

SIX-STATE HIGH PLAINS-OGALLALA AQUIFER
REGIONAL RESOURCES STUDY
AN OVERVIEW

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INTRODUCTION

The purpose of this overview of the Six-State High Plains-Ogallala Aquifer Regional Resources Study, now drawing to a close, is to serve as background for the papers and discussion to follow. The history of the study, its objectives, how and by whom it has been conducted, the current status and what remains to be done will be discussed. Economic results will not be presented; this is left to the others who will follow. The policy issues to be resolved by the High Plains interests, the states and the Congress and the legal/institutional change that might be required for effective actions will be presented.

LEGISLATION

The Congress, concerned over the declining water levels in the Ogallala Aquifer, the decreasing oil and gas resources, the potential effects on the state, regional and national economies, and on national food supplies, authorized the study by Public Law 94-587, Sec. 193, in October 1976. Six million dollars were authorized and subsequently appropriated for the study. The full text of Sec. 193 is on page 25.

THE HIGH PLAINS REGION

The region encompassed by the Six-State High Plains-Ogallala Aquifer Regional Resources Study as shown in Figure 1 (p. 10) comprises some 180

counties. This area of about 220,000 square miles, wholly or partly overlying the Ogallala Aquifer, is the principal source of water supply for irrigation and other uses. Counties formed the areal base for the study since most economic data are available by counties. The aquifer extends from the High Plains area of west Texas and eastern New Mexico, north under the panhandle area of Oklahoma, western Kansas and eastern Colorado, and the central and western parts of Nebraska. It extends north into South Dakota and northwest into Wyoming, but these extensions were not included in the authorizing legislation.

The region is one of the most heavily irrigated areas in the United States, comprising some 20 percent of the national total. About 40 percent of the fed beef for American consumers is fattened within the region from the grain grown there. Rapid expansion of irrigation began after World War II and will expand further in those areas where ground water continues to remain available within economic pumping limits. About 16 million acres are currently under irrigation out of a total of 35-40 million potential irrigable acres.

The region has been and still is an important source of oil and gas, a significant sector of the regional economy.

The Ogallala Aquifer is one of the most extensive and important interstate aquifers in the country. It varies widely in hydrologic and hydraulic characteristics, amount of recharge, lateral extent and depth, and remaining saturated thickness. It is severely overdrawn. The overdraft is increasing as irrigation expands. The degree of overdraft also varies widely being much less in Nebraska than in west Texas and eastern New Mexico. The aquifer is now subject to planned management only to a very limited degree.

For purposes of the study, the region has been subdivided into 21 subregions, each having approximately similar soils, climate, water resource availability and economic characteristics. Study results have been aggregated by each state, by north (Colorado, Kansas and Nebraska) and south (New Mexico, Oklahoma and Texas) subregions, and for the entire region.

