12.1
Jefferson	8.8
Larimer	<u>52.2</u>
Total	181.9

High Plains Counties--Unirrigated

Kiowa	22.9
Lincoln	27.0
Cheyenne	<u>19.5</u>
Total	69.4 (3.5% of state)

(9.0% of state)

Arkansas Valley Counties

Bent	21.7
Crowley	34.9
Otero	54.9
Prowers	<u>75.2</u>
Total	186.7 (9.3% of state)

South Platte Valley Counties

Logan	144.9
Morgan	148.6
Sedgwick	28.1
Weld	<u>600.9</u>
Total	922.5

(47% of State)

Source: Census of Agriculture, Colorado, County Summary Data, 1974,
Table 8, p. 11-9.

Throughout eastern Colorado, most of the crop value is produced on irrigated land. This is in contrast to the more extensive production of wheat and range livestock in the unirrigated areas that comprise the majority of the land of the High Plains. In the High Plains there are about 4.8 million acres of rangeland, and nearly 4 million acres of unirrigated cropland, in addition to about 600,000 acres (in 1979) of irrigated cropland. Thus, the less intensive land uses dominate the landscape of most of the region, even though the much smaller area of irrigated land produces nearly half the total crop value of the entire High Plains Region of Colorado.

Range livestock production was one of the earliest economic activities in the High Plains, preceding agriculture, but has recently been somewhat neglected. Concentration by farmers on wheat and irrigated feed crops, together with an unfavorable cattle market, seems to have diminished the interest in ranching, even though Extension Service livestock specialists believe there is a potential for expanding this industry with the available rangeland.

Oil and Gas

During the 1950's, oil and gas discoveries and development in the High Plains contributed substantially to the regional economy in Washington County, and to a lesser extent elsewhere, but at present, oil and gas production is declining and contributes little to the local economy. The 1978 royalty payments of 2.1 million dollars on oil and gas are small compared with the total 1978 crop sales value of \$237 million for the eight High Plains counties. (2,3) Continuing decline of oil and gas production in the region

is expected, from eight million barrels of crude oil in 1970 to three million in 1980, and only about 500 thousand barrels in 2000. Natural gas production is expected to follow a similar trend, from 12,000 million cubic feet in 1970 to less than 10,000 million in 1980 and 4,000 million in 2000.

Other Economic Activities

Services to tourists and other travellers bring some income to the region. Five transcontinental highways cross eastern Colorado. Most of the towns have at least a motel, restaurant, and service station, and the larger towns have several of each. Generally, the region is fairly scenic, and some of the towns could be considered interesting or attractive. But the attractions of the region are scattered over too large an area to create focal points for tourists, so services to tourists remain a very small part of the local economies. Tourism has probably declined somewhat in the High Plains region since demographic changes, increasing gasoline costs, and changing recreational preferences have tended to discourage transcontinental automobile touring.

The larger towns of eastern Colorado, including several High Plains towns, have attracted substantial numbers of retired people. Most of these people lived in the region before retiring or have returned to the region after leaving to make their livings elsewhere. Retired people support the local economy from their savings and income from outside the region, purchasing housing, food, transportation, and medical, dental, and social services. This demand has contributed substantially to the maintenance of a disproportionately large number of retirement homes and hospitals in several of the larger towns. Retired people also contribute largely to the social life of several

towns, having more leisure time than people who are still working, and sometimes extensive experience in a variety of activities.

Local Services

Local wholesale, retail, and services are not generally considered to be economic base industries, but they intensify the local economic structure, increase the multiplier effect of basic income, and retard the flow of income out of the region. The development of these sales and service industries reflects the level of economic development, the internal viability of the regional economy, and its resistance to influences from outside the region. Table 4 outlines the wholesale, retail and service economy of the region for both High Plains and the more populated valley counties. This table also shows the differences between the more developed economies of the irrigated counties in the High Plains and the valleys and the less developed economies of the unirrigated counties.

The relative intensity of business activity is better shown by the ratio of transactions to population for retail, wholesale and services (Table 5). For example, the very high ratio for Denver reflects the city's position as the major commercial center of the state and of a large metropolitan region. Excluding Denver may provide a better basis for comparison among rural areas, as the average for the state, including Denver, is \$10,600 per person, but without Denver it is only \$7,600. Two irrigated High Plains counties--Kit Carson and Phillips--have per capita transactions values higher than the state average, as do two South Platte Valley counties--Logan and Morgan. These ratios indicate a high level of economic activity and local self-sufficiency in these counties, and also a high income multiplier. Conversely,

Table 4

Value of Sales and Services and Number of Establishments--Selected
Eastern Colorado Counties and Towns 1977

(Values in millions of dollars)

County or Town	All Establishments					
	Retail		Wholesale		Services	
	Number	Sales	Number	Sales	Number	Receipts
Baca	88	14.0	22	28.9	81	1.9
Kit Carson	108	26.7	29	97.4	96	3.8
Burlington	76	21.3	12	47.4	62	2.8
Phillips	63	12.8	19	35.8	41	0.9
Washington	69	10.5	18	20.3	51	1.0
Yuma	121	26.0	39	58.3	96	3.1
Total	449	90.0	127	240.7	365	10.7
Cheyenne	40	5.9	8	6.3	33	0.8
Kiowa	25	3.5	13	7.5	16	0.5
Lincoln	88	19.4	22	16.6	75	2.5
Total	153	28.8	43	30.4	124	3.8
Logan	245	70.9	67	162.1	214	12.1
Sterling	212	67.7	49	112.8	188	11.7
Morgan	258	75.8	76	187.3	228	8.1
Brush	75	17.5	17	107.4	66	1.8
Ft. Morgan	158	54.5	46	51.7	144	6.0
Otero	251	63.1	55	70.0 (est.)	222	7.4
LaJunta	127	40.0	22	43.0 (est.)	131	5.0
Rocky Ford	79	16.4	21	23.3	54	1.7
Prowers	181	51.9	43	49.6	165	7.8
Lamar	141	47.2	31	37.0 (est.)	128	7.3
Total	935	261.7	241	469.0	829	35.4
Colorado	25675	9825	5457	15618	30112	2481

Sources: U.S. Bureau of the Census, Geographic Area Series, Colorado--1977
Census of Retail Trade, 1977 Census of Service Industries, and 1977
Census of Wholesale Trade.

Table 5

Value of Sales and Services per Capita, Colorado, Denver
and Selected Counties and Regions--1977

<u>Place</u>	<u>Population, Thousands</u>	<u>Sales & Receipts--Retail, Wholesale, Services</u>		
		<u>Total, \$ Millions</u>	<u>Per Capita \$ Thousands</u>	<u>Percentage of State</u>
High Plains Counties--irrigated				
Baca	5.7	44.8	7.9	0.2
Kit Carson	7.8	127.9	16.4	0.5
Phillips	4.4	49.5	11.3	0.2
Washington	5.5	31.8	5.8	0.1
Yuma	<u>9.5</u>	<u>87.4</u>	<u>9.2</u>	<u>0.3</u>
Total	32.9	341.4	10.4	1.2
High Plains Counties - unirrigated				
Cheyenne	2.1	13.0	6.2	
Kiowa	1.9	11.5	6.1	
Lincoln	<u>4.8</u>	<u>38.5</u>	<u>8.0</u>	
Total	8.8	63.0	7.0	0.2
South Platte & Arkansas Valley Counties (most populated only)				
Logan (S. Pl.)	19.8	245.1	12.4	0.9
Morgan (S. Pl.)	21.6	271.2	12.6	1.0
Otero (Ark.)	23.9	140.5	5.9	0.5
Prowers (Ark.)	<u>13.8</u>	<u>109.3</u>	<u>7.9</u>	<u>0.4</u>
Total	79.1	766.1	9.7	2.7
Colorado	2626.0	27924.0	10.6	100.0
Denver	475.1	11648.0	24.5	41.7
Colo. (except Denver)	2151.0	16276.0	7.6	58.3

Compiled from Colorado population estimates for 1977 (State Demographer's Office) and data in Table 4.

the lower ratios for Baca, Washington, Cheyenne, Kiowa and Lincoln Counties reflects their simpler and less-developed economies, lower multipliers, and greater use of goods and services from outside the county.

INTERREGIONAL RELATIONSHIPS

The Colorado High Plains may usefully be considered as a part of the larger six-state High Plains Region mainly because of agricultural similarities and because the entire region markets its grain and livestock products through similar channels (Figure 1). However, the Colorado High Plains Region shares many characteristics with the rest of eastern Colorado, and its proximity to Denver and the Colorado Metropolitan Area^{*} gives all of eastern Colorado a unique association with this heavily-populated part of the state.

The regional structure of eastern Colorado, including the High Plains may be usefully defined according to several criteria. These include the markets where its products are sold, its sources of goods and services, its social connections, and its economic alternatives. For this study these connections are important to explain the effects of changes in the level of economic activity or population location in the region. The locations of possible economic alternatives are especially important in considering the possibility of migration within the region or out of it as an adaptation to change in the resource base or other economic conditions. More specifically,

* Throughout this report the term "Colorado Metropolitan Area" is used to refer to the most densely-populated part of the state which may be roughly defined as a strip about 40 miles from west to east extending for 190 miles from Fort Collins south to Pueblo. This area is sometimes referred to somewhat erroneously as the "Front Range Urban Corridor".

if changes in water supplies, production costs, or markets cause a population decline in the High Plains counties, what are the possibilities of maintaining economic opportunities, employment, and community services within the larger region of eastern Colorado?

Most of the wheat grown in Colorado is shipped to markets and terminals throughout the United States. Only 20 percent of the corn produced in Colorado was so distributed, however. (4) Corn--at present the highest-value crop of the Colorado High Plains--is mainly used at feedlots in eastern Colorado, and is moved mainly by truck over short distances. Grain-fed cattle are shipped to Denver and to packing plants in Kansas or Nebraska. Thus, the market for High Plains cattle and feed grains includes the Colorado Metropolitan Area. Some of these commodities go directly to the metropolitan area, and some move through feedlots and packing plants elsewhere in eastern Colorado. As the Colorado Metropolitan Area is growing in population, this market is increasing in importance for all of eastern Colorado, expanding the economic potential of the entire region.

With the growth of the Colorado Metropolitan Area, the market for other agricultural products may also be expected to expand. Increasing transportation costs for meat, milk, vegetables and fruits are likely to further increase the potential demand for these products from eastern Colorado. The South Platte and Arkansas valleys have a proven capability to provide part of the food needs of the Colorado Metropolitan Area, having produced food for Denver and other Colorado cities before this market was taken over by lower-cost California producers. With increasing population in the Colorado Metro-

politan Area, increasing production costs in California, and increasing transportation costs, the advantages of food production in the South Platte and Arkansas valleys, and perhaps elsewhere in eastern Colorado, should increase.

Interregional relationships may be described in terms of the supply of goods and services as well as markets for the products of the region. Those goods and services include consumption goods as well as the machinery, equipment, materials, information, and other services needed for agricultural production. Like the marketing network, the supply network of the High Plains is complex and may be considered as a part of the economy of eastern Colorado, and of the Colorado Metropolitan Area. As the area considered increases, of course, the relative importance of the High Plains economy in the total, decreases. Thus, purchases by High Plains residents and producers are almost the entire economic base of High Plains towns, contribute significantly to the economies of the valley towns, are of minor importance in the economy of the Colorado Metropolitan Area, and are insignificant in the national economy.

Durable goods are obtained from a wide area. Some are undoubtedly ordered by mail from major national markets, some are brought in personally from distant sources. Most, however, are purchased in Colorado. Nearly all towns of more than 1,000 people, and several smaller ones, have automobile dealerships, hardware stores, and clothing stores. However, many of the people of the High Plains make frequent trips to the larger valley towns such as Sterling, Fort Morgan, Lamar or La Junta, or to Denver or other Metropolitan Area towns. Here they can find larger selections, and sometimes lower prices, so a substantial proportion of durable goods purchases are made

outside the High Plains region. As food is bought more frequently than durable goods, a larger proportion is obtained from the High Plains towns. Nearly all of the towns of more than 700 people, and some smaller towns, have grocery stores, but many of these stores have limited selections. For people living in remote areas or small towns, weekly, biweekly, or monthly trips to a larger town to obtain a large part of the food supply are common. For most High Plains residents these sources are Limon, Sterling, Fort Morgan, Lamar and La Junta, as well as the larger towns of the High Plains--Burlington, Yuma, Wray and Holyoke, and perhaps the larger Kansas towns.

Services are also obtained from a wide area. People in rural areas generally show more ability to provide their own services or do without them than urban residents, but certain services--mechanical, construction, financial and medical, for example--are usually purchased. The existence of automobile dealerships in High Plains towns is probably supported more by service functions than by sales, although sometimes the service function enhances local sales. Most towns of more than 1,000 people and some of the smaller ones have banks and insurance firms. Medical services are limited in the region. Although there are nine hospitals in Colorado High Plains towns, the number of physicians, dentists, nurses and technicians is limited, so medical and dental services are often obtained in the valley towns, in Denver, or in other cities of the Metropolitan Area.

Production goods are also obtained through a widespread network. Farm machinery and equipment are available in most of the larger towns, together with necessary maintenance and repair services. Complete center-pivot irrigation systems are provided mainly by dealers in Yuma in the High Plains, Lamar in the Arkansas Valley and Sterling in the South Platte valley. Seed,

fertilizers, pesticides and other supplies, on the other hand, are mainly obtained from local dealers who often also operate elevators for grain shipment.

Agricultural services include--in addition to supply and marketing--information, insurance, finance, maintenance of and repairs to equipment, and installation of storage structures and irrigation systems. All these services are available in the larger towns in the region. Some of them, however, originate in the Colorado Metropolitan Area. (For example, some major equipment distributors and providers of financial services are based there.) Information and research services are provided by the Cooperative Extension Service and Department of Agriculture through a network consisting of regional offices at Denver and Fort Collins with field offices in the county seats in the High Plains.

Social as well as economic connections are part of the regional structure. More than 15 percent of the residents of the High Plains moved from outside their counties of residence between 1965 and 1970 (Table 6). The stable or declining population of the region has generally been the result of a high rate of emigration at the same time new residents were coming into the region. This has undoubtedly extended social connections--at least with relatives--widely throughout the region, Colorado, and the United States. Maintenance of families within close proximity has frequently been expressed as a goal in maintaining economic opportunities in eastern Colorado. The extent to which decisions to leave the region are based on economic opportunities is unknown, but such opportunities undoubtedly influence decisions to remain in the region.