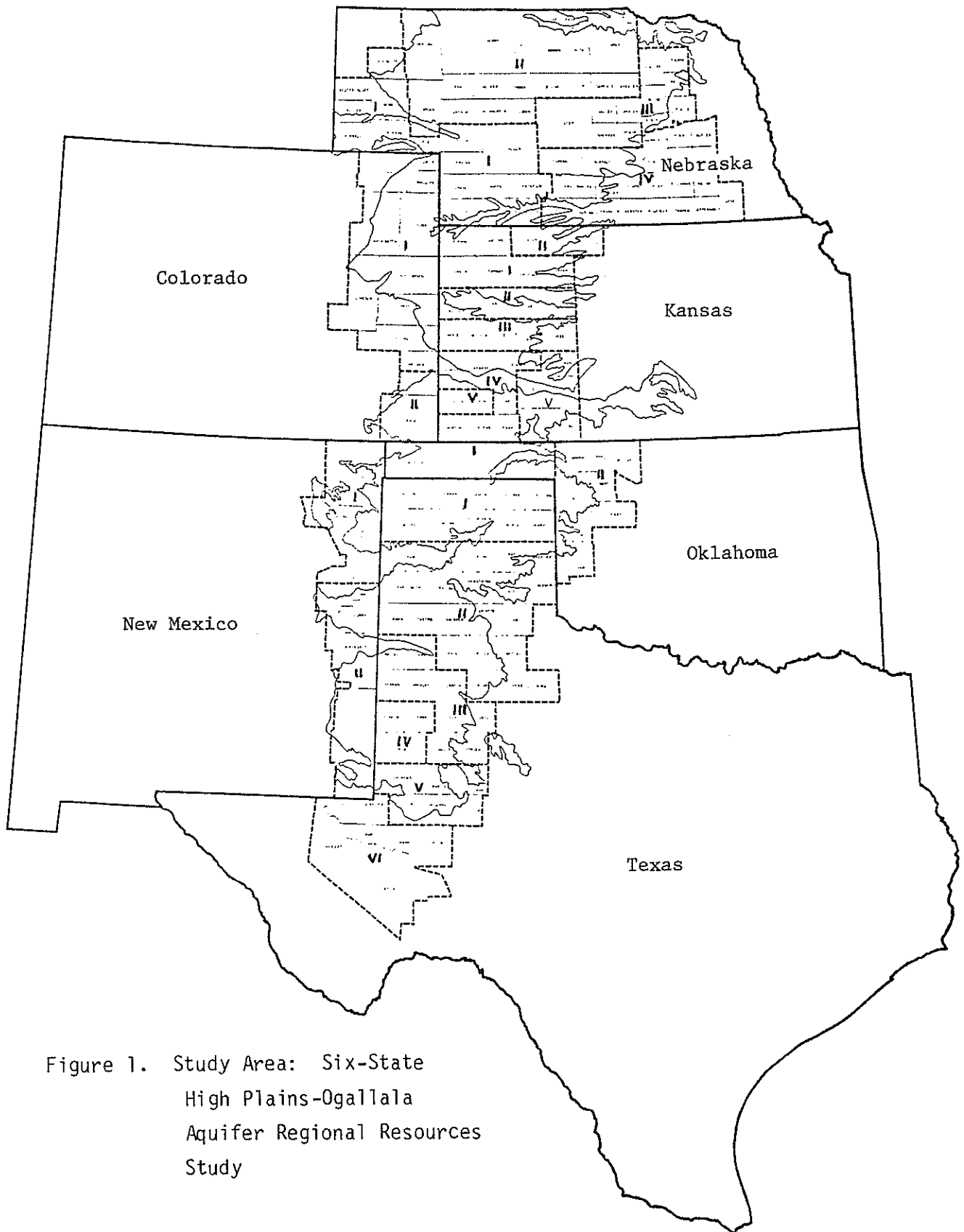


Figure 1. Study Area: Six-State High Plains-Ogallala Aquifer Regional Resources Study

STUDY ORGANIZATION

The U.S. Department of Commerce, Economic Development Administration (EDA), is the responsible federal agency. The study has been directed by the High Plains Study Council, composed of the governor of each of the six states and three interested citizens designated by the governor, and a representative of the EDA. The council was formed in 1977 at the insistence of the states after an initial plan of study, federally oriented, had been formulated by Resources for the Future under a contract with the EDA. The council then developed the plan of study which has been followed and will prepare the final conclusions and recommendations for submittal to the Secretary of Commerce and the Congress.

The regional study has been conducted for the EDA under a contract executed in September 1978 by the High Plains Associates, the general contractor. The consulting group is composed of:

Camp Dresser & McKee Inc. (CDM); Austin, Texas, the prime contractor
Arthur D. Little, Inc. (ADL); Cambridge, Mass.
Black & Veatch (B & V); Kansas City, Mo.

CDM has been responsible for the overall management of the study; the conservation, water resource, environmental and legal/institutional aspects; and the final report to the High Plains Study Council and the EDA. ADL has conducted the agricultural, economic and social studies. B & V has been responsible for the energy studies. The role of the general contractor has been to develop and evaluate alternative action programs for the future of the High Plains region. The general contractor will not draw any conclusions or make any recommendations; that is the responsibility of the High Plains Study Council.

Each of the six states, under subcontract with CDM, has assembled relevant data for that state and has conducted research on the economic, environmental and social effects of various alternative courses of action in the state. Results of the state research have been used by the general contractor in the regional analysis and evaluations.

The U.S. Army Corps of Engineers, under separate contract with the EDA, has studied the possibilities of importing water -- sources, points of diversion, amounts, conveyance routings, storage and costs -- from adjacent areas, particularly the Missouri River, the Arkansas River and other streams in Arkansas.