Table 6

Mobility of Population - 1970

	<u>Population -Total</u>	<u>Born in Colorado</u>	<u>Residence in 1965</u>			
			<u>Different House</u>	<u>Different County</u>	<u>Different State</u>	
Baca	5564	2641	1955	740	13%	471
Cheyenne	2508	1267	676	337	13%	201
Kiowa	2012	1025	816	382	19%	223
Kit Carson	7547	3921	2517	1292	17%	666
Lincoln	4836	2592	1592	787	16%	307
Phillips	4131	2092	1287	751	18%	283
Washington	5550	3131	1416	617	11%	267
Yuma	<u>8544</u>	<u>5125</u>	<u>2969</u>	<u>1409</u>	17%	<u>450</u>
	40692	21794		6315	15.5%	

Source: Census of Population, 1970, Part 7-Colorado, Vol. 1, Characteristics of Population, Table 119, Social Characteristics for Counties.

POPULATION AND EMPLOYMENT

As in most of eastern Colorado, population in the High Plains region is closely related to economic conditions. These have generally been closely related to the agricultural economy, and have responded to climatic cycles, agricultural mechanization, and irrigation. The people of the High Plains have reacted to economic pressure by moving into or out of the region, or within it. The 1970 Census indicates that about half of the residents of High Plains counties were born in Colorado, and more than 15 percent had moved from another county in the previous five years (Table 6).

The responsiveness of the population to economic opportunities has largely prevented income from declining to extremely low levels (Table 7), but has instead caused a continual decline in population since the 1920's (Table 8, Figure 3). The people of the High Plains have not become immobilized by regional attachments or cultural differentiation that would decisively limit their ability to migrate in response to changing economic conditions, as has happened in parts of the San Luis Valley, for example.

Several High Plains towns--notable Burlington, Holyoke, Wray and Yuma--have developed fairly prosperous internal economies, but their economic diversity is still low compared to urban areas (Table 9), leaving employment and economic activities vulnerable to changes in the primary sector--agriculture. Possibly in the larger valley towns--Fort Morgan, Sterling, Lamar and La Junta--both the primary and other economic sectors may have become diverse enough to reduce their vulnerability to climatic, economic, and technical changes in agriculture.

The age structure of the High Plains population, like that of most of eastern Colorado, reflects the pattern of migration from the area in early

Table 7

Per Capita Annual Income, 1977 (estimated) and Family Income
and Poverty Status, 1969

County	Per Capita Income, 1977 (dollars)	Family Income, 1969 (dollars)		Income less than poverty level, 1969	
		Median	Mean	Number of families	Percent of population
Baca	4874	6728	8677	270	17
Kit Carson	4650	7459	9418	279	14
Phillips	5868	7561	8124	170	15
Washington	5550	6786	7938	210	14
Yuma	4477	6623	7728	326	14
Cheyenne	4085	6800	8017	101	17
Kiowa	4133	6567	7421	84	15
Lincoln	4320	7786	8256	174	14
Logan	5120	8186	9210	528	11
Morgan	4644	7554	8492	730	14
Otero	4252	6849	7746	985	17
Prowers	4294	6755	8124	620	18
Denver	7093	9654	11440	11911	9
State	6118	9555	10875	49850	9
Urban	7000 (est.)	9951	11266	34416	8
Rural	5300 (est.)	8190	9499	15434	13

Sources: Census, Population, Colorado, 1970, Tables 68, 69, 124.
Colorado, State Demographer, Population Estimates, April, 1980

Table 8

Population of High Plains and South Platte
and Arkansas Valley Counties - 1910-1980

<u>County</u>	<u>1910</u>	<u>1920</u>	<u>1930</u>	<u>1940</u>	<u>1950</u>	<u>1960</u>	<u>1970</u>	<u>1980*</u>
Baca	2516	8721	10571	6207	7964	6310	5674	5366
Kit Carson	7483	8915	9725	7512	8600	6957	7530	7564
Phillips	3179	5499	5797	4948	4924	4440	4131	4526
Washington	6002	11208	9591	8336	7520	8625	5550	5301
Yuma	8499	13897	13613	12102	10827	8012	8544	9658
<u>Total</u>	<u>27679</u>	<u>48240</u>	<u>49296</u>	<u>39105</u>	<u>39835</u>	<u>35244</u>	<u>31429</u>	<u>32415</u>
Cheyenne	3687	3746	3723	2964	3453	2789	2396	2137
Kiowa	2899	3755	3786	2793	3003	2425	2029	1867
Lincoln	5917	8273	7850	5882	5909	5310	4836	4679
<u>Total</u>	<u>12503</u>	<u>15774</u>	<u>15359</u>	<u>11639</u>	<u>12365</u>	<u>10524</u>	<u>9261</u>	<u>8683</u>
Logan	9549	18427	19946	18370	17187	20302	18852	19772
Morgan	9577	16124	18284	17214	18074	21192	20105	22313
Otero	20201	22623	24390	23571	25275	24128	23523	22393
Prowers	9520	13845	14762	12304	14836	13296	13258	13038
<u>Total</u>	<u>48847</u>	<u>71019</u>	<u>77382</u>	<u>71459</u>	<u>75372</u>	<u>78918</u>	<u>75738</u>	<u>77516</u>
Bent	5043	9705	9134	9653	8775	7419	6493	5922
Crowley	N. Av.	6383	5934	5398	5222	3978	3086	2961
Sedgwick	3061	4207	5580	5294	5095	4242	3405	3264
<u>Total</u>	<u>8104</u>	<u>20295</u>	<u>20648</u>	<u>20345</u>	<u>19092</u>	<u>15639</u>	<u>12984</u>	<u>12147</u>
<u>15 Counties</u>	<u>97133</u>	<u>155298</u>	<u>162685</u>	<u>142548</u>	<u>146664</u>	<u>140325</u>	<u>129411</u>	<u>130761</u>

*Preliminary Census Data.

Source: Census, Population, Colorado, 1910-1980.

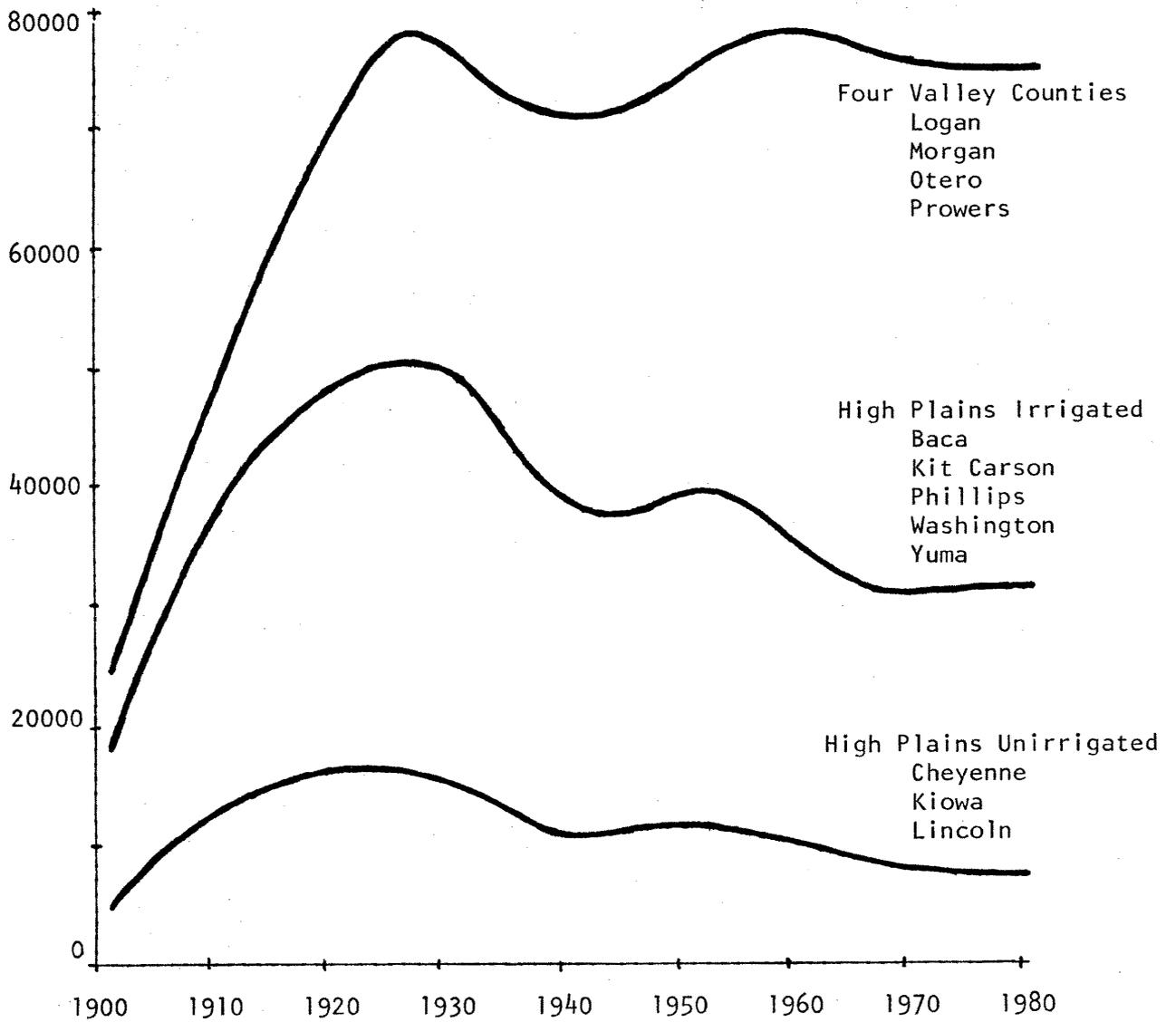


Figure 3

Population Trends in High Plains and Major South Platte and Arkansas Valley Counties 1910-1980

Source: Table 8.

Table 9

Employment in High Plains Counties of
Colorado, 1979, by Sector

<u>Economic Sector</u>	<u>Number of Employees, 1979*</u>							
	<u>Baca</u>	<u>Chey.</u>	<u>Kiowa</u>	<u>K.Car.</u>	<u>Linc.</u>	<u>Phil.</u>	<u>Wash.</u>	<u>Yuma</u>
Agricultural Services	**	**	0	53	**	44	35	53
Mining & Drilling	**	7	**	**	**	0	15	51
Contract Construction	22	8	**	81	13	49	34	179
Manufacturing	14	**	**	71	**	44	14	33
Transport & Utilities	40	58	19	95	58	71	92	118
Wholesale Trade	114	34	24	338	123	119	93	312
Retail Trade	252	75	79	410	381	229	157	548
Finance, Insurance and Real Estate	47	26	**	70	35	46	49	102
Services	82	86	70	399	225	105	113	207
Government	<u>443</u>	<u>218</u>	<u>203</u>	<u>585</u>	<u>433</u>	<u>345</u>	<u>369</u>	<u>587</u>
TOTALS	1014	512	395	2102	1268	1052	971	2190

*Annual mean.

**Not available--confidential.

Source: Colorado Division of Employment (unpublished).

Table 10

Agricultural and Non-Agricultural Employment and Unemployment
Monthly Average, January-December, 1979

County	Employment			Percent Agric.	Unemployment	
	Total	Agricul- tural*	Other		Number	Percent of labor force
High Plains, Irrigated						
Baca	2416	686	1730	28	21	0.9
Kit Carson	3716	955	2761	26	78	2.1
Phillips	1922	523	1399	27	28	1.4
Washington	2258	868	1390	38	38	1.7
Yuma	4361	1180	3181	27	57	1.3
High Plains, Unirrigated						
Cheyenne	1017	347	670	34	14	1.4
Kiowa	796	313	483	39	13	1.6
Lincoln	2470	435	2035	18	45	1.8
South Platte Valley						
Logan	9234	1105	8129	12	245	2.6
Morgan	10571	1724	8847	16	375	3.4
Arkansas Valley						
Otero	10057	720	9337	7	454	4.3
Prowers	6557	932	5625	14	216	3.2

*Agricultural employment includes farm operators and farm workers.

Source: Colorado Division of Employment, County Labor Force Estimates, 1980.

adulthood to seek economic opportunities elsewhere. In some cases, this is later followed by a return to take over the family farm and sometimes eventual retirement in the region. In other cases, the return is later and only for retirement. The result is a larger proportion of older people in eastern Colorado than in the entire state. For the state, 8.5 percent of the population is older than 64 years, while for the High Plains the percentage over 64 ranges from nine percent in Cheyenne and Kiowa Counties to 19 percent in Phillips County. The range is as follows:

Phillips	19%	Washington	15%	Prowers	12%
Yuma	18%	Baca	14%	Logan	11%
Lincoln	17%	Kit Carson	13%	Cheyenne	9%
Otero	17%	Morgan	13%	Lincoln	9%

(Source: 1980 Census, Population, Colorado, Preliminary.)

Phillips and Yuma Counties in the High Plains, and the larger valley towns, contain fairly extensive complexes of retirement homes and services for elderly people. Whether this is the reason for, or the result of, the large proportion of people over 64 years of age in these counties is unclear. By contrast, Kit Carson County has a relatively low proportion of elderly people even though it contains Burlington, the largest town in the Colorado High Plains.

As would be expected, employment in the region is predominantly in agriculture. In addition, much of the employment in other sectors is actually in agricultural support services. While mechanization has reduced the number of workers directly employed in farm operations, it has increased the number employed in machinery and equipment sales and services.

The increase in agricultural service workers has not been as large as the decrease in the number of farm workers, but total payments may be close,

as most agricultural service workers are paid more than farm workers. Agricultural services include sales of, and services to, machinery and irrigation equipment, including trucks and other vehicles, fertilizer, pesticide, and herbicide sales and application services, transportation, construction, finance, and information services. Some of the latter services, especially research and information, are mainly included as "government" in employment data.

Population Changes 1970-1980

Population changes in the High Plains area between 1970 and 1980 have been closely related to the development of irrigated agriculture. Generally, the areas with irrigation have gained population while those without irrigation, or with very little, have lost population (Table 8).

Specifically, population remained unchanged in Kit Carson County and increased by 400 people in Phillips County, and by 1,100 people in Yuma County, where the irrigated land area is still being expanded. The exception is Baca County, where the population has declined continuously since 1950, and continues to decline as ground water availability and energy costs become increasingly unfavorable.