The U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Department of Agriculture, and other federal agencies have cooperated in the study.

The general contractor has been advised by a consulting panel of 12 internationally recognized authorities in various aspects of the study. The study organization is shown in Figure 2.

The \$6 million appropriated was allocated approximately as follows: general contractor, \$3.2 million; High Plains Study Council and the states, \$2.0 million; and the U.S. Army Corps of Engineers, \$775,000.

STUDY ORGANIZATION

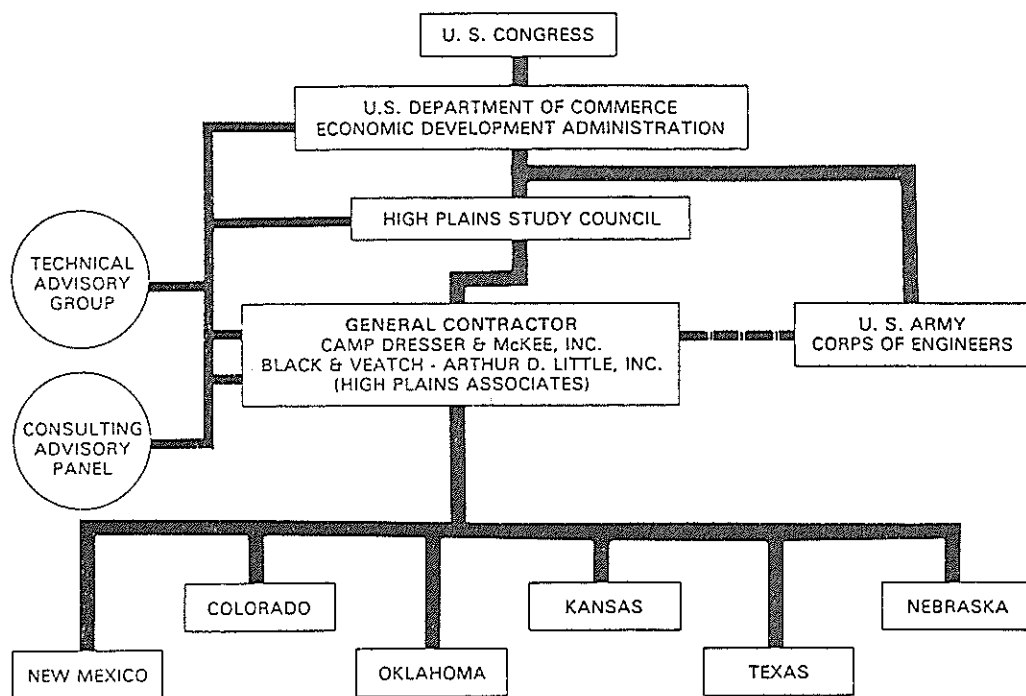


Figure 2

- DIRECTION AND REPORTING
- INTERACTION
- ADVISORY

STUDY OBJECTIVES

P.L. 94-587, Sec. 193 (excerpted)

- Assure adequate water supplies to the area,
- assure an adequate supply of food to the nation,
- promote economic vitality of the High Plains region,
- develop plans to increase water supplies in the area, and
- assure continued growth and vitality of the region.

High Plains Study Council

- Determine potential development alternatives for the High Plains region,
- identify and describe the policies and actions required to carry out promising development strategies, and
- evaluate the local, state and national implications of these alternative development strategies.

STUDY PROGRAM

Water is the key resource involved in meeting the study objectives. Therefore, the study has been conducted by analyzing and evaluating the economic, environmental and social impacts on the states, the region and the nation, and the costs and the legal/institutional changes that would be required for implementation of alternative water resource management strategies. The future of the energy sector of the High Plains region and the potential for non-agricultural production economic development also have been evaluated.

The "base" year 1977 was selected because it was the last year for which economic and hydrologic data were available when the study was started. The study period extended to 2020 with projected results presented for 1985, 1990, 2000 and 2020. All projected monetary results are presented in terms of 1977 dollars.

The water management strategies analyzed in the study are:

- A "baseline" trend projection of currently available water conservation and use technology and practices already in use to some extent, with no new purposeful public policy to intervene with action programs for altering the course of irrigation water consumption (Baseline).
- A strategy which would stimulate voluntary action to reduce water demands through research, education, demonstration programs and incentives, using technology and practices either not considered in the Baseline analysis or reflected at rates which would be purposefully accelerated (Management Strategy One).
- A strategy which assumes Strategy One policies and programs, and in addition projects further water demand reduction by mandatory programs of a regulatory nature to control water use (Management Strategy Two).
- A strategy to add local water supply augmentation actions to demand reduction efforts. These actions could include local practices such as cloud-seeding, local storage, ground water recharge, desalination, and snowpack and vegetation management (Management Strategy Three).
- A strategy of intrastate surface water interbasin transfers, importing water into the High Plains region in accordance with state water plans of the six High Plains states (Management Strategy Four). The opportunities for such interbasin transfers in New Mexico are limited and such plans are not being considered. Only Nebraska and Oklahoma have considered plans for potential intrastate interbasin transfers.
- A strategy of interstate surface water transfers, importing surplus water from sources in areas adjacent to the Ogallala region by means of large-scale federal-state or federal projects to restore and maintain irrigation of the acreage that would have reverted to dryland farming by 2020 under Strategy One or Two (Management Strategy Five). Such a transfer could not possibly be operational before 2000. It is important to note that in making its studies of interbasin diversion, the U.S. Army Corps of

Engineers has not made a determination that there would be surplus water available for such imports from any of the sources considered.

For each water management strategy, state-level linear programming (LP) models were used to project crop production, irrigated and dryland crop acreages, value of agricultural production, returns to land and management (plus returns to imported water for Strategy Five), and ground water use and ground water remaining in storage, each for 1985, 1990, 2000 and 2020. State and regional input/output (I/O) models were then used to project industry sector activities, sector employment, total value added, total household income, and state and local tax revenues, each related to the LP projections for the future years.

A special feature of the regional I/O model was its division of outputs by northern (Nebraska, Kansas and Colorado) and southern (Oklahoma, New Mexico and Texas) subregions so as to highlight the probable difference in conditions in the future for these parts of the study region. Projections of energy production, economic effects and prices were incorporated into the LP and I/O models.

Projected trends in energy production and availability are important factors in the regional economy. These projections, however, do not indicate significant differences among the effects for the several water management strategies although a major interstate water diversion project under Strategy Five would impose very large energy production and use requirements. Over the study period to 2020, the decline in crude oil and marketed natural gas production is projected to continue. By 2020, these production levels are projected to be approximately 1/10 the levels at the beginning of the study period. Electricity production, however, is projected to increase, both in installed generating capacity and electric energy production, by approximately threefold over the study period. Some increase is projected in water consumption associated with energy production.

The projected results of each strategy were compared to those projected for the "baseline" condition.

It is emphasized that this has been a comprehensive regional resources study. It is not limited to water resources although that aspect has been given major emphasis since water could be the limiting resource over the long term.

Research Conducted by the States

A-1 State Agriculture and Farm Level Research. Project cropping patterns; agricultural output and output value; inputs and input costs; agricultural employment and income.

A-2 Energy Industry Impacts. Project energy production; energy requirements for irrigation; employment; royalties and other income from energy industry; and water requirements.

A-3 State Water Resources Evaluation and Impacts Research.

A-3a. Evaluate intrastate water resource situation; project intrastate water supplies and demands under alternative management strategies.

A-3b. Project economic adjustments and socioeconomic and environmental impacts at the subregional and state level resulting from changes in land use and changes in supply and uses of water, energy and other sources under each alternative development strategy.

Results of the state research have been used by the general contractor in the regional and national analyses.

Regional Research by the General Contractor

The regional research has assessed and evaluated:

B-1 Interbasin transfers -- in cooperation with U.S. Army Corps of Engineers.

B-2 National and regional changes in commodity prices, shifts in consumer expenditures.

B-3 Effects and costs of applying advanced agricultural and water management technologies to achieve more efficient use of water.

B-4 Environmental impacts.

B-5 Technologies for augmenting locally available water supplies and costs.

B-6 Legal and institutional framework for implementing alternative development strategies.

B-7 Crop price projections, analyses of total revenue and costs for a wide range of commodity and livestock enterprise situations.