Populations continue to decline in the High Plains counties having little or no irrigated land--Cheyenne, Kiowa and Lincoln--but the rate of decline is only about half the 1960-70 rate. Apparently the populations of these counties are closely approaching a balance with their agricultural capabilities. The population declines in these counties from 1970 to 1980 were mainly outside the larger towns, and these towns have shown little population change since 1970.

In general, then, the population of the Colorado High Plains has been fairly stable, with slight increases in areas of intensive irrigated agriculture and slight decreases in areas with unirrigated wheat and ranching economies. Exceptions have been Yuma County, where population has grown strongly in response to the expansion of the irrigated area, and Baca County, where population has continued to decline in response to difficult agricultural conditions.

In the South Platte Valley the populations of Logan and Morgan Counties, have continued to increase from 1970 to 1980. During this period the population of Logan County increased by nearly 1,000, while that of Morgan County increased by 2,200. These increases seem to reflect the attractiveness of the larger towns in these counties--Sterling, Brush and Fort Morgan--and their ability to sustain moderate internal economic growth.

However, in the Arkansas Valley populations of counties containing towns of similar size and characteristics have not grown, but have declined slightly. Apparently, these areas have not been as highly regarded as the South Platte Valley for residential and business locations.

SETTLEMENT PATTERNS

The distribution of population, towns, and smaller settlements varies greatly throughout eastern Colorado. In the High Plains, the most obvious difference is between areas having extensive irrigated agricultural development and areas of unirrigated agriculture and ranching (Tables 11, 12, 12, Figure 4). Between the High Plains and the South Platte and Arkansas valleys the difference is even greater. The main population concentrations of eastern Colorado are in these valleys, and include the areas around Brush and Fort

TABLE 11

Settlement Patterns
High Plains Counties, Colorado, 1980

Place and Population				
<u>County</u>	<u>Main Town(s)</u>	<u>Other Incorporated Places</u>		<u>Unincorp. (pop.)</u>
		<u>>500 pop.</u>	<u><500 pop.</u>	
Baca 5366	Springfield 1656	Walsh 866	Campo 185 Vilas 118 Pritchett 187 Two Buttes 84	2270 (42%) (7 settlements)
Phillips 4526	Holyoke 2098	Haxtun 1008	Paoli 81	1341 (29%) (4 settlements)
Kit Carson 7564	Burlington 3116	Flagler 545 Stratton 704	Bethune 145 Seibert 178 Vona 94	2782 (37%) (6 settlements)
Washington 5301	Akron 1702	Otis 534		3065 (58%) (4 settlements)
Yuma 9658	Yuma 2820 Wray 2131		Eckley 262	4464 (46%) (6 settlements)
Cheyenne 2137	Cheyenne Wells 938		Kit Carson 277	922 (43%) (3 settlements)
Kiowa 1867	Eads 810		Haswell 127 Sheridan L. 87	843 (45%) (4 settlements)
Lincoln 4679	Limon 1804	Hugo 787	Arriba 238 Genoa 166	1684 (36%) (4 settlements)

Source: 1980 Census of Population and Housing, Colorado
(Preliminary Report) January, 1981.

TABLE 12

Settlement Patterns, South Platte and
Arkansas Valley Counties, Colorado, 1980

County	Main Town(s)	Other Incorporated Places		Unincorp. (pop.)
		>500 pop.	<500 pop.	
Bent 5922	Las Animas 2818			3104 (52%) (4 settlements)
Crowley 2961	Ordway 1129		Crowley 192 Olney Spgs. 253 Sugar City 302	1085 (37%) (no settlements)
Logan 19772	Sterling 11364		Crook 179 Fleming 392 Iliff 218 Merino 252 Peetz 219	6998 (35%) (2 settlements)
Morgan 22313	Fort Morgan 8759 Brush 4074		Hillrose 213	8031 (36%) (3 settlements)
Otero 22393	La Junta 8297 Rocky Ford 4717	Fowler 1217	Cheraw 233 Manzanola 459 Swink 669	6801 (30%) (2 settlements)
Prowers 13038	Lamar 7699	Granada 553 Holly 959	Hartman 127 Wiley 430	3270 (25%) (4 settlements)
Sedgwick 3264	Julesburg 1524		Ovid 439 Sedgwick 258	1043 (31%) (no settlements)

Source: 1980 Census of Population and Housing, Colorado
(Preliminary Report), January, 1981.

Table 13

Population Distribution by Settlement Size,
Eastern Colorado, 1980

	<u>High Plains Counties</u>		<u>Valley Counties</u> ³	<u>Totals, 15 Counties</u>
	<u>Irrigated</u> ¹	<u>Unirrigated</u> ²		
Total Population	32,415	8,683	89,663	130,761
Percent in:				
- unincorporated areas	44	19	34	36
- incorporated places	56	81	66	64
- of 5000-12,000	0	0	40	28
2500-5000	18	0	13	13
1500-2500	23	21	2	8
500-1500	11	50	6	10
< 500 people	4	10	5	5

1) Baca, Phillips, Kit Carson, Washington & Yuma

2) Cheyenne, Kiowa & Lincoln

3) Bent, Crowley, Logan, Morgan, Otero, Prowers, Sedgwick

Source: Tables 11 & 12

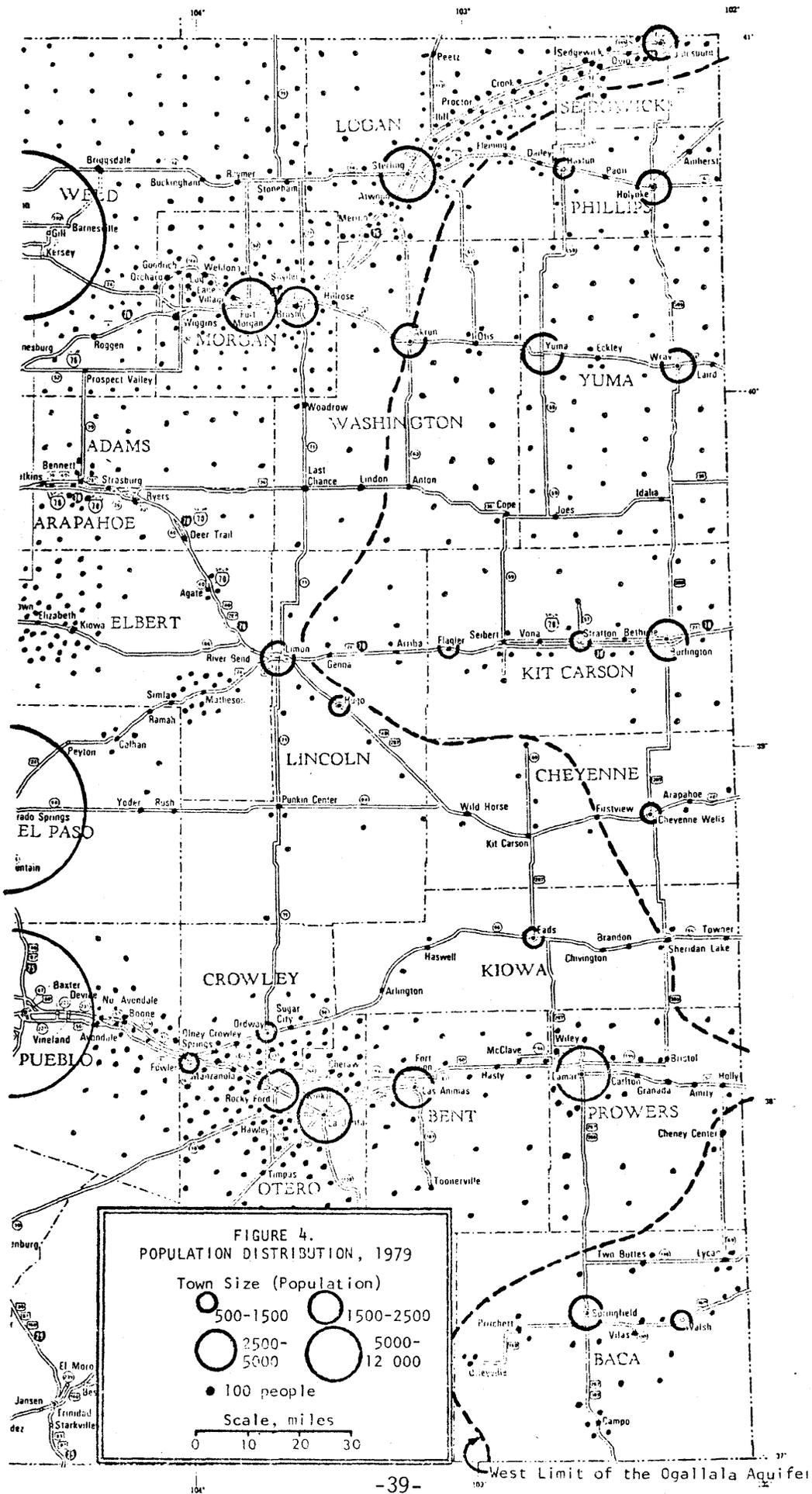


FIGURE 4.
POPULATION DISTRIBUTION, 1979

Town Size (Population)

○ (smallest)	○ (medium)
○ (medium)	○ (large)
○ (large)	○ (largest)

● 100 people

Scale, miles

0 10 20 30

Morgan, Sterling, Lamar, and Rocky Ford and La Junta. The approximate populations of these are as follows:

Brush-Fort Morgan: 20,000	La Junta-Rocky Ford: 23,000
Sterling: 20,000	Lamar: 12,000

In the High Plains, Burlington is the largest town. It is also the town that is farthest from any larger town, and is thus the major service center of the region. The smaller settlements to the west of Burlington essentially function as its satellites, providing residential locations and a few services, such as fuel and fertilizer sales and grain storage and shipment services. The second most important service center is Yuma, followed by Wray, Holyoke, Springfield and Akron. Several smaller towns--Haxtun, Walsh, Hugo, Eads and Cheyenne Wells provide more limited services. Burlington, however, is the only High Plains town large enough to include any significant number of people from smaller towns in its service area. Altogether, Burlington's service area includes about 7,000 to 8,000 people--most of the residents of Kit Carson County plus some of Cheyenne and Yuma Counties.

Three of the four population centers of the South Platte and Arkansas Valleys, therefore, each contain about three times as many people as the Burlington area--the largest population center in the High Plains. Thus, although the larger High Plains towns are quite well-developed for their size, the larger valley towns remain the most important service centers in eastern Colorado, and have the greatest potential for further development.

COMMUNITY CONDITIONS

Settlements in the Colorado High Plains range from crossroads to small towns. Most originated as shipment points and minimal service centers on east-west railroads or as rural post offices with a general store. Some of

the smaller settlements along the railroads have survived as elevators, very limited service centers, and residential locations of a few farm families and others. With the institution of rural mail delivery and faster transportation, most of the minimal settlements away from the railroads have disappeared or survive only as several houses occupied by farm families.

The small settlements--of less than 500 people, usually--still provide minimal services, usually limited to an elevator and a service station. These offer local services to farmers and to the highway trade, such as automotive and farm machinery service and repair, motor fuel, and some agricultural supplies.

The larger towns--Akron, Holyoke, Springfield, Wray, Yuma, Burlington, and Limon--generally offer most of the necessary agricultural supplies and services, basic medical services, food, agricultural extension and information services, financial and insurance services, and contain larger elementary and high schools. They all have at least one hardware store and one to several farm machinery dealers and automobile dealers. Burlington--with more than 3,000 people, the largest town in the Colorado High Plains, and one of the most prosperous--has four physicians, two dentists, two optometrists, five financial institutions, a 50-bed hospital, and a local newspaper. Yuma has nearly as complete services, but its hospital is smaller and physicians have shown little inclination to stay in the town. Although Yuma is as nearly as large as Burlington, it is closer to two other towns--Akron and Wray--both of which are within 30 miles.

Infrastructure and Public Investment

Public investment in High Plains towns includes the usual water and sewer systems, streets, hospitals, schools, libraries, and a variety of

other services. Infrastructure in the region is generally adequate and in reasonably good condition. Streets appear adequately maintained. Water and sewer systems generally seem to receive--or need--little attention. The Water Quality Management Plans for Planning Regions 1, 5, and 6 reveal few significant problems in the sewer systems of any of the High Plains towns. (5) Although some of these systems are old, many have required little attention and have given little trouble. Occasionally, major water or sewer system replacements or improvements have been required, but their costs have generally been less than \$500,000. (6) However, most of the systems were installed in the 1930's, and may reach critical levels of deterioration at any time.

Declining ground water sources have created problems for some towns. New wells are expected to be necessary at Holyoke, and Springfield has recently acquired new wells for its municipal water supply. Springfield also recently replaced its entire water system. Occasional additional replacements or improvements will probably be needed in the future, but the time they may be needed seems unpredictable. However, the only real problem associated with such investments seems to be financing from limited budgets, and most replacements and major investments have, to date, been financed mainly through state and federal aid.

Total Investment

The assessed valuation of the five irrigated High Plains counties in 1979 was \$264 million, or 1.7 percent of the total state valuation. The assessed valuation of the South Platte and Arkansas valley counties was \$362 million, or 2.3 percent of the state total (Table 14). (Assessed valuation is intended to be 30 percent of actual market value.) These figures show

fairly large absolute investment in the region, but this is a small part of the total valuation of the state.

Electric Cooperative Investment

One investment in the irrigated High Plains counties that has been of special concern is the cooperative investment in electric power generation and transmission plant and equipment. This investment is especially large in Yuma, Kit Carson and Phillips Counties. Its average value per farm in these counties is \$43,000, \$38,000, and \$35,000 respectively (Table 15). However, much of the investment is in services to towns and for purposes other than agriculture, so the actual assessment of responsibility for cooperative debts to farms is probably only about half of these levels. These are rough estimates based on the approximate relationship between assessed valuation and market value. They do, however, show a substantial investment in electric installations, in total and per farm.

TABLE 14

Total State Valuation*, by County, Eastern Colorado
1979

Millions of Dollars

High Plains Counties - Irrigated

Baca	38.9
Kit Carson	54.3
Phillips	28.3
Washington	67.7
Yuma	<u>74.6</u>
Total	263.8 (1.7% of state)

Valley Counties

Bent	27.4
Crowley	12.2
Logan	107.7
Morgan	121.3
Otero	74.2
Sedgwick	19.3
Weld	<u>757.7</u>
Total	1119.8 (7.1% of state)

High Plains Counties - Unirrigated

Cheyenne	25.5
Kiowa	20.3
Lincoln	<u>31.2</u>
Total	77.1 (0.5% of state)

State Total: \$15,745 million

Source: Colorado Division of Property Taxation, Ninth Annual Report,
1979, p. 110.