B-8 Energy price and technology.

B-9 Impacts of transition to dryland farming.

B-10 Regional potential for non-agricultural production economic development.

B-11 Evaluation of alternative development strategies.

Evaluations of alternative strategies are being reported to the High Plains Study Council for consideration and recommendations to the Secretary of Commerce and the Congress.

LEGAL/INSTITUTIONAL ASPECTS

As noted at the beginning, the economic results of the study will not be presented here. However, the legal/institutional implications will not be covered by the other papers. Since these will be significant for the decisions that must be made on the future of the High Plains region, they are presented in Table 1.

POLICY ISSUES

During the course of the High Plains-Ogallala Aquifer Regional Resources Study, analyses have been made of the resource use alternatives available to the six states and to the nation in the face of depletion of the Ogallala Aquifer and the decline of oil and gas production and reserves.

The alternatives were considered with the recognition that some constraints might hinder their implementation. For example:

- The Ogallala Aquifer has been intensively mined for irrigation since the years following World War II. Some areas such as in the southern High Plains of Texas are already either out of water or water levels have dropped below economically feasible pumping lifts.

Table 1: INTER-STRATEGY COMPARISONS - LEGAL/INSTITUTIONAL CONSIDERATIONS

STRATEGY	LEGAL/INSTITUTIONAL ASPECTS		
	LOCAL	STATE	FEDERAL
BASELINE	<p>There is sufficient authority at the local government level in all of the states to carry out many of the voluntary and regulatory water demand reduction and supply augmentation measures now in place or projected for the Baseline.</p>	<p>Each of the six states have water and natural resource agencies to administer programs at state and local levels and provide local assistance to districts and farmers.</p>	<p>Many state resource agencies are now supported to some extent by federal agencies and programs, such as those of the Department of Agriculture and Interior in present ongoing Baseline efforts.</p>
MS-1	<p>Implementation of MS-1 would require little change or realignment of the institutions in the area at local level. Additional funding and staff required.</p>	<p>Implementation of MS-1 would require little change or realignment of the institutions at state government level. Authorization and funding for selected financial incentives required. Additional funding and staff necessary.</p>	<p>Federal agency authorities to support state and local efforts in water demand reduction would need some extension to carry out certain MS-1 programs. Additional funding and some additional staff needed, particularly for research.</p>
MS-2	<p>Some local political subdivisions would need added powers to promulgate rules and regulations, and to enforce restrictions on uses of water. Additional funding and staff might be needed.</p>	<p>Nebraska, New Mexico and Oklahoma appear to have adequate statutory authorities to control ground water use although there may be constitutional questions as to power to reduce use under existing permits. Colorado and Kansas statutes may require broadening. State level agencies in Texas have no statutory authority to control ground water use. Additional funding and staff required.</p>	<p>Enforcement of mandatory restrictions on ground water use would not be a federal responsibility.</p>
MS-5a	<p>Local management agencies would be needed with adequate powers to contract for, receive and distribute imported water, to finance, construct, operate and maintain local facilities, and to levy and collect water charges and taxes to pay local costs and to repay allocated reimbursable costs of import project.</p>	<p>State legislation would be needed to provide necessary authorization for local management agencies, to contract with exporting states for water, to participate with the federal government or with the other states and the federal government in a federal-interstate compact management commission to plan, finance, construct, manage, operate and maintain the import project, and to provide necessary funding for cost-sharing and other costs.</p>	<p>Congressional actions needed to authorize and fund planning and feasibility studies, to provide for participation with the states in a federal-interstate compact management commission, and to authorize and fund federal participation in the import project.</p>
MS-5b	<p>Same as MS-5a</p>	<p>Same as MS-5a</p>	<p>Same as MS-5a</p>

- The waters of the Missouri River system and the other streams being considered by the U.S. Army Corps of Engineers for interstate interbasin transfers to the High Plains region are already largely developed, mostly by federal projects, and committed. For these interstate streams, available storage has been committed for flood control, hydropower generation, navigation and local consumptive uses even where the water has not yet been fully developed and allocated.
- Upstream and downstream states are developing state water plans to meet their potential water needs that will have major long-term impacts on the potential availability of water for diversion to the High Plains region.

Under these circumstances, certain public policy questions arise that will determine the mix of alternatives, including the option of no-action, to be implemented. These are not new questions -- they have been raised for many years in various contexts with respect to water and related resource management. Through the results of this study, however, their resolution within the context of the High Plains region may be possible. Experience in the region indicates that the questions to be answered cannot be related singularly to an alternative strategy. Rather, these questions relate to the choices to be made that will tailor alternatives and mixes of alternatives to the physical, social, economic, environmental and institutional conditions to local areas in the High Plains. This will shape the future of the High Plains region.

1. Major changes would occur in production of agricultural commodities (feed grains, food grains, cotton, etc.) as the result of transition in the High Plains from irrigated to dryland farming. Climatic variations make dryland less assured, year to year, than irrigated production. These changes and uncertainties would impact federal policies on agricultural commodity market stability, international trade and balance of payments, inflationary controls, support for agricultural prices and income, and related programs. These impacts would be the basis for considering implementation of all alternative strategies for

the region. Would these impacts justify federal intervention to assure continued levels of agricultural production? How could these impacts be considered quantitatively in analysis of the federal subsidy that probably would be required for interbasin transfers of water? There also would be adverse economic and social impacts on the states. Would state intervention be justified, and if so, in what manner?

2. Should promotion of, or a requirement for, conservation of water and energy in irrigation enterprises be a major federal objective and program? If so, could and should this be built into programs of the Department of the Interior, Environmental Protection Agency, Department of Agriculture, and the U.S. Army Corps of Engineers? Should such promotion include research and development aid to states and local districts, education incentives such as low interest loans, or a mix of these and others built into existing agency programs? What could be the mechanism for getting it underway? If a federal requirement, in what manner should it be implemented? Should it be a major state objective and program? What actions should the states and state agencies take? Should primary responsibility for enforcement of conservation measures be at the local water resources management agency level? If so, what statutory changes would be necessary including source of funds? This would vary among the states as Strategies One, Two, and Three are considered.
3. The economic study results indicate that mandatory water demand management (Management Strategy Two) through laws and regulations controlling the use of Ogallala water, would significantly extend the duration of availability of such water, but would result in decreased annual agricultural production and returns to land and management over the period to 2020. Would it be in the public interest to legally restrict current usage of the ground water with near-term economic detriment in order to prolong the availability of water for far future economic benefit?

4. Should investigation and planning of possible interstate interbasin transfers be continued? Should investigations and planning encompass the basins and states of origin? What institutional mechanism should be established for accomplishment? Should planning for an interstate transfer be integrated with planning for potential intrastate interbasin transfers?
5. Should further study be given to local water supply augmentation measures examined under Strategy Three such as desalting, direct use of brackish and saline waters, water harvesting, water banking, and other innovative approaches to augmentation of local water supplies for the region? By whom? What actions, if any, should the federal agencies and the states take to encourage augmentation of water supplies from local sources?
6. Although the High Plains Study preliminary results indicate that the overall regional irrigation economy could be maintained into the next century, projections of oil and gas reserves indicate that adverse declines would have occurred by that time unless significant new reserves are found. Depletion of the Ogallala by the end of the study period to 2020 would already have occurred in several intrastate subregions, with many other subregions going out of irrigation in the following decade or two. Experience with large-scale water diversions demonstrates that a long time period is needed for the necessary engineering, economic, financial, social and environmental planning and feasibility studies, and to achieve the political consensus required to move such projects to fruition. Is there a federal interest in making a participatory commitment now for that time frame in order to maintain the food and fiber production of the region? Assuming that federal interest, what federal-state mechanism could and should be established to provide continuity of leadership over such an extended time frame?
7. The present administration has emphasized reliance on the states as the responsible cornerstone for water resources planning and

management. It has effectively moved to abolish the Economic Development Act of 1965 Title V Regional Commissions, and the River Basin Commissions. In the case of the six-state High Plains region, action by an individual state could have little significant effect in implementing actions with regional consequences under any mix of alternative strategies. What would be the federal and state interests in:

- Continuation of a multi-state regional entity such as the High Plains Study Council as a planning and policy body?
 - A new federal-state-local institutional mechanism, a compact or commission for example, for multi-state resource planning, development and management for the High Plains region by itself, or in combination with upstream and downstream states in basins of origin for possible interstate transfers? Would such a mechanism, including states of origin, be of value in gaining support for both intrastate and interstate developments?
 - A federal approach to planning and development for the High Plains region on a regionalized systems basis, including basins of origin?
8. In view of the increasing in-basin demands for consumptive and instream uses, and possible out-of-basin needs, for example the High Plains region, and the competition among the states and with federal reserved and Indian water rights, for the waters of interstate stream systems, should the Congress establish an institution for continued investigations and planning to advise the Congress, states and others as to the proper allocation and reallocation of interstate waters among states, areas and uses?
 9. The gains resulting from any regional alternative approach, and in some cases even a subregional approach, to solution of water problems of the High Plains would not be distributed evenly among all those who might achieve some gain. What legal/institutional/financial mechanism(s) might be developed and implemented to achieve equitable distribution of costs and resultant obligation

for repayment? Creation of zones of benefit and variable pumping assessments have been used in similar instances elsewhere.

10. Non-agricultural economic development might alleviate to some extent the adverse impacts on the regional economy of a decline in irrigated agriculture and would have some positive actions for implementation. Should the states or local governments develop and carry out programs to stimulate non-agricultural development? Concentration of the labor force in a few centers might make the High Plains more attractive to industry. However, this would provide no relief for small farm towns where irrigated farming is declining. What tradeoffs are possible and acceptable?
11. Base flows in interstate and intrastate streams have been significantly reduced in the High Plains study area as pumping from the Ogallala has lowered ground water levels. Significant examples of this occur in the northern High Plains area in Nebraska and Kansas. This has had and will have increasing adverse impacts on availability of surface water for diversion for irrigation. This will result in increased costs and greater demands on the groundwater and the aquatic and riparian habitats. In the case of interstate streams, is there need for a mechanism for federal or state intervention or both, to prevent further reduction in base flows? Should the states take action and, if so, what?
12. As water levels in the Ogallala Aquifer continue to decline, and as surface application of pumped water is reduced because of economics, riparian wetland habitat will be increasingly impacted. The High Plains study area is a major flyway for migratory birds. Substantial federal law and policy have been established to protect water critical habitat. Is there a federal interest and appropriate role in intervening to minimize adverse impacts? Is there a state interest and appropriate role?

STUDY STATUS

The general contractor has completed a draft final report. It is now being printed and will be submitted to the High Plains Study Council about April 10, 1982. The next step is up to the council to prepare and submit its conclusions and recommendations to the Secretary of Commerce and the Congress.

The contract of the general contractor with the EDA under which the study has been conducted, terminated March 31, 1982. The council has requested an extension to September 30, 1982, in order to complete its work.

Sec. 193. In order to assure an adequate supply of food to the Nation and to promote the economic vitality of the High Plains Region, the Secretary of Commerce (hereinafter referred to in this section as the "Secretary"), acting through the Economic Development Administration in cooperation with the Secretary of the Army, acting through the Chief of Engineers, and appropriate Federal, State, and local agencies, and the private sector, is authorized and directed to study the depletion of the natural resources of those regions of the States of Colorado, Kansas, New Mexico, Oklahoma, Texas, and Nebraska presently utilizing the declining water resources of the Ogallala aquifer, and to develop plans to increase water supplies in the area and report thereon to Congress, together with any recommendations for further congressional action. In formulating these plans, the Secretary is directed to consider all past and ongoing studies, plans, and work on depleted water resources in the region, and to examine the feasibility of various alternatives to provide adequate water supplies in the area including, but not limited to, the transfer of water from adjacent areas, such portion to be conducted by the Chief of Engineers to assure the continued economic growth and vitality of the region. The Secretary shall report on the costs of reasonably available options, the benefits of various options, and the costs of inaction. If water transfer is found to be a part of a reasonable solution, the Secretary, as part of his study, shall include a recommended plan for allocating and distributing water in an equitable fashion, taking into account existing water rights and the needs for future growth of all affected areas. An interim report, with recommendations, shall be transmitted to the Congress no later than October 1, 1978, and a final report, with recommendations, shall be transmitted to Congress not later than July 1, 1980. A sum of \$6,000,000 is authorized to be appropriated for the purposes of carrying out this section.