*State valuation includes all land, buildings and improvements, and is intended to be 30 percent of market value.

TABLE 15

Assessed Valuation, Estimated Value, and
Value per Farm of Rural Electric Cooperatives, 1979

<u>County</u>	<u>Assessed Valuation</u> (Millions of dollars)	<u>Estimated Value*</u> (Millions of dollars)	<u>Number of Farms</u>	<u>Average Value per Farm</u>
Baca	1.9	6.5	710	\$ 9 100
Kit Carson	9.2	30.5	804	38 000
Phillips	3.4	11.5	429	25 800
Washington	2.3	7.8	864	9 100
Yuma	12.8	42.5	967	43 000
Cheyenne	0.8	2.7	346	7 900
Kiowa	0.9	2.9	363	8 000
Lincoln	1.7	5.8	420	13 900

Sources: (assessed valuation) Colorado Division of Property Taxation, Ninth Annual Report, 1979, pp. 30-32.

(number of farms) Census of Agriculture, 1974, Colorado County Summary Data, Table 4, p. 11-5.

*Estimated by multiplying by 3.33 to convert assessed valuation to an approximation of market value.

CHAPTER THREE

REGIONAL PROBLEMS

The socio-economic concerns that have most often been expressed in connection with the High Plains are related to its extensive rural nature. Essentially, these are problems of maintaining adequate services for a widely scattered population. Many of the conditions are perceived as problems only by comparison with urban areas, and often by urban people. Problems exist in urban as well as rural areas, but may be manifested in different ways. This perspective should be maintained in considering the problems of the High Plains.

Many of the concerns of urban as well as rural areas are the problems of extremes. In urban areas many problems are caused by dense population. In rural areas some inconveniences are caused by the widely scattered distribution of population. This probably accounts for recent indications that many people prefer to live in or near small cities. However, to some extent, people also seem to be fairly successful in choosing their environments. Thus, most of the rural people contacted in this study, including High Plains and other eastern Colorado residents, report being quite satisfied with their present environments. Many said they would consider living in a city or metropolitan area less desirable. Nevertheless, rural areas, including the High Plains, do have some specific problems.

Comparisons of services or income levels between rural and urban areas are of limited relevance. Conditions, needs and preferences are different, and this diversity of lifestyle alternatives is one of the most important

reasons for maintaining rural communities. However, certain basic needs must be met in one way or another. Failure to meet them efficiently increases economic stress which can cause shifts of population from rural areas to cities or metropolitan areas. In regions where population density is already low, the result could be a collapse of the local socio-economic structure. As population declines, the level of services that can be provided locally also declines, and the distance that must be travelled to obtain services increases. Several of the smaller towns appear to have already become marginal, and are in a state of decline. These towns are in the un-irrigated areas of the High Plains, where population densities on wheat farms and ranches averaging 2,500 to 3,800 acres are inadequate to support local services. Furthermore, some of the residents of these large, scattered farms and ranches in Washington, Cheyenne, Lincoln, and Kiowa Counties are close enough to Fort Morgan, La Junta, or Lamar to obtain their services in these larger towns, rather than in smaller local towns. Finally, extensive wheat farms and ranches require less machinery, fertilizer, herbicide, and agricultural services per family, per unit of production, and per unit of area, than the more intensive irrigated agriculture.

The situation is quite different in the irrigated High Plains areas. Here the local towns are large enough to serve the more intensive agricultural economy, and in turn are supported by it. Goods and services are frequently needed, and are largely obtained locally because that is where they are most conveniently available. Farms are smaller in the irrigated areas, averaging 1,100 to 1,700 acres, supporting more people within the service areas of local towns. In response to the increasing intensity of agriculture, populations and services in the larger towns of the irrigated areas have expanded, generating self-reinforcing social and economic attractions. Meanwhile, the smaller

settlements in the irrigated area have lost most of their regional service center functions, and have become outlying residential centers with generally stable populations.

The towns of the irrigated areas, however, have grown with their agricultural economic base, and during the last decade have maintained or increased their populations. Their stability is based on their functions as service centers for an intensive agricultural economy which is stable or still expanding.

A major concern in the High Plains is the maintenance of populations, social structures, and services in the presence of possible economic stresses that may result from expected changes in the agricultural economic base. If the economic base should change, with resulting changes in income or population levels or distribution, how would this affect the population and services in the towns of the region? To answer this question, it is necessary to identify existing weaknesses, deficiencies, and inefficiencies in the economic and spatial organization of the region and its towns. These towns already have some difficulties in maintaining adequate levels of services. Inefficiencies that are tolerable in a growing, affluent, economy could become serious and threaten the quality or existence of High Plains communities under conditions of increased economic stress.

The deficiencies, weaknesses and inefficiencies that have been frequently identified in rural areas in general, and in the High Plains in particular, are in education, medical services, consumer services, transportation and housing. Water and sewer systems also sometimes become problems, but no more so than elsewhere. These concerns are discussed in turn as follows:

EDUCATION

The fifteen counties of eastern Colorado contain 58 school districts, with enrollments from fewer than 100 to over 3,000. The eight High Plains counties contain 31 of these school districts, with enrollments ranging from fewer than 100 to over 1,000 (Table 16). Only the six largest school districts in the High Plains counties have more than 500 pupils, and many have fewer than 200 (Table 17).

The combination of the small number of families and pupils in some school districts, together with their remoteness and large areas, creates several problems. Some districts have difficulty obtaining enough qualified teachers to offer an adequate range of instruction. Expenses per pupil are inordinately high because of the lack of economies of scale in plant and operation. The cost of transporting pupils over the long distances from their homes to schools is especially high. Finally, severe winter weather conditions often make travel hazardous, creating anxiety about the distance children must travel on their return from school.

A 1969 analysis found that total education costs per pupil were much higher in several High Plains counties than in other rural counties. The extreme was in Kiowa County, where education costs were \$872 per pupil, of which \$105 was transportation cost. Costs for Weld, Morgan and Logan Counties are given for comparison (Table 16). The scattered distribution of schools has some advantages, which is why it persists in spite of its high cost. The advantages are that it facilitates communication between parrents, children and school staff, it provides focal points for social activities in the smaller communities, and it minimizes commuting distances for school children. It also supports local business in marginal settlements.

TABLE 16

Number of School Districts, 1979, and
Expenditures per pupil, 1966-67, High Plains
Counties and Three Valley Counties

<u>County</u>	<u>Number of School Districts, 1979</u>	<u>Expenditures per pupil, 1966-67</u>		
		<u>Total</u>	<u>Transpor- tation</u>	<u>Total, less Transpntn.</u>
Baca	5	659	86	573
Cheyenne	3	854	124	730
Kiowa	2	872	105	767
Kit Carson	7	688	86	602
Lincoln	5	665	62	603
Phillips	2	694	64	630
Washington	5	824	112	712
Yuma	<u>2</u>	795	98	697
Total	31			
Logan	4	638	31	606
Morgan	4	623	35	588
Weld	12	593	27	566

Sources: Neill, Dwight, Colorado Preliminary State Development Plan, Four Corners Regional Commission, 1969. Table 4-7, following p. 33.

Colorado Department of Education, Pupil Membership and Related Information, Fall, 1979, Statistical Series No. 80-2, March, 1980, p. 25.

TABLE 17

Enrollment in the Larger School Districts,
High Plains and Valley Towns, 1978-79

<u>High Plains Towns</u>		<u>Valley Towns</u>	
Yuma	1116	Sterling	3398
Burlington	1016	Fort Morgan	2711
Wray	863	La Junta	2509
Holyoke	595	Lamar	2085
Springfield	511	Rocky Ford	1524
Akron	500		
Limon	487		
Haxtun	348		

Source: Colorado Department of Education, Pupil Membership and Related Information, Fall, 1979

Statistical Series No. 80-2, March, 1980, p. 25.

Consolidation of school districts has occurred to some extent, although several very small school districts remain. The schools in the larger High Plains towns have enrollments of 500 to more than 1,000 pupils and some smaller towns have quite adequate schools, but the smallest school districts would appear likely to be improved by further consolidation. With consolidation of districts, elementary schools could, in some cases, remain at the smaller centers, while consolidated high schools could provide for the necessary diversity and specialization of teachers and classes. Location at the larger towns could also enhance the possibility of obtaining qualified teachers, as many teachers prefer to live in larger population centers near other teachers and professional people.

MEDICAL SERVICES

Certain characteristics of the High Plains region are important in considering its medical service needs. One of these is the number of elderly people who have retired in the region. Another is the agricultural economy. A third is the long distance between the larger towns and the rural population. Elderly people generally require medical services more frequently than younger people. Agriculture is one of the most hazardous occupations, with a high rate of serious accidents. The distance between the larger towns increases the time required to provide emergency medical services.

Medical services include several elements--hospitals, clinics, equipment, physicians, technicians and other specialists, nurses, and emergency medical services. All these are organized in various ways to provide some level of medical services to any particular area.

Hospitals

Each of the nine towns of more than 900 people in the High Plains region of Colorado has a hospital. Their capacities range from 17 beds at Haxtun to

41 beds at Burlington. Throughout the 15 counties of eastern Colorado, 18 towns have hospitals and one other has a clinic. This distribution of hospitals is considered by the Governor's Rural Health Advisor to be adequate, but not excessive. The problems in medical services in eastern Colorado are in the services of physicians, technicians, registered nurses, and in emergency medical services.

Medical Practitioners and Services

Several towns seem to have a fairly adequate number of physicians, although the ratio of physicians to population is much lower than the state average. Burlington, for example, has four physicians, two dentists, and two optometrists--but not enough nurses. In Wray and Yuma the ratio of physicians to population is lower--even though these towns contain larger proportions of retired people--and most physicians do not remain more than a few year.

The problem of maintaining physicians in rural communities appears to be largely one of isolation. Apparently, many physicians, especially specialists, consider almost daily contact with colleagues necessary to maintain their hard-won skills. This appears to be because medical technique evolves rapidly, and any physician who is isolated from centers of medical practice feels a risk of becoming obsolete in a few years. Several solutions to the problem of physicians' services in eastern Colorado (and other non-metropolitan areas) have been suggested or tried. Electronic communications to computer information systems have been suggested. These should become increasingly feasible with the continued development of computers, telecommunications, and medical information systems at major hospitals. Another partial solution

appears to be increased efforts to encourage regular communication between rural physicians and the urban medical establishment. Services to rural areas on a regular schedule have been arranged by some urban physicians, with varying success. Physicians, nurses, and technicians from rural areas undoubtedly attend formal meetings and seminars at urban hospitals and medical schools, but daily work loads may inhibit extended absences from local practice. If there were more medical practitioners in rural areas, the pressures of local practice could be relieved, allowing local practitioners more opportunity for communication with centers of medical progress and training.

Another area of deficiency in medical services in eastern Colorado is in emergency medical services. This mainly includes ambulance service and prompt medical attention for urgent cases. The organization of such services requires coordination of ambulance operations and emergency medical technicians for quick response. Such organization has been achieved in varying degrees, but could stand improvement in many parts of the region. More medical technicians and more participation by local physicians are needed if emergency medical services are to be strengthened.

Medical services in eastern Colorado, especially in its more rural areas, appear to be related to a complex of social, economic and organizational conditions. These services have been most adequately provided in the largest and most prosperous towns in the region, but deficiencies still remain even there. Such limitations are probably to some extent unavoidable in remote rural areas, but the medical establishment and others have identified problems and proposed measures to improve medical services in rural areas. The Governor's Rural Medical Advisor, in particular, has been exploring this complex problem

and possible solutions. The solutions are not directly dependent on population and economic conditions. They generally appear more likely to be effective in the more developed communities of rural eastern Colorado, but appear to be social and organizational as much as economic.

CONSUMER SERVICES

Consumer services include direct services such as automotive and appliance repairs, custom construction, food service in restaurants, and medical, dental, and optometric services, and a variety of other activities. They also include the provision of goods needed for daily life, such as food, clothing, furniture and appliances, and automobiles. Traditionally, such services have been provided more completely in larger towns and cities than in small rural towns. With a greater variety of goods and services available in the larger population centers, a large part of the expenditures of rural residents has been in towns such as Sterling, Fort Morgan, Lamar, and La Junta, or in cities such as Denver or Colorado Springs.

As the agricultural economy of the High Plains has developed, however, an increasing variety of services and goods has become available in the local towns, and in the last decade the cost of travelling has increased. Community awareness and appreciation of the local availability of goods and services may also be increasing as trips to larger centers become more expensive. These trends have strengthened the economies of several High Plains towns--especially Burlington, Wray, and Yuma. Burlington has been the town most affected by these trends, because of its distance from any larger population center, and because of the intensification of its agricultural economy and increasing population. Continuing agricultural development farther north near

Yuma and Wray appears likely to increase the development of these communities and the range of goods and services available there. Agriculture is already well developed in the vicinity of Holyoke and Haxtun, and these towns are closer to Sterling, so there may be less intensification of their consumer goods and services sectors. However, increasing numbers of retired people are living in Haxtun, Holyoke, Yuma, and Wray, and will probably contribute to their economic development.

Development in the consumer goods and services economy appears to be self-sustaining. A developed local service sector makes a town more attractive to teachers, physicians, business people and others, who generate additional demand for goods and services. As the service economy develops, an increasing share of the income generated by the agricultural economic base remains in the community. This, in turn, furthers the development of the service sector.

Possibilities may exist for further development of the local service sector. Studies of several small towns by the Division of Commerce and Development of the Colorado Department of Local Affairs revealed several possibilities for improvement. Their findings suggest that local service economies could be further developed if local merchants were more aware of consumer needs and preferences and if streets and shops were more attractive and better organized. Such improvements were considered likely to attract increased patronage by local residents. They might also attract tourists who would otherwise not stop or would not purchase goods and services, and help the community attract desired professional people, who could in turn add to the income of the community as well as to its range of services.

TRANSPORTATION

The transportation network--both highway and railroad--becomes progressively less dense from the Missouri River west to the Rocky Mountains. In eastern Colorado this net is noticeably less dense than farther east in Kansas and Nebraska, coinciding with the less dense population and settlement pattern, and with the general decrease in precipitation and agricultural productivity. However, except for a few settlements that originated as rural post offices away from the railroads, the settlements of the High Plains and the South Platte and Arkansas Valleys were established along the railroads as they were built across the plains. Thus all the towns and settlements remaining viable as commercial centers are now on transcontinental railroad lines. Shipments from the High Plains consist of wheat, feed grains, and livestock. Most of the wheat--67 percent of Colorado's 1978 shipments--is moved by rail. Some of this goes to Denver, but most of it is sent to markets and export terminals throughout the United States. Also, in 1978, 56 percent of the barley and 89 percent of the sorghums shipped from Colorado went by rail to terminals throughout the nation. (4)

Eastern Colorado, including the High Plains, also has a very adequate system of state and federal highways. The county road network has evolved with agricultural development to provide adequate access to field and farmsteads. Generally, east-west highway connections are better than north-south, consisting of five transcontinental highways, two interstate routes, and State Highway 96. However, north-south connections are also adequate, with three or four state and federal highway connections. The highway system links eastern Colorado quite efficiently with Denver and other cities of the Metropolitan Area, with distances from Denver, for example, of 163 miles to

Burlington and 249 miles to Springfield. The highway network also provides good connections through Nebraska, Kansas, Oklahoma, and Texas to national and international terminals. Large and small trucking companies, many based in eastern Colorado, provide flexible and expeditious service in transporting wheat, corn, livestock and other products to local and national markets.

Truck transport offers advantages to the High Plains economy. Many trucking firms are locally controlled, flexible, and responsive to local needs, while rail service has become less satisfactory. In 1980 the Chicago, Rock Island and Pacific, under critical financial pressures, discontinued service on the line through Burlington to Colorado Springs. Tracks and roadbeds on several lines are in poor condition because of deferred maintenance. Railroad management appears to be planning to discontinue service to small elevators and limit their operations to unit trains from the largest elevators. The Colorado Department of Highways has identified problems in rate structures, which seem to discriminate against Colorado High Plains shippers. This problem results partly from a lack of systematic reporting on origins, destinations, and products, that could be used to substantiate requests for continued service and more favorable freight rates. (4)

In spite of the advantages of truck transport--flexibility, local control, and contributions to the local economy, railroad transport is inherently more efficient in the long run. Railroads are about three times as fuel-efficient as trucks. A ton of freight can be moved about 220 miles per gallon of fuel consumed, compared with 70 miles for trucks. Fuel costs more than doubled between 1976 and 1980 (current dollars) increasing average truck operating costs from 59 cents to 92 cents per mile--a 56 percent increase. (4)

High transportation costs reduce returns to farmers in the region, especially those shipping grains long distances. Prices to farmers are based on prices at major terminal elevators, minus costs of transportation to those elevators, and these costs can be as high as 20 to 30 percent of the price of the product. (4)

Furthermore, the loss of rail service to small elevators would remove the major source of business activity in many of the smaller towns, hastening their demise as economic centers. Also, the increasing use of trucks has increased road damage, especially as frequently overloaded trucks use lightly-built local roads to avoid inspection stations. Increased numbers of trucks to major terminals will increase general traffic congestion, air pollution, and road maintenance costs near these terminals. Increasing truck operations on highways in the region will increase automobile maintenance costs and accident probabilities due to road hazards, and local and state highway maintenance costs. Railroads pay their own maintenance costs. Thus, in the long run, any measures that can be taken to maintain or improve rail service for transporting agricultural products from the region will probably be a net benefit. The benefit will probably increase as the price of motor fuel increases in the future. Such measures could include critical review of rates and proposals for discontinuance of service by the Public Utilities Commission of the state and the Interstate Commerce Commission, or a state-operated railroad system on the Kansas model.

Air transport in eastern Colorado operates from regional airports at Lamar and Sterling, and from about 15 community and private airports that do not offer any scheduled service. The nearest airport with direct connections to most cities in the United States, and some foreign ports, is at Denver. A few direct flights to cities outside Colorado are available from Lamar,

Pueblo, and Colorado Springs. (7) This distribution of airports and air service appears adequate to serve the needs of the region, although moderate increases in industrial activity and population in the South Platte and Arkansas valleys may increase the intensity of service at regional airports.

Personal transportation in the High Plains is predominantly by private automobile. With the diffuse distribution of population employment centers in the region, this is probably the most efficient and satisfactory transportation arrangement. Especially as long as the scattered population requires long distance bus transportation to schools and long distance travel by automobiles, maintenance of good highway conditions is especially important. This is a significant reason to maintain or enhance rail transport for agricultural products, as intensive use by heavy trucks retards traffic movement and seriously damages road surfaces.

Interstate and intercity bus lines provide regular but infrequent (usually once or twice a day) service to some high plains towns, but these appear to be of minor importance in meeting the total transportation needs of the region. However, for the less affluent, the elderly, and some others living in the towns served, they are probably useful. Various forms of common or pooled transportation have been arranged, mainly for elderly people, in some of the larger towns. (8) In general, personal transportation needs appear to be served as adequately as would be economically feasible, although some people, especially the elderly, undoubtedly suffer somewhat from remoteness and inadequate mobility.

HOUSING

The population and income characteristics of eastern Colorado and its High Plains are closely related to housing conditions in these regions. The

population level is stable or declining except in some of the larger towns where it has increased moderately. The average income is below that of the state (especially below the average income in urban areas), many families have incomes below the "poverty level" (Table 7), and many residents are elderly.

Several High Plains towns--notably Wray, Yuma, Holyoke, and Haxtun--have extensive housing complexes for elderly people. Most of these are recently-built, generally well-maintained, well-equipped, and fairly well-insulated. If the number of people retiring in the region continues to increase, more retirement accommodations, especially those with common kitchens and facilities for assistance in personal maintenance, will probably be desirable.

Improvement or replacement of substandard housing and needed expansion of the housing stock in some communities could contribute moderately to the economic activity of several High Plains towns, and to general development in their service sectors.

The absence of population growth has meant a low level of new housing construction than in urban areas, leaving a large proportion of the population in older houses. Many of these houses are well built and have been maintained in good condition or made more comfortable, convenient, and weather-tight. Others, however, were originally of more or less makeshift construction, small and uninsulated, and some have not been maintained adequately.

Housing costs are generally lower than in metropolitan areas, and many residents have long since paid for their houses or have very low payments. Housing condition, however, is a significant problem, and this problem is compounded by the large number of elderly people. Kit Carson County is

probably fairly typical of eastern Colorado in this respect. Here a housing survey by the East Central Colorado Council of Governments in 1976 found that in the towns 34 percent of the houses surveyed were deteriorating and 3.4 percent were dilapidated. Outside the towns, 16 percent of the houses were deteriorating and 15 percent were dilapidated. Altogether 800 houses were in substandard condition, out of 2200 surveyed. (9) However, most "dilapidated" houses have been abandoned, and are not inhabited.

Substandard housing, low incomes, and elderly occupants are closely correlated. This makes the problem of substandard housing especially serious, as the occupants of the least adequate houses are people who are least able to cope with hardships and inconveniences, and are least able to afford improvements, high heating costs, or new houses. The problem has been dealt with, at least partially, by local government with federal assistance through Farmer's Home Administration programs. Many houses remain substandard, however, and Farmer's Home Administration programs appear likely to be discontinued in the near future.

Many of the elderly people, like others in the region, have incomes adequate to rehabilitate or replace their houses, or to move into apartment complexes. Rehabilitation of existing houses and new construction both contribute to the local economy, and reduce local dependency on increasingly expensive oil and gas for heating.

CHAPTER FOUR

EFFECTS OF PROJECTED SCENARIOS

The preceding chapters describe the Colorado High Plains region as it is at present, with particular emphasis on socio-economic and community conditions. This chapter considers the socio-economic and community implications of the projections of the agricultural economy and regional employment by the Colorado study team (10,11). These projections are based on certain assumptions about economic trends and possibilities for measures to improve the agricultural economy of the Ogallala Aquifer area of the Colorado High Plains. Particular attention has been given to alternatives to maintain, or improve the efficiency of, irrigated crop production in the region.

As the regional economy is based mainly on agriculture, agricultural conditions can be expected to strongly affect regional income, employment, and local services, and ultimately the population of the region. This is true of the eleven-county region for which the regional economic analysis (11) was done, as well as for the more restricted High Plains area that lies directly above the Ogallala formation. However, it seems obvious that the more restricted Ogallala Aquifer area would be more strongly affected by any change in its irrigated production than would the larger region, where such changes would be absorbed by a larger and more diverse economy.

One of the main concerns of the Six-State High Plains-Ogallala Aquifer Study has been the effect of changes in the agricultural economy on the communities of the region--both within the Aquifer area and in the larger eleven-county area which contains it. Especially within the Aquifer area--as in

other parts of the High Plains--local communities are small and services have been near the minimum level considered acceptable by many people. Per-capita costs of education, medical services, and some other services have been high, and there has been a general concern about the continued capability of the agricultural economy to provide enough income and employment to maintain local services. Declines in the economic base could cause losses in local employment, population, and services sufficient to bring about a collapse of the present community structure. This has already occurred in some of the unirrigated parts of the Colorado High Plains.

THE BASELINE

The BASELINE projection forecasts a growing agricultural economic base in the Ogallala Aquifer area until the year 2000, and an essentially stable agricultural economy from then through 2020. However, some of the assumptions on which this projection is based may be too optimistic. Specifically, the BASELINE projections are predicated on assumptions that agricultural productivity--crop yields per acre--will continue to increase strongly throughout the next 40 years, although not as much as in the last several decades. Another assumption used in the BASELINE is that real commodity prices--especially the price of corn which is the main irrigated crop--will increase steadily to nearly one-third higher than its present level by 2020.

There are fairly convincing reasons to doubt the validity of these assumptions. Yield increases in the past have been based largely on increasing fertilizer applications. The easy problems have been solved. Fertilizer is generally energy intensive and based on petroleum products, thus may become increasingly expensive. Real feed grain prices have generally declined

for several decades. Some interpretations of demand trends, energy costs, and livestock production alternatives suggest little likelihood of any real increases in feed grain prices in the future. Finally, there is some concern that the costs of fuel and electricity for irrigation and tillage, as well as the cost of fertilizer, may increase more rapidly than assumed in the BASELINE.

Less-favorable assumptions were used by the Colorado study team to develop a PESSIMISTIC BASELINE projection. This projection forecasts severe declines in the agricultural economy of the Ogallala Aquifer area.

ALTERNATE SCENARIOS

The BASELINE projections assumed changes in economic conditions that were presumed to occur without strong public policies or programs to improve agricultural conditions in the Colorado High Plains. The PESSIMISTIC BASELINE projection was essentially a test of the sensitivity of the model to the basic economic assumptions.

The six states participating in the High Plains-Ogallala study were directed to project the results of five sets of assumptions in addition to the BASELINE. These alternate scenarios included assumptions that definitive action would be taken to mitigate the effects of increasing production costs--especially irrigation pumping costs--and declining ground water resources. For Colorado, these alternates have been named and defined as follows:

Scenario 1. EFFICIENCY. The projections of this scenario are based on the assumption that significantly less energy can be used in irrigation, and costs reduced, by increasing the efficiency of irrigation pumping and water distribution. Such improvements would be initiated as irrigation equipment is re-

placed or repaired, with the additional investments being absorbed by savings in pumping costs.

Scenario 2. RESTRICTION. This scenario is created by projecting the results of public action to restrict the use of water, in addition to the improvements assumed in the EFFICIENCY scenario. Such restrictions would presumably be enforced with the intent of stabilizing the regional economy and extending water resources that would otherwise be depleted sooner.

Scenario 3. ENHANCEMENT. This scenario would be created by projecting the results of measures to increase aquifer recharge through infiltration and to increase precipitation through weather modification. However, no projections were made because no information on the results of such measures could be obtained.

Scenario 4. INTRASTATE TRANSFERS. This scenario would be created by projecting the results of transferring water to the High Plains from other river systems in Colorado-- probably the South Platte. Such transfers appear to be physically feasible, but their costs and potentials were not available during the course of the farm level and hydrologic analysis, so no projections were made.

Scenario 5. INTERSTATE TRANSFERS. This scenario is created by projecting the results of transferring water to the Colorado High Plains from outside the state. The source considered was the Missouri River. Preliminary estimates by

the U.S. Army Corps of Engineers indicate that the cost of water made available through such transfers would exceed, by several times, the additional net value that could be generated through the resulting crop production. To examine the results of making additional water available, a projection was made by disregarding cost and assuming that by 2000 enough water could be made available to restore irrigation on all lands where it had been discontinued. It was further assumed that the efficiency improvements of Scenario 1 would be incorporated, to create Scenario 5A. Scenario 5B was generated by assuming the incorporation of these efficiency improvements, plus the restrictions on water use assumed in Scenario 2. These scenarios are described in detail in the Colorado Farm Level Economic Analysis (10).

RESULTS OF SCENARIOS

Projections were made for the sets of assumptions and alternatives designated as the BASELINE and Scenarios 1 and 2--the EFFICIENCY and RESTRICTION scenarios. Projections were also made of the results of providing additional irrigation water as described in Scenario 5. All these projections assumed the same favorable yield increases and commodity price increases as the BASELINE. Finally, a projection was made of the PESSIMISTIC case, which assumed less favorable yield and price increases. The results of the scenarios are shown in Tables 18 and 19 and Figure 5.

The BASELINE projects an agricultural economy in the Ogallala Aquifer area growing by 23 percent in the next decade, 40 percent by 2000, and 45 percent by 2020--all in real terms, or constant dollars. The EFFICIENCY

scenario (Scenario 1) projects even stronger growth following a similar trend--strong growth until 2000 followed by stability through 2020. The RESTRICTION scenario (Scenario 2) shows the dampening effects of water use restraints beyond those imposed by pumping costs, with production levels dropping below those of the BASELINE until 2020. But after 2020, production levels might remain stable longer or increase more under the RESTRICTION scenario than in the BASELINE and EFFICIENCY cases, because of the effect of restrictions in extending groundwater resources.

As expected, the additional water brought into use through the 5A and 5B, INTERSTATE TRANSFER alternatives would increase agricultural production considerably after 2000. From then until 2020 the value of crop production under these alternatives would be about 15 percent above the levels projected for the EFFICIENCY and RESTRICTION scenarios, respectively. The production value in the 5B alternative, however, would be only about three percent above that for the EFFICIENCY case.

The PESSIMISTIC scenario projects a rapid decline in irrigated production, with irrigation being discontinued almost entirely by 1990 and corn production in the region dropping to zero by then. This is because under the PESSIMISTIC assumptions about commodity prices and energy costs, irrigation equipment could not be economically replaced and major maintenance would be deferred indefinitely. By 1990, under this scenario, crop production would be about 38 percent below that in 1979, where it would remain through 2020. This would be below the BASELINE level by 23 percent in 1985, by 46 percent in 1990, and by 55 percent after 2000.

QUALIFICATIONS--LIVESTOCK

The scenarios just described are based entirely upon projected changes in crop production in response to changing production costs, water availability, and commodity prices.

Crop production is the major economic base of the High Plains-Ogallala region, but livestock sales also contribute substantially to the regional economy. In 1979, crop production value in the Aquifer area was \$321 million, while livestock sales were \$193 million (10).

Projections of the livestock economy in the Ogallala Aquifer area were not included in the High Plains Study workplan. This section discusses briefly the importance of the livestock economy in the Colorado portion of the Ogallala region.

Estimates based on Colorado's inter-industry production model of the eleven-county region that includes the High Plains-Ogallala area (11) indicate that about \$60 million worth of feed grains were used in the Ogallala Aquifer area. Thus, crop sales to buyers outside the Ogallala Aquifer area (but not necessarily outside the eleven-county region) were about \$321 million, minus \$60 million, or \$261 million. Adding this to the livestock sales of \$193 million gives a total of \$454 million in 1979, for sales of crops and livestock to buyers outside the aquifer area.

The livestock economy of the Ogallala Aquifer area may be more responsive to national demand for livestock products than to the amount of feed grain produced in the region. This seems to be indicated by the local use of only about \$60 million worth of feed grains, while the remainder--about \$130 million in 1979, was sold outside the Ogallala Aquifer area. The level of feed grain production would then appear to be sufficient to maintain

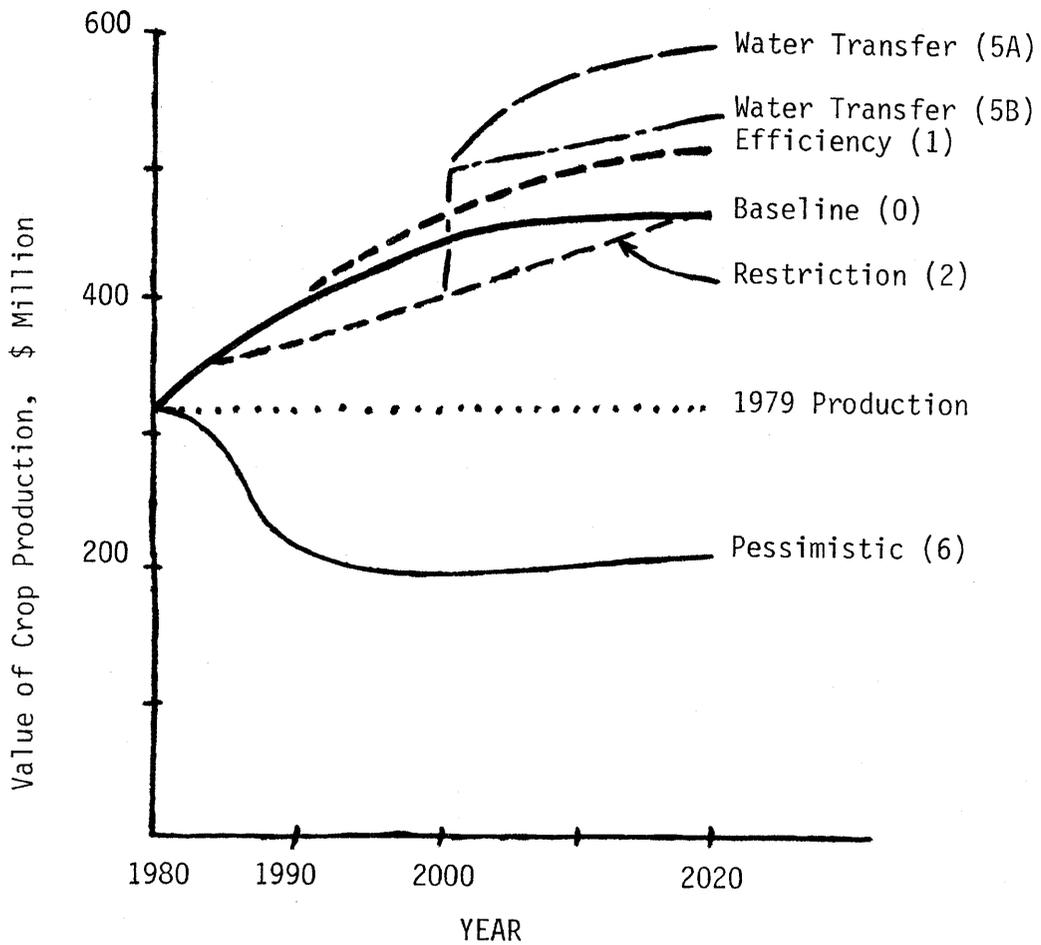


Figure 5. Value of Crop Production Under Different Scenarios, Ogallala Aquifer area.

Table 18. Value of Crop Production Under Different Scenarios.

Millions of Dollars

<u>PROJECTIONS</u>	<u>1979</u>	<u>1985</u>	<u>1990</u>	<u>2000</u>	<u>2020</u>
0. BASELINE Total	321	371	396	450	464
Irrigated Crops	189	223	230	255	208
Non-Irrigated	132	148	166	195	256
1. EFFICIENCY Total			409	466	519
Irrigated Crops			245	272	270
Non-Irrigated			164	194	249
2. RESTRICTION Total		359	371	402	473
Irrigated Crops		211	205	207	228
Non-Irrigated		148	166	195	247
5A. WATER TRANSFER Total				505	595
Irrigated Crops				316	357
Non-Irrigated				189	238
5B. WATER TRANSFER Total				459	533
Irrigated Crops				270	295
Non-Irrigated				189	238
6. PESSIMISTIC Total		286	214	199	205
Irrigated Crops		140	52	19	0
Non-Irrigated		146	162	180	206

Source: Young, R. A. et al. Colorado Farm Level Analysis, Six-State High Plains-Ogallala Aquifer Study, Chapters 5, 6, 7, 10, and 11.

Table 19. Value of Crop Production Under Different Scenarios--Irrigated and Unirrigated Totals, and Percent Changes.

Millions of Dollars

<u>Scenario</u>	<u>1979</u>	<u>1985</u>	<u>1990</u>	<u>2000</u>	<u>2020</u>
0. BASELINE	321	371	396	450	464
Difference from 1979	0	50	75	129	143
Pct. change from 1979	0	16	23	40	45
1. EFFICIENCY			409	466	519
Difference from 1979			88	145	198
Pct. change from 1979			27	45	62
2. RESTRICTION		359	371	402	473
Difference from 1979		38	50	81	152
Pct. change from 1979		12	16	25	47
5A. WATER TRANSFER				505	595
Difference from 1979				184	274
Pct. change from 1979				57	85
5B. WATER TRANSFER				495	533
Difference from 1979				174	212
Pct. change from 1979				54	66
6. PESSIMISTIC		286	214	199	206
Difference from 1979		-35	-107	-122	-115
Pct. change from 1979		-11	-33	-38	-36

livestock production at the 1979 level under any of the scenarios considered, except the PESSIMISTIC. Most of the grains presently fed to cattle--mainly corn--are grown with irrigation. Under the PESSIMISTIC scenario, irrigation would be almost entirely discontinued by 1990, and the volume of corn production would become negligible.

But, even under the PESSIMISTIC scenario, it appears likely that livestock production would continue to be determined largely by demand. Studies in Southwestern Kansas (12) suggested that feeding practices may change rapidly with the availability of different feeds. In Southwestern Kansas, unirrigated feed grains such as sorghum and wheat, as well as longer periods of grazing on rangelands, were suggested as alternatives to feeding corn and other irrigated crops. Historical evidence and the opinions of Extension Service livestock specialists seem to substantiate this conclusion. Except under the PESSIMISTIC assumptions, and with no effective measures to preserve irrigated feed grain production, it appears unlikely that projected changes in crop production would seriously affect livestock production and sales in the Ogallala Aquifer area.

The preceding analysis implies that the livestock industry would probably remain a stabilizing factor in the economy of the Ogallala Aquifer area--even under the least favorable crop production scenario.

REGIONAL ECONOMIC EFFECTS--ELEVEN-COUNTY REGION

A regional economic analysis was done only for the entire eleven-county region that contains the Ogallala Aquifer area in Colorado. (11) This section examines the projections for that eleven-county region. Implications for the more limited Ogallala Aquifer area are discussed later.

The eleven-county region contains about 80,000 people--2½ times as many as the 33,000 in the Ogallala Aquifer area of Colorado. Total employment in the larger region was 30,000 people in 1978. This region includes, in addition to the aquifer area, parts of the South Platte and Arkansas Valleys, with a larger and more diverse economy and two large towns--Sterling and Lamar. More than half the feed grain produced in the aquifer area is used elsewhere in the eleven-county region.

Projections of employment changes in the eleven-county region, based on changes in the aquifer area under the BASELINE and Scenarios 1, 2, and 5, and the PESSIMISTIC case, were made by the Colorado study group (11). The results are shown in Table 20 and Figure 6. These projections are based only on the changes in agricultural production projected by the scenarios. They do not include any employment changes that might result from new industries, changing residential preferences, or agricultural changes outside the aquifer area or outside the scope of the projections. Changes in livestock production methods, for example, could affect the regional economy in ways not considered in the projections.

These projections are based on assumptions that livestock sales to final demand in the eleven-county region will follow recent growth trends until 1985, then remain at their 1985 level. Considering recent livestock prices--often below costs of production--this assumption may be unduly optimistic. The PESSIMISTIC projection is based on the assumption that livestock sales will remain at their 1978 level.

Under the BASELINE, and all the other projections except the PESSIMISTIC case, employment would grow until nearly 2000. After 2000, under BASELINE assumptions, employment would level off at about 35,000 people--about 13 per-

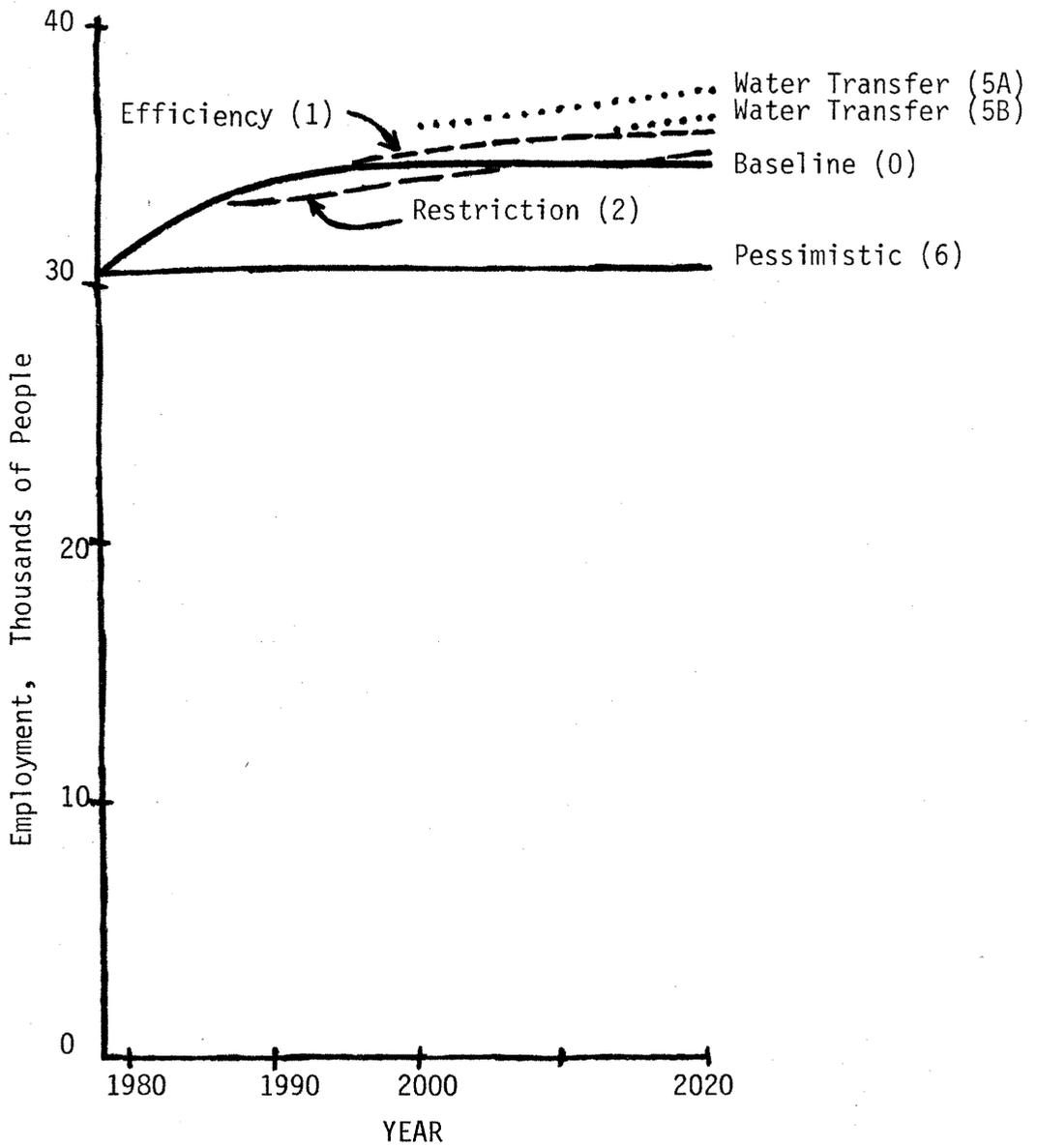


Figure 6. Employment Projections for the Eleven-County Region Under Alternate Scenarios.

Table 20. Employment and Population Projections for the Eleven-County Colorado High Plains Region

1978 Employment: 30,090; Population, 79,650; Ratio = 2.647

<u>Scenario</u>	<u>1985</u>	<u>1990</u>	<u>2000</u>	<u>2020</u>
0. BASELINE				
Employment	33,495	33,884	34,857	34,981
Population	88,661	89,691	92,266	92,595
Pct. increase from 1978	11	13	16	16
1. EFFICIENCY				
Employment	33,495	34,149	35,168	36,107
Population	88,661	90,392	93,090	95,575
Pct. increase from 1978	11	13	17	20
2. RESTRICTION				
Employment	33,384	33,362	34,093	35,121
Population	88,367	88,309	90,244	92,965
Pct. increase from 1978	11	11	13	17
5A. WATER SUPPLY				
Employment	33,495	34,149	36,136	37,767
Population	88,661	90,392	95,652	99,969
Pct. increase from 1978	11	13	20	25
5B. WATER SUPPLY				
Employment	33,384	33,362	35,260	36,339
Population	88,367	88,309	93,333	96,189
Pct. increase from 1978	11	11	17	21
6. PESSIMISTIC				
Employment	30,426	30,744	30,565	30,691
Population	80,538	81,379	80,906	81,239
Pct. increase from 1978	1	2	1	2

Source: McKean, Weber and Ericson. An Input-Output Study of the High Plains Region of Eastern Colorado, 1981. (11)

cent above the 1978 level. The EFFICIENCY and WATER TRANSFER scenarios project continued growth throughout the 40 year period. Under the PESSIMISTIC projection, regional employment and population would remain stable at the 1978 level throughout the 40 year period--a continuation of the trend of the last three decades.

Altogether, the scenarios projected under the assumptions of increasing yields and commodity prices--all but the PESSIMISTIC scenario--forecast rather small differences in regional employment. The greatest effect of the measures considered is projected for the 5A TRANSFER scenario--eight percent above the BASELINE by 2020. The largest difference is between any of these and the PESSIMISTIC, suggesting the vulnerability of the regional economy to demand, prices, and costs determined outside the eleven-county region. But even under the PESSIMISTIC assumptions of no real increase in commodity prices, employment in the eleven-county region is projected to remain at its present level.

Under any of the scenarios described, the economy of the eleven-county region is expected to remain stable or grow moderately. This would maintain local services for most of the people in this region. At present these are quite adequately provided in Sterling and Lamar--the two largest towns in the region. It would also maintain employment alternatives for people desiring to remain in Eastern Colorado, even though opportunities in High Plains towns might decline.

As shown by the projections, employment in the eleven-county region is less dependent on irrigated agriculture in its High Plains area than in the Ogallala Aquifer area itself. The eleven-county region has a larger population, larger towns, and areas of crop production irrigated by surface di-

versions and shallow wells fed by the South Platte and Arkansas Rivers. With their larger populations--about 20,000 people in the Sterling area and about 12,000 around Lamar, and substantial infrastructures, services, and institutions--these towns offer much more potential for industrial development and elaboration of service economies than the High Plains towns. Both towns already have some industrial activity and local colleges.

The population estimates in Table 20 were obtained by multiplying employment projections by 2.647. This was the ratio of population to employment in 1978, as determined through the regional economic model for the eleven-county region. However, this ratio could change the future, resulting in actual populations different from those projected, even if employment projections prove accurate. These employment projections are based entirely on projected agricultural changes in the Ogallala Aquifer area. They do not include any of the other possible sources of employment increases in the region, such as increasing levels of manufacturing or commercial services. As population increases these economic activities tend to grow, often providing a basis for further population and economic growth. (As such growth is not included in the regional projections for this study, the population figures in Table 20 probably underestimate the future population of the eleven-county region.) Such growth appears fairly likely but will depend on factors which have not been forecast and which may be unpredictable, such as demographic trends, residential preferences, and industrial development.

REGIONAL ECONOMIC EFFECTS--OGALLALA AQUIFER AREA

In an agricultural region, changes in the agricultural economy are likely to be fairly accurate predictors of employment, income, and population changes. For the Ogallala Aquifer area, income, employment, and population are expected to follow the production value projections shown in Figure 5.

In these projections, the BASELINE shows strong growth until the year 2000, with stability well above the present level from 2000 to 2020. The other scenarios--except the PESSIMISTIC--project continuing growth beyond 2000.

The PESSIMISTIC scenario, however, indicates a severe economic decline for the Ogallala Aquifer area. This in contrast to its projected effect in the larger eleven-county region, where its net result would be a stable or non-growing economy.

Under all but the PESSIMISTIC scenario, continued economic growth would be expected to maintain the well-developed community structure that has evolved in the irrigated parts of the Ogallala Aquifer area during the last two decades. Growing incomes, employment, and population would provide a growing base of support for schools, medical services, commercial services, and other services in the region. The trends toward prosperity of the last two decades would continue and would stabilize the economies of local communities at higher levels than at present.

The PESSIMISTIC scenario is based on assumptions that would lead to nearly total discontinuation of irrigated agriculture in the Ogallala Aquifer area by 2000. The economic base of the area would then revert to unirrigated wheat and ranching, similar to that in the unirrigated areas of the High Plains. The resulting decline in income, employment, and eventually population, would probably so attenuate the base for public and commercial services that the present system of communities, schools, medical services, and other services could not be economically maintained. Probably the largest towns, at the greatest distances from the towns of the South Platte and Arkansas Valleys, would continue to function as service centers, but with a

more rudimentary level of services than at present. As the projection for the eleven-county region shows employment remaining constant for this larger region even under the PESSIMISTIC projection, presumably the population of the Ogallala Aquifer area would shift to other locations within the eleven-county region under this scenario.

The distance between the BASELINE and PESSIMISTIC curves in Figure 5 suggests the potential for maintaining an intermediate level of production, even if conditions were less favorable than assumed for the BASELINE case. This might result from improved irrigation techniques such as those incorporated in the EFFICIENCY scenario. Such improvements could maintain some of the region's irrigated production in spite of unfavorable demand and prices for commodities or increasing costs of irrigation pumping, fuel for tillage, and fertilizer.

SUMMARY

The BASELINE projects a strongly expanding agricultural economy in the eleven-county region and in the Ogallala Aquifer area of Colorado through the year 2000, after which it would remain stable until 2020. All the other scenarios based on similar assumptions of increasing commodity prices and productivity project similarly favorable future conditions.

Only the PESSIMISTIC scenario--based on less favorable assumptions about commodity prices and productivity--projects an economic decline. But this scenario projects decline only for the Ogallala Aquifer area. Even under this projection, the economy of the eleven-county region would remain stable.

Under all but the PESSIMISTIC scenario, income, employment, and population are expected to increase somewhat throughout the eleven-county region, including the Ogallala Aquifer area. This should provide a basis for the con-

tinued existence, and possible further development of, the communities and services that have developed during the last two decades.

Under the PESSIMISTIC scenario, the economy of the Ogallala Aquifer area would decline sharply, probably resulting in loss of employment, income, and population in this area. Under this projection, population and revenue would probably become inadequate to support the present levels of community development and services in the Ogallala Aquifer area. But even under the PESSIMISTIC assumptions, population and employment in the eleven-county region are projected to remain at their present levels.

For the eleven-county region there are more options for maintaining the economic base, even with the decline projected by the PESSIMISTIC scenario. This broader-based economy increases the range of possibilities open to people living in the Ogallala Aquifer area--especially young people who may chose to remain in eastern Colorado.

CHAPTER FIVE

ECONOMIC ALTERNATIVES

This chapter considers the possibilities for additional economic development in the High Plains region of Colorado, and elsewhere in eastern Colorado.

LOCATION FACTORS

As Chapter Two has shown, most of the people of eastern Colorado are concentrated around four towns in the South Platte and Arkansas Valleys, with much less concentration in the irrigated areas of the High Plains. The unirrigated High Plains areas contain an extremely diffuse population, with only small and declining settlements. Thus, markets, supply sources, labor for alternate economic activities, and many consumer services, are mainly at the four valley towns. These towns and their surrounding areas also have access to continuous sources of water for irrigation from the South Platte and Arkansas rivers and well developed transportation to the Colorado Metropolitan Area and to national markets.

AGRICULTURE

Although the South Platte and Arkansas valleys have advantages as centers of economic development and for many kinds of agricultural production, the High Plains have their own advantages for certain kinds of agriculture and livestock operations. These include extensive grazing, unirrigated wheat production, and production of corn and some other crops under irrigation where ground water resources remain adequate. Soils are especially productive throughout much of the area of the High Plains, for wheat raising where irrigation water is unavailable, and for irrigated crops where water

is available. Range grazing is the most appropriate use for less-fertile land and areas of rough terrain unsuitable for cultivation.

Water resources are expected to remain adequate for irrigation in most of the presently-irrigated parts of the High Plains for at least another 20 to 40 years, and irrigation may be expanded in some areas of the region. Technical developments and changes in agricultural practices may even lead to expansion of total irrigated area and production and to its maintenance well beyond the expected limits of water resources at present rates of depletion. Higher prices to farmers for their products are forecast. This may intensify agricultural practices. Motivated by high energy costs for pumping water, intensification may be directed into more efficient systems for applying water and crops that use less water. The demand for corn is expected to increase, but greater oilseed demand is also expected. With higher prices for both of these crops, and with higher energy prices for pumping water, more efficient water application for corn may be combined with increasing proportions of crops that use less water. This could extend water resources beyond the predicted times of exhaustion. The balance and economic calculus is intricate, and may be expected to vary throughout the region with soils, microclimate, and individual farmers experience.

Although ranching--more specifically, cow-calf production--has become generally unprofitable in recent years, it appears likely to become more profitable again in response to increasing national and international demand for beef. As corn becomes more costly, the increasing demand for beef may cause shifts to more use of rangeland, increasing the stocking of rangelands in the High Plains. Thus, it appears that the livestock economy of the region will be maintained, but may shift somewhat, from feedlot to range operations.

In summary, the agricultural economy of the High Plains appears most likely to expand slightly in response to expected price increases to farmers and ranchers for grains, oilseeds and cattle. Depletion of ground water resources in some areas will create difficulties to which some producers will adapt by discontinuing operation or moving elsewhere, but in total a thriving agricultural economy is expected to remain. In addition, the expected general expansion of demand for agricultural products should intensify the agricultural economy of the South Platte and Arkansas valleys, further contributing to the economic base and development of eastern Colorado.

MANUFACTURING

Manufacturing has often been considered as a desirable addition to the economic base of rural areas. The benefits of a manufacturing plant in a rural community may include increased employment, sales in the local service and goods sector, and tax revenues.

But new manufacturing industries also involve costs. These include the costs of promotion to attract new industry, loss of revenues through any tax exemptions, the costs of necessary public services, and environmental costs. Generally, direct net gains to the public sector have been small or negative, and most gains have been mainly to the private sector. The extent of the benefits to the private sector depends on the level of development of the local service sector. The greatest benefits (multiplier effects) are to communities that offer a wide range of goods and services and are regional service centers. (12)

A study by the Colorado State University Cooperative Extension Service (13) found that of 32 companies responding to a survey, none would consider locating in a community of fewer than 2,500 people. Three would consider

locating in towns of fewer than 5,000 people and more than half the firms would locate in towns of more than 10,000 people. The number of firms that said they would locate in towns of different sizes was as follows:

Population less than 2,500:	0
2,500 to 5,000:	3
5,000 to 10,000:	6
10,000 to 50,000:	14
more than 50,000:	9

The respondents specifically mentioned a developed community infrastructure, large labor source, good transportation connections, and an environment attractive to technical and professional help as being of important to their location decisions. This would seem to limit most of the potential for adding manufacturing industries to local economic bases in eastern Colorado to the four largest population centers in the South Platte and Arkansas valleys. There appears to be some possibility of certain kinds of small firms locating at the larger High Plains towns, but small firms might contribute only marginally to their economies. For example, very small manufacturing firms, employing fewer than 30 people each, have located at several plains towns.* Proposals have been received for alcohol, gasohol, and sunflower oil plants at High Plains towns, but the largest of these would employ only about 30 people. But with related trucking and other locally-obtained services, the total contribution of such firms to local employment would be greater than their direct employment at their own plants.

The main potential for manufacturing development in High Plains towns appears most likely to be based on the agricultural products of the region. Alcohol production and sunflower seed processing appear especially promising. These processes use large volumes of bulky agricultural products that may be

*(See Table 9 for 1979 manufacturing employment in High Plains counties.)

obtained locally, and generate large volumes of by-products that can be fed to livestock near the plant. Another possibility is for small industries developed by local entrepreneurs in their home towns. However, in any of these enterprises, High Plains towns appear to have few advantages and may be at substantial disadvantage relative to the larger valley towns. Certain kinds of small manufacturing plants might be feasible at High Plains towns, but a decision to locate a plant at one of these towns would seem somewhat improbable.

LOCAL SERVICES

Local services, however, offer possibilities for economic development in the larger towns of the irrigated areas of the High Plains. Studies by the Division of Commerce and Development (Colorado Department of Local Affairs) show large losses of sales from small towns to larger towns and cities. They also suggest that, with adequate planning at the local level, many of these lost sales could be recaptured by the smaller towns. This would require measures to better provide for the preferences and needs of local residents by local businesses. The possibilities have been identified by the Division of Commerce and Development, and methods have been developed to provide for them in local government planning in cooperation with community leaders and business people. They require analysis, planning, and financing, all of which can generally be done at the local level but which may require technical or legal assistance. Technical assistance in organizing such efforts is available in the Division of Commerce and Development and possibly through the community development programs of universities. Altogether, community development seems to have considerable potential to increase the economic strength of the larger towns of the High Plains, with concomitant benefits

to smaller settlements and rural residents. The approach is based on the mutual reinforcement effects of successful economic development enterprises and the need to achieve threshold levels of development to prevent losses of business to larger towns. Well-developed local services make communities more attractive to residents, tourists, and potential residents who could contribute further to the economic activity of the community and the provision and support of local services.

INVESTMENT IN REGIONAL DEVELOPMENT

Investment in regional development by the public sector (through government) occurs at the local, state, and federal levels. Private sector investments, are not usually made explicitly or mainly for regional development purposes, but may contribute to regional development as much as, or more than, public investments. Private investment may also be considered as occurring on a geographic basis ranging from local to national or international.

The purpose of investment by the public sector in regional development is generally accepted as being to improve the welfare of the general public, but this public is defined partly by the level (of government) involved. Thus investment decisions at the local level need only to consider local priorities, whereas such decisions at the state or national level must be made in the context of a larger range of priorities.

However, investment decisions are made through a series of steps, which progressively constrain the decision process. For example, agencies are established in response to generally-perceived needs. These agencies then establish programs according to problems and priorities identified within their scope of operation. Finally, individual projects must be chosen. If

this process is working in the public interest, the projects chosen will be those that will make the most effective use of limited resources to accomplish the maximum public benefits. If an agency is operating at the state level, the projects will be chosen from among the state's priorities. At the federal level, priorities may still be set at state, or substate or multistate regional levels, because of the geographic organization of federal agencies and the political power base. At the local level, priorities need only be chosen from among local concerns, but the resources available are more limited for small communities, and residents may prefer lower taxes to public investment. Rational and "progressive" local businesspeople usually recognize development potential in their own communities, and support community development investments, but if such potential is not perceived they will withhold their support, oppose higher taxes or other means of directing local funds into local investment, and invest their resources elsewhere--often outside the local community.

Thus, in any rational investment decision, public or private, it is necessary to ascertain where the return will be greatest. In the private sector, the criterion is largely net profits. In the public sector the benefits are more difficult to define, but no less important. They are measurable, at least in part, through a variety of social, economic, and physical indicators. Such indicators can range from population and income trends, to costs and returns associated with specific public investments (such as water projects) and costs per person served by schools, hospitals, and other public services.

Goals of Regional Development

Certain goals are generally accepted as criteria in allocating public investment to regional development. These include:

- efficient use of geographically-distributed resources,
- minimizing dislocation of population and existing communities,
- maintaining desirable life-style alternatives and ranges of choice in residential environments, and
- mitigating hardships associated with residence at certain locations.

For eastern Colorado, these criteria imply:

- maintaining an economically beneficial agricultural economy and existing community infrastructure,
- maintaining adequate levels of community services at reasonable costs,
- improving, insofar as possible, the quality of life in small towns and rural areas, and
- specific measures to improve medical services, school systems, and low income housing.

A major component of all these goals is the maintenance of the status quo in essential socio-economic and demographic conditions, as rapid changes in these conditions are usually disruptive. However, evolutionary development can mitigate certain problems and allow for constructive response to changing social and economic conditions. Development may stabilize the regional economy and contribute to the welfare of local residents. Improvements are desirable in agricultural efficiency and local services. These include more efficient water and energy use in agriculture, soil conservation, better transportation for agricultural products, and expansion of the agricultural and livestock economy to make fuller use of the region's resource potential. Desirable improvements in local services include strengthening of the local service sector, additional medical services, and more rational organization of school systems. Still other community investment that could increase the welfare of residents include improvements in housing--especially

repairs and maintenance of low-income housing occupied by elderly people, and attention to the appearance and organization of the community. Continuing development of social and cultural functions is also like to enhance the attractiveness of many communities and will contribute to the total welfare of community residents.

The evidence accumulated through this study seems to indicate that the economic base of the Colorado High Plains will remain capable of supporting the existing communities in the irrigated areas at their present levels for at least the next four decades. Creative community development and improvements in agricultural techniques can increase the stability and quality of life in these communities. At the same time, the future of communities in the unirrigated areas is uncertain. Here, the natural resource base supports large-scale unirrigated wheat farming and range livestock raising. Such an extensive land-based economy appears incapable of supporting the existing smaller settlements except possibly as very limited local service centers.

The attractiveness of High Plains community life can also be increased, and regional development goals met, by development in the South Platte and Arkansas valleys. These valleys and their larger towns have advantages of scale, population, location, and resources--especially water--that cannot be duplicated in the High Plains. Development of their potentials can increase employment and entrepreneurial opportunities for High Plains families, expand available goods and services, attract needed professional people and technicians to the region, and generally maintain the services and innovation needed in the entire region. With the present and expected future irrigated agricultural economic base of the region, and continued efforts at community development, development in the South Platte and Arkansas valleys should be

complementary to, rather than competitive with, High Plains development. Development of eastern Colorado, based on the existing distribution of natural resources and investment appears likely to benefit the entire population of the region. By making the most efficient use of existing resources, the total income of the region will be maximized, the regional economy will be strengthened, and opportunities will be increased. Thus, in any investment decision, especially at the state level, priorities should be based on all of eastern Colorado as much as on the needs of any individual community or part of the region.

RECOMMENDATIONS

Recommendations for maintaining viable communities and productivity in the Colorado High Plains include those for maintaining or enhancing the agricultural economic base and those for community development. Recommendations for strengthening the economic base are as follows:

1. Intensify agricultural research by Colorado State University, the Agricultural Experiment Stations, and the Cooperative Extension Service, to develop effective methods of producing crops adapted to the High Plains with minimum economic use of water and energy.
2. Intensify agricultural extension information services to communicate the results of research to farmers in synchronization with changing price structures for their products.
3. Investigate the possibilities of further development in the range livestock industry, consistent with economic constraints and conservation of rangelands.
4. Intensify soil conservation efforts, with maximum powers to local soil conservation districts to enforce soil conservation measures.

5. Continue efforts to organize satisfactory rail service to local elevators at equitable shipping rates. This is presently being undertaken by the Colorado Departments of Agriculture and Highways and by the state Public Utilities Commission, but could perhaps be intensified and supported through attention by the ICC and Federal Department of Transportation.
6. Continue efforts to encourage alcohol production and gasohol use, subject to new experience and raw material constraints.
7. Increase efforts in the Colorado Department of Agriculture and obtain U. S. Department of Agriculture support for increasing Colorado's regional self-sufficiency in agricultural products.

Recommendations for community development include the following:

1. Cooperation between communities and the Division of Commerce and Development to investigate possibilities for improving the goods and services sectors in small towns identified as regional service centers. Similar assistance with local services development may also be available through universities and the Cooperative Extension Service.
2. Continued efforts by the Governor's Office and state agencies to organize improved medical services throughout eastern Colorado, including additional physicians, technicians, emergency medical services, and nurses.
3. Cooperation among communities, regional councils of government, the state department of education, and the State Legislature to continue to rationalize school districts for economic efficiency and to obtain the desirable range of qualified teachers.

4. Maintenance of federal support for programs to provide for low-income housing, house repairs, transportation and housing for elderly people, and medical and social services in rural towns.
5. Maintenance of federal support for grant programs for maintenance, improvement or replacement of water and sewer systems in rural towns.
6. Comprehensive planning, using professional assistance with community participation to develop attractive towns with appropriate services and minimum conflict among land uses, housing, services and aesthetic values.

REFERENCES AND FOOTNOTES

1. Skold, Melvin D., "Great Plains Agricultural Production Under Limited Energy Supplies", Proceedings of the Great Plains Agricultural Council, University of Nebraska, Lincoln, 1975. pp. 63-84.
2. Colorado, Office of Energy Conservation, Energy Production and Use in Colorado's High Plains Region (Draft). Report Submitted to Camp, Dresser and McKee, Inc., Austin, Texas, September 1980. p. 75.
3. Colorado Department of Agriculture, 1980 Colorado Agricultural Statistics, The Department, Denver, 1981. p. 7.
4. Colorado Department of Highways, Colorado State Rail Plan: Agricultural Rate Study. (Photocopy) The Department, Denver, April, 1980.
5. Colorado Department of Local Affairs, Water Quality Management Plan (for East Central Colorado, Northeastern Colorado, and The Lower Arkansas Valley) (3 volumes), The Department, Denver, June, 1980.
6. Colorado Department of Local Affairs, Division of Planning, A-95 Review Files, 1975-1980.
7. Evans, Richard, Susan Connors, and Michael Vance, Colorado Public Transportation Inventory. Colorado Department of Local Affairs, Division of Planning, Denver, 1976. pp. 1-10.
8. Ibid. p. 62.
9. Bayer, Rich, Final Report, Kit Carson County Land Use and Housing, East Central Council of Governments, Stratton, Colorado, 1976.
10. Young, Robert A., Colorado Farm Level Analysis (Study Element A-3a High Plains-Ogallala Aquifer Study files, March 1980.
11. McKean, John R., and Joseph C. Weber, An Input-Output Study of the High Plains Region of Eastern Colorado. Colorado State University, Department of Economics, Fort Collins, 1981.
12. Little, Arthur D., Inc. Interim Report (Draft)--Study Element B-9, Dryland Farming Assessment, High Plains-Ogallala Aquifer Study. A. D. Little, Inc., Cambridge, Massachusetts, November, 1980.
13. Summers, Gene F., et. al., Industrial Invasion of Nonmetropolitan America. Praeger, New York, 1976. pp. 83-92 ff.
14. Davis, LeRoy, John Knapp, and Forrest Walters, Patterns, Policies and Problems in Colorado Land Use and Development--Industrial Development in Rural Colorado, Colorado State University Cooperative Extension Service, Fort Collins, 1974.

BIBLIOGRAPHY

Abt Associates, Inc., Draft Social Assessment of the Proposed Narrows Unit and Alternatives Thereto, Abt Associates, Inc., Cambridge, Massachusetts, June, 1974.

Anderson, Raymond L. and Karla Perri, Urbanization of Rural Lands in the Northern Colorado Front Range, Colorado State University Cooperative Extension Service, Fort Collins, 1978.

Antonides, Robert J., Some Guidelines for Organizing Development Efforts in South Dakota Along Trade Area Lines, South Dakota State University, Cooperative Extension Service Circular 651, (no date).

Bailey, Warren R., "Adapting Farming to the Great Plains", Proceedings of the Great Plains Agricultural Council, Montana State University, Bozeman, 1966, p. 79-85.

Bittinger, M. S., et. al., Impact of Irrigation Efficiency Improvements on Water Availability in the South Platte River Basin, Colorado State University, Technical Report No. 13, Fort Collins, January, 1979.

Blouet, Brian W., and Frederick C. Luebke, The Great Plains: Environmental and Culture, University of Nebraska Press, Lincoln, 1979, pp. 187-202.

Colorado Department of Agriculture, Agricultural Land Conversion in Colorado, The Department, Denver, 1979.

Colorado Department of Health, Status of Water Quality in Colorado, The Department, Denver, 1979.

Colorado Department of Labor and Employment, Division of Employment and Training, Colorado Manpower Review, Volume 27, No. 7, July, 1980.

Colorado Department of Local Affairs, Division of Planning, Land Area, Population Density, and Population Change of Regions, Counties and Metropolitan Areas in Colorado, 1950-1979, Population Report CP-26, No. 80(E)-2, March, 1980.

Colorado Department of Local Affairs, Division of Planning, Population Trends, 1970-77 and Preliminary July 1, 1978 and 1979 Population Estimates of Counties and Incorporated Places in Colorado: Revenue Sharing Series, Population Report CP-26, No. 79(C)-1, October, 1979.

Colorado Department of Local Affairs, Division of Planning, Regional Economic Development Studies--Northeastern Colorado and Lower Arkansas Valley (two volumes), 1978.

Colorado Department of Local Affairs, Division of Planning, From Bonanza to Last Chance: Changing Economic Expectations in Colorado, 1978.

Colorado Department of Local Affairs, Division of Property Taxation, Ninth Annual Report, 1979.

Great Plains Agricultural Council--Task Force Report, "Energy Related Impacts on Great Plains Agricultural Productivity in the Next Quarter-Century, 1976-2000", Proceedings of the Meeting of the Great Plains Agricultural Council, University of Nebraska, Lincoln, 1976.

Koelzer, Victor A. (editor), Proceedings of the Symposium on Water Policies on U. S. Irrigated Agriculture: Are Increasing Acreages Needed to Meet Domestic or World Needs? Colorado State University, Environmental Resource Center Information Series No. 15, March, 1975.

Little, Arthur D., Inc. Interim Report (Draft)--Study Element B-9, Dryland Farming Assessment, High Plains-Ogallala Aquifer Study. Arthur D. Little, Inc., Cambridge, Massachusetts, November, 1980.

Lonsdale, Richard E., and H. L. Seyler, Nonmetropolitan Industrialization, Wiley, New York, 1979.

Missouri River Basin Commission, Missouri River Basin Water Resources Management Plan, Missouri River Basin Commission, Omaha, Nebraska, May, 1980.

Pimentel, David, et. al., "Energy and Land Constraints in Food Protein Production", Science, 21 November 75, p. 759.

Pimentel, David, et. al., "Food Production and the Energy Crisis", Science, 2 November 73, p. 444.

Rivkin-Carson, Economic Development and Water Resource Investments, A report to the Bureau of Reclamation. Rivkin-Carson, Inc., Washington, D.C., 1973.

Skold, Melvin D., Farmer Adjustments to Higher Energy Prices: The Case of Pump Irrigators, ERS-663, U.S. Department of Agriculture, Economic Research Service, Fort Collins, Colorado, November, 1977.

Steinhart, John S. and C. E. Steinhart, "Energy Use in the U. S. Food System", Energy: Use, Conservation and Supply (ed. Philip H. Abelson) AAAS Special Science Compendium, p. 48-60.

Sundquist, James L., Dispersing Population: What America Can Learn From Europe. The Brookings Institution, Washington, D.C., 1975.

Todd, Daniel, "Welfare or Efficiency: Can the Growth Center Offer a Compromise?" Growth and Change, July, 1980, p. 39-43.

U. S. Department of Agriculture, Economic Research Service, Looking Forward: Research Issues Facing Agriculture and Rural America, U.S.D.A., Washington, D.C., 1977.

U. S. Department of Agriculture, Soil Conservation Service, Perspective on Prime Lands and Recommendations on Prime Lands, Soil Conservation Service, Washington, D.C., 1975.

U. S. Department of Commerce, Bureau of the Census, Census of Agriculture--Colorado, 1974.

_____ 1977 Census of Retail Trade-Colorado (RC77-A-6)
_____ 1977 Census of Service Industries-Colorado (SC77-A-6)
_____ 1977 Census of Wholesale Trade-Colorado (WC77-A-6)
(Geographic Area Series, Issues 1979.)

_____ County Business Patterns, 1978, Colorado (CBP-78-7)
Issues March, 1980.

_____ Characteristics of the Population, Colorado, Years 1890-1970, and preliminary 1980 statistics.

U. S. Department of the Interior, Bureau of Reclamation Report on the Narrows Unit, Colorado. August, 1966, revised January, 1977.

University of Colorado, Graduate School of Business Administration, Growth Attitude Study, prepared for the Colorado Rural Development Commission, Boulder, 1972.

Western Governors' Policy Office, Balanced Growth and Economic Development: A Western White Paper, 1978.

PERSONS AND ORGANIZATIONS CONSULTED

Colorado State Government

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Governor's Office, Rural Health Advisor
Local Affairs Department, Divisions of Commerce and Development, Local
Government, Planning, and Property Taxation

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Rocky Mountain Farmer's Union

